2018 ANNUAL PERFORMANCE REPORT:

Model Criteria for Groundwater Monitoring in Areas of Oil and Gas Well Stimulation

Reporting Period: January 1, 2018 through December 31, 2018

STATE WATER RESOURCES CONTROL BOARD

April 5, 2019

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GLOSSARY

Axial Dimensional Stimulation Area (ADSA) - The estimated maximum length, width, height, and azimuth of the area(s) affected by a well stimulation treatment (WST) (State of California Department of Conservation, Division of Oil, Gas, and Geothermal Resources [DOGGR] Well Stimulation Treatment Regulations, July 1, 2015). 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 State Water Resources Control Board (State Water Board) staff has approved either a groundwater monitoring plan or request for exclusion from groundwater monitoring associated with the permitted well(s).

Exempted aquifer – As defined in 40 Code of Federal Regulations (CFR) part 146.4, an aquifer or a portion thereof which meets the criteria for an underground source of drinking water that

1) does not currently serve as a source of drinking water, and

2) it cannot now and will not in the future serve as a source of drinking water.

Refer to 40 CFR part 146.4 for regulation specifics.

Groundwater Monitoring – Monitoring of protected water in a specific area to characterize baseline water quality conditions and to assess potential effects to beneficial use waters from well stimulation treatment activities (i.e., monitoring well sampling and gauging of water levels).

Groundwater Monitoring Plan (GMP) – A groundwater monitoring plan submitted by the oil field operator to characterize baseline water quality conditions and detect potential impacts to protected water from well stimulation treatments ("area-specific"). A GMP may be developed for a stimulated well or group of stimulated wells. The GMP will describe the groundwater monitoring design, as well as proposed groundwater sampling and analytical testing that will be conducted. An operator may propose additional wells to stimulate in an area that has already been approved by State Water Board and Regional Water Quality Control Board (collectively Water Boards) staff for an area-specific GMP (GMP Addendum). Specific submittal requirements are detailed in the *Model Criteria for Groundwater Monitoring in Areas of Well Stimulation (Model Criteria)*.

Interim Groundwater Monitoring Plans (Interim GMPs) - GMPs approved during the interim period (January 1, 2014 - July 6, 2015) prior to the State Water Board adoption of the Model Criteria.

Model Criteria for Groundwater Monitoring in Areas of Oil and Gas Well Stimulation – Outlines the methods to be used for assessment, sampling, analytical testing, and reporting of water quality associated with oil and gas well stimulation treatments. Adopted by the State Water Board July 17, 2015.

Performance Measures – The product of collecting, analyzing, and/or reporting information regarding the performance of the Model Criteria. Five (5) goals were developed through a process of meetings with stakeholder groups. Performance measures are included in the *Model*

Criteria for Groundwater Monitoring in Areas of Well Stimulation: Summary of Goals, Strategies, Proposed Performance Measures, and Plans for Implementation (March 1, 2016).

Project Sites - Locations of area-specific GMPs or requests for exclusions from groundwater monitoring.

Protected Water - Water with less than 10,000 milligrams per liter (mg/L) of total dissolved solids and located outside an exempt aquifer (meeting the criteria of 40 CFR part 146).

Regional Groundwater Monitoring Program (RMP) – As required by Senate Bill 4 (Statutes of 2013), and detailed in the Model Criteria, the State Water Board is to implement an oil and gas RMP in order 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 RMP include well stimulation treatments, among other events or activities that have the potential to contaminate groundwater, such as an oil and gas well failure or breach. Fluids produced or introduced in the well stimulation process such as produced water ponds and Class II Underground Injection Control wells are included. The US Geological Survey is the technical lead on the RMP.

Request for Exclusion from Area-Specific Groundwater Monitoring (Request for Exclusion) – A document submitted by the oil field operator to request exclusion from groundwater monitoring before proceeding with well stimulation activities. Water Boards staff must provide a written concurrence to the operator for the exclusion from groundwater monitoring. Specific submission requirements are provided in the Model Criteria.

Well stimulation treatment (WST) – A treatment procedure for a well to enhance production by increasing the permeability of the formation. WSTs include, but are not limited to, hydraulic fracturing treatments and acid well stimulation treatments. WSTs do not include steam flooding, water flooding, cyclic steaming, or routine well work.

ABBREVIATIONS AND ACRONYMS

Annual Model Criteria Performance Report	2018 Annual Performance Report: Model Criteria for Groundwater Monitoring in Areas of Oil and Gas Well Stimulation
API	American Petroleum Institute
bbl	barrel(s) of oil
Central Valley Water Board	Central Valley Regional Water Quality Control Board
CIPA	California Independent Petroleum Association
COGG	United States Geological Survey California Oil, Gas, and Groundwater Program (synonymous with RMP)
DOGGR	State of California Department of Conservation, Division of Oil, Gas, and Geothermal Resources
ESI	Electronic Submittal of Information
GeoTracker	GeoTracker Information System (http://geotracker.waterboards.ca.gov/)
GeoTracker GAMA (GAMA GIS)	Groundwater Ambient Monitoring and Assessment Groundwater Information System (http://geotracker.waterboards.ca.gov/gama/gamamap/public/)
GMP	Area-specific groundwater monitoring plan
GMR	Area-specific groundwater monitoring report associated with GMPs
mg/L	milligrams per liter
MCL	maximum contaminant level
Model Criteria	Model Criteria for Groundwater Monitoring in Areas of Oil and Gas Well Stimulation
Notifications	DOGGR Well Stimulation Treatment Neighbor Notification Form
Operator	oil and gas field operator
RMP	Regional Monitoring Program (synonymous with COGG)
Regional Water Board	Regional Water Quality Control Board
Reporting period	January 1, 2018 - December 31, 2018
State Water Board	State Water Resources Control Board
TDS	total dissolved solids
USGS	United States Geological Survey

USDW	Federal designation of an underground source of drinking water
Water Boards	California State Water Resources Control Board and Regional Water Quality Control Board (collectively)
WSPA	Western States Petroleum Association

EXECUTIVE SUMMARY

This 2018 Annual Performance Report: Model Criteria for Groundwater Monitoring in Areas of Oil and Gas Well Stimulation fulfills the requirements identified in the *Model Criteria for Groundwater Monitoring in Areas of Well Stimulation: Summary of Goals, Strategies, Proposed Performance Measures, and Plans for Implementation* (Performance Measures). This report summarizes work performed from January 1, 2018 through December 31, 2018 by staff from the State Water Resources Control Board (State Water Board) and associated agencies to implement the *Model Criteria for Groundwater Monitoring in Areas of Oil and Gas Well Stimulation* (Model Criteria). The Model Criteria was adopted by the State Water Board on July 7, 2015 (Resolution No. 2015-0047).

The Model Criteria was developed to assess potential effects of well stimulation treatments (WSTs) on California's groundwater resources. It outlines groundwater monitoring requirements for area-specific groundwater monitoring conducted by oil and gas operators (operators), as well as the approach State Water Board staff will take to conduct a Regional Monitoring Program (RMP).

A WST cannot be performed until staff from the State of California Department of Conservation, Division of Oil, Gas, and Geothermal Resources (DOGGR) issues a WST permit and the State Water Board and the Regional Water Quality Control Board (Water Boards) staff have:

1) approved an operator-submitted groundwater monitoring plan (GMP), or GMP Addendum or
2) approved an operator-submitted request for exclusion from groundwater monitoring (Request for Exclusion).

Additionally, approval of a GMP or GMP addendum cannot occur until the Axial Dimensional Stimulation Area (ADSA) has been approved by DOGGR and reviewed by Water Boards staff.

The requirement for an area-specific GMP 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
- Water located outside of an exempt aquifer (meeting the criteria of 40 Code of Federal Regulations (CFR) part 146.4).

Efforts performed by Water Boards staff for the Model Criteria during the reporting period (January 1, 2018 to December 31, 2018) are presented in six sections of this report, as follows, 1) introduction and background of the Model Criteria, 2) area-specific groundwater monitoring, 3) property owner's requests for water quality testing, 4) RMP, 5) performance measures, and 6) lessons learned.

Area-Specific Groundwater Monitoring. Area-specific groundwater monitoring is required unless an operator has 1) clearly demonstrated that the wells to be stimulated do not penetrate

protected water and 2) submitted and received an approved Request for Exclusion. Operators must submit a GMP addendum or a Request for Exclusion in areas previously approved for groundwater monitoring.

In 2018, the number of GMPs (new and addenda), Requests for Exclusions, or added WST wells in an approved area submitted by the operators to Water Boards staff and their review status (i.e., approved, denied, or review in progress) are summarized in the table below.

Area-Specific Groundwater Monitoring Summary (January 1, 2018 – December 31, 2018)	**Approved**	**Denied**	**Review in Progress / On Hold**	**Total**	***No. of WST Wells***
GMPs (New)	3	1	4	8	*62*
GMP Addenda	11	0	5	16	*68*
Requests for Exclusions (New)	2	1	1	4	*4*
Requests to Add Wells to Previously Approved Areas of Exclusion	32	0	1	33	*97*

Property-Owner Notifications and 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. A property owner that has received a notification can access a list of designated contractors on the State Water Board website. Designated contractors are required to notify State Water Board staff prior to sampling and upload the results to GeoTracker after sampling. In 2018, the majority of the notifications were sent by third-party agents of Aera Energy, LLC (250 out of 546) and Berry Petroleum Company, LLC (160 out of 546), which corresponds to their activity at North Belridge, South Belridge, Buena Vista Nose, and Lost Hills Oil Fields. State Water Board staff were not notified of any property owner requests for water quality testing in 2018.

Regional Monitoring Program. The goal of the RMP is to evaluate potential impacts from WST and oil field operations and characterize the risk to subsurface water designated for any beneficial use (e.g., drinking water), while prioritizing the highest areas of risks to be monitored. In 2018, the United States Geological Survey (USGS) as technical lead of the RMP continued their salinity mapping work; performed airborne electromagnetic surveys; collected well depth, casing gas and produced water, and water chemistry data; and met with program stakeholders. The USGS refers to the work performed under the RMP as the California Oil, Gas, and Groundwater (COGG) Program.

Performance Measures. The State Water Board directed staff to collaborate with stakeholders to develop performance measures for evaluation of the Model Criteria. These performance measures were presented to the State Water Board on March 1, 2016 and included goals, strategies, and plans for implementing the Model Criteria. A summary of the five performance measures and actions completed during this reporting period is provided below.

Performance Measures	Water Boards Staff Actions During the Reporting Period
1. Provide transparent and availability of online information and documentation	• Developed, modified, and updated tools in GeoTracker to streamline staff review time, avoid errors, and concentrate staff workload to data evaluation during review. • Consolidated existing oil and gas data into GeoTracker • Completed periodic updates to the State Water Board's Oil and Gas Monitoring Program and the USGS COGG Program webpage. • Solicited feedback from the operators regarding their experience with GeoTracker and any suggestions to improve user experience. • Continued providing GeoTracker support to users via phone or email in order to ensure an accurate and complete public data set. • Shared data between Water Boards and DOGGR staff. • Water Boards and DOGGR staff participated in monthly conference calls to coordinate and share data related to WST permit applications.
2. Provide clear milestones and timely deliverables	• Initiated plans to complete the State Water Board requirements outlined in Water Code § 10783 (Milestone Schedule). • Prepared the 2018 Annual Model Criteria Performance Report. • Updated review processes and documented procedures including the Completeness Review Checklist and Groundwater Monitoring Report Review Checklist. • Continued to utilize process flowcharts for upload and review of area-specific GMPs and Requests for Exclusion. • Evaluated the Water Boards staff timeliness of review with respect to initial and total time spent reviewing GMPs, GMP Addenda, Requests for Exclusions, and additions of WST wells to previously approved exclusions. • Collaborated with DOGGR to provide cross training and held meetings to discuss WST permit comments and questions. • Enhanced program efficiencies by implementing a 14-day completeness check process for GMPs and conducted meetings with the operator to discuss concerns or comments with submittals of GMPs.
3. Understand and mitigate impacts of well stimulation on water quality and public health	• The USGS held semi-annual technical briefings during the January and June 2018 stakeholder meetings. • Performed analysis of preliminary data from the RMP and the area-specific monitoring. • Worked with the USGS, DOGGR, and other technical experts to gather more information regarding identified indicator compounds or tracer compounds. • Worked with operators to assess sampling and reporting of appropriate indicator compounds. • Conducted a survey to obtain operator feedback regarding the Model Criteria. • Began the planning process to re-evaluate the Model Criteria.
4. Provide region-specific or localized flexibility	The Model Criteria allows for alternative GMPs. One alternative GMP was submitted in 2018, however due to data gaps and uncertainties associated with the direction of groundwater flow, the operator revised the GMP to comply with the Model Criteria.

Performance Measures	Water Boards Staff Actions During the Reporting Period
5. Assess implementation costs	In 2018, operators spent approximately $1.1 million on implementing groundwater monitoring. During the same time period, operators spent approximately $46,000 on submittals for Requests for Exclusion from groundwater monitoring.

Lessons Learned and Planned Actions for 2019. Based on the efforts performed during the reporting period and lessons learned documented in this report, the following State Water Board actions are planned for 2019.

Planned State Water Board Staff Actions for 2019
Goal #1: Transparency and Availability of Online Information and Documentation • Update the GeoTracker mapping function to improve presentation of GMPs and Requests for Exclusion. • Continue updating the list of available chemical names in GeoTracker when new analytes are added. • Continue to ask operators for feedback and collaborate with DOGGR in 2019 to reduce duplication across respective web portals. • Discuss sharing of WST data between GeoTracker and DOGGRs Well State Tracking and Reporting (WellSTAR) as new phases are released. • Exchange data between State Water Board and the USGS using GeoTracker as the primary data collection system. • Continue to hold teleconferences between Water Boards and DOGGR staff to discuss comments and explore questions arising from reviews of WST permit applications.
Goal #2: Provide Clear Milestones and Timely Deliverables • State Water Board will hold a public Staff Workshop to review the definition of protected water as required by Water Code § 10783(k)(2) (scheduled for May 2019). • An update from DOGGR will be provided following review and evaluation for acid matrix threshold values. • Prepare the 2019 Annual Model Criteria Performance Report. • Continue to hold team meetings with DOGGR to discuss document processes and procedures for Model Criteria-related tasks. • Conduct periodic review and update of procedures, process flowcharts, and checklists based on lessons learned, to streamline reviews and avoid duplicative efforts between Water Boards and DOGGR staff. • Develop methods to track review status for GMPs, Request for Exclusions, and GMP Addendum reviews using existing tools in GeoTracker. This tool will allow the staff to routinely assess timeliness and improves upon the current process used for tracking. • Document key communications between State Water Board staff and operators and track action items to ensure they are resolved in a timely manner. • Continue to work with operators as efficiently as possible during the area-specific GMP review process and proactively communicate any concerns.
Goal #3: Understand and Mitigate the Impacts of Well Stimulation on Water Quality and Public Health • Continue to schedule semi-annual technical briefings with the stakeholders to present results from the RMP.

Planned State Water Board Staff Actions for 2019
• State Water Board and the USGS staff will provide operators with a summary of the scope and goals of the sampling program and the rationale for selected sampling points prior to RMP sampling efforts. • State Water Board staff will compile and evaluate responses from the operators regarding the implementation of the area-specific GMP and feedback for suggested modifications to the Model Criteria. • State Water Board and USGS staff will continue to evaluate monitoring data collected as part of both the RMP and area-specific monitoring programs. • Continue to work with the USGS and other state agencies to better understand which compounds used in WST fluids are the most appropriate tracer and/or indicator compounds. • Begin to re-evaluate the Model Criteria.
Goal #4: Provide Region-Specific or Localized Flexibility – Consider Alternative Plans as they are proposed.
Goal #5: Assess Implementation Costs - None planned.

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*[1] (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 January 1, 2018 through December 31, 2018 (reporting period) associated with the State Water Board's *Model Criteria for Groundwater Monitoring in Areas of Oil and Gas Well Stimulation*[2] (Model Criteria). Well stimulation permits are issued to operators by the State of California Department of Conservation, Division of Oil, Gas, and Geothermal Resources (DOGGR) and are required prior to performing well stimulation treatments (WSTs). 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 - "WST Permit Website" icon.

This report is organized into six sections. This section, Section 1.0, provides a description of the establishment of the Model Criteria and Performance Measures. Section 2.0 describes the process of the area-specific groundwater monitoring plan (GMP) and results for 2018. Section 3.0 summarizes the procedures and the number of the property owner notifications sent prior to performing WSTs in 2018. Section 4.0 describes the Regional Monitoring Program (RMP) activities to date, a summary of completed activities in 2018, preliminary results, and a listing of planned activities for 2019. Performance Measures, described in Section 5.0, provides strategies and actions taken in 2018 for each of the five performance goals. Lastly, Section 6.0 summarizes the efforts in this report as a list of lessons learned and planned actions for 2019.

1.1 Background

California Water Code section 10783 (Senate Bill 4, Pavley, statutes of 2013) requires the State Water Board to establish and implement a comprehensive regulatory groundwater monitoring and oversight program for WSTs (including hydraulic fracturing) in areas of oil and gas operations. The State Water Board was also required to develop model criteria for groundwater monitoring in order to assess potential effects of WSTs 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 GMP conducted by operators, as well as the approach the State Water Board will take to conduct the RMP.

Upon the passage of Senate Bill 4, the State Water Board and DOGGR developed Emergency Interim Regulations[3] which included interim groundwater monitoring requirements. Effective January 1, 2014 through June 30, 2015, well operators were required to submit either an approved groundwater monitoring plan (Interim GMP) or a letter from State Water Board staff concurring that the well(s) planned for WST does not penetrate protected water. If WSTs were

[1] https://www.waterboards.ca.gov/water_issues/programs/groundwater/sb4/performance_measures/index.shtml
[2] https://www.waterboards.ca.gov/water_issues/programs/groundwater/sb4/well_stimulation/index.shtml
[3] http://www.conservation.ca.gov/dog/Pages/WSTInterimProgram.aspx

planned after adoption of the Model Criteria, the operator was required to submit a new GMP following the requirements of the Model Criteria. If no additional WSTs were planned in an area with an approved Interim GMP, the operator was allowed to continue monitoring under the Interim GMP. Therefore, there are several Interim and Model Criteria GMPs active during this reporting period. Data from both Interim and Model Criteria GMPs are uploaded to the publicly-accessible State Water Board's GeoTracker information system (GeoTracker).

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

Five performance measures were identified, as provided below:

1. Provide transparent and availability of online information and documentation,
2. Provide clear milestones and timely deliverables,
3. Understand and mitigate impacts of well stimulation on water quality and public health,
4. Provide region-specific or localized flexibility, where possible, and
5. Assess implementation costs.

More information regarding the status of these Performance Measure goals is provided in Section 5.0 of this report.

