WELL STIMULATION TREATMENT ANNUAL REPORT

Program Assessment
August 2023

Reporting Period: January 1, 2020 to December 31, 2020
Prepared Pursuant to Senate Bill 4 (Ch. 313, Stats. of 2013)

(This page intentionally blank.)

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS, ABBREVIATIONS & UNITS

ADSA	Axial Dimensional Stimulation Area
BBLS	barrels
CalGEM	California Geologic Energy Management Division
CAS	Chemical Abstract Service
CCR	California Code of Regulations
CEQA	California Environmental Quality Act
DOC	Department of Conservation
DOF-OSAE	Department of Finance – Office of State Audits and Evaluations
EIR	Environmental Impact Report
FT	feet
IWSTN	Interim Well Stimulation Treatment Notice
LLC	Limited Liability Corporation
LLNL	Lawrence Livermore National Laboratory
µg/L	micrograms per liter
mg/L	milligrams per liter
NOD	Notice of Deficiency
NOV	Notice of Violation
OSAE	Office of State Audits and Evaluations
pCi/L	picocuries per liter
PRC	Public Resources Code
RF	Recovered Fluid Sample
SB 4	California State Senate Bill 4 (Pavley, Ch. 313, Statutes of 2013)
SOP	Standard Operating Procedure
TVD	True Vertical Depth
UIC	Underground Injection Control
WST	Well Stimulation Treatment
WellSTAR	Well Statewide and Reporting System

ABOUT THE CALIFORNIA GEOLOGIC ENERGY MANAGEMENT DIVISION

The California Geologic Energy Management Division (CalGEM) prioritizes the protection of public health, safety, and the environment in its oversight of the oil, natural gas, and geothermal operations in California. To do that, CalGEM uses science and sound engineering practices to regulate the drilling, operation, and permanent closure of energy resource wells. CalGEM also regulates certain pipelines and facilities associated with production and injection.

When CalGEM was established in 1915 (then known as the Division of Oil, Gas, and Geothermal Recovery), the initial focus of regulation was the protection of oil and gas resources in the state from production practices that could harm the ultimate level of hydrocarbon recovery. Early CalGEM regulations included well spacing requirements and authority to limit production rates. In 2019 CalGEM's mission changed to focus on the protection of public health and safety, environmental quality, and the reduction and mitigation of greenhouse gas emissions associated with the development of hydrocarbon and geothermal resources in a manner that meets the energy needs of the state.

In 2020 CalGEM operated out of four districts: Coastal, Northern, Inland, and Southern (Figure 1).[1] Each district has its own offices where staff are available to assist the public and stakeholders. CalGEM districts are responsible for all field oversight of Well Stimulation Treatment (WST) operations, including witnessing pre-WST pressure tests, WST operations, and chemical spot-checks during stimulation. District duties also include a review of the 72- Hour Notification form and a final review of all relevant well logs prior to the start of the treatment.

For more information about CalGEM, visit CalGEM's website at: https://www.conservation.ca.gov/CalGEM.

All WST permit applications and post-WST data submissions are reviewed and approved by CalGEM headquarters WST program staff. For more information about WSTs, visit: https://www.conservation.ca.gov/calgem/Pages/WST.aspx

For questions regarding the content of this report, contact DOC's Public Affairs Office at pao@conservation.ca.gov.

[1] In mid-2021, CalGEM reorganized its districts from four to three – Coastal and Northern Districts merged to form a new Northern District. The change brings the new Northern District into parity with the other two Districts, Southern and Inland, in terms of staff size and leadership structure.

FIGURE 1: 2020 CalGEM District Locations Map

1.0 EXECUTIVE SUMMARY

This 2020 annual report is CalGEM's fifth annual report summarizing WST activities in California. This report satisfies the legislative reporting requirements of Senate Bill (SB) 4 (Pavley, Ch. 313, Statutes of 2013). The reporting period discussed herein spans from January 1, 2020, through December 31, 2020. This report also discusses WST data collected since the January 1, 2014 implementation of interim SB 4 regulations to regulate well stimulation activities in California. Permanent regulations were subsequently adopted, effective July 1, 2015.

During the 2020 reporting period, CalGEM continued to implement its stringent approach to regulating well stimulations. Only 83 permits to conduct stimulations were issued in 2020, which continues a decline seen since 2018 in the number of permits issued each year. For the first time since the implementation of the WST program, 57 permits were denied in 2020 mainly due to the lack of valid Kern County job cards for California Environmental Quality Act (CEQA) review.

While 83 permits were approved in 2020, only 58 wells were stimulated. The number of permits approved and wells stimulated is not one-for-one because operators have one year from the date of permit issuance in which to perform the stimulation. The 58 wells stimulated during the reporting period are located solely in western Kern County, in mature oil fields that have been stimulated since, as well as prior to, the implementation of WST regulation in California. The stimulations performed in 2020 were completed without any reported spills, incidents, or well failures, which continues the long-term trend of safe performance observed since regulation implementation.

The annual oil production volume from wells stimulated under approved WST permits issued since the beginning of the permanent WST regulatory period reached a high of approximately 2.25 million BBLS during the 2020 reporting period. CalGEM calculated the 2020 WST production volume by taking the production data from permitted WST wells stimulated since the start of the permanent WST regulatory regime in 2016 through the end of 2020. Therefore, the 2.25 million BBLS figure accounts for all 2020 production from wells that were stimulated at any time since 2016. As total 2020 oil production volume in California is approximately 144.6 million BBLS, production from wells stimulated under the permanent WST regulatory period is approximately 2 percent.

CalGEM also took additional measures to further strengthen its WST program by having Lawrence Livermore National Laboratory (LLNL) and the Department of Finance - Office of State Audits and Evaluations (DOF-OSAE) review its permitting processes. The reviews performed by LLNL and DOF-OSAE found that CalGEM's WST program is fulfilling its mandate to issue WST permits in compliance with statutory and regulatory requirements.

CalGEM continues its increasingly stringent approach to WST management as the WST program completes the processing of a backlog of permit applications received prior to implementation of the Division's online electronic database known as the Well Statewide Tracking and Reporting System (WellSTAR) and begins the move towards reviewing applications wholly received through WellSTAR. Permit reviews will continue to be performed in compliance with all statutory and regulatory requirements with a focus on risk mitigation to ensure public safety and environmental protection.