2.0 AREA-SPECIFIC GROUNDWATER MONITORING

This section provides a summary of the area-specific GMPs submitted by operators to the State Water Board and Regional Water Quality Control Boards (collectively Water Boards) staff during the reporting period. All GMPs submitted during the reporting period were within the jurisdiction of the Central Valley Regional Water Quality Control Board (Central Valley Water Board).

A WST cannot be performed until DOGGR issues the WST permit and Water Boards staff have:

- approved an operator-submitted GMP or GMP addenda, or
- approved an operator-submitted request for exclusion from groundwater monitoring (Request for Exclusion).

The requirement for area-specific GMP 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 40 Code of Federal Regulations (CFR) part 146.4).

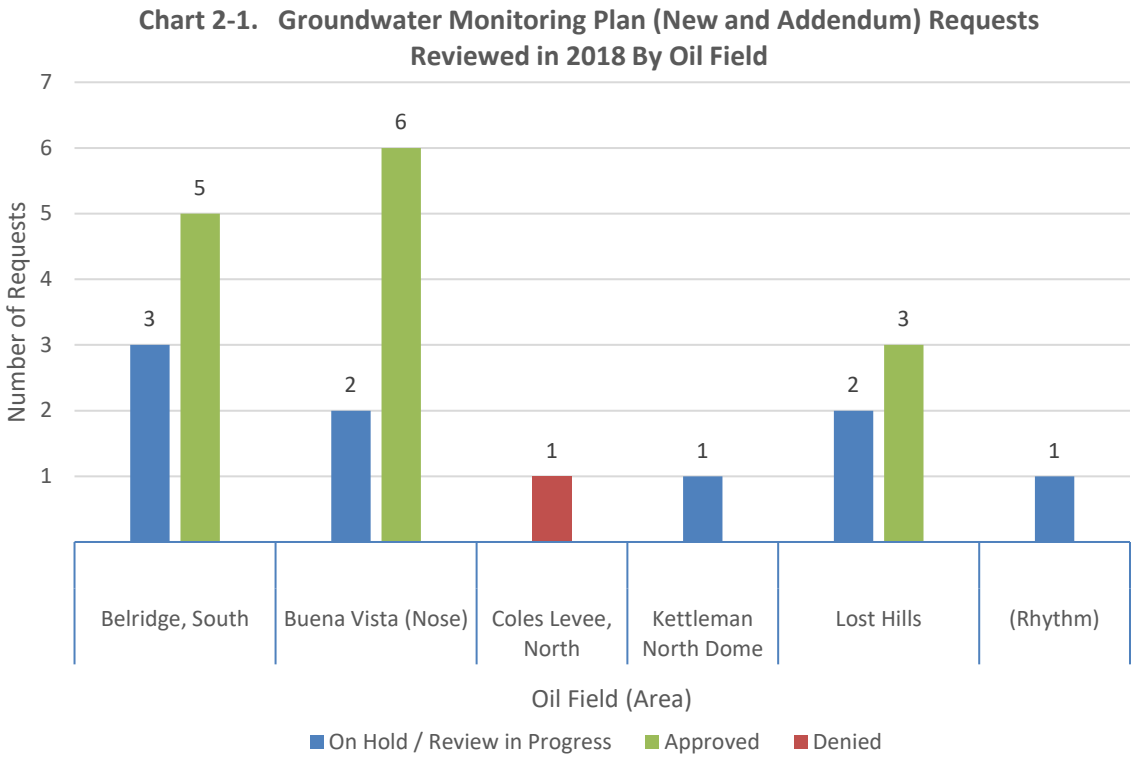
Process flowcharts can be found in Appendix A.

2.1 Requests for Groundwater Monitoring

This section provides a summary of the number, status, and location of GMP requests (new GMPs and GMP addenda) submitted in 2018 and the Water Boards review process and timeline. A GMP addendum is required if the operator proposes WST at additional wells in an area of a previously approved GMP. This section also provides the number, status, and location of requests to add WST wells for GMP addenda in 2018.

2.1.1 Summary of Groundwater Monitoring Plans Submitted for Review

During the reporting period, a total of 24 proposed new GMPs or GMP addenda were submitted by operators for Water Boards staff review. Twenty-three GMPs are for oil fields located in Kern County (South Belridge, Buena Vista Nose, North Coles Leve, Lost Hills, and Rhythm) and one GMP is for an oil field area located in Kings County (Kettleman North Dome) as highlighted in Chart 2-1.



Of the 24 GMPs submitted in 2018, 14 were approved, one (North Coles Levee) was denied because it did not meet the Model Criteria requirements, and nine are still in review or on hold during the reporting period (Chart 2-1). Table 2-1 summarizes the status of GMPs reviewed in 2018.

There were 130 WST wells included in GMPs approved during 2018. The location and status of wells stimulated in 2018 are shown on Figure 2-1.

Note: The locations of stimulated wells shown on Figure 2-1 and Figure 2-2 were obtained from the DOGGR WST Disclosure webpage[4]. This webpage populates data from the WST Disclosure Form that is uploaded by the operator after a WST has been completed. Data available on this website may not reflect all the wells stimulated in 2018. The stimulated wells shown on figures in this report reflect data that was last uploaded as of March 1, 2019.

GMPs listed in figures, charts, and tables of this report are specified as “Approved”, “Denied”, “Review in Progress” or “On Hold”. “Approved” indicates that the submittal was reviewed and has met the requirements of the Model Criteria. “Denied” indicates that the submittal did not meet the minimum requirements of the Model Criteria. “Review in Progress” indicates that the submittal is still being reviewed by Water Boards staff. “On Hold” indicates that Water Boards staff are not currently reviewing the submittal. Please note that submittals may be put “On Hold”

[4] http://www.conservation.ca.gov/dog/Pages/WSTDisclosureSearchDisclaimer.aspx

for a variety of reasons, for instance: Water Boards staff may have already forwarded comments to the operator and the operator is working on a revised submittal; Water Boards staff may be waiting on approval of the Axial Dimensional Stimulation Area (ADSA) from DOGGR; or the GMP may have been put on hold at the request of the operator. Submittals that are “On Hold” are not included in the calculation of total time spent by Water Boards staff.

Table 2-1. Groundwater Monitoring Plans Reviewed
(January 1, 2018 - December 31, 2018)

GeoTracker Global Identification	Oil Field or (Area)	Township (T), Range (R), Section (S)[1]	Operator	GMP Date Accepted	New or Addendum GMP	Days for Initial Response	Interim Review Actions (GeoTracker Submittal Date(s))	Status/ Determination[2]	Number of WST Wells Approved	Status/ Determination Date	Days to Complete Process[3]	Comments
GAOG10009277	Belridge, South	T28S, R20E, S12, S13, S18	Aera Energy, LLC	1/16/2018	Addendum	22	--	Approved	7	2/7/2018	22	
				2/28/2018	Addendum	6	Operator submitted revised Addendum (3/21/2018)	Approved	15	4/3/2018	19	Comments sent to operator on 3/6/2018. Operator submitted revised Addendum 3/21/2018. Issued approval letter 4/3/2018.
				3/22/2018	Addendum	29	Operator submitted revised Addendum (5/3/2018)	Approved	4	5/16/2018	42	Comments sent to Operator on 4/20/2018. Operator submitted revised Addendum 5/3/2018. Issued approval letter 5/16/2018.
				7/17/2018	Addendum	80	Operator submitted revised Addendum (10/25/2018)	Approved	5	11/16/2018	97	Comments sent to operator on 10/5/2018. Staff participated in teleconference with operator on 10/10/2018 to discuss comments. Operator submitted revised Addendum 10/25/2018. Issued approval letter 11/16/2018.
GAOG10011328		T28S, R21E, S19	Berry Petroleum Company, Inc	2/21/2018	New	58	Operator submitted revised GMP (6/13/2018)	Approved	40	7/12/2018	82	Denial letter sent to operator on 4/20/2018. The GMP was denied due to uncertainties related to the extent of protected water. Staff met with operator on 4/26/2018 and 6/4/2018 to discuss comments. Operator provided responses to comments on 5/16/2018 and submitted revised GMP on 6/13/2018. Received DOGGR's approval of ADSAs on 6/28/2018. Issued approval letter on 7/12/2018.
				12/14/2018	Addendum	60	Operator submitted revised Addendum (2/18/2019)	Review in Progress	--	--	--	Permit Group 6. Comments sent to operator on 2/12/2019. Operator submitted revised Addendum 2/18/2019. The revised Addendum dated 2/18/2019 is now being reviewed.
				12/17/2018	Addendum	50	Operator submitted revised Addendum (2/27/2019)	Review in Progress	--	--	--	Permit Group 5. Comments sent to operator on 2/5/2019. Operator submitted revised Addendum 2/27/2019. The revised Addendum dated 2/27/2019 is currently being reviewed.
				12/14/2018	Addendum	60	--	On Hold	--	--	--	Permit Group 7. Comments sent to operator on 2/12/2019. GMP Addendum is currently being revised by the operator.
GAOG10009209	Buena Vista (Nose)	T32S, R25E, S3-11, 14-17 & T31S, R25E, S31	California Resources Corporation	11/3/2017	Addendum	62	--	Approved	3	1/4/2018	62	Addendum 1. Issued approval letter on 1/4/2018. Approval was given conditional upon operator's further refinement of the hydrogeologic conceptual model to address uncertainties related to the direction of groundwater flow.
				1/8/2018	Addendum	30	--	Approved	2	2/7/2018	30	Addendum 2. Issued conditional approval letter on 2/7/2018. Approval was given conditional upon operator's installation of an additional shallow downgradient monitoring well.

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GeoTracker Global Identification	Oil Field or (Area)	Township (T), Range (R), Section (S)[1]	Operator	GMP Date Accepted	New or Addendum GMP	Days for Initial Response	Interim Review Actions (GeoTracker Submittal Date(s))	Status/ Determination[2]	Number of WST Wells Approved	Status/ Determination Date	Days to Complete Process3	Comments
GAOG10009209	Buena Vista (Nose)	T32S, R25E, S3-11, 14-17 & T31S, R25E, S31	California Resources Corporation	1/10/2018	Addendum	83	--	Approved	2	4/3/2018	83	Addendum 3. Staff held meeting with operator on 1/31/2018 to discuss initial comments. Comments were related to transitioning from deep to intermediate monitoring. Issued conditional approval letter on 4/3/2018. Approval was given conditional upon operator's development of plans to expand the monitoring well network in the intermediate zone.
				2/21/2018	Addendum	72	--	Approved	3	5/4/2018	72	Addendum 4. Staff met with operator on 4/19/2018 to discuss the workplan for intermediate zone monitoring wells. Issued conditional approval letter on 5/4/2018. Approval was given conditional upon operator's installation of intermediate zone monitoring wells.
				5/29/2018	Addendum	35	Operator submitted revised Addendum (7/11/2018)	Approved	5	7/25/2018	49	Addendum 5. Comments sent to operator on 7/3/2018. Operator submitted revised Addendum on 7/11/2018. Issued conditional approval letter on 7/25/2018. Approval was given conditional upon operator's installation of intermediate zone monitoring wells.
				7/24/2018	Addendum	31	Operator submitted revised Addendum (8/29/2018)	Approved	8	11/9/2018	108	Addendum 6. Comments sent to operator on 8/24/2018. Operator submitted revised Addendum 6 on 8/29/2018. Received DOGGR's approval of ADSAs on 10/30/2018. Issued conditional approval letter on 11/9/2018. Approval was given conditional upon operator's installation of intermediate monitoring wells.
		T32S, R25E, S13-16 & T31S, R25E, S22-24		9/13/2018	New	56	--	On Hold	--	--	--	Southeast expansion of the existing Buena Vista Nose GMP. Staff met with operator on 10/15/2018, to discuss comments. Comments sent to operator on 11/8/2018. GMP is currently being revised by the operator.
		T32S, R25E, S3-11, 14-17 & T31S, R25E, S31		10/22/2018	Addendum	86	--	On Hold	--	--	--	Addendum 7. Water Boards staff met with operator on 12/18/2018 to discuss initial comments on the GMP Addendum. Comments were related to uncertainties associated with the direction of groundwater flow. Comments sent to operator on 1/16/2019. GMP Addendum is currently being revised by the operator.
GAOG10011004	Coles Levee, North	T30S, R25E, S28	California Resources Corporation	10/3/2017	New	146	--	Denied	--	2/26/2018	146	The GMP was denied because it did not meet many of the Model Criteria requirements, namely, inadequate monitoring network and lack of sentry wells to protect existing drinking water supply wells.
GAOG10011823	Kettleman North Dome	T22S, R17E, S11 (Kings County)	California Resources Corporation	7/23/2018	New	85	Operator submitted revised GMP (2/6/2019)	On Hold	--	--	--	Comments sent to operator on 10/16/2018. Staff met with operator on 10/15/2018, 12/18/2018, and 2/4/2019 to discuss comments on this GMP. Revised GMP submitted by operator on 2/6/19. DOGGR's approval of ADSA's has not yet been received as of 3/1/19.
GAOG10010391	Lost Hills	T26S, R21E, S29, S32, S33 & T27S, R21E, S4, S5	Chevron USA, Inc	4/26/2018	New	50	Operator submitted revised GMP (7/17/2018)	Approved	18	8/10/2018	74	Comments sent to operator on 6/15/2018. Staff held teleconference with operator on 7/3/2018 to discuss comments. Operator submitted revised GMP on 7/17/2018. Issued approval letter on 8/10/2018.

… continued on next page

GeoTracker Global Identification	Oil Field or (Area)	Township (T), Range (R), Section (S)[1]	Operator	GMP Date Accepted	New or Addendum GMP	Days for Initial Response	Interim Review Actions (GeoTracker Submittal Date(s))	Status/ Determination[2]	Number of WST Wells Approved	Status/ Determination Date	Days to Complete Process3	Comments
GAOG10010391	Lost Hills	T26S, R21E, S29, S32, S33 & T27S, R21E, S4, S5	Chevron USA, Inc	9/13/2018	Addendum	50	Operator submitted revised Addendum (12/15/2018)	On Hold	--	--	--	Comments sent to operator on 11/2/2018. Operator submitted revised Addendum on 12/15/2018. Project put "On Hold", pending DOGGR's approval of the ADSAs. On 1/24/2019, operator informed staff that a revised Addendum with 25 wells would be submitted.
GAOG10009406	Lost Hills	T27S, R21E, S4, S5	Aera Energy, LLC	9/23/2016	New	103	Operator submitted revised GMPs (2/21/2018, 4/25/2018, and 5/9/2018)	Approved	4	5/14/2018	145	GMP originally submitted in 2016 and put on hold from late 2016 to late 2017. Denial letter sent to operator on 10/23/2017 due to insufficient monitoring well network for proposed WST wells. Staff met with operator on 11/15/2017. Worked with operator on monitoring well installation work plan from 1/12/2018 to 2/14/2018. Comments sent to operator on 2/7/2018 regarding the monitoring well work plan. Operator submitted revised GMP on 2/21/2018. Additional Comments sent on 3/26/2018 and 5/9/2018. Operator submitted revised GMPs on 3/28/2018 and 5/9/2018. Issued approval letter on 5/14/2018.
GAOG10009406	Lost Hills	T27S, R21E, S4, S5	Aera Energy, LLC	8/20/2018	Addendum	46	Operator responded to comments (10/22/2018)	Approved	14	11/16/2018	71	Comments sent to operator on 10/5/2018. Water Boards staff held teleconference with operator on 10/10/2018 to discuss comments. Additional information received from operator on 10/22/2018, 10/24/2018, and 11/14/2018. Issued approval letter on 11/16/2018.
GAOG10011556	Lost Hills	T25S, R20E, S11	California Resources Corporation	4/19/2018	New	92	Operator revised GMP (9/12/2018, 1/30/2019)	Review in Progress	--	--	--	GMP initially submitted by operator with alternative methods proposed for area-specific GMP. Comments sent to operator on 7/20/2018 and 12/3/2018. Comments were related to the operator's proposal for an alternative plan as well as the operators proposed methods for monitoring well construction. Operator submitted revised GMPs on 9/12/2018 and 1/30/208 to address comments. The revised GMP dated 1/30/2019 is currently being reviewed.
GAOG10011753	(Rhythm)	T27S, R25E, S8, S9, S16, S17	California Resources Corporation	6/21/2018	New	47	Operator submitted revised GMP (8/16/2018)	On Hold	--	--	--	Comments sent to operator on 8/7/2018. Operator submitted revised GMP on 8/16/2018. Additional comments sent to operator on 10/8/2018. Staff held meeting with operator on 10/15/2018 to discuss comments. GMP is currently being revised by the operator.

	Approved	*No. of WST Wells*
GMPs (New)	3	*62*
GMP Addenda	11	*68*
Totals	**14**	**130**

Notes and Acronyms:
-- = not applicable
ADSA = Axial Dimension Stimulation Area
DOGGR = Division of Oil, Gas, and Geothermal Resources – Department of Conservation
GMP = Groundwater Monitoring Plan

1. Located in Kern County, unless otherwise noted.
2. On Hold indicates that Water Board staff are waiting on additional information from the operator or the approved ADSA from DOGGR. Denied indicates that the GMP did not meet the minimum requirements in the Model Criteria.
3. Days to complete the process equates to the elapsed time between the "GMP Date Accepted" to "Status/Determination Date". For GMPs (new and addenda) with multiple revisions, days to complete the process equates to the sum of days to review the original submittal and the days to review each of the revisions. This time includes communications with the operator, Regional Water Board staff, and DOGGR, review of data and the submittal, and preparation and review of agency correspondence. Refer to **Flowchart A-1 - Process Flowchart for Uploading and Reviewing Area-Specific GMPs (New or Addendum) in Appendix A** for the detailed flowchart of the GMP review process.

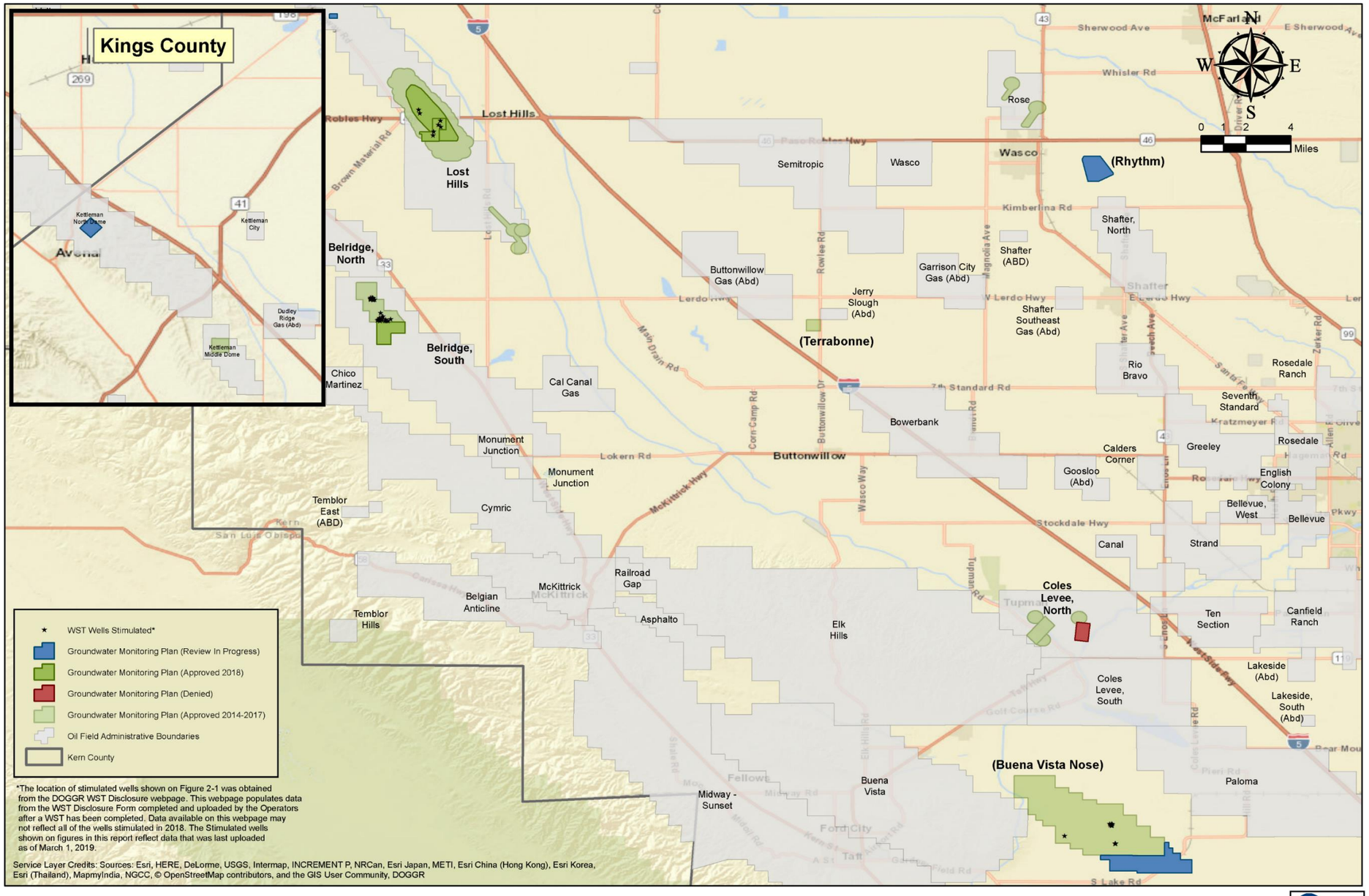


Figure 2-1. Groundwater Monitoring Plans and Wells Stimulated (January 1, 2018 - December 31, 2018)

State Water Board, March 2019

Figure 2- 1 Groundwater Monitoring Plans and Wells for Stimulated Treatment Submitted (January 1, 2018 - December 31, 2018)

2.1.2 Process and Timeline for Reviewing Groundwater Monitoring Plans

The process flowchart for review of GMPs is shown on Figure A-1 in Appendix A. The Water Boards staff review begins after a GMP or GMP addendum has been uploaded to GeoTracker and has been accepted by Water Boards staff as complete. Water Boards' staff intend to respond to the operator with initial review comments within 45 calendar days from acceptance of the submittal. After review by Water Boards staff, additional information may be requested, the GMP may be denied, or the GMP may be approved. If a GMP is denied and the Operator chooses to pursue WST at that location, they are required to submit a revised GMP addressing Water Boards staff comments to GeoTracker. The ADSA must be approved by DOGGR and reviewed by Water Boards staff before a GMP or GMP addendum can be approved.

In 2018, the average time for Water Boards staff to respond to the operator with initial review comments was 49 days for a GMP addendum and 65 days for a new GMP. Average response times were not estimated prior to 2018.

In 2018, the average time for Water Boards staff to complete the entire review process (including review of multiple iterations and requests for additional information from the operator) was 112 days for a new GMP and 60 days for a GMP addendum (Table 2-1 and Table 2-1a). In 2017, reviews took an average of 78 days for new GMPs and 48 days for GMP addenda. The average time to complete the entire review process for GMPs/GMP Addenda in 2018 increased from 2017.

Table 2-1a GMP and GMP Addendum Summary	**Total GMP and GMP Addenda**	***No. of WST Wells***	***New GMP (Average Days)***	***GMP Addendum (Average Days)***
2017	12	*130*	*78*	*48*
2018	24	*210*	*112*	*60*

The review process for GMPs and GMP addenda increased due to several factors. Many of the new GMPs required multiple iterations of the document, meetings with operators, and discussions on the number and locations of wells before approval. In addition, several new GMPs were in areas where 1) there was little to no hydrogeologic information, 2) there were complex hydrogeologic conditions in folded strata, and 3) additional efforts to investigate and collect hydrogeologic information was required. Several GMPs have included either alternative proposed monitoring well networks or non-standard monitoring well construction methodologies proposed for future monitoring wells and soil borings. Finally, the workload for Water Boards staff has increased by 62 percent since 2017. In 2018, 24 GMPs and GMP addenda consisting of 210 wells were reviewed; in 2017, 12 GMPs and GMP addenda consisting of 130 wells were reviewed (Table 2-1a).

2.2 Groundwater Monitoring Plans Submitted that Propose Alternative Methods

The Model Criteria allows Water Boards staff to consider proposed alternatives and modifications to the methods for area-specific GMPs 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). Water Boards staff 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 staff received one request to consider an alternative method during the reporting period. The operator had proposed installing fewer monitoring wells than that required by the Model Criteria. Water Boards staff reviewed the alternative to ensure it would not impair their ability to assess the potential effects of WSTs as required by Water Code § 10783. Water Boards staff found data gaps and uncertainties associated with the direction of groundwater flow in this location. Due to these concerns, the operator subsequently revised the GMP to include three monitoring wells which now meets the Model Criteria requirements.

2.3 Requests for Exclusion from Groundwater Monitoring

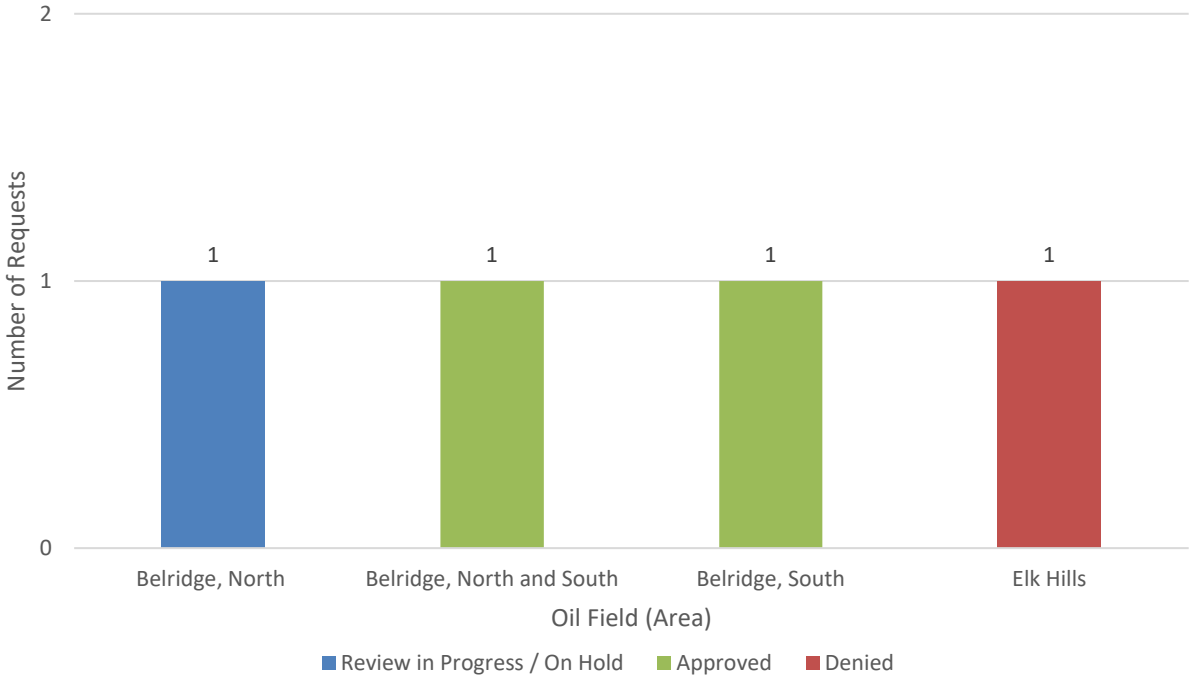
An area-specific GMP is required unless an operator can clearly demonstrate that the wells to be stimulated do not penetrate protected water. If Water Boards staff concur, an exclusion from groundwater monitoring requirements may be granted to the operator. Operators must also obtain approval from Water Boards staff for additional WST wells to be stimulated in areas where an exclusion from groundwater monitoring was previously granted.

This section provides a summary of the 2018 Requests for Exclusion (i.e., number, status, and location) submitted to Water Boards staff and the process and timeline involved in reviewing a Request for Exclusion. This section also summarizes the number of WST wells added to previously approved areas of exclusion during the reporting period.

2.3.1 Summary of Requests for Exclusion from Groundwater Monitoring Submitted for Review

Four new Requests for Exclusion from groundwater monitoring were submitted to Water Boards staff during the reporting period. These Requests for Exclusion are publicly available in GeoTracker. In 2018, the Requests for Exclusion were made in three oil fields, as highlighted in Chart 2-2.

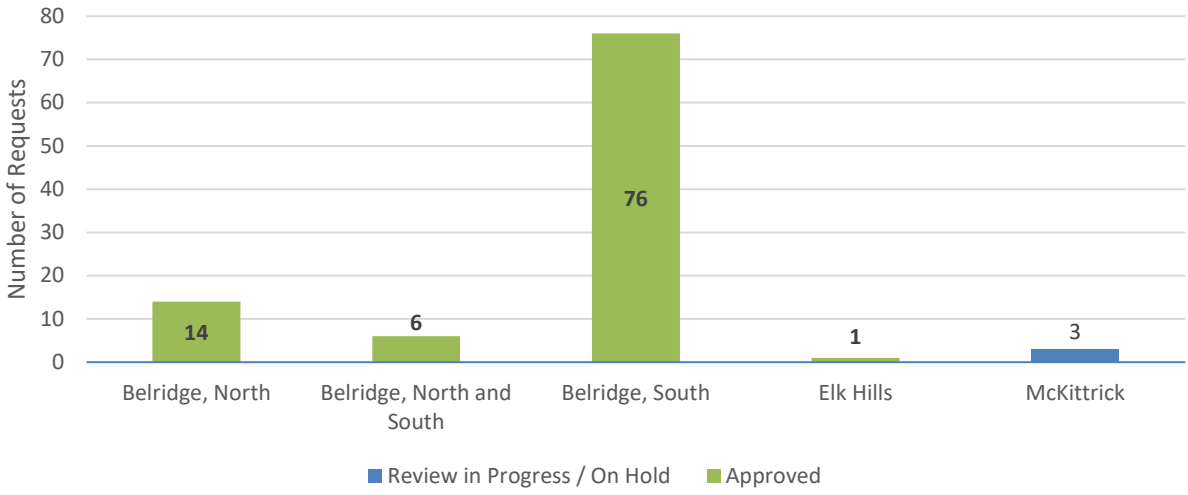
Chart 2-2. Requests for Exclusion from Groundwater Monitoring Reviewed in 2018 by Oil Field



One of the four Requests for Exclusion is on hold because it is currently being revised by the operator; two Requests for Exclusion were approved, and one Request for Exclusion was denied because it did not meet the Model Criteria requirements. Detailed information about the status of Requests for Exclusion submitted during the reporting period is provided in Table 2-2.

Operators submit information for additional wells to be stimulated in areas that have previously been granted an exclusion from groundwater monitoring. In 2018, ninety-seven (97) wells proposed for WST were verified by Water Boards staff to be in previously approved exclusion areas and three wells are currently still under review (Table 2-3).

Chart 2-3. Requests to Add Wells for WST to Existing Exclusions Reviewed in 2018 by Oil Field



Most of the requests to stimulate additional wells were for the South Belridge Oil Field (Chart 2 -3). Detailed information about the status of these wells is provided in Table 2-3. Locations of wells stimulated in 2018 are shown on Figure 2-2.

Table 2-2. Requests for Exclusion Reviewed (January 1, 2018 - December 31, 2018)

GeoTracker Global Identification	Oil Field	Township (T), Range (R), Section (S)	County	Operator	Request for Exclusion Accepted Date	Days for Initial Response	Interim Review Actions (GeoTracker Submittal Date(s))	Status/ Determination	Status/ Determination Date	Number of WST Wells	Days to Complete Review Process[1]	Comments
GAOG10012394	Belridge, North	T27S, R20E, S27	Kern	Aera Energy, LLC	12/12/2018	51		On Hold	--	1	--	Comments sent to operator on 2/1/2019. Request for Exclusion is currently being revised by the operator.
GAOG10010818	Belridge, North and South	T28S, R20E, S1, S12	Kern	Breitburn Operating LP	3/23/2018	28	Operator submitted revised Request for Exclusion (7/3/2018 and 8/7/2018)	Approved	8/28/2018	0	84	Staff denied operator's Request for Exclusion on 4/20/2018 because there was insufficient data to confirm the absence of protected water. Operator collected additional data and reported the results in a groundwater monitoring report dated 6/22/2018. Issued approval letter on 8/28/2018.
GAOG10012000	Belridge, South	T38S, R21E, S30	Kern	Aera Energy, LLC	8/22/2018	44	Operator submitted revised Request for Exclusion (1/25/2019)	Approved	2/13/2019	2	63	Comments sent to operator on 10/5/2018. Staff held meeting with operator on 10/10/2018 to discuss comments. Operator submitted revised Request for Exclusion on 1/25/2018. Issued approval letter on 2/13/2019.
GAOG10011793	Elk Hills	T30S, R23E, S14, 15, 16, 17, 20, 21, and 23	Kern	California Resources Corporation	7/11/2018	78		Denied	11/2/2018	1	114	Comments sent to operator on 9/27/2018. Staff held meeting with operator on 10/15/2018 to discuss comments. Staff commented that there was insufficient evidence to confirm the absence of protected water in the Upper Tulare. Issued denial letter on for this Request for Exclusion on 11/2/2018. Operator has since prepared a separate Request for Exclusion of a smaller area.

Notes and Acronyms:
-- = not applicable
WST = well stimulation treatment

4	Total Number of Reviews of Requests for Exclusion in 2018

1. Days to complete the process equates to the elapsed time between the "Request for Exclusion Accepted Date" to "Status/Determination Date". For Requests for Exclusions with multiple revisions, days to complete the process equates to the sum of days to review the original submittal and the days to review each of the revisions. This time includes communications with the operator, Regional Water Board staff, and DOGGR, review of data and the submittal, and preparation and review of agency correspondence. Refer to **Flowchart A-2. Process Flowchart for Reviewing Requests for Exclusion from Groundwater Monitoring in Appendix A** for the detailed flowchart of the Exclusions from Groundwater Monitoring review process.

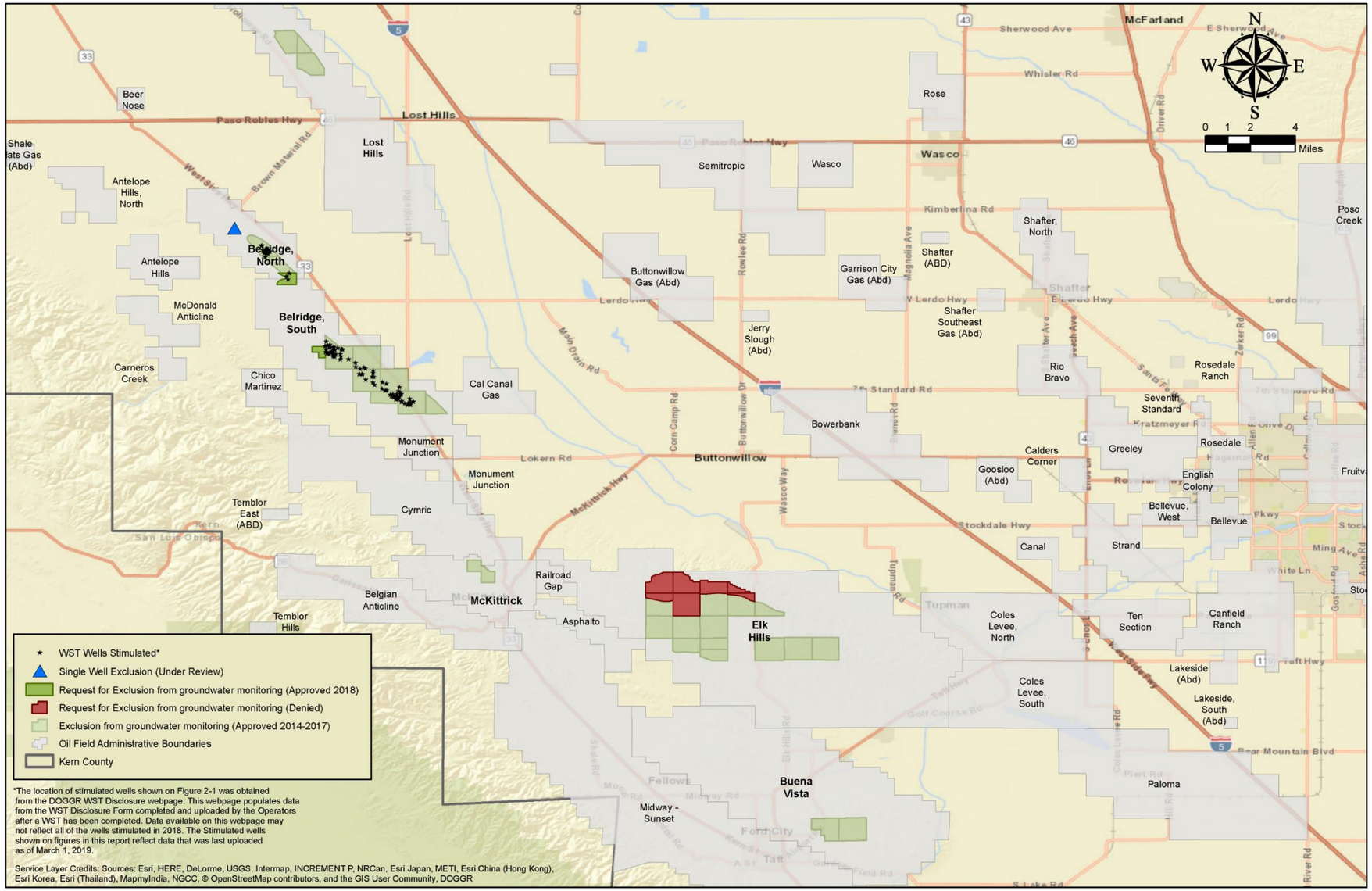


Figure 2-2. Requests for Exclusion from Groundwater Monitoring and Wells Stimulated (January 1, 2018 - December 31, 2018)