2.0 INTRODUCTION

A WST is a treatment of a well designed to enhance oil and gas production or recovery by increasing the permeability of geologic formation containing oil and gas. Hydraulic fracturing is a type of WST. Acid fracturing (hydraulic fracturing where acid is the primary WST fluid) and acid matrix stimulation (an acid treatment of a formation at low pressure that does not create fractures) are other types of well stimulations; however, these stimulation types are rarely completed in California and have only been performed 20 times (out of a total 2,224 stimulations) since the beginning of the WST program in 2014. The most recent acid fracturing stimulation was completed in August 2018.

Hydraulic fracturing is the most common type of WST used in California. The hydraulic fracturing process involves injecting a mix of fluids (primarily water), sand (proppant), and chemical additives at high pressure into an oil or gas reservoir. WSTs do not include steam flooding, water flooding, or cyclic steaming, which are Enhanced Oil Recovery (EOR) techniques. WST is a well completion technique that is typically completed before using the well to extract oil. Compared to EOR injections, WSTs are short-term, discrete injection operations that are designed to increase reservoir permeability.

WSTs became regulated in California with the passage of SB 4, which was signed into law on September 20, 2013. On January 1, 2014, interim WST regulations were issued pending the development of permanent regulations. On July 1, 2015, permanent WST regulations went into effect, with new WST permit application requirements, including requirements for review by multiple state and local government agencies, neighbor notifications, CEQA review, advanced notification for witnessing by regulatory agencies, seismic monitoring, and submission of a comprehensive post-stimulation report including recovered fluid sampling. In September 2016, CalGEM issued its first WST permits under the permanent WST program.

As directed by Governor Gavin Newsom, in November 2019, CalGEM took steps to further strengthen its regulatory review of WST permits by initiating a third-party scientific review of pending permit applications to ensure the state's technical standards for public health, safety, and environmental protection are met prior to the approval of each permit. CalGEM retained experts at the LLNL to assess the WST permit review process and evaluate the completeness of operators' application materials and the CalGEM's engineering and geologic analyses.

The LLNL review process and recommendations derived from the review are discussed in Section 3.1.

In addition to the third-party review by LLNL, the DOF- OSAE also reviewed the CalGEM's WST and Underground Injection Control (UIC) permitting programs to ensure compliance with oil and gas statutes and regulations. Released in November 2020, the audit report includes recommendations to strengthen operational processes and procedures discussed further in Section 3.2.

3.0 WELL STIMULATION TREATMENT PROGRAM UPDATE

In late 2019, Governor Gavin Newsom approved new oil and gas initiatives that included a requirement for a third-party assessment of pending WST applications before new WST permits were issued. CalGEM retained the expertise of LLNL scientists to provide the independent scientific review of pending applications. LLNL is drafting a summary report of the WST review activities it completed in 2020 and the recommendations stated in each of the assessment reports. In addition, the Governor's Office requested for DOF-OSAE to conduct an audit of the WST permitting program. The DOF-OSAE's Final Report – California Department of Conservation, Underground Injection Control and Well Stimulation Treatment Programs, Performance Audit, was released on November 23, 2020. The recommendations from each review are presented in Sections 3.1 and 3.2, respectively.

CalGEM has also taken strides to improve the transparency of WST operations and data within California by releasing two publicly accessible data programs. CalGEM's WellSTAR became available in 2019, allowing operators to submit WST data (along with other oil and gas data) to the Division in a more streamlined and standardized format. In December 2019, WST permit and disclosure data was also made available to the public through the publicly accessible part of WellSTAR. In late 2020, CalGEM's new Power BI data dashboards provide the public customizable charts and tables of WST permit and disclosure data in an easily accessible format that is updated nightly.

Public users can view and search WST records and connect to CalGEM's Well Finder online map to view spatially related data for completed WSTs.

Other state agencies have also been engaged in the oversight of WST operations and their potential impacts in California. The California Air Resources Board (CARB) recently released two studies that aimed to help assess air impacts of well stimulation treatment operations in California. The studies conducted are discussed in Section 3.5.

3.1 Lawrence Livermore National Lab Review

In November 2019, CalGEM engaged experts from LLNL to conduct a third-party scientific review of pending WST permit applications. This scientific review, which assesses the methodology and completeness of each proposed permit

application, ensures that the state's technical standards for public health, safety, and environmental protection are met prior to the approval of the permit.

To ensure proposed permits comply with California laws, the experts at the LLNL are tasked with: (1) determining whether the WST review process is consistent with the guiding regulations; (2) ensuring that the supporting information, especially that pertaining to the Axial Dimensional Stimulation Area (ADSA) determination, is adequately documented and that the reasoning and data supporting are sound and;(3) formulating recommendations for continued WST monitoring to accompany permitted projects.

LLNL's scientific review of the permit applications and process confirmed that the permitting process meets statutory and regulatory requirements. LLNL found that CalGEM could improve its evaluation of the technical models used in the permit approval process. As a result, CalGEM started requiring all operators to provide an ADSA Narrative Report for each oilfield and fracture interval as part of the CalGEM permitting process starting in January 2020. This assists CalGEM as it independently validates each applicants' fracture modeling. The approved ADSA Narrative Report is a required reference in the Frac Modeling Narrative accompanying each WST permit application.

LLNL has reviewed and evaluated five ADSA Narrative Reports, submitted by different operators (Aera, Chevron, and CRC), for the Lost Hills, South and North Belridge, and Buena Vista Nose oil fields. In addition to providing a review of ADSA Narrative Reports, LLNL also provided an independent third-party review of the entire WST permit application for 85 applications in 2020. LLNL's scientific review of well stimulation permit applications and technical processes is currently in its final stage. LLNL is drafting a summary report of the WST review activities it completed in 2020 and the recommendations stated in each of the assessment reports.

The findings to date from the technical review by the LLNL can be found at: https://www.conservation.ca.gov/calgem/Pages/Well-Stim-National-Lab-Scientific-Review.aspx

3.2 Department of Finance – Office of State Audits and Evaluations Audit

In accordance with Government Code sections 13070 and 13293 through 13295, the DOF-OSAE conducted a third-party performance audit of CalGEM's WST program to evaluate the WST program's permit approval process for compliance with statutes and regulations. The audit reviewed a total of 33 WST permits issued between January 1, 2019 through October 31, 2019.

The DOF-OSAE's Final Report – California Department of Conservation, Underground Injection Control and Well Stimulation Treatment Programs, Performance Audit, was released on November 23, 2020. The DOF-OSAE audit concluded that CalGEM's WST permitting process was in overall compliance with the WST statutes and regulations. The findings for WST by the DOF-OSAE indicated that improvement is needed to ensure that ADSA review and risk assessment review determinations are supported and documented consistently, with better document retention.