State Water Board, March 2019

Figure 2- 2 Requests for Exclusion from Groundwater Monitoring and Wells for Stimulated Treatment Submitted (January 1, 2018 - December 31, 2018)

Table 2-3. Requests to Add WST Wells to Existing Approved Areas of Exclusion (January 1, 2018 - December 31, 2018)

GeoTracker Global Identification	Oil Field	Township (T), Range (R), Section (S)	County	Operator	Date Accepted Request of Additional WST Wells	Days for Initial Response	Status/ Determination	Number of WST Wells added to Approved Exclusion	Status/ Determination Date	Days to Complete Review Process1
GAOG10011108	Belridge, North	T27S, R20E, S35	Kern	Aera Energy, LLC	12/28/2017	13	Approved	3	1/10/2018	13
GAOG10011108	Belridge, North	T27S, R20E, S35	Kern	Aera Energy, LLC	5/31/2018	11	Approved	10	6/11/2018	11
GAOG10011109	Belridge, North	T27S, R20E, S36	Kern	Aera Energy, LLC	12/28/2017	14	Approved	1	1/11/2018	14
GAOG10010818	Belridge, North and South	T28S, R20E, S1, S12	Kern	Breitburn Operating LP	9/17/2018	9	Approved	6	11/15/2018	32
GAOG10009503	Belridge, South	T28S, R21E, S29	Kern	Aera Energy, LLC	1/2/2018	9	Approved	4	1/11/2018	9
GAOG10009503	Belridge, South	T28S, R21E, S29	Kern	Aera Energy, LLC	3/21/2018	1	Approved	2	3/22/2018	1
GAOG10009503	Belridge, South	T28S, R21E, S29	Kern	Aera Energy, LLC	6/14/2018	7	Approved	5	6/21/2018	7
GAOG10009503	Belridge, South	T28S, R21E, S29	Kern	Aera Energy, LLC	7/5/2018	6	Approved	2	7/11/2018	6
GAOG10009503	Belridge, South	T28S, R21E, S29	Kern	Aera Energy, LLC	8/15/2018	20	Approved	1	9/4/2018	20
GAOG10009503	Belridge, South	T28S, R21E, S29	Kern	Aera Energy, LLC	9/20/2018	8	Approved	2	9/28/2018	8
GAOG10009503	Belridge, South	T28S, R21E, S29	Kern	Aera Energy, LLC	12/11/2018	8	Approved	4	12/19/2018	8
GAOG10008913	Belridge, South	T28S, R21E, S28	Kern	Aera Energy, LLC	6/6/2018	12	Approved	1	6/18/2018	12
GAOG10008913	Belridge, South	T28S, R21E, S28	Kern	Aera Energy, LLC	6/13/2018	15	Approved	2	6/28/2018	15
GAOG10008913	Belridge, South	T28S, R21E, S28	Kern	Aera Energy, LLC	8/15/2018	6	Approved	1	8/21/2018	6
GAOG10009914	Belridge, South	T28S, R21E, S28	Kern	Aera Energy, LLC	6/13/2018	15	Approved	2	6/28/2018	15
GAOG10009592	Belridge, South	T28S, R21E, S28	Kern	Aera Energy, LLC	3/1/2018	5	Approved	7	3/6/2018	5
GAOG10008892	Belridge, South	T28S, R21E, S33	Kern	Aera Energy, LLC	6/14/2018	7	Approved	2	6/21/2018	7
GAOG10008892	Belridge, South	T28S, R21E, S33	Kern	Aera Energy, LLC	8/14/2018	3	Approved	3	8/17/2018	3
GAOG10008892	Belridge, South	T28S, R21E, S33	Kern	Aera Energy, LLC	9/19/2018	8	Approved	4	9/27/2018	8
GAOG10008892	Belridge, South	T28S, R21E, S33	Kern	Aera Energy, LLC	9/19/2018	8	Approved	1	9/27/2018	8
GAOG10008892	Belridge, South	T28S, R21E, S33	Kern	Aera Energy, LLC	10/19/2018	10	Approved	1	10/29/2018	10
GAOG10008892	Belridge, South	T28S, R21E, S33	Kern	Aera Energy, LLC	12/27/2018	8	Approved	7	1/4/2019	8
GAOG10008915	Belridge, South	T28S, R21E, S34	Kern	Aera Energy, LLC	3/1/2018	5	Approved	1	3/6/2018	5
GAOG10008915	Belridge, South	T28S, R21E, S34	Kern	Aera Energy, LLC	6/11/2018	7	Approved	1	6/18/2018	7
GAOG10008915	Belridge, South	T28S, R21E, S34	Kern	Aera Energy, LLC	6/14/2018	13	Approved	3	6/27/2018	13
GAOG10008915	Belridge, South	T28S, R21E, S34	Kern	Aera Energy, LLC	8/15/2018	2	Approved	1	8/17/2018	2
GAOG10008915	Belridge, South	T28S, R21E, S34	Kern	Aera Energy, LLC	9/20/2018	8	Approved	1	9/28/2018	8
GAOG10008915	Belridge, South	T28S, R21E, S34	Kern	Aera Energy, LLC	12/21/2018	17	Approved	2	1/7/2019	17
GAOG10010731	Belridge, South	T29S, R21E, S2	Kern	Aera Energy, LLC	12/15/2017	49	Approved	9	2/2/2018	49
GAOG10010731	Belridge, South	T29S, R21E, S2	Kern	Aera Energy, LLC	3/1/2018	5	Approved	6	3/6/2018	5
GAOG10010731	Belridge, South	T29S, R21E, S2	Kern	Aera Energy, LLC	3/28/2018	6	Approved	1	4/3/2018	6
GAOG10011834	Elk Hills	T30S, R23E, S36	Kern	California Resources Corporation	7/25/2018	2	Approved	1	7/27/2018	2
GAOG10011060	McKittrick	T30S, R22E, S7, 8, and 17	Kern	Chevron USA, Inc	10/31/2017	--	On Hold	--	--	--
								97 wells		

Notes and Acronyms:
-- = not applicable
WST = well stimulation treatment
1. Days to complete the process equates to the elapsed time between the "Date Accepted Request of Additional WST Wells" to "Status/Determination Date". For Requests of Additional WST Wells with multiple revisions, days to complete the process equates to the sum of days to review the original submittal and the days to review each of the revisions. This time includes communications with the operator, Regional Water Board staff, and DOGGR, review of data and the submittal, and preparation and review of agency correspondence. Refer to **Flowchart A-3. Process Flowchart for Reviewing Well Stimulation Permit Applications.**

33	Number of Requests to Add WST Wells to Approved Exclusions
97	Total number of Approved WST Wells to be Added to Approved Exclusions in 2018

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2.3.2 Process and Timeline for Reviewing Requests for Exclusion

The process flowchart for reviewing Requests for Exclusion is shown on Figure A-2 in Appendix A. Water Boards staff begin their review after a Request for Exclusion has been uploaded to GeoTracker and has been accepted as complete. The goal is to respond to the operator with initial review comments within 45 calendar days from acceptance of the submittal. After staff have completed their review, additional information may be requested, the Request for Exclusion may be denied, or the Request for Exclusion may be approved. Request for Exclusion approval does not depend on DOGGR approving an ADSA but is based solely on whether sufficient technical information was submitted to indicate the absence of protected water.

In 2018, the average time for Water Boards staff to respond to the operator with initial review comments for a Request for Exclusion was 50 days. In 2017, these average times were not estimated for the initial review.

In 2018, the average review time was 87 days for staff to complete the entire review process for a new Request for Exclusion (including review of multiple iterations and requests for additional information from the operator) (Table 2-2 and Table 2-2a). In 2017, the average review time was 83 days. The review time required to process new Requests for Exclusions in 2018 has remained nearly the same as the time required in 2017.

On average, the time required for Water Boards staff to review requests for additional wells to be stimulated within an area previously approved for exclusion was 10 days in 2018. In 2017, the average review time was 22 days. In 2018, the time required to review requests to add wells to existing Exclusions was reduced by 55 percent from that reported in 2017.

Table 2-2a – Wells Proposed for Stimulation in Areas Previously Granted Exclusion

	WST Wells (Total)	New Exclusions Review Time (Days)	Previously Approved Exclusion Additional Wells Review Time (Days)
2017	194	83	22
2018	104	87	10

2.4 Groundwater Monitoring Reports

Groundwater monitoring data uploaded to GeoTracker from groundwater monitoring wells sampled as part of Interim GMPs and Model Criteria GMPs was reviewed by Water Boards staff. From 2014 to 2018, a total of 118 sampling rounds of data have been collected from 10 different oil fields in 4 different counties (Table 2-4). The county with the most data is Kern

County with a total of 105 sampling rounds from 45 monitoring wells at 7 different oil fields. A sampling event consists of one or more wells sampled during a discrete period (i.e. one to multiple days of sampling depending on the number of wells). Each sample is then tested at an analytical laboratory for a suite of analytes per the water quality testing standards, protocols, and procedures in the Emergency Interim Regulations for an Interim GMP or in the Model Criteria for a post-Model Criteria GMP.

State Water Board staff evaluated submitted analytical data against comparison levels (e.g. maximum contaminant levels (MCLs) for drinking water[5]) as required in the Model Criteria. If the test result of an analyte exceeded its respective comparison level, staff assessed the magnitude of the exceedance. The objective of this review was to report our findings to the Regional Water Board staff for further investigation, where warranted.

Several analytes exceeded their respective comparison levels in 2018. For example, TDS, arsenic[6], barium, molybdenum, strontium, boron, selenium, radium-226, or radium-228[7]. The State Water Board is working with the operators to evaluate these data and all data collected during the sampling rounds to determine baseline water quality conditions, such as the use of the following tools:

- Use of chemical isoconcentration maps to show extent and magnitude along with graphs showing concentration trends over time with a narrative explanation.
- Inclusion of a statistical evaluation to characterize groundwater quality, assess whether a constituent release has occurred, and if so, determine if concentrations reported meet comparison concentrations. Statistical evaluations should be designed to allow for the identification of significant changes in groundwater when compared to background or baseline levels. The Model Criteria provides guidance to perform statistical evaluations using the "United States Environmental Protection Agency (U.S. EPA) (2009) Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Unified Guidance, U.S. EPA 530/R-09-007". Statistical evaluations should be supported by a detailed narrative, figures, tables, method(s) used, and conclusions or data gaps derived from the evaluation.

[5] https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/MCLsandPHGs.shtml
[6] https://www.waterboards.ca.gov/gama/docs/coc_arsenic.pdf
[7] https://www.waterboards.ca.gov/gama/docs/coc_radionuclides.pdf

Table 2-4. Summary of Sampling Events for the Area-Specific Groundwater Monitoring Program

GeoTracker Global Identification	Oil Field or (Area)	Interim GMP or GMP	Township (T), Range (R), Section (S)	County	Operator	Number of Groundwater Monitoring Wells	Sampling Events						Comments
							2014	2015	2016	2017	2018	Total	
GAOG10010818	Belridge, North and South	GMP	T28S, R20E, S1, S12	Kern	Breitburn Operating, LP	3	NA	NA	NA	NA	2	**2**	GMP approved on 10/24/17. Stimulation occurred from 4/2/2018 through 8/4/2018. Exclusion approved on 8/28/2018.
GAOG10011328	Belridge, South	GMP	T28S, R21E, S19	Kern	Berry Petroleum Company, LLC	5	NA	2	1	2	2	**7**	GMP approved on 7/12/2018. Sampling data includes interim sampling events since 2015. Stimulation occurred starting on approximately 8/9/2018 and is ongoing.
GAOG10009277	Belridge, South	GMP	T28S, R20E, S12, S13, S18	Kern	Aera Energy, LLC	4	NA	4	4	4	3	**15**	GMP approved on 4/11/2017. Sampling data includes interim sampling events since 2015. Stimulation started on 1/2/2014 and is ongoing.
GAGW10000050	Brea-Olinda	Interim GMP	T3S, R9W, S6	Orange	Bridge Energy, LLC	1	0	2	1	1	1	**5**	Interim GMP received on 4/3/2014. Stimulation occurred on 9/23/2015 to 9/24/2015.
GAOG10009209	Buena Vista (Nose)	GMP	T32S, R24E, S1; T31S, R24E S36; T32S, R25E, S3-11, 14-17; & T31S, R25E, S31	Kern	California Resources Corporation	11	2	2	1	3	2	**10**	GMP approved on 11/18/2016. Sampling data includes interim sampling events since 2014. Stimulation started on 10/27/2014 and is ongoing.
GAGW10000018	Coles Levee, North	Interim GMP	T30S, R25E, S29, 30	Kern	California Resources Corporation	3	2	2	2	2	1	**9**	Interim GMP received on 8/19/2014. Stimulation occurred on 10/24/2014 to 10/26/2014 and 11/7/2014 to 11/9/2014.
GAGW10007872	Coles Levee, North	Interim GMP	T30, S25E, S31	Kern	California Resources Corporation	1	0	3	2	2	1	**8**	Interim GMP received on 9/19/2014. Stimulation occurred on 6/19/2015 to 6/20/2015.
GAOG10010467	Coles Levee, North	GMP	T30S, R25E, S30	Kern	California Resources Corporation	3	NA	NA	NA	0	0	**0**	GMP approved on 10/24/17. No wells stimulated.
GAGW10000042	Hopper Canyon	Interim GMP	T4N, R18W, S13	Ventura	DCOR, LLC	2	1	0	0	0	0	**1**	Interim GMP received on 5/22/2014. Pre-stimulation/baseline sampling only conducted in 2014. No wells stimulated.
GAGW10000040	Kettleman Middle Dome	Interim GMP	T23S, R19E, S19	Kings	California Resources Corporation	1	1	3	0	2	1	**7**	Interim GMP received on 6/11/2014. Stimulation occurred on 11/23/2014 to 11/28/2014 and 2/16/2015 to 3/13/2015. Post stimulation sampling was not performed in 2016.
GAOG10009406	Lost Hills	GMP	T27S, R21E, S4 and S5	Kern	Aera Energy, LLC	5*	3	5	3	2	1	**14**	GMP approved on 5/14/2018. Sampling data includes interim sampling events since 2014. Stimulation started on 6/4/2014 and is ongoing.
GAGW10000039	Lost Hills	Interim GMP	T27S, R21E, S36	Kern	Seneca Resources Corporation	1	3	2	2	2	1	**10**	Interim GMP received on 3/10/2014. Stimulation occurred on 10/13/2014 and 10/20/2014.
GAOG10010391	Lost Hills	GMP	T26S, R21E, S29, S32, S33 & T27S, R21E, S4 & S5	Kern	Chevron USA, Inc	10	1	3	2	2	1	**9**	GMPs approved on 9/20/2017 and 8/10/2018. Sampling data includes interim sampling events since 2014. Stimulation occurred from 3/17/2014 through approximately 2/10/2018.
GAGW10000032	Rose	Interim GMP	T26S, R24E, S36	Kern	California Resources Corporation	1	1	2	2	2	1	**8**	Interim GMP received on 5/5/2014. Stimulation occurred on 9/16/2014 to 9/22/2014. Pre-stimulation (baseline) sampling event was not performed.
GAGW10000031	Rose	Interim GMP	T26S, R24E, S26	Kern	California Resources Corporation	2	3	3	2	2	1	**11**	Interim GMP received on 2/18/2014. Stimulation occurred on 10/7/2014 to 10/8/2014.
GAGW10000041	Stockdale	Interim GMP	T30S, R27E, S22	Kern	Crimson Resources	1	2	0	0	0	0	**2**	Interim GMP received on 7/15/2014. Approved Interim GMP proposed a baseline sampling event and one post-stimulation sampling event. Stimulation occurred on 11/17/2014 – 11/21/2014.
							19	**33**	**22**	**26**	**18**	**118**	

Notes:
NA = not applicable
GMP = Groundwater Monitoring Plan
Interim GMPs were approved by DOGGR. Sampling events are required pre-well stimulation and post well stimulation. Events may be zero because well stimulation was not performed, sampling was not performed, or sampling reports have not been uploaded to GeoTracker.
*Two of these monitoring well belong to Chevron USA, Inc and are monitored during Chevron's Lost Hills groundwater monitoring events (GAOG10010391).

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3.0 PROPERTY-OWNER NOTIFICATIONS AND REQUESTED WATER SAMPLING

Operators are required to use a 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[8] (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 from 2014 through 2018 are summarized in Table 3-1. Notifications increased from 140 in 2017 to 546 in 2018.

Table 3-1. Number of Neighbor Notifications Sent by Operators

Operator	2014	2015	2016	2017	2018
Aera Energy, LLC	818	960	29	138	250
Berry Petroleum Company, LLC	-	-	-	-	160
Breitburn Energy Co., LLC	18	-	-	-	1
Central Resources, Inc	19	-	-	-	-
Chevron USA, Inc	35	6	-	-	42
Crimson Resource Management	194	-	-	-	-
DCOR, LLC	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	2	93
Linn Operating, Inc	-	273	-	-	-
Salt Creek Oil, LLC	-	-	2	-	-
Total	**1,279**	**1,284**	**73**	**140**	**546**

Source: State Water Board staff communication with Randall Jeffries, Staff Services Analyst, DOGGR, Well Stimulation Program. February 14, 2019.

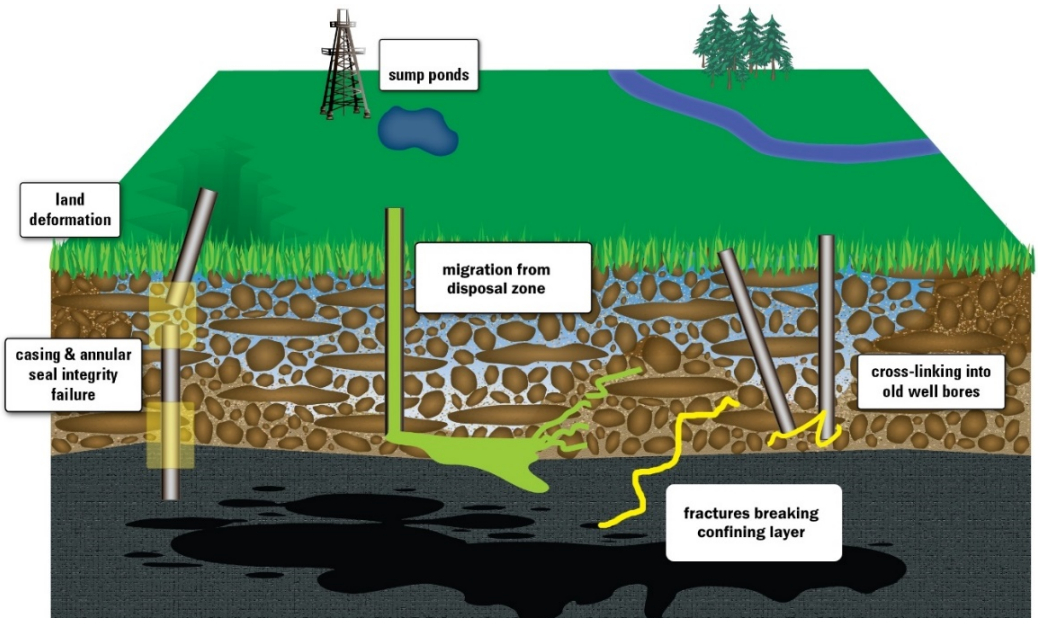
State Water Board staff are required to designate qualified independent third-party contractors (designated contractor) to perform property owner requested water quality sampling and the list can be found on the State Water Board website[9]. Once a property owner that has received a notification regarding WST from an operator, they can choose a designated contractor from the list to perform water quality sampling at their property. The designated contractor is to sample in accordance with the standards and protocols outlined in the Model Criteria. Designated contractors are required to notify State Water Board staff prior to sampling and upload the

[8] ftp://ftp.consrv.ca.gov/pub/oil/forms/Oil%26Gas/WST/WST%20Neighbor%20Notification%20Form.pdf
[9] https://www.waterboards.ca.gov/water_issues/programs/groundwater/sb4/sampling_contractor/index.shtml

results to GeoTracker after sampling. During 2018, State Water Board staff did not receive any notifications of water sampling performed by a designated contractor.

State Water Board staff reviewed well surveys conducted by operators and compared this information to the locations of public water system wells in the Groundwater Ambient Monitoring and Assessment Program Groundwater Information System (GAMA GIS). According to information in GAMA, there were no water supply wells within 1,500 feet of a stimulated well or within 500 feet of the surface representation of the horizontal path of the bottom of that stimulated well.

4.0 REGIONAL MONITORING PROGRAM



Potential Pathways between Oil & Gas Activities and Protected Groundwater
(Source: USGS, https://ca.water.usgs.gov/projects/oil-gas-groundwater/science/pathways/)

The goal of the RMP is to evaluate potential impacts from WST and oil field operations and characterize the risk to subsurface water designated for any beneficial use (e.g., drinking water), while prioritizing the highest areas of risks to be monitored. The RMP is evaluating pathways (see illustration below) by determining which WSTs and other oil and gas production practices have the potential to contaminate groundwater. Potential pathways include the injection of water and/or steam during enhanced oil recovery practices, underground oil field waste injection, or leakage along improperly constructed and/or compromised wells.
The RMP is designed to answer the following questions:

- Where are protected groundwater resources?
- How close are oil and gas operations and protected groundwater, and what geologic materials (i.e., features and properties) separate them?
- Where is there evidence of fluids from oil and gas sources in protected groundwater? Where does evidence indicate no connections?
- When fluids from oil and gas sources are present in protected groundwater, what pathways or processes are responsible for observed transport?
- Have oil and gas operations contributed to overall water-quality changes in groundwater basins?

The approaches being used to answer those questions include: 1) mapping protected groundwater, 2) characterizing and monitoring groundwater in wells near oil fields, and 3)

characterizing oil field fluids. Together, with robust, site-specific information about the local geology, hydrology, and historic disposal areas, 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 United States Geological Survey (USGS) is the technical lead of the RMP. The USGS refers to the work performed under the RMP as the California Oil, Gas, and Groundwater (COGG) Program.

The RMP is being conducted in a phased approach that allows findings to be assessed and future work to be refined. A "phase" depicts the compilation, review, synthesis, collection, and interpretation of data. Generally, the phases are as follows:

> **Phase 1** - Prioritizing areas for regional monitoring and collecting groundwater and produced water quality data for high priority oil fields. This phase began in 2015.
>
> **Phase 2** – Divided into four primary tasks for each oil field study area: 1) salinity mapping, 2) groundwater sampling, 3) oil field fluid sampling, and 4) interpretative analysis of the collected data from tasks 1 through 3. Types of data used in this phase include historical water sample data, newly sampled water supply and produced water sample data, borehole geophysical logs, well construction data, and surface and airborne electromagnetics methods. This phase includes determining gaps in the data, and potentially installing monitoring wells to fill-in those data gaps. This phase also includes an analysis of risks to groundwater quality. This phase began in 2016.
>
> **Phase 3** – If results from Phase 2 indicate there is a high risk to protected groundwater from oil production activities, a sampling plan will be developed and could include the installation of groundwater monitoring wells.

Progress in answering the questions above in particular study areas are summarized in the Sections 4.1 through 4.4 below.

4.1 Overview of Completed Phases (2015 to 2018)

An overview of completed work by phases is provided below for 2015 through 2018.

Phase 1 – Initiated in 2015, Phase 1 focused on prioritizing areas for regional groundwater monitoring and compiling data from oil fields and nearby groundwater aquifers. Data obtained from the underground injection control activities and aquifer exemption proposals were used in the prioritization process. About 100 oil fields with the presence of protected groundwater and active oil production and injection were given the highest priority.

A final report and data release documenting the prioritization work was published:

- Davis, T.A., Landon, M.K., and Bennett, G.L., 2018, Prioritization of oil and gas fields for regional groundwater monitoring based on a preliminary assessment of petroleum

resource development and proximity to California's groundwater resources: U.S. Geological Survey Scientific Investigations Report 2018–5065, 115 p., https://doi.org/10.3133/sir20185065

- Davis, T., Bennett, G., Metzger, L., Kjos, A., Peterson, M., Johnson, J., Johnson, T., Brilmyer, C., and Dillon, D., 2018, Data analyzed for the preliminary prioritization of California oil and gas fields for regional groundwater monitoring: U.S. Geological Survey data release, https://doi.org/10.5066/F7FJ2DV3

All reports generated as part of the RMP are publicly available on the State Water Board Oil and Gas Monitoring website at: http://www.waterboards.ca.gov/water_issues/programs/groundwater/sb4/regional_monitoring/index.shtml

Phase I work also included exploratory sampling to evaluate the utility of chemical constituents used in similar studies elsewhere in California. The USGS sampled 51 groundwater wells and 4 oil wells in and near oil fields in the Los Angeles Basin and Kern County. Reports and data releases documenting this work are listed below:

- McMahon, P.B., Kulongoski, J.T., Wright, M.T., Land, M.T., Landon, M.K., Cozzarelli, I.M., Vengosh, Avner, and Aiken, G.R., 2017, Preliminary results from exploratory sampling of wells for the California oil, gas, and groundwater program, 2014–15 (ver 1.1, January 2017): U.S. Geological Survey Open-File Report 2016–1100, 8 p., http://dx.doi.org/10.3133/ofr20161100
- Kulongoski, J.T., McMahon, P.B., Land, M.T., Wright, M.T., Johnson, T.A., and Landon, M.K., 2018, Origin of methane and sources of high concentrations in Los Angeles groundwater, Journal of Geophysical Research: Biogeosciences. 123. https://doi.org/10.1002/2017JG004026
- Davis, T.A., Kulongoski, J.T., and McMahon, P.B., 2016, Produced water chemistry data for samples from four petroleum wells, Southern San Joaquin Valley, California, 2014: U.S. Geological Survey data release. https://www.sciencebase.gov/catalog/item/57a50c48e4b0ebae89b6d87f
- Dillon, D.B., Davis, T.A., Landon, M.K., Land, M.T., Wright, M.T., and Kulongoski, J.T., 2016, Data from exploratory sampling of groundwater in selected oil and gas areas of coastal Los Angeles County and Kern and Kings Counties in southern San Joaquin Valley, 2014–15: California Oil, Gas, and Groundwater Project, U.S. Geological Survey Open-File Report 2016–1181, 24 p. https://pubs.er.usgs.gov/publication/ofr20161181

Work conducted during Phase I also included preliminary mapping of protected groundwater near 30 selected oil fields, mostly in Kern County, using historical water sample data only. This reconnaissance effort helped to highlight data gaps that need to be filled using other approaches. Reports and data releases documenting this work are listed below:

- Metzger, L.F., and Landon, M.K., 2018, Preliminary groundwater salinity mapping near selected oil fields using historical water-sample data, central and southern California: U.S. Geological Survey Scientific Investigations Report 2018–5082, 54 p., https://doi.org/10.3133/sir20185082

- Metzger, L.F., Davis, T. A., Peterson, M.F., Brilmyer, C.A, and Johnson, J.C., 2018, Data used for preliminary regional groundwater salinity mapping near selected oil fields in central and southern California: U.S. Geological Survey data release, https://doi.org/10.5066/F7RN373C

Phase 2 – Phase 2 of the RMP began in 2016. The USGS and the State Water Board collaboratively selected fields for study using results from the prioritization analysis described above (Davis and others, 2018 – see above for full citation). Well depth and water chemistry data were compiled into numerical databases for use in the regional analyses. Work then began in each of these study fields on one or more of four major tasks 1) salinity mapping, 2) groundwater sampling, 3) oil field fluid sampling, and 4) interpretative analysis of the collected data from tasks 1 thru 3 in each of these selected fields.

- Beginning in 2016, the first oil fields identified for all four tasks were: Fruitvale, Lost Hills, South Belridge, and North Belridge. In addition, salinity mapping work began in the following fields: Elk Hills, Montebello, Poso Creek, Rosedale Ranch, and Cal Canal Gas.
- In 2017, oil fields selected for sampling included Oxnard, Elk Hills, North Coles Levee, Orcutt, and Montebello with salinity mapping proceeding in Midway-Sunset, South Coles Levee, and South Cuyama.
- In 2018, oil fields selected for sampling included: Placerita, Santa Maria Valley, Midway-Sunset, Buena Vista, San Ardo, and Kern River, with salinity mapping beginning in Yowlumne.

In each of the study areas sampled, the USGS identified suitable locations of groundwater wells and oil wells/injectate sites that would meet well and oil fluid sample criteria for the RMP. Once the well locations were determined, the USGS worked with well owners to get permission to collect the samples. In 2016, the USGS sampled 12 water supply wells and eight oil wells/injectate sites in the Fruitvale oil field, and 11 water supply or monitoring wells and nine oil wells in the Lost Hills and South Belridge oil fields. In 2017, the USGS collected 74 groundwater samples in 6 study areas and 8 oil field site samples in 2 study areas.

4.2 Work Conducted in 2018

Information on the RMP is updated on a public website (https://ca.water.usgs.gov/projects/oil-gas-groundwater/) that is organized as a Conceptual Study Plan. This website combines information from the public briefings, scientific approaches, and answers questions about the

RMP. This website contains a repository of publicly available documents published by the USGS regarding this program and is updated with new publications.

In 2018, the USGS continued their salinity mapping work, collected airborne electromagnetic surveys, compiled geologic data (well depth, water chemistry, injection and production volume, well integrity, borehole geophysical, temperature, etc.), collected new water sample data, drilled and installed multiple well monitoring sites, analyzed historical and newly collected data, published manuscripts and data, and met with stakeholders. The work conducted in 2018 is summarized below:

- Oil well construction data was extracted and compiled from scanned or paper records and included oil well perforation depth and drill date (70,000 wells), types and depths of geophysical logs collected (40,000 wells), bottom-hole temperatures (11,000 wells), oil show and/or core properties data (2,387 wells), depths of geologic markers (2,500 wells), and oil well integrity data (1,400 wells). Borehole geophysical logs have been digitized and/or analyzed to determine salinity profiles with depth at about 750 wells. Oil field injection records since 1977 were extracted from digital files available from DOGGR are being analyzed. Records of pre-1977 injection, well integrity observations, and formation contact depths are being compiled in selected areas.
- Well depth and water chemistry data were compiled from many sources into numerical databases for use in the regional analyses. Depth and chemistry data have been compiled for about 19,000 wells in 470 oil field areas. These data have been combined with data from existing databases for analysis.
- Salinity mapping continues near high priority oil fields to evaluate groundwater quality by using water sample data, oil well borehole geophysical logs, and collecting airborne and surface geophysical surveys. A salinity mapping study of the Fruitvale oil field was completed (see publications below) and a study of the Lost Hills/Belridge oil fields area was accepted for publication (in press). Data releases associated with salinity mapping were published for several study areas. Salinity mapping studies are progressing in the areas of the Elk Hills/North Coles Levee, Midway-Sunset, Poso Creek, South Cuyama, and Montebello oil field study areas.
- Airborne (helicopter-mounted) electromagnetic surveys were performed in areas adjacent to the Midway-Sunset, Buena Vista, and Yowlumne oil fields.
- Eighty-one water supply and monitoring wells in 8 study areas, as well as 16 oil wells, injectate sites, and pond sites were sampled in the Orcutt, Oxnard, and Placerita oil fields.
- Analysis of water chemistry and ancillary data was completed for the Fruitvale study area and continued for the Lost Hills/South Belridge/North Belridge, Elk Hills/North Coles Levee, Oxnard, Orcutt, and Montebello study areas. Groundwater and produced water sample data from these study areas were sent to well owners.

- Two multiple completion monitoring well sites were drilled and installed adjacent to the Lost Hills and North/South Belridge oil fields. Each well site was constructed with 5 individually cased well screens completed within the same borehole, at different depths in the aquifer. Each site was drilled to about 1,800 ft below land surface; geologic cuttings and borehole geophysical logs were collected; the wells were installed and developed; and data on water-level changes was collected over time. These data are publicly available on the USGS website.
- Program personnel updated stakeholders on RMP activities in public stakeholder meetings in January and June, as summarized in Section 5.3, Strategy #1.
- Manuscripts and data releases on the chemistry of casing gas and produced water in the Fruitvale, Lost Hills, South Belridge, and North Belridge oil fields were published.
- Data releases of the groundwater and historical produced water chemistry data in the Fruitvale oil field were published.
- Manuscripts describing the results of groundwater quality analysis near the Fruitvale and Lost Hills/Belridge study areas were completed and are in peer review.

Phase 2 Reports published in 2018

- Barry, P.H., Kulongoski, J.T., Landon, M.K., Tyne, R.L., Gillespie, J.M., Stephens, M.J., Hillegonds, D.J., Byrne, D.J., and Ballentine, C.J., 2018, Tracing enhanced oil recovery signatures in casing gases from the Lost Hills oil field using noble gases. Earth and Planetary Science Letters, 496, 57-67. https://doi.org/10.1016/j.epsl.2018.05.028
- Davis, T.A., Teunis, J.A., McCarlson, A.J., Seitz, N.O., and Johnson, J.C., 2018, Water chemistry data for samples collected at groundwater and surface-water sites near the Lost Hills and Belridge oil fields, November 2016–September 2017, Kern County, California: U.S. Geological Survey data release, https://doi.org/10.5066/F7NS0T5M.
- Gannon, R.S., Saraceno, J.F., Kulongoski, J.T., Teunis, J.A., Barry, P.H., Tyne, R.L., Kraus, T.E.C., Hansen, A.M., and Qi, S.L., 2018, Produced water chemistry data for the Lost Hills, Fruitvale, and North and South Belridge study areas, Southern San Joaquin Valley, California: U.S. Geological Survey data release, https://doi.org/10.5066/F7X929H9
- Gans, K.D., Metzger, L.F., Gillespie, J.M, and Qi, S.L., 2018, Historical produced water chemistry data compiled for the Fruitvale Oil Field, Kern County, California: U.S. Geological Survey data release, https://doi.org/10.5066/F72B8X8G
- Haugen, E.A., Finney, D.M.N., Ducart, A., Stephens, M.J., and Shimabukuro, D.H., 2018, Geophysical and geochemical data for salinity mapping in the Midway-Sunset oil field area: U.S. Geological Survey data release, https://doi.org/10.5066/P9I0Q1B2
- McCarlson, A., Wright, M. T., Teunis, J.A., Davis, T.A., Johnson, J., and Qi, S.L., 2018, Water chemistry data for samples collected at groundwater sites near the Fruitvale oil

field, September 2016–February 2017, Kern County, California, https://doi.org/10.5066/F7ZW1K7T.

- McMahon, P.B., Kulongoski, J.T., Vengosh, A., Cozzarelli, I.M., Landon, M.K., Kharaka, Y.K., Gillespie, J.M., and Davis, T.A., 2018. Regional patterns in the geochemistry of oil field water, southern San Joaquin Valley, California, USA. Applied Geochemistry, https://doi.org/10.1016/j.apgeochem.2018.09.015

- Stephens, M.J., Shimabukuro, D.H., Gillespie, J.M., and Chang, W., 2018, Groundwater salinity mapping using geophysical log analysis within the Fruitvale and Rosedale Ranch oil fields: Kern County, California, USA. Hydrogeology Journal, https://doi.org/10.1007/s10040-018-1872-5

- Stephens, Michael J., Shimabukuro, David, Gillespie, Janice, Metzger, Loren, Ducart, Ashley, Everett, Rhett, and Gans, Kate, 2018, Geochemical and geophysical data for wells in the Fruitvale and Rosedale Ranch oil and gas fields; Kern County, California, USA: U.S. Geological Survey Data Release, https://doi.org/10.5066/F7S181PH

- Stephens, M.J., Haugen, E.A., Shimabukuro, D.H., Gillespie, J.M., Sowers, T.A., Ducart, A., and Medrano, V., 2018, Geochemical, geological, and geophysical data for wells in the Poso Creek oil and gas field, Kern County, California: U.S. Geological Survey data release, https://doi.org/10.5066/P9RR9UYN.

4.3 Preliminary Results

A focus of RMP efforts in 2018 was the compilation, review, analysis, and interpretation of salinity and water sample analysis data obtained at the Fruitvale and Lost Hills/Belridge oil field study areas. Differences in water quality between these study areas in different hydrogeologic settings on the east and west sides of the Central Valley, and comparisons to preliminary results from other oil field study areas in progress (Elk Hills/North Coles Levee, Oxnard, Orcutt) indicate that hydrogeologic setting plays an important role on the relations of oil/gas development to groundwater. Study results were published in 2018 (see list above) or are in review and will be published in 2019 (see list below). The observations below summarize results from multiple study areas.

Salinity mapping. Estimating salinity from borehole log analysis fills gaps in sample data and helps indicate relations of salinity structure to depth, recharge, stratigraphy, and faulting (Stephens and others, 2018). Analysis of airborne electromagnetic data coupled with borehole and sample data fills in three-dimensional understanding of salinity and clay confining unit distributions in the upper 600 feet. This information extends beyond existing data and has helped to trace saline water from historical surface pond disposal (Ball and others, in preparation). Changes in borehole resistivity over time can be used to map effects of produced water disposal in injection wells and surface ponds near fields (Gillespie and others, in review). There is limited data to assess potential lateral movement of produced water injected for disposal as there are few groundwater wells at the depths of injection, which may be greater than 800 feet below land surface.