CalGEM's responses to specific WST audit findings included: recognition of the need for CalGEM's WST permitting Standard Operating Procedure (SOP) to impose a requirement for more stringent verification of two times the ADSA (2xADSA) documentation; identification of all wells in the surface projection within the 2xADSA (including wells that do not penetrate the 2xADSA as well as those that do) in the risk assessment template; updating the risk assessment template used in the WST application to incorporate the WST SOP updates; and ensuring that sufficient review documentation and files supporting the evaluation of WST risk are adequately retained and accessible. The permitting process SOP has since been updated to reflect all the changes.

The DOF-OSAE audit report can be found here: https://esd.dof.ca.gov/reports/reportPdf/5631D3F7-882E-EB11-9121-00505685B5D1/California Department of Conservation Underground Injection Control and Well Stimulation Treatment Programs Audit November 2020

3.3 WellSTAR

WellSTAR is CalGEM's comprehensive electronic database, developed to improve data collection and analysis, streamline operations and processes, and better adhere to the requirements of not only SB 4 but also other state and

federal laws. As of November 2019, all WST related forms and notifications are submitted and reviewed in WellSTAR. This 2020 reporting period is the first full year WST program data has been captured in WellSTAR.

Additionally, starting in December 2019, WST data became publicly viewable in WellSTAR, replacing CalGEM's previous public disclosure webpages. Public WellSTAR users can now view approved permit data and operator-submitted disclosure data. CalGEM continues to upload permit application data received before the implementation of WellSTAR into the WellSTAR system.

WellSTAR WST data can be viewed at:
https://wellstar-public.conservation.ca.gov/.

3.4 Power BI Public Data Dashboard

To further improve access to WST data, CalGEM has designed a data dashboard system using the Power BI business analytics service. The dashboard parses information from the WellSTAR system and presents it in customizable charts and tables with updated nightly data. The dashboards also provide links to detailed state well records and CalGEM's online mapping application, Well Finder. More than 99% of drilled wells (including all wells that have undergone stimulation) can be mapped and displayed through Well Finder.

The WST data dashboards for both permit and disclosure data can be viewed at: https://www.conservation.ca.gov/calgem/Online_Data/Pages/WellSTAR-Data-Dashboard.aspx

3.5 Air Resources Board Air Monitoring Data Analysis

SB 4 required CalGEM to collaborate and to enter into formal agreement with other state agencies including CARB on the WST regulatory oversight. As part of the agreement between CARB and CalGEM, air sampling and analysis are required as a permit condition of WST permits for selected stimulations. CARB contracted third-party experts from Stringfellow and Associates and PSE Healthy Energy to review and evaluate the WST air sample data and potential implications for human health. The results of the two studies conducted were detailed in recently released reports.

The goal of the Stringfellow and Associates study was to determine statistically significant differences in pollutant concentrations between hydraulic fracturing, cleanout activities, and nearby background concentrations. The goal of the PSE Healthy Energy study was to determine the potential implications for human health associated with air pollutants identified during hydraulic fracturing and cleanout activities. Both studies concluded that emitted volatile hydrocarbon concentrations during WST activities are at levels similar to general oil and gas production emissions and due to the short-term nature of the WST activities, emissions from WSTs are indistinguishable from background oilfield emissions. 64 out of approximately 150 tested toxic air pollutants, greenhouse gasses, atmospheric gasses, and volatile organic compounds were detected.

The results of both studies can be found on CARB's Analysis of Data Collected during Well Stimulation Treatment Operations website at: https://ww2.arb.ca.gov/resources/documents/analysis-data-collected-during-well-stimulation-treatment-operations

4.0 WELL STIMULATION TREATMENT DATA REVIEW

This section documents and discusses WST data relative to the 2020 reporting period and the entire period of WST regulation (beginning January 2014).

4.1 Permitting and Completions

A total of 83 WST permits were issued during the 2020 reporting period. This represents a 61% decrease in issued permits from the previous reporting period (213 issued in 2019).

It should also be noted that 57 WST permit applications were denied in 2020.

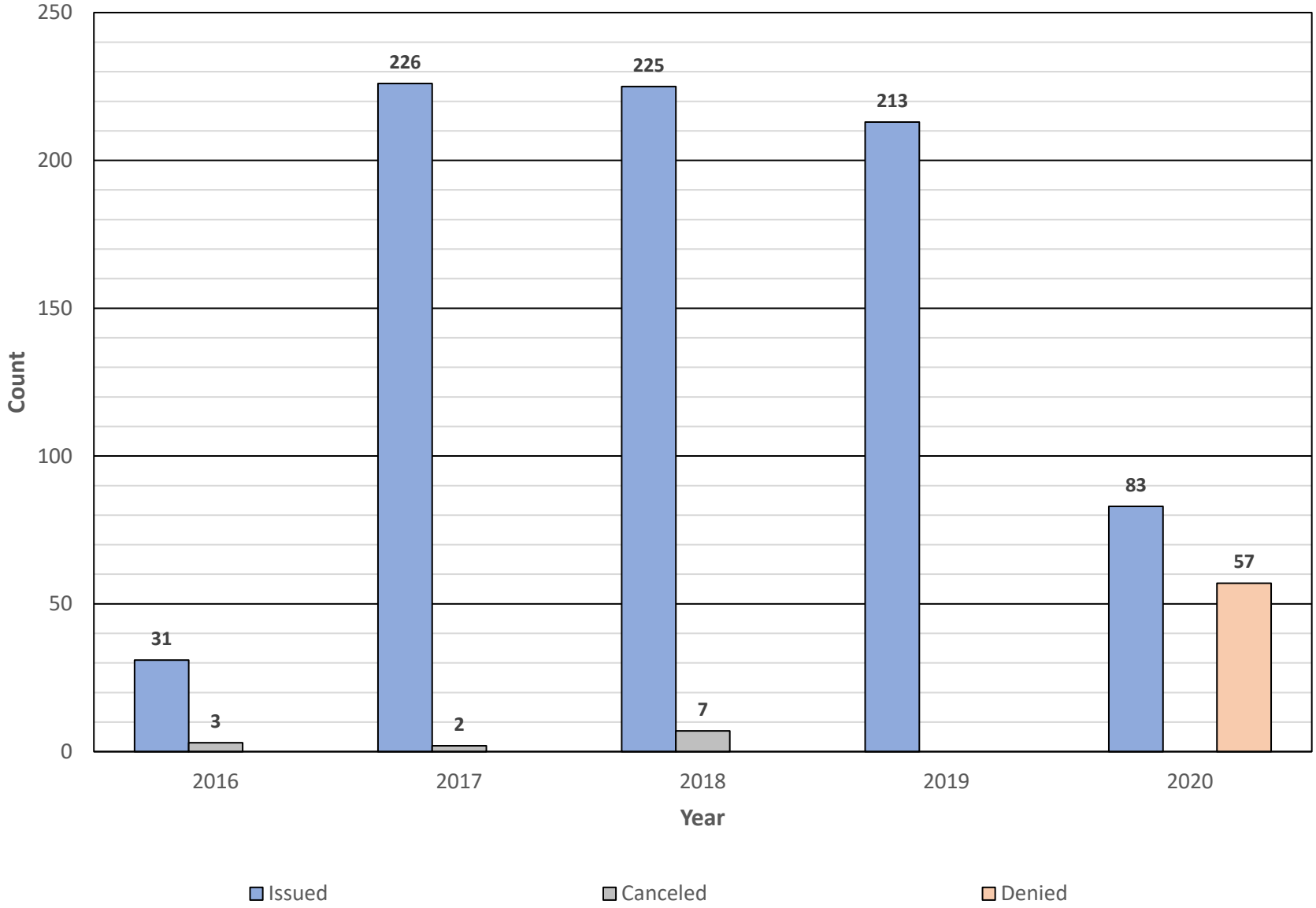
A total of 58 wells were stimulated during this reporting period (a 74% decrease from the 219 stimulations performed during the 2019 reporting period). This is also the lowest number of stimulations that have been completed in a calendar year since the inception of WST regulation in 2014. Of the stimulations completed during this reporting period, 56 were performed under permits issued in 2020, with two stimulations completed under permits issued in 2019. Additional information about permits issued and stimulated during the 2020 reporting period is provided in Table B1.

Historically, a maximum of 730 stimulations were completed in 2015 (all performed under Interim Well Stimulation Treatment Notices [IWSTNs]). The largest number of stimulations completed annually under a WST permit was 245 in 2018.

Since the implementation of WST regulations in 2014, a total of 2,224 stimulations have been completed. A total of 1,533 stimulations (69% of the total) were completed under the interim program between January 2014 and June 2016. A total of 691 stimulations have been completed under permits issued during the permanent WST program, which went into effect July 1, 2015. However, some stimulations continued to be completed under approved IWSTNs until June 2016, because operators had one year from the date of issuance to complete a stimulation under an interim notice, all of which were issued prior to the start of the permanent WST regulation period. The first permit under the permanent WST program was issued in September 2016.

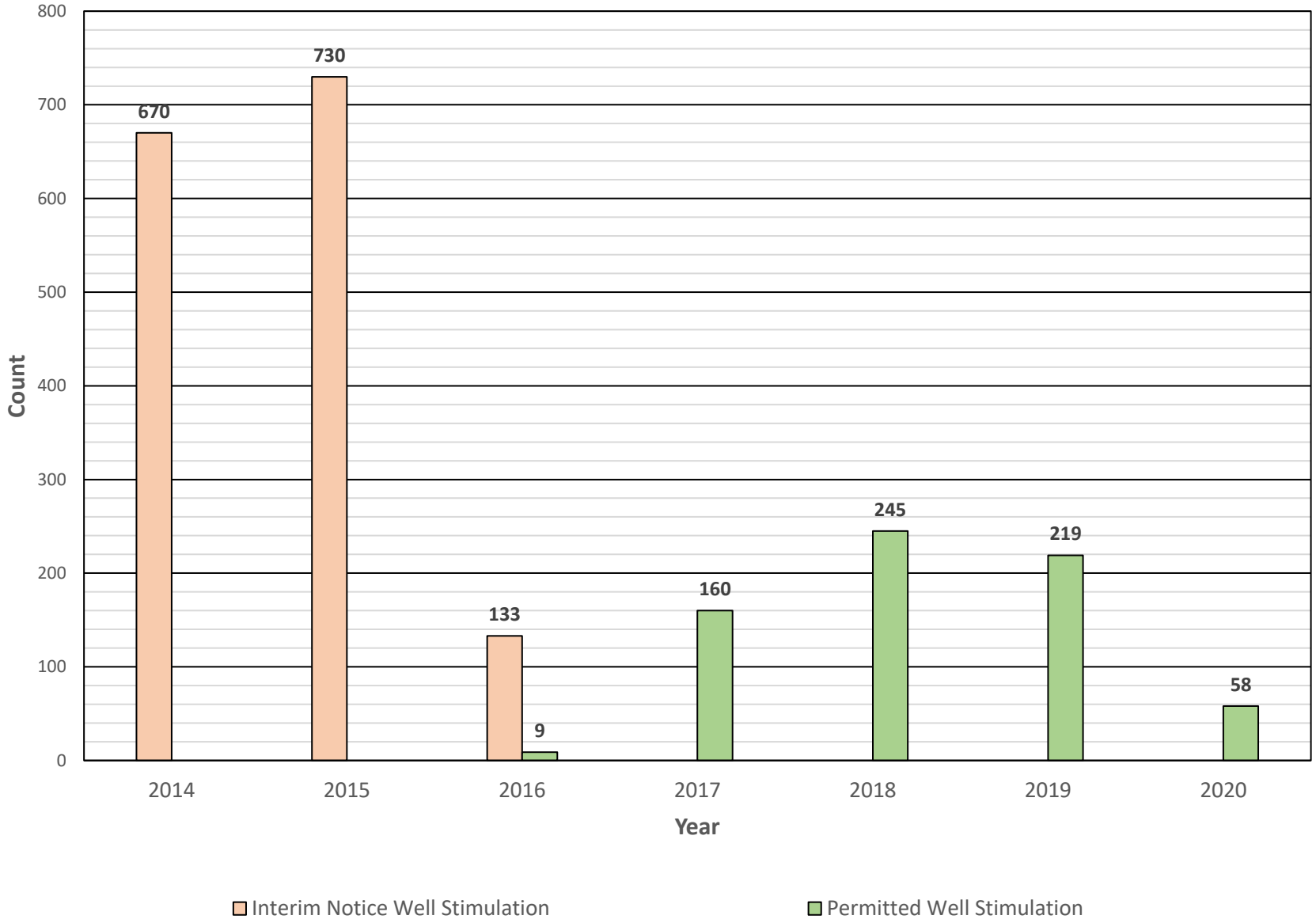
Figure 2 depicts permits issued from 2016 to 2020. This chart also includes counts of permits that have been canceled by operators or denied by the Division. Figure 3 depicts counts of well stimulations performed annually from 2014 to 2020 based on whether the stimulation was performed under an IWSTN or WST permit.

Figure 2: Well Stimulation Treatment Permit Status (2014 – 2020)



(This page intentionally blank.)

Figure 3: Well Stimulation Treatment Completions (2014 – 2020)



(This page intentionally blank.)