Oil field fluid sampling. Produced water sampling and historical data analysis conducted as part of the RMP indicate large variability in the chemistry of oil field water between fields, in relation to depth of production zones, and in relation to injection processes (McMahon and others, 2018). The variability is due to natural and anthropogenic processes. The variability indicates that further sampling in each field is warranted. A single set of tracers is insufficient to characterize variability. Using a diverse set of tracers improves our understanding of this variability and of mixing between groundwater and oil field water (Barry and others, 2018; McMahon and others, 2018).

Groundwater sample analysis. A multi-tracer approach can distinguish oil/gas fluids from other sources in groundwater; the most useful tracer(s) vary. The RMP uses additional tracers that have added insight including carbon isotopic values of dissolved inorganic carbon to evaluate mixing of produced water in groundwater; noble gases to help distinguish groundwater influenced by surface disposal ponds from subsurface sources; and radium isotopes to identify mobilization from disposal pond water interactions with the underlying aquifer and mixing. Mining historical water chemistry, oil well, and injection records is necessary to develop spatial coverage and to understand relations of water quality to potential risk factors.

Hydrogeologic setting plays a large role in the occurrence of oil field fluids in groundwater, as evidenced by a comparison of monitoring results between the Fruitvale and Lost Hills/Belridge study areas. The Fruitvale study area is on the east side of the San Joaquin Valley, groundwater above oil-bearing zones is heavily used, and there is a vertical separation of water and oil well perforations greater than 670 meters (m) (Wright and others, in review). The Fruitvale study area has relatively high recharge from the Kern River that determines regional groundwater quality. Oil field fluids were infrequently detected as minor local deviations from regional conditions. These detections sometimes occurred in water wells near areas of high produced water injection and high density of oil wells, some of which may provide pathways for oil field gases and solutes to reach groundwater.

On the west side of the San Joaquin Valley, protected groundwater is located primarily east (and downgradient) of the Lost Hills, South and North Belridge oil fields (Davis and others, in preparation). Adjacent to these fields, many groundwater samples from wells currently used for irrigation or industrial supply showed no evidence of mixing with oil field fluids, but some samples indicated mixing with produced waters, likely a result of historic disposal in surface ponds. Within the fields, multiple lines of geochemical evidence indicated overlying groundwater is mixing with oil field fluids. This result may be expected considering the vertical (less than 140 m) and lateral proximity of sampled wells to oil-bearing formations and production activities.

4.4 Upcoming Work in 2019

The following work is planned for the 2019 RMP:

- Sampling of groundwater and produced water in the following oil fields will be completed: Buena Vista, Midway-Sunset, and Kern River (Kern County), San Ardo (Monterey County), and Santa Maria Valley (Santa Barbara County).
- State Water Board staff in collaboration with the USGS staff will generate a new list of up to four oil field study areas for sampling in 2019-20 based on the prioritization report (Phase 1) for 2018. Analysis of additional data may be used to modify the priority of oil fields. Suitable locations of water supply wells and/or oil wells/injectate sites within and near these oil fields will be identified. Once the well locations are determined, the USGS will work with well owners to get permission to collect the samples.
- Drilling and installation of a multiple completion monitoring well site for monitoring fluid pressure and water quality at different depths in groundwater systems near an oil field. The multiple completion monitoring well site consists of 5 separate, discretely screened and cased wells within a single borehole. Potential monitoring well sites have been selected to fill-in priority gaps in existing data required for an initial interpretive analysis.
- Continue salinity mapping using borehole geophysical log analysis, water sample data, and in some cases airborne electromagnetic data in the Elk Hills/North Coles Levee, Midway-Sunset/Buena Vista, Poso Creek, Montebello, and South Cuyama study areas.
- Publish additional results from the salinity mapping, groundwater quality, produced water chemistry results, and data collection efforts at the Fruitvale, Lost Hills/South Belridge/North Belridge, Oxnard, Elk Hills/North Coles Levee, Midway Sunset, Orcutt, and South Cuyama study areas.
- Provide data to well owners in the Montebello, Placerita, Midway-Sunset/Buena Vista, Santa Maria Valley, Kern River, and San Ardo Oil Fields.
- Update executive summaries of findings on the USGS web page. https://ca.water.usgs.gov/projects/oil-gas-groundwater/finding
- Continue to update stakeholders on RMP activities via technical meetings, workshops, and other face to face meetings.
- In advance of sampling activities, the USGS will continue to perform the following:
    - Provide written summaries to the operators of sampling objectives, a general history of major fluid flows (e.g., water disposal, water flood, steam enhanced oil recovery, surface disposal), and proposed areas for monitoring wells.
    - Request review and input from the operators' technical experts to identify sampling locations, to further document fluid flows, and specific conditions and characteristics of the site to be sampled.
    - Review the information provided by the operators as input to finalizing the sampling plan and interpretation of the data.

Reports expected to be published in 2019:

- Anders, R.A. and others, in preparation, Regional groundwater monitoring results near the Orcutt Oil Field, Journal Article

- Ball, LB., and others, in preparation, Groundwater salinity mapping adjacent to the Lost Hills, North Belridge, and South Belridge Oil Fields using airborne geophysics, Journal Article

- Ball, L.B., and others, in review, Airborne electromagnetic and magnetic survey data, San Joaquin Valley near Lost Hills, California, October 2016: U.S. Geological Survey Data Release.

- Davis and others, in preparation, Mixing between oil field fluids and groundwater: results of a groundwater quality study at the Lost Hills and Belridge Oil Fields, Kern County, California, USA, Journal Article

- Everett, R.R., and others, in preparation, Multiple-well monitoring site near the Lost Hills Oil Field, Kern County, California: U.S. Geological Survey Open-File Report

- Everett, R.R., and others, in review, Geochemical and geophysical data for selected wells in and surrounding the South Cuyama oil and gas field: U.S. Geological Survey Data Release.

- Gans, K.D., Metzger, L.F., Gillespie, J.F., and Qi, S.L., 2019, Historical produced water chemistry data compiled for the Lost Hills and North and South Belridge Oil Fields, Kern County, California: U.S. Geological Survey Data Release, https://doi.org/10.5066/F7F18Z12.

- Gillespie, J.M., Stephens, M.J., Davis, T.A., and Landon, M.K., in review, Aquifer Architecture and Groundwater Salinity in the Tulare Formation, Lost Hills-Belridge Oil Fields area, Kern County, California. Journal Article.

- Gillespie, J.M., Davis, T.A., Ball, L.B., Herrera, P.J., Wolpe, Z., Medrano, V., Bobbitt, M., and Stephens, M.J., in review, Geological, geochemical and geophysical data from the Lost Hills and Belridge Oil Fields: U.S. Geological Survey Data Release

- Johnson, J., and others, in preparation, Water chemistry data for samples collected at groundwater sites near the Elk Hills and North Coles Levee Oil Fields, 2017-18, Kern County, California, U.S. Geological Survey Data Release

- Johnson, J., and others, in preparation, Water chemistry data for samples collected at groundwater sites near the Orcutt Oil Field, 2017-18, Santa Barbara County, California, U.S. Geological Survey Data Release

- McMahon, P.B., and others, in review, Radium in groundwater related to oil and gas production, Southern San Joaquin Valley, California, Journal Article

- Rodriguez, O., and others, in preparation, Water chemistry data for samples collected at groundwater sites near the Oxnard Oil Field, 2017, Ventura County, California, U.S. Geological Survey Data Release

- Rosecrans, C., and others, in preparation, Regional groundwater monitoring results near the Oxnard Oil Field, Journal Article

- Seitz, N.O., and others, in preparation, Produced water chemistry data collected from the Orcutt Oil Field, February 2018, Santa Barbara County, California: U.S. Geological Survey Data Release

- Shimabukuro, D. and others, in preparation, Location, volume, and tempo of UIC in Kern County, California and possible fluid migration pathways, Journal Article

- Warden, J.F., and others, in preparation, Regional groundwater monitoring results near the Elk Hills and North Coles Levee Oil Fields, Journal Article

- Wright, M.T., McMahon, P.B., Landon, M.K., and Kulongoski, J.T., in review, Groundwater quality of a public-supply aquifer in proximity to oil development, Fruitvale Oil Field, Bakersfield, California. Journal Article

5.0 PERFORMANCE MEASURES

In 2015, the State Water Board directed staff to collaborate with stakeholder groups to develop performance measures for the evaluation of the Model Criteria. Performance measures were developed by stakeholders including DOGGR, Clean Water Action, Environmental Working Group, Chevron USA, California Resources Corporation, Western States Petroleum Association (WSPA), California Independent Petroleum Association (CIPA), and State Water Board staff. 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. Provide region-specific or localized flexibility where possible
5. Assessment of implementation costs

These performance measures are a means to evaluate the effectiveness and efficiency of the Model Criteria. When the original goals and strategies were developed in 2016, it was anticipated that the performance measures and implementation plans would be periodically re-evaluated and updated through a stakeholder process. A table of the original performance measures and strategies can be found in Appendix B.

The following sections provide an overview of the five performance measures (goals), each corresponding strategy, and actions performed in 2018 to meet each goal. During the review of these performance measures, some actions were identified for 2019 and are mentioned below in ***italicized bolded*** text.

5.1 Goal #1: Transparency and Availability of Online Information and Documentation

This goal is to provide transparent, effective, and efficient access for the public and state agencies to online information and documentation on the permitting and approval process of well stimulation activities in California. GeoTracker provides public online access to operator-submitted plans, requests, data, reports, and State agency correspondence. These data and information are publicly available for export and analysis. GeoTracker provides capabilities and guides for operators to upload information.

Strategies and actions to meet this goal in 2018 included the following:

Strategy #1: Improve and expand upon available data sets and the ability to analyze and manipulate that data.

Action #1: Develop/Modify/Update Tools in GeoTracker. In order to utilize GeoTracker as a data management system, continuous improvements are being made within GeoTracker based on internal and external feedback. These tools help to streamline staff review time, avoid errors and concentrate staff workload to the data evaluation aspect of the review.

- Created tools on the GeoTracker – Regulator Portal to determine if Electronic Submittal of Information (ESI) data is complete and flag analytes detected above comparison levels with respect to the Model Criteria. Additionally, changes were made to enhance visualization of GMP boundaries, which allow for Water Boards staff to expedite their review effort.
- Updated the GeoTracker map function to show the boundaries of approved GMPs or Exclusions under Oil/Gas Sites in the legend on the left sidebar *(GeoTracker – Regulator and Public Portals).* ***This function is being modified to better visualize and differentiate boundaries and will be updated on the GeoTracker – Regulator and Public Portals in 2019***.
- The list of chemical names was updated to include analytes related to WST chemical additives or their degradation products. This list of chemical names allows the operator and/or laboratory to upload electronically the corresponding chemical data. ***The list of available chemical names for ESI data will be reviewed and new analytes added as a new GMP is approved.***

Action #2: Consolidate existing oil and gas data into GeoTracker. As specified in the Data Sharing Plan (see Strategy #3, Action #1 in this section below), Water Boards staff are continuing to consolidate and upload existing oil and gas data and information within the Water Board's purview to GeoTracker (e.g. produced water pond geolocations and associated monitoring data are being consolidated into GeoTracker). Continued efforts are being made to enter the locations of produced water ponds into GeoTracker. Additionally, WST permits, and 72-hour WST notices are linked to GMPs (new or addendum) and Exclusions in GeoTracker. ***This effort will continue into 2019***.

Strategy #2: Improve online user experience with simplified and clear messaging to make data easier to access.

Action #1: Model Criteria Webpage Updates: Periodic updates are made to the State Water Board's Oil and Gas Monitoring Program webpage[10]. In 2018, updates to the webpage included posting the 2017 Annual Model Criteria Performance Report; a USGS summary letter regarding RMP objectives, sample collection and analysis protocols, quality-assurance procedures, approaches, and reporting procedures; reports and data releases published by the USGS, and recordings from Oil and Gas Stakeholder meetings. Additionally, the USGS updates their COGG Program website[11] periodically. This COGG Program webpage provides information on the most recent published

[10] https://www.waterboards.ca.gov/water_issues/programs/groundwater/sb4/
[11] https://ca.water.usgs.gov/projects/oil-gas-groundwater/

studies performed to assess the impacts from oil and gas well stimulation activities on a regional groundwater basis in California.

Action #2: Feedback from the Operators on Information Portals. State Water Board staff solicited input from operators in October 2018. Stakeholders were asked for input on 1) their experiences using GeoTracker, and 2) their suggestions for improving the State Water Board information portals. One comment received asked to optimize digitally submitted information on Water Boards and DOGGR web portals. In 2018, DOGGR communicated progress to Water Boards staff regarding data that would be uploaded to DOGGRs Well State Tracking and Reporting (WellSTAR) web portal. ***Water Boards and DOGGR staff will continue to ask operators for feedback and provide progress updates regarding WellSTAR roll-out in 2019 to reduce duplication across respective web portals.***

Action #3: GeoTracker Technical Support. In 2018, Water Boards staff continued to provide timely support to GeoTracker users via email or phone in order to provide the most accurate and complete data available to the public. ***Water Boards staff will continue to assist users by responding to user comments and questions in 2019.***

Strategy #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.

Action #1: Sharing data. The State Water Board continues to implement the "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[12]). The Data Sharing Plan was developed by Water Boards staff, in collaboration with DOGGR, with the objective of outlining 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. The Data Sharing Plan was developed in response to these performance measures; however, it broadly outlines data sharing between DOGGR and Water Boards staff for all oil and gas programs.

Effective sharing of oil field related data and information will help streamline regulatory efforts, avoid duplicate collection and submittal requirements, facilitate data submittal processes for operators, and help provide the public easy access to the information. For example, Water Boards and DOGGR staff continue to use a secure file sharing and online storage "drop box" to easily share documents.

In 2018, State Water Board staff coordinated with DOGGR regarding the roll-out of the WellSTAR system. **DOGGR plans to require *operators to submit WST permit applications directly to WellSTAR beginning in 2019. It is expected information currently forwarded to Water Boards staff through "drop box", will begin to***

[12] https://www.waterboards.ca.gov/water_issues/programs/groundwater/sb4/docs/data_sharing_plan_06012016.pdf

transition to WellSTAR. Water Boards staff plan to participate in DOGGR-led training focused on the use of WellSTAR.

State Water Board staff provide the USGS with periodic downloads (at a minimum, annually) of all oil and gas related data in GeoTracker. The USGS incorporates this data into their ongoing RMP studies. State Water Board and USGS staff outlined the process for the USGS to upload oil and gas information from the RMP to GeoTracker. ***State Water Board and the USGS will continue to exchange data using GeoTracker as the primary data collection system.***

Action #2: Coordinated Communications. Water Boards and DOGGR staff presently use a well-established system for sharing data associated with WST permit applications, GMPs (New and Addendum), Exclusions, and well stimulation 72-hour notices, as outlined in the Data Sharing Plan. Water Boards staff routinely communicate with their counterparts at DOGGR as project-related questions and issues arise. Additionally, Water Boards and DOGGR staff began holding teleconferences on a monthly basis to discuss comments and questions arising from reviews of well stimulation permit applications submitted by operators. These teleconferences were initiated to resolve comments or issues that could delay the permitting process. ***Water Boards and DOGGR staff will continue to hold teleconferences in 2019 to discuss comments and explore questions arising from reviews of well stimulation permit applications.***

5.2 Goal #2: Provide Clear Milestones and Timely Deliverables

This goal is to 1) report on the completion of the milestones and deliverables included within the Water Code and to 2) provide timely deliverables (i.e., staff letters) during the review of GMPs, Requests for Exclusion, and requests to add WST wells to previously approved exclusions from groundwater monitoring.

Strategies and actions to meet this goal in 2018 included the following:

Strategy #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.

Action #1: Availability of Milestone Schedule. The milestone schedule[13] and status of Senate Bill 4/Water Code § 10783 deliverables are posted on the State Water Board website. All the State Water Board's milestones have been completed except for review of the use of the United States Environmental Protection Agency's (USEPA) definition of Underground Source of Drinking Water (USDW) as containing less than 10,000 mg/L TDS and whether exempt aquifers pursuant to 40 CFR 146.4 should be subject to groundwater monitoring. **As required by California Water Code section 10783, *the criteria for exclusion from groundwater monitoring must be reviewed by the State***

[13] https://www.waterboards.ca.gov/water_issues/programs/groundwater/sb4/docs/sb4_deliverable_schedule.pdf

Water Board through a public process on or before January 1, 2020. In order to meet this deadline Water Boards staff will be holding a public staff workshop in May 2019.

Strategy #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.

Action #1: Preparation of Annual Model Criteria Performance Report. State Water Board staff prepared and made publicly available the "2017 Annual Performance Report: Model Criteria for Groundwater Monitoring in Areas of Oil and Gas Well Stimulation" (dated March 27, 2018) for the reporting period of January 1, 2017 through December 31, 2017. This report is posted on the State Water Board, Division of Water Quality, Oil and Gas webpage under Performance Measures[14]. This 2018 Annual Performance Report: Model Criteria for Groundwater Monitoring in Areas of Oil and Gas Well Stimulation was made available on the website in March 2019. ***The Annual Model Criteria Performance Report for the 2019 calendar year will be drafted and publication is anticipated for March 2020.***

Action #2: Updated Review Processes.

- *Completeness Review Checklist.* In 2018, Water Boards staff began conducting a completeness check of operator's submittals (GMP, GMP Addenda, Exclusions, etc.) within 14 days of receipt of the submittal into GeoTracker. The purpose for this completeness check is to identify any deficiencies in the submittal early in the process. Water Boards staff added this step to the review checklist May 2018.

- *Groundwater Monitoring Report (GMR) Review Process.* Water Boards staff developed a standard process for GMR reviews and created a GMR review checklist to streamline staff review.

Action #3: Prepare/Update Flowcharts. In 2018, State Water Board staff continued to utilize the process flowcharts for "Uploading and Reviewing Area-Specific Groundwater Monitoring Plans" and "Reviewing Requests for Exclusion from Groundwater Monitoring" on the Oil and Gas Monitoring webpage[15]. These flowcharts provide the operator's process for uploading GMPs or Requests for Exclusion from into GeoTracker and the Water Board's process for review. Estimated timelines for responding to the operator are provided in these process flowcharts. ***In 2019, flowcharts, procedures, and checklists will continue to be updated on an as-need basis.***

Action #4: Evaluate State Water Board's Timeliness of Review.

[14] https://www.waterboards.ca.gov/water_issues/programs/groundwater/sb4/performance_measures/index.shtml
[15] https://www.waterboards.ca.gov/water_issues/programs/groundwater/sb4/area_specific_monitoring/index.shtml

Sections 2.1.2 and 2.3.2 of this report provide an evaluation of the time Water Boards staff take to review deliverables. State Water Boards staff's goal is to provide review comments (initial review) to the operator within 45 calendar days from acceptance of the GMP or Request for Exclusion into GeoTracker. The initial review includes the time Water Board's staff take from acceptance of the submittal into GeoTracker to when they send the initial set of comments to the operator. The operator may have to revise the submittal and re-submit. Time spent by Water Board's staff reviewing revised submittals or drafting additional comments is included in the total review time.