4.2 Well Stimulation Treatment Locations

During the reporting period, stimulations were limited geographically to three mature oil fields in western Kern County, all of which are encompassed by CalGEM's Inland District boundary.

Of the 58 wells stimulated during the reporting period, 24 were completed in the Lost Hills field, 22 in the North Belridge field, and 12 in the South Belridge field.

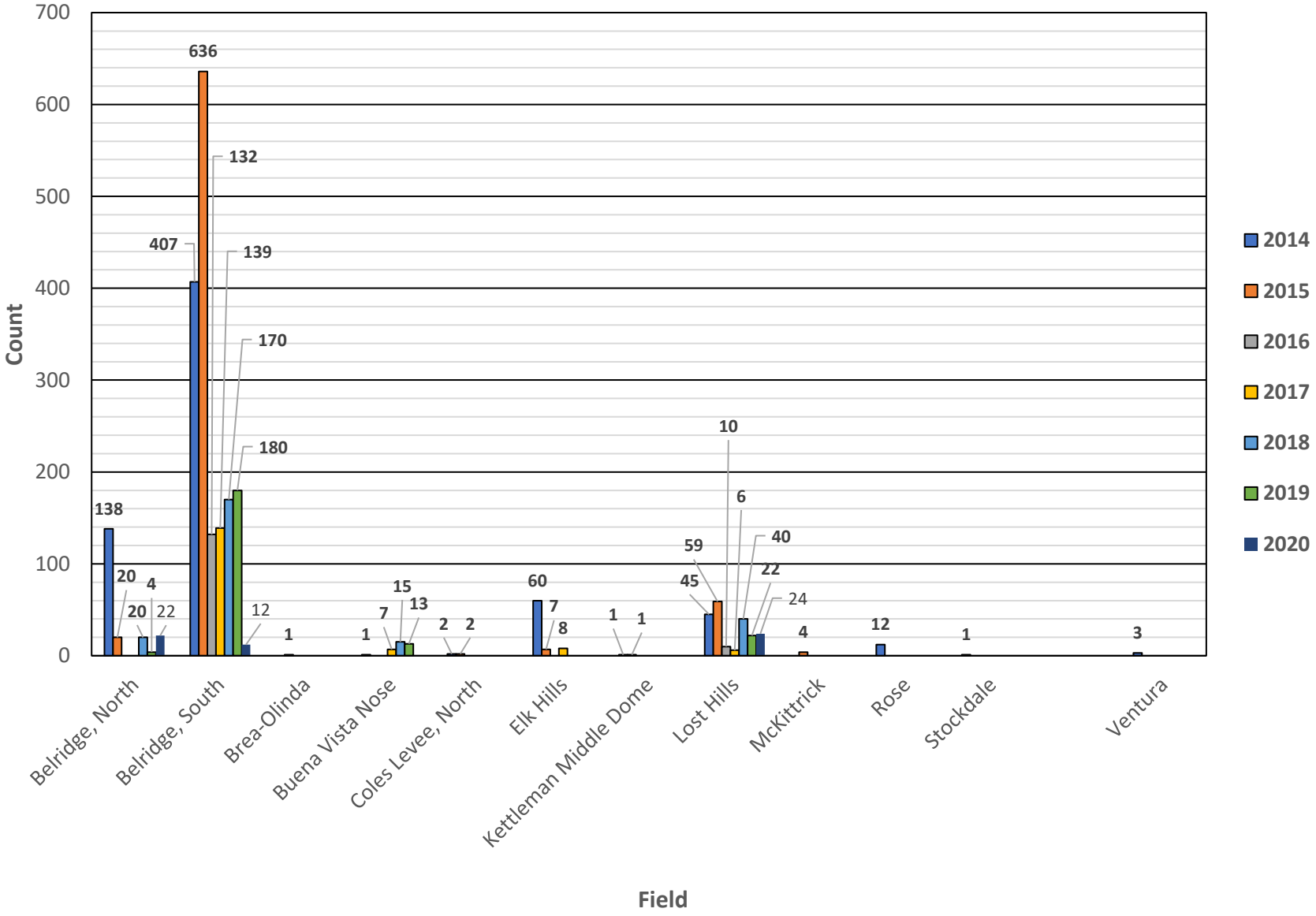
Figure 4 graphically depicts the number of stimulations completed during the reporting period, as well as during the entire WST regulation period (beginning in 2014). As is shown, the number of oil fields where WSTs have been completed has decreased since the implementation of SB 4 regulations.

The North Belridge and South Belridge fields are relatively remote, with wells stimulated in 2020 being located further than five miles from populated areas. However, the stimulations completed in the Lost Hills field are in proximity to the town of Lost Hills, located in Kern County. Of the wells stimulated in 2020 in this field, the closest stimulated well is located approximately 2,100 feet from the nearest potential receptor. **Figure 5** provides a regional map showing all WST locations completed in 2020. **Figures 6 through 8** illustrate focused views of each stimulated field.

Each field-specific map provides the surface locations of well stimulations completed in 2020, with locations color-coded by the operator that performed the stimulation. Each location is bounded on the map by a 1,500-feet boundary, which depicts the Neighbor Notification area identifying the location of landowners or tenants to whom notification must be sent that a WST is occurring in the area. This notice also provides the opportunity to request water sampling of existing wells or surface water bodies (Neighbor Notifications are discussed in more detail in Section 5). As is shown in each field-specific map, notification areas are fully encompassed by existing oil field boundaries and do not overlap any populated area boundaries. This indicates populated areas are a minimum of 1,500 feet (approximately 0.25 miles) from all wells stimulated in 2020.

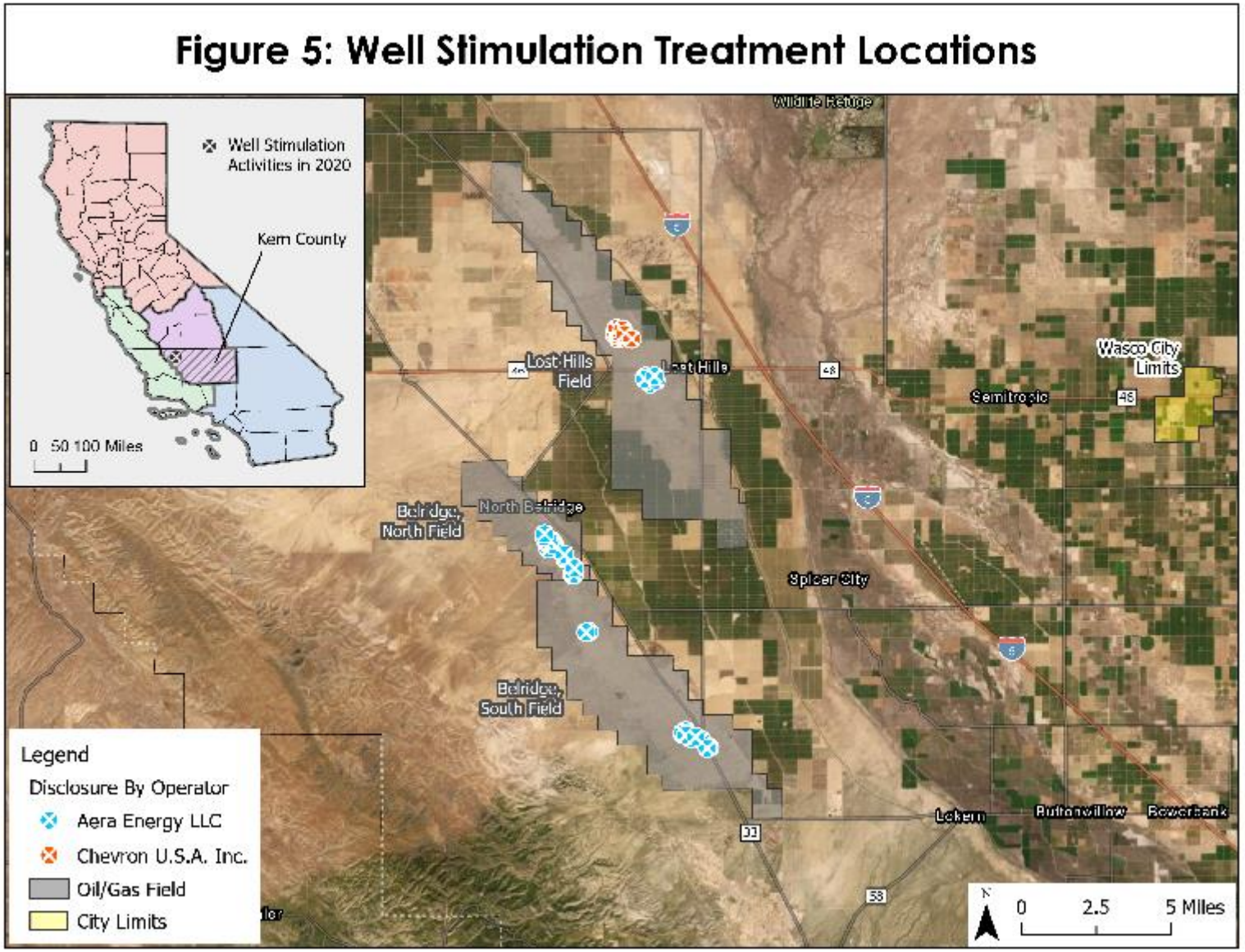
(This page intentionally blank.)

Figure 4: Well Stimulation Treatment Completions by Field (2014 – 2020)



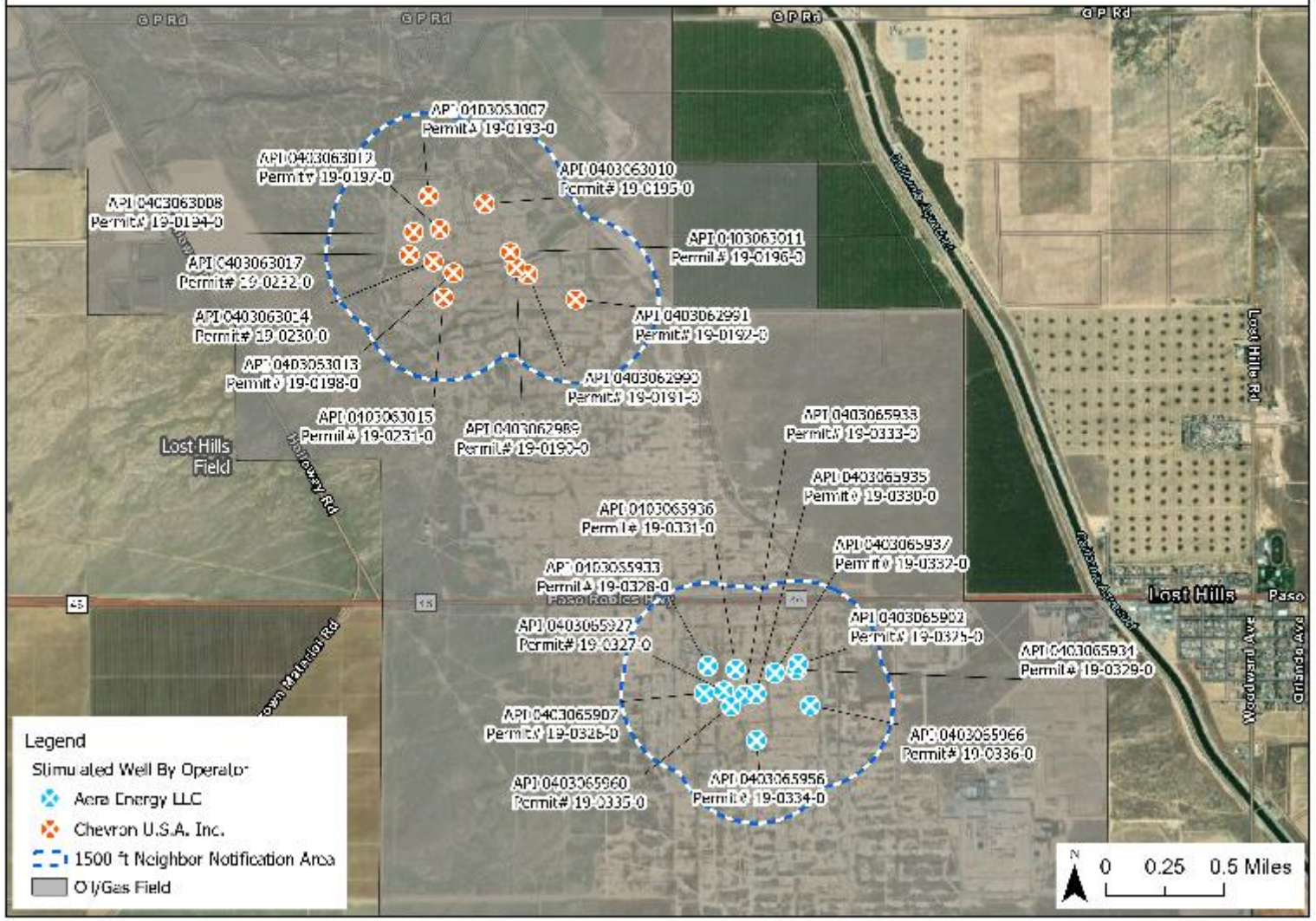
(This page intentionally blank.)