The average time for the initial review of a GMP, GMP Addendum, Request for Exclusion, and requests to add WST wells to existing areas of exclusion is summarized in Table 5-1 for 2018. On average, time spent for the initial review process was close to the goal of 45 days for GMP addenda, and Requests for Exclusion in 2018. Review of new GMPs required additional review time for the reasons described in Section 2.1.2.

Table 5-1. Average Days to Complete Initial Review in 2018

Item to Review	Calendar Days	
	Goal	Actual
New GMP	45	65
GMP Addenda	45	49
New Requests for Exclusion	45	50
Request to Add WST Wells to Existing Exclusion	not established	10

Note:
Days to complete the initial review equates to the time elapsed between the date accepted in GeoTracker to the date of the first response from the State Water Board (Draft Comments, Approval Letter, or Denial Letter). Review time includes communications with the operator, Water Boards staff, and DOGGR, review of data and the submittal, and preparation and review of agency correspondence.

The total time to review new GMPs and GMP Addenda increased in 2018 compared to 2017 (Table 5-2). The total time to review new Requests for Exclusion remained close to the time required in 2017. Average time spent reviewing requests to add wells to an approved exclusion decreased in 2018 to 11 days.

In 2019, the State Water Board will establish systems that flag interim milestones and strategic check points in an effort improve the timeline for regulatory review of GMPs. The State Water Board will also utilize existing functions in GeoTracker to track review status for GMPs and Requests for Exclusion. These tools will help Water Boards staff to routinely assess timeliness and improve upon the current performance.

Table 5-2. Average Days to Complete Review Process

Item to Review	Calendar Days		
	2016	2017	2018
New GMP	not estimated	78	112
GMP Addenda		49	60
New Request for Exclusion	112	83	87
Request to Add WST Wells to Existing Exclusion	18	22	11

Note: Days to complete the process equates to the elapsed time between the date accepted in GeoTracker to the date of the Approval or Denial Letter from the State Water Board. For GMPs or Requests for Exclusion with multiple revisions, days to complete the process equates to the sum of the days to review every version of the submittal. Review time includes communications with the operator, Water Boards staff, and DOGGR, review of data and the submittal, and preparation and review of agency correspondence.

Action #5: Collaborate Between Agencies.

In 2018, Water Boards and DOGGR staff held a meeting to provide cross-training to staff in both organizations regarding the WST application review process. DOGGR provided presentations to describe the WST permit application risk assessment, ADSA review and approval process, and evaluation of reservoir properties. State Water Board staff provided a presentation on the Water Boards role with respect to well stimulation including an overview of the Model Criteria requirements and considerations when reviewing GMPs.

In September 2018, Water Boards and DOGGR staff began holding monthly teleconferences to discuss comments and questions arising from reviews of WST permit applications submitted by operators. These discussions have also served as a forum to collaborate between agencies on other related issues and upcoming changes such as the roll-out of WellSTAR.

Periodic review and updates of procedures and checklists will be continued in 2019 based on lessons learned to streamline reviews and avoid duplicative efforts amongst Water Boards staff and DOGGR staff.

Action #6: Enhance Program Efficiencies.

Water Boards staff continue to work with the operators as efficiently as possible during the area-specific GMP review process and proactively communicate the Water Boards' concerns. As the area-specific groundwater monitoring program has evolved, it has become evident that hydrogeologic and geologic conditions at oil fields are very complex, and the process to develop GMPs can be highly iterative. Examples of collaboration with operators to maintain communication channels and enhance efficiency include*:*

1) As implemented in 2018, a 14-day review was performed as the initial check of completeness for a GMP submitted by an operator. This completeness check identified significant deficiencies in the GMP to meet the requirements of the Model Criteria. State Water Board staff communicated those results soon thereafter.

2) In 2018, Water Boards staff took steps to schedule more frequent in-person meetings and teleconferences with operators to provide early notice of concerns arising from preliminary review of GMPs. Water Boards staff also developed processes and procedures to streamline GMP reviews and accommodate cases when multiple versions of GMPs are required.

Key communications between State Water Board staff and operators will continue to be documented and any action items will be tracked to ensure they are resolved in a timely manner.

5.3 Goal #3: Understand and Mitigate the Impacts of Well Stimulation on Water Quality and Public Health

This goal is to assess groundwater monitoring data as required in the approved GMPs. In total, data associated with 118 groundwater sampling events have been uploaded into GeoTracker for GMPs and Interim GMPs for sampling events conducted from 2014 through 2018.

	2014	2015	2016	2017	2018
Total Number of Sampling Events Uploaded into GeoTracker by Year	18	33	22	26	18
Total Number of Sampling Events = 118					

In 2018, a total of 18 sampling rounds have been submitted into GeoTracker. However, in 2017, 26 sampling rounds were received in GeoTracker (Table 2-4). Groundwater sampling is required on a semi-annual basis. The quarter selected for sampling alternates each year (e.g. 1st and 3rd quarter in the 1st year and then 2nd and 4th quarter in the 2nd year). Therefore, if the sampling round occurs in the fourth quarter, the final report will be received generally in April 2019, after this report is finalized.

A breakdown of sampling events by year is provided in the table to the right. Strategies and actions to meet this goal in 2018 include the following:

Strategy #1: Provide regular assessments of monitoring data, including pilot study results and identification of any chemicals of concern.

The Model Criteria addresses two types of groundwater monitoring activities: 1) area-specific GMP and 2) the RMP. Water quality information collected will be used to evaluate groundwater and hydrogeological conditions, including establishing a baseline of water quality that will be used to assess future potential impacts. State Water Board staff will consider both the USGS and operator recommendations when assessing collected data and information.

Action #1: Regional Monitoring Program Technical Briefings. In 2018, the USGS provided semi-annual technical briefings on the following subjects to the Oil and Gas Stakeholders.

- January 30, 2018 Oil and Gas Monitoring Stakeholder Meeting
  - Update on RMP Activities
  - Groundwater salinity mapping using geophysical log analysis within the Fruitvale and Rosedale Ranch oil field
  - Results from the RMP Study of the Fruitvale oil field
  - Tracing enhanced oil recovery signatures in casing gases using noble gases
- June 12, 2018 Oil and Gas Monitoring Stakeholder Meeting
  - Update on RMP Activities
  - Aquifer architecture and salinity in the Tulare Formation, Lost Hills and Belridge oil fields Areas
  - Groundwater salinity mapping adjacent to the Lost Hills and Belridge oil fields using airborne geophysics
  - Regional patterns in the geochemistry of oil field water, Southern San Joaquin Valley
  - Groundwater Quality in the Lost Hills and Belridge Areas
- Past publications are located on the USGS' COGG Program website at https://ca.water.usgs.gov/projects/oil-gas-groundwater/.

State Water Board staff will continue to facilitate and provide technical briefings by the USGS on the RMP to stakeholders on a semi-annual basis. The first semi-annual stakeholder meeting in 2019 was held on February 25, 2019.

Action #2: USGS Interactions with Operators in Advance of RMP Sampling. The State Water Board initiated new steps in March 2018 to improve the interaction between the USGS and the operator(s) when a new study area is proposed. The objective of these changes was to improve transparency of the RMP and to convey the importance of the program to the overall approach in assessing the potential effects from oil production on the groundwater resources in the state of California. A summary of USGS interactions with operators prior to sampling efforts is provided in Table 5-3. ***In 2019, these interactions with operators in advance of RMP sampling will continue.***

Table 5-3. Regional Monitoring Program
Interaction with Operators in Advance of Sampling

Steps/Actions	Elements of each Action	Timeline
Email notification to operator	High level overview of the RMP.	60 days in advance of mobilization
	Scope of the sampling program/summary of samples to be collected ("the what").	
	Rationale for selecting sampling points ("the why").	
	Overarching goals of the sampling program ("why we're looking for the data").	
	Logistics for sampling.	
	Points of contact.	
	Attachment - Written summary of sampling objectives, a general history of fluid flow, and proposed areas and depth zones for sampling.	
Kickoff meeting	PowerPoint presentation of the proposed field program.	30 days in advance of mobilization
	Dialogue between SWRCB/USGS and operator regarding the proposed field program.	
Follow-up	Operators provide input and feedback on the proposed sampling program.	14 days in advance of mobilization
	Iterative discussions between SWRCB/USGS and operator regarding sampling program plans and logistics.	

Action #3: Provide an analysis of preliminary data of the most significant results. A summary of the results of the data collected is provided in Section 2.4 for the area-specific groundwater monitoring and in Section 4.3 of the RMP. USGS and Water Boards staff held regular internal meetings in 2018 to collaborate and share findings from the RMP. Additionally, on May 30, 2018, State Water Board and USGS staff met to review data collected as part of area-specific GMPs in comparison to data that has been collected as part of the RMP. ***In 2019, State Water Board and USGS staff will continue to evaluate monitoring data collected as part of both the RMP and area-specific monitoring programs.***

Strategy #2: Mitigate problems as they occur and share mitigation efforts with stakeholders.

Action #1. Implement Action Plan. If data demonstrates a potential water quality or public health concern, Water Boards staff will expeditiously work with the appropriate Regional Water Board and/or Division of Drinking Water staff to address the issue. Data collected thus far has not necessitated action to be taken.

Action #2: Continue to work with the USGS and other state agencies to better understand which compounds used in WST fluids are the most appropriate tracer and/or indicator compounds. In April 2018 and October 2018, a working group including Water

Boards, USGS, DOGGR, Lawrence Berkeley National Laboratory, California Department of Toxic Substances Control, and California Air Resources Board staff held a meeting to gather more information on identified indicator compounds or tracer compounds from new research studies. Additional meetings were held with Division of Drinking Water staff to identify appropriate analyses and lab certification for uncommon chemicals associated with WST fluids. ***In October 2018, this group merged with the Produced Water Studies Interagency Coordination group and will continue to meet on a bi- or tri-annual basis in 2019 as this work is ongoing.***

Strategy #3: Develop a plan to re-evaluate the effectiveness of monitoring. Modify the scope of work and approach based on evaluation of the data collected and evaluated.

Action #1: Re-evaluate Model Criteria.

1. **October 2018 Operator Feedback Survey** - In October 2018, State Water Board staff requested feedback from operators on implementation of the Model Criteria. Consolidated feedback was received from WSPA on November 21, 2018. Some feedback was used to make immediate changes. For example, Water Boards staff have been working to ensure that comments on GMPs are directly tied to requirements of the Model Criteria. ***State Water Board staff will continue to request feedback from operators in 2019. All feedback will be considered as the Model Criteria is re-evaluated.***

2. **Review the Definition of Protected Water**. In accordance with Water Code § 10783(k)(2), the use of the USEPA's definition of an USDW as containing less than 10,000 mg/L TDS in groundwater (40 CFR part 144.3) and whether exempt aquifers pursuant to 40 CFR part 146.4 shall be subject to groundwater monitoring shall be reviewed by the state board through a public process on or before January 1, 2020. ***State Water Board staff will host a public "Staff Workshop" to review this issue in 2019.***

Action #2: Compliance to Area-Specific Monitoring Program - Operator Sampling for Indicator Compounds. The Model Criteria requires operators to sample for indicator compounds. In 2018, State Water Board staff reviewed operator's ESI data for the identification of and sampling for indicator compounds in groundwater samples. The State Water Board's findings identified the following issues: 1) operators not identifying indicator compounds in GMPs, 2) operators not sampling for specified indicator compounds when identified in GMPs, and 3) operators not reporting indicator compounds in ESI data uploads. State Water Board staff worked with operators to identify corrective actions to bring area-specific GMPs into compliance with the Model Criteria. The State Water Board also recognized that GeoTracker's list of chemical names related to WST chemical additives or their degradation products available for ESI data files was not up to date (refer to Goal #1, Strategy #1, Action #1) and made necessary corrections. ***State Water Board staff will work with the operators to provide a list of possible indicator and/or tracer compounds in the submittal for a GMP (new or addendum).***

Action #3: Re-evaluate Area-Specific GMP and RMP. State Water Board staff developed a plan to re-evaluate the effectiveness of the Model Criteria and to provide on-going program evaluation. Elements and status of the evaluation of each program is provided below:

Area-specific monitoring

- Groundwater data collected during area-specific sampling events will be used to establish a baseline of water quality conditions at localized areas.
- Results of groundwater sampling data along with the composition of the well stimulation fluids used will 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 were asked to complete a survey in October 2018 and provide suggestions to improve the process. The responses from that survey will be considered in any recommended changes to the Model Criteria.

Regional Groundwater Monitoring: The USGS plans to assess the RMP data following three years of interpretive data collection, which is expected to occur in Spring 2020. The USGS will include information collected as part of the area-specific monitoring in the analysis, as well. Based on the result of the analysis, the USGS will make recommendations for potential revision(s) to the Model Criteria.

State Water Board staff plan to initiate discussions with technical experts and stakeholders in 2019 to evaluate the effectiveness of both monitoring programs.

Strategy #4: Coordinate with other agencies to identify risk.

Action #1: Gather, Consolidate, and Publish Significant Findings. Significant findings from the RMP to date are provided in Section 4.3 of this report and a list of current publications is provided in Sections 4.1 and 4.2 of this report.

Action #2. Gather, Consolidate, and Publish Lessons Learned. State Water Board staff requested a list of lessons learned from the staff at the Regional Water Boards, USGS, and DOGGR. The accumulated lessons learned during this reporting period are provided in Section 6.0 of this report.

5.4 Goal #4: Provide Region-Specific or Localized Flexibility Where Possible

Water Boards staff consider localized conditions (i.e., geologic, hydrogeologic, land use restrictions, access restrictions, monitoring frequency) when reviewing GMPs or Requests for Exclusion. The strategies for this goal include:

1) Consider local conditions when reviewing GMPs.

2) Clearly communicate why region-specific activities are occurring.

3) Use consistent flexibility criteria for monitoring.

The Model Criteria allows for alternative GMPs. As discussed in Section 2.2, one alternative plan was submitted in 2018. Based on Water Boards staff comments related to hydrogeologic data gaps, the operator revised the GMP to meet Model Criteria requirements. Additionally, the RMP is geared towards evaluating any regional geological trends that may provide further guidance in the review of those plans. As these region-specific conditions are identified (see Section 4.0 of this report), they are included in this report.

5.5 Goal #5: Assess Implementation Costs

State Water Board staff, in cooperation with operators and representatives from CIPA and 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.

5.5.1 Operator Costs

Estimated operator costs for the periods of 2014 through 2016, 2017, and 2018 are summarized in Table 5-4. The total costs reported by operators for groundwater monitoring declined by 61 percent in 2018 (a total cost of $1,143,831 was reported in 2018 vs. $2,965,708 in 2017). The number of GMPs developed, samples collected, samples analyzed, and wells stimulated increased in 2018. However, the number of monitoring wells installed in 2018 declined by 33 percent. The total cost for groundwater monitoring declined in 2018 likely because the capital costs associated with installation of new wells also declined.

The total costs reported by operators for Requests for Exclusion declined by 39 percent ($46,400 in 2018 vs. $76,075 in 2017). The number of Requests for Exclusion increased in 2018; the number of WSTs in areas of previously approved exclusions remained about the same (115 wells in 2018 vs. 122 wells in 2017).

The estimated groundwater monitoring cost per sample; groundwater monitoring cost per barrel of oil; and average cost of compliance per monitoring well all declined in 2018 compared to 2017. The average cost of compliance has declined because many operators have already established GMPs and capital costs to install new monitoring were realized in prior years.

Table 5-4. Estimated Operator Costs Provided by CIPA and WSPA

		2014 through 2016 (1)	2017	2018
Groundwater Monitoring				
GMPs	Number of New GMPs Developed	19	7	**16**
	Total Cost	$517,250	$207,843	**$131,719**
Monitoring Well Installation	Number of Wells Installed	19	12	**8**
	Total Cost	$5,806,232	$2,000,673	**$351,744**
Sampling and Reporting	Number of Samples Collected	105	85	**106**
	Number of Reports Submitted	28	12	**12**
	Total Cost	$990,000	$418,702	**$273,423**
Laboratory Testing	Number of Samples Analyzed	86	80	**106**
	Total Cost	$172,500	$188,490	**$288,345**
Other Subcontractor and Consultant Fees		$111,969	$150,000	**$98,601**
Total Cost (Capital + Opex)		*$7,597,951*	*$2,965,708*	***$1,143,831***
Number of Well Stimulation Treatments Performed		176	34	**129**
Oil Production from Stimulated Wells (bbl)		1,362,969	451,478	**312,501**
Exclusions from Groundwater Monitoring				
Numbers of Requests for Exclusion		11	7	**29**
Total Cost		*$73,710*	*$76,075*	***$46,400***
Number of Well Stimulation Treatments Performed		1,089	122	**115**
Oil Production from Stimulated wells (bbl)		9,438,976	296,336	**523,299**
Regional Monitoring Program				
Estimated Total Operators Cost		*$15,000*	*$18,000*	***$265,525***
Summary Table				
Oil Produced subject to Model Criteria Requirements (bbl)		10,801,945	747,814	**835,800**
Estimated Groundwater Monitoring Cost per Sample		$72,361	$34,891	**$10,791**
Groundwater Monitoring Cost per bbl of oil		$5.57	$6.57	**$3.66**
Average Cost of Compliance per Monitoring Well		$43,170	$87,227	**$8,867**

Note: (1) Reporting period equal to 2.5 years.
bbl = barrel(s) of oil

5.5.2 State Water Board Costs

Statewide 14 Water Boards staff positions are dedicated to work on implementing the Model Criteria (approximately $2.45 million per year). The USGS is under a contract agreement with the Water Boards to implement the RMP at approximately $7.25 million per year (via the Oil, Gas and Geothermal Administrative Fund).

6.0 LESSONS LEARNED AND PLANNED ACTIONS FOR 2019

This section summarizes lessons learned from State Water Board, DOGGR, Central Valley Water Board, and USGS staff this past year. Please note that GMPs and Requests for Exclusion reviewed this year were all located within the Central Valley Regional Water Quality Control Board's boundaries.

Table 6-1 organizes the lessons learned to align with the five (5) Performance Measure goals: transparency and availability of online information and documentation; clear milestones and timely deliverables; understand and mitigate the impacts of well stimulation on water quality and public health; provide region-specific or localized flexibility; and assess costs of implementation. This table describes the lesson, the relative impact to the Model Criteria program, and the next steps or actions planned for 2019.