Figure 5: Well Stimulation Treatment Locations



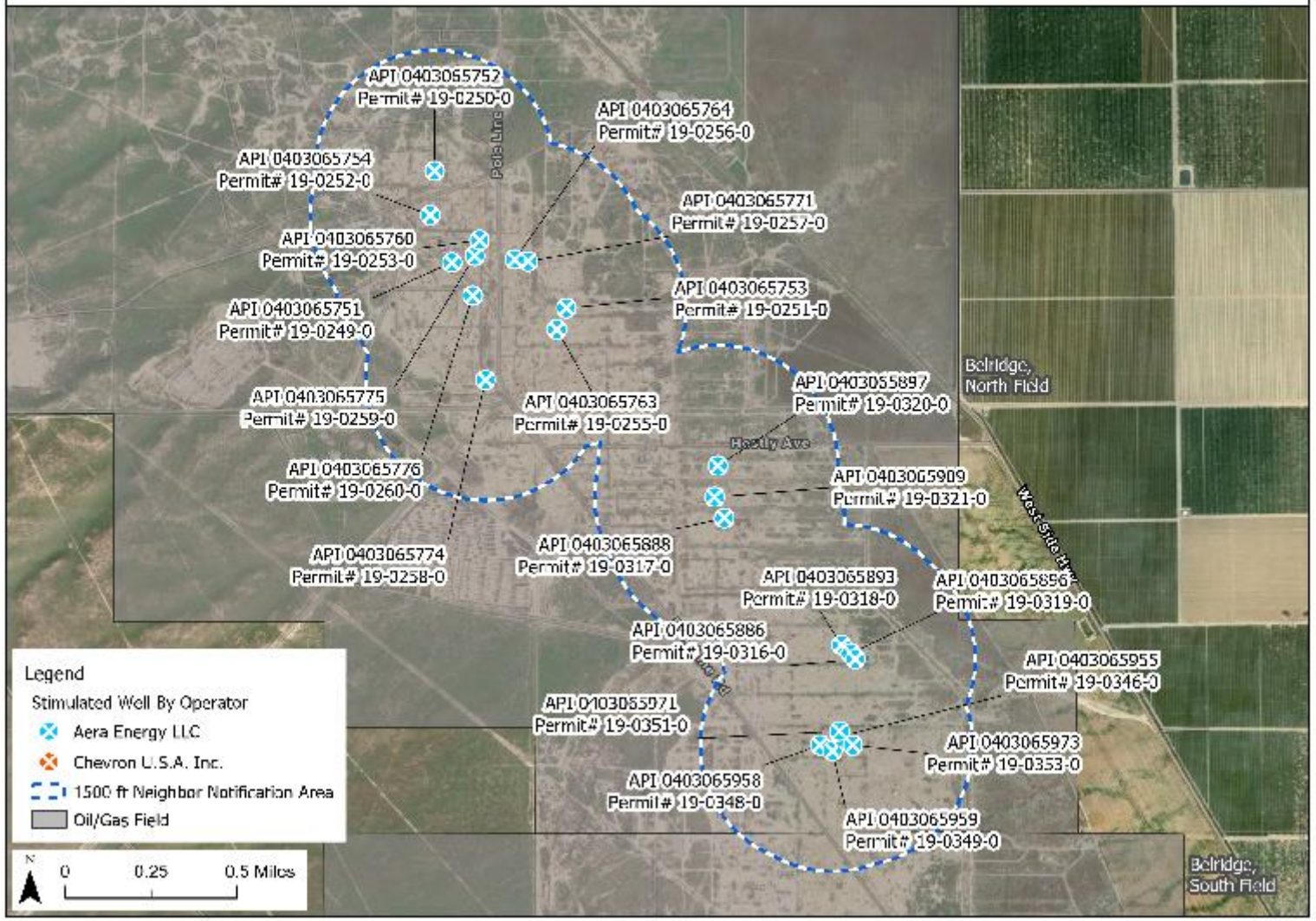
(This page intentionally blank.)

Figure 6: Well Stimulation Treatment Locations - Lost Hills Field



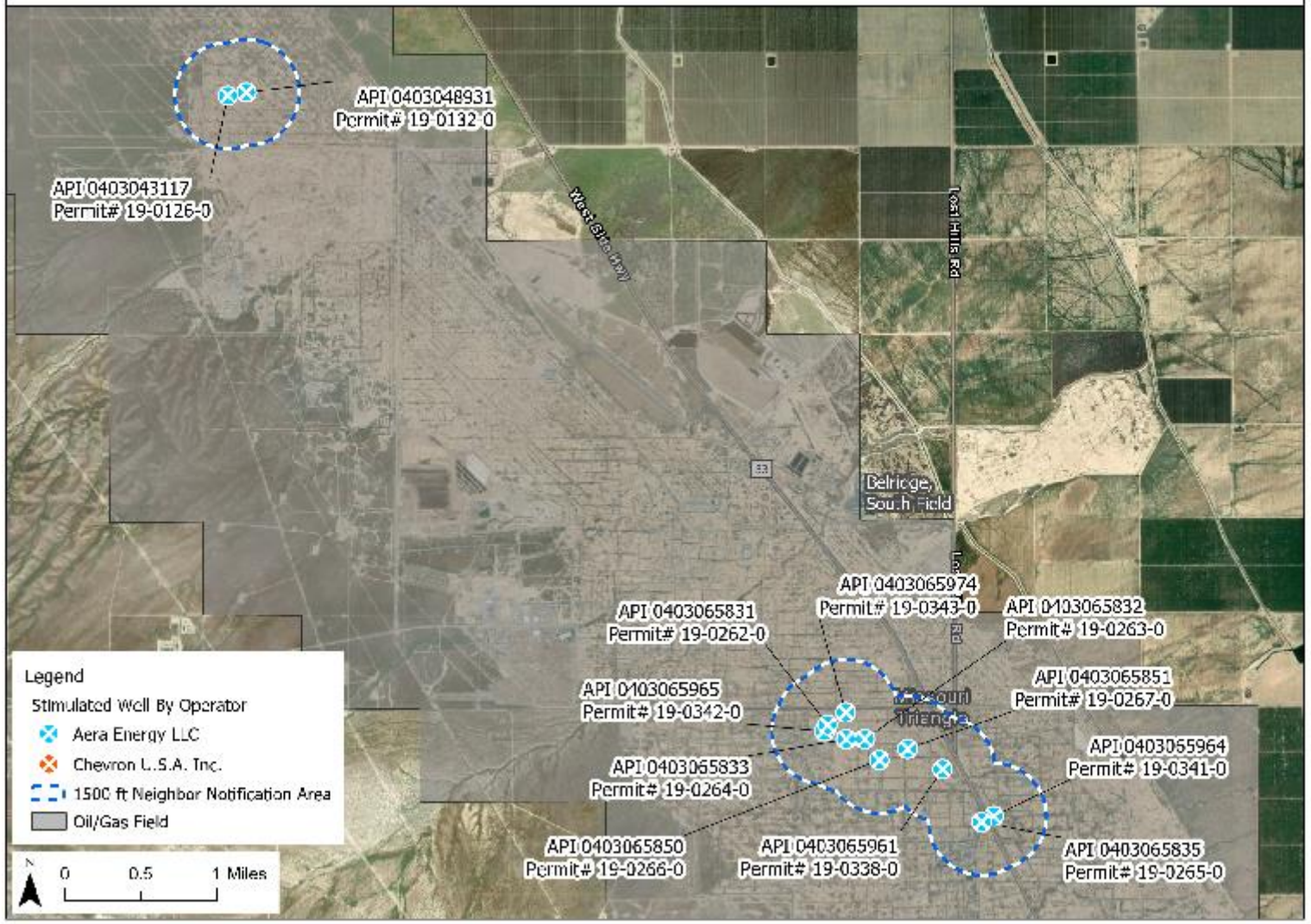
(This page intentionally blank.)