Table 6-1. Model Criteria - Lessons Learned and Planned Actions for 2019

Performance Measure Goal	Lesson	Next Steps/Actions for 2019
Goal #1: Transparency and Availability of Online Information and Documentation	GeoTracker updates for the public portal are periodically needed.	The GeoTracker mapping function will be updated to show boundaries of approved GMPs or Exclusions by adding fill colors to improve readability for the public and regulator. The list of available chemical names for ESI data will be reviewed and new analytes added as a new GMP is approved.
	Operator's perspective of the Water Board's information portals (i.e., GeoTracker GAMA, State Water Board's Oil and Gas Monitoring Program website) should be evaluated.	State Water Board staff will continue to ask operators for feedback and collaborate in 2019 to reduce duplication across respective web portals.
	GeoTracker and DOGGR's newly released WellSTAR website provide operators online access to their data. Any unnecessary overlaps or data gaps in data systems should be evaluated.	State Water Board and DOGGR staff will continue to discuss future well stimulation data sharing between GeoTracker and DOGGR's WellSTAR system to leverage existing capabilities, reduce redundancies between agencies, and meet the Model Criteria data needs.
	Data sharing and coordinated communications amongst the Water Boards, USGS, and DOGGR are necessary to provide effective data exchange and collaboration between the organizations.	State Water Board and the USGS will exchange data using GeoTracker as the primary data collection system.
		Water Boards and DOGGR staff will continue to hold teleconferences in 2019 to discuss comments and explore questions arising from reviews of well stimulation permit applications.

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Table 6-1. Model Criteria - Lessons Learned and Planned Actions for 2019 (cont'd)

Performance Measure Goal	Lesson	Next Steps/Actions for 2019
Goal #2: Provide Clear Milestones and Timely Deliverables	Tracking the status of Senate Bill 4 deliverables is necessary to deliver on these milestones in a timely manner.	Water Boards staff will be holding a public Workshop to facilitate discussions on the definition of protected water (scheduled for May 2019). An update from DOGGR will be provided following review and evaluation for acid matrix threshold values.
	Annual performance evaluation is a necessary step for continuous improvement of the program.	State Water Board staff will prepare the 2019 Annual Model Criteria Performance Report – Final publication anticipated March 2020.
	The development of standard procedures, checklists, and staff training are critical for statewide consistency and efficient program implementation.	Conduct periodic review and update of procedures, process flowcharts, and checklists based on lessons learned to streamline reviews.
	Review processes used by State Water Boards staff are continuously updated and improved upon, and clearly communicating and training staff members on up-to-date processes is important.	State Water Board staff will hold monthly team meetings to discuss document processes and procedures for Model Criteria-related tasks.
		For the purpose of streamlining reviews and avoiding duplicative efforts between Water Boards staff and DOGGR staff, periodic review and updates of procedures, process flowcharts, and checklists will be conducted based on lessons learned.
	The process of compiling the review timeline for GMPs, GMP Addenda, Requests for Exclusions, and requests to add WST wells to existing areas of exclusion on an annual basis could be improved	The State Water Board will utilize tools in GeoTracker to better track review status for GMPs, Requests for Exclusion reviews. Utilization of GeoTracker tools will allow Water Boards staff to routinely assess timeliness and improves upon current process of manual tabulation.
		Key communications between State Water Board staff and operators will be documented, and any action items will be tracked to ensure they are resolved in a timely manner.

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Table 6-1. Model Criteria - Lessons Learned and Planned Actions for 2019 (cont'd)

Performance Measure Goal	Lesson	Next Steps/Actions for 2019
Goal #2: Provide Clear Milestones and Timely Deliverables, cont'd	Hydrogeologic and geologic conditions that exist at these oil fields can be very complex; thereby, review time may exceed goal.	Water Boards staff will continue to work with the operators as efficiently as possible during the review process and proactively communicate any of the Water Boards' concerns.
Goal #3: Understand and Mitigate the Impacts of Well Stimulation on Water Quality and Public Health	Transparency of data and findings is essential for program success.	State Water Board staff will continue to schedule semi-annual technical briefings with stakeholders to communicate findings of the RMP.
	The operators have valuable site-specific data and knowledge that improves the design of the RMP sampling program.	The USGS will continue to provide a summary of site characteristics and site selection criteria as part of the notification to operators prior to RMP sampling. As part of this notification, the USGS will request input from operators' technical experts during the design of the sampling program.
	Implementability of the Model Criteria from the operator's perspective has not been evaluated.	State Water Board staff will compile and evaluate responses from the operators regarding the implementation of the area-specific GMP and feedback for suggested modifications to the Model Criteria.
	Preliminary data requires further analysis.	State Water Board and USGS staff will continue to evaluate monitoring data collected as part of both the RMP and the area-specific monitoring programs.
	Better understanding of tracer and/or indicator compounds is needed to determine the persistence of WST fluids.	State Water Board will continue to meet on a bi- or tri-annual basis along with the USGS, DOGGR, Lawrence Berkeley National Laboratory, California Department of Toxic Substances Control, and California Air Resources Board to evaluate tracer and/or indicator compounds. State Water Board staff will work with the operators to provide a list of possible indicator and/or tracer compounds in the submittal for a GMP (new or addendum).
	The Model Criteria should be re-evaluated based on lessons learned.	State Water Board staff will begin evaluation of the Model Criteria in 2019. Continue to request feedback from operators, work with the operators on indicator and/or tracer compounds for GMPs (new or addenda), and initiate discussions with technical experts and stakeholders to evaluate the effectiveness of both monitoring programs.

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Table 6-1. Model Criteria - Lessons Learned and Planned Actions for 2019 (cont'd)

Performance Measure Goal	Lesson	Next Steps/Actions for 2019
Goal #4: Provide Region-Specific or Localized Flexibility where Possible	Lessons and future steps or actions will be evaluated on a case-by-case basis.	
Goal #5: Assess Implementation Costs	Implementation costs are reported annually and included in the Performance Measures report.	

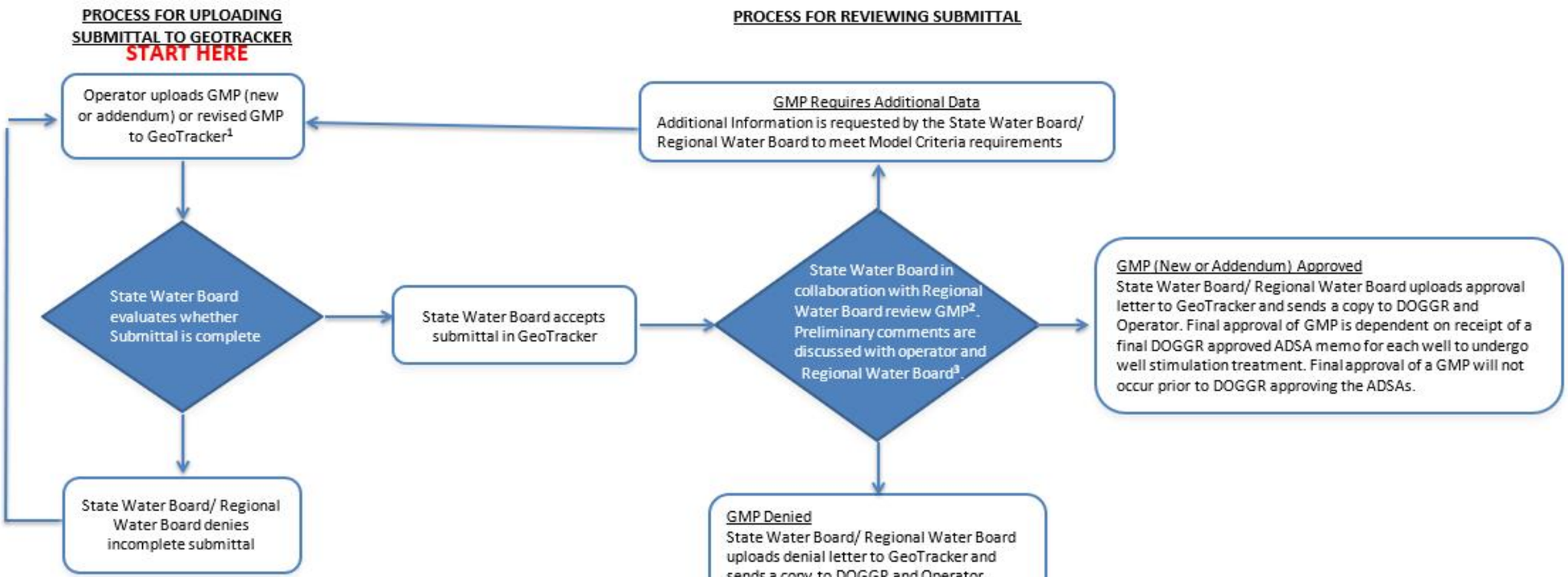
APPENDIX A
PROCESS FLOWCHARTS

APPENDIX A: LIST OF FLOWCHARTS

Flowchart A-1. Process Flowchart for Uploading and Reviewing Area-Specific Groundwater Monitoring Plans (New or Addendum)

State Water Resources Control Board

Oil and Gas Monitoring Unit



DEFINITIONS

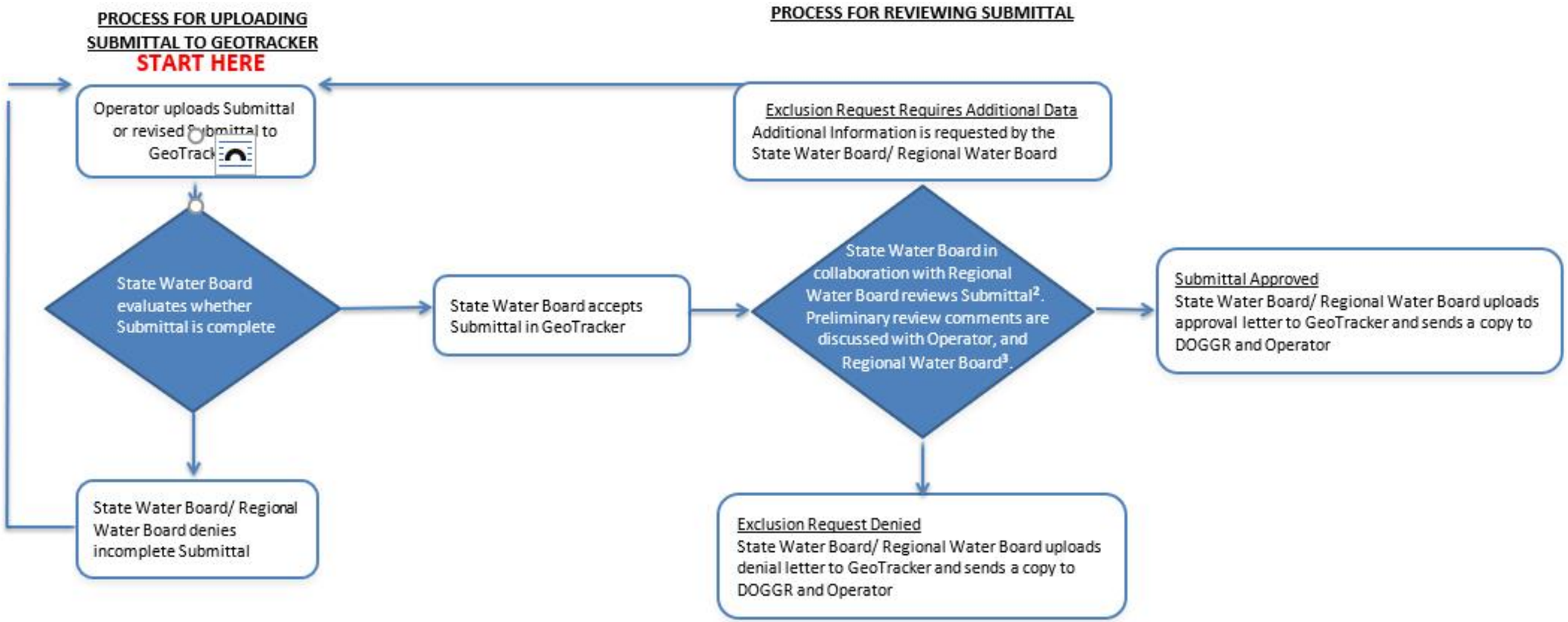
ADSA = Axial Dimensional Stimulation Area
DOGGR = Division of Oil, Gas, and Geothermal Resources
GMP = Groundwater Monitoring Plan
Regional Water Board = Regional Water Quality Control Board
State Water Board = State Water Resources Control Board

FOOTNOTES

1. New monitoring plans, or addenda 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 GMP.

Flowchart A-2. Process Flowchart for Reviewing Request for Exclusion from Groundwater Monitoring

State Water Resources Control Board
Oil and Gas Monitoring

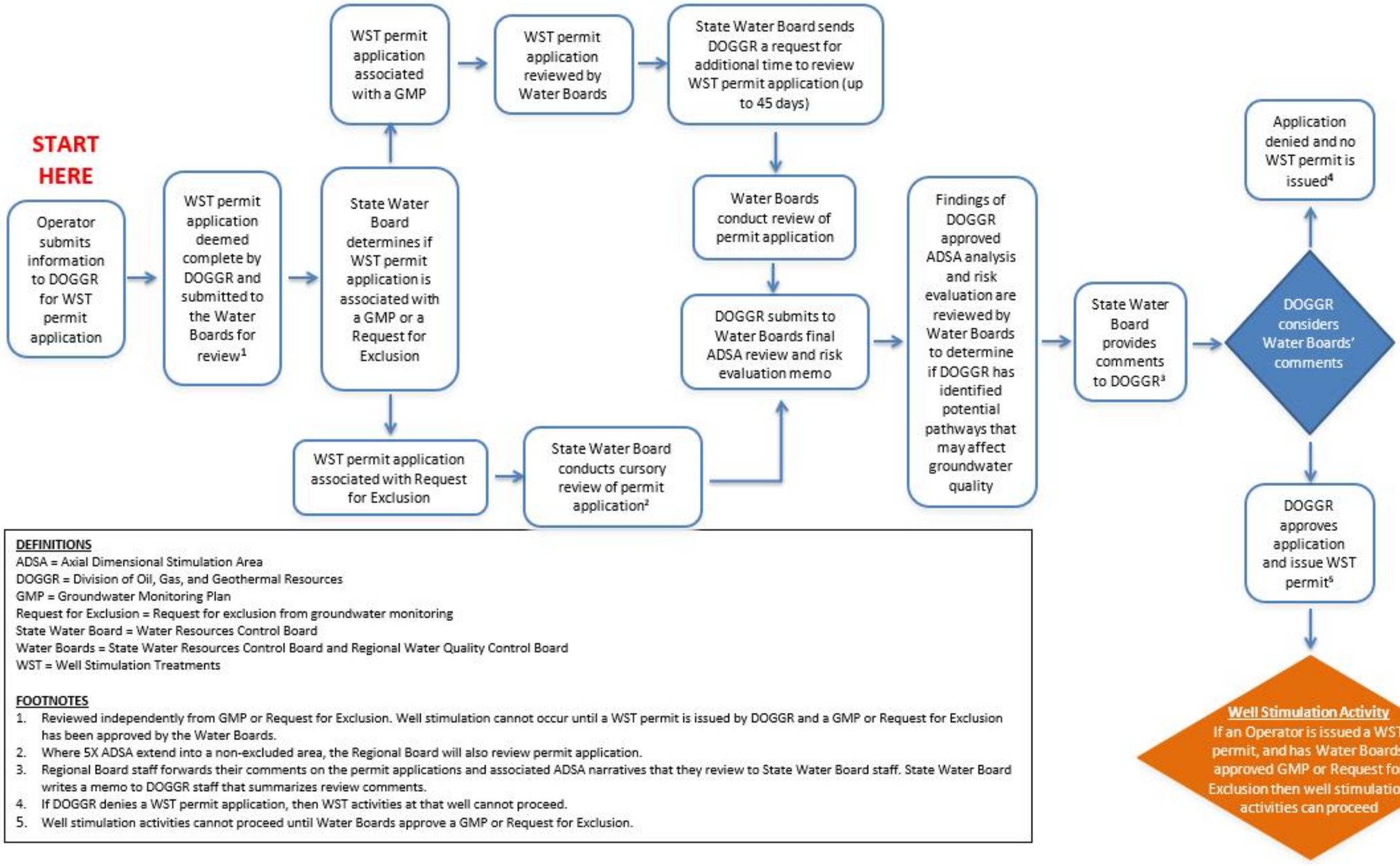


DEFINITIONS
DOGGR = Division of Oil, Gas, and Geothermal Resources
Regional Water Board = Regional Water Quality Control Board
Submittal = Request for Exclusion from Groundwater Monitoring
State Water Board = State Water Resources Control Board

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.

Flowchart A-3. Process Flowchart for Reviewing Well Stimulation Permit Applications

State Water Resources Control Board
Oil and Gas Monitoring Unit



DEFINITIONS

ADSA = Axial Dimensional Stimulation Area
DOGGR = Division of Oil, Gas, and Geothermal Resources
GMP = Groundwater Monitoring Plan
Request for Exclusion = Request for exclusion from groundwater monitoring
State Water Board = Water Resources Control Board
Water Boards = State Water Resources Control Board and Regional Water Quality Control Board
WST = Well Stimulation Treatments

FOOTNOTES

1. Reviewed independently from GMP or Request for Exclusion. Well stimulation cannot occur until a WST permit is issued by DOGGR and a GMP or Request for Exclusion has been approved by the Water Boards.
2. Where 5X ADSA extend into a non-excluded area, the Regional Board will also review permit application.
3. Regional Board staff forwards their comments on the permit applications and associated ADSA narratives that they review to State Water Board staff. State Water Board writes a memo to DOGGR staff that summarizes review comments.
4. If DOGGR denies a WST permit application, then WST activities at that well cannot proceed.
5. Well stimulation activities cannot proceed until Water Boards approve a GMP or Request for Exclusion.

APPENDIX B

ORIGINAL PERFORMANCE MEASURES

Goals	Strategy
Goal #1: Transparency and availability of online information and documentation.	1.1 Improve and expand upon available datasets and the ability to analyze and manipulate that data.
	1.2 Improve online user experience with simplified and clear messaging to make data easier to access.
	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.
Goal #2: Provide clear milestones and timely deliverables.	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.
	2.2 Prepare review processes, flowcharts, and timelines for reviewing GMPs and requests for exclusion from groundwater monitoring, including interagency collaboration and program efficiencies.
Goal #3: Understand and mitigate impacts of well stimulation on water quality and public health.	3.1 Provide regular assessments of monitoring data, including pilot study results and identification of any chemicals of concern.
	3.2 Mitigate problems as they occur and share mitigation efforts with stakeholders.
	3.3 Develop a plan to re-evaluate the effectiveness of monitoring. Modify the scope of work and approach based on evaluation of the data collected and evaluated.
	3.4 Coordinate with other agencies to identify risk.
Goal #4: Provide region-specific or localized flexibility where possible.	4.1 Consider local conditions when reviewing groundwater plans.
	4.2 Clearly communicate why region- specific activities are occurring.
	4.3 Use consistent flexibility criteria for monitoring.
Goal #5: Assess implementation costs.	5.1 Assess implementation cost for the State Water Board and stakeholders.