Figure 7: Well Stimulation Treatment Locations - North Belridge Field



(This page intentionally blank.)

Figure 8: Well Stimulation Treatment Locations - South Belridge Field



(This page intentionally blank.)

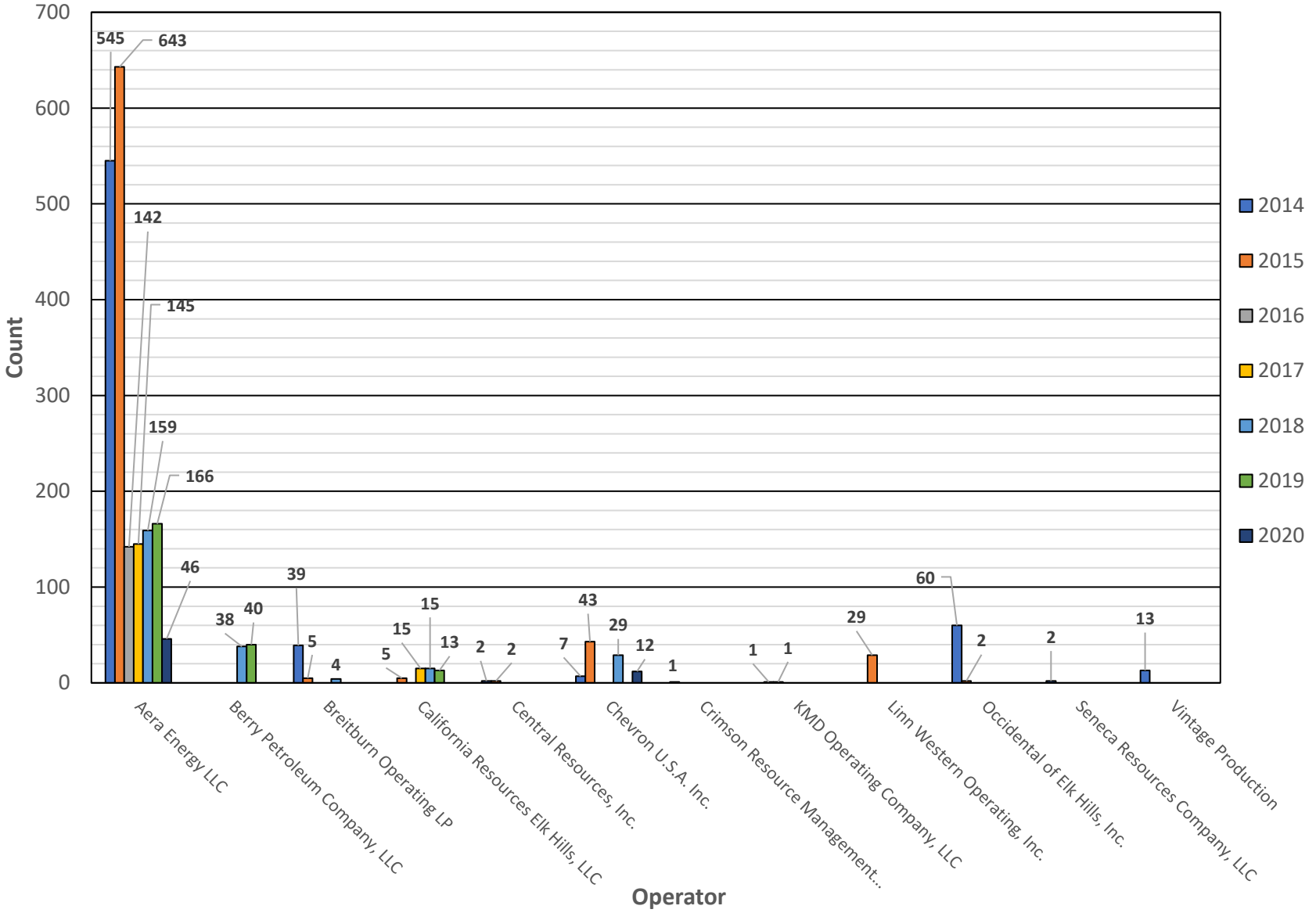
4.3 Well Stimulation Treatment Operators

All WSTs were completed by two operators during the 2020 period. A total of 46 WSTs (79% of the 58 total stimulations) were completed by Aera Energy LLC (Aera), which completed stimulations in the Lost Hills field, North Belridge field, and South Belridge field (as shown in **Figures 5 through 8**). The remaining 12 WSTs (21% of 58 total stimulations) were conducted by Chevron U.S.A. Inc (Chevron). Chevron completed stimulations only in the Lost Hills field (see **Figures 5 and 6**).

Figure 9 depicts the number of stimulations completed by each operator annually, from 2014 to 2020, with Aera performing the greatest number of stimulations year over year. On average, Aera accounts for more than 80% of stimulations completed since 2014. The number of operators that have completed stimulations since the start of WST regulation has decreased from nine in 2014 to two in 2020.

(This page intentionally blank.)

Figure 9: Well Stimulation Treatment Completions by Operator (2014 – 2020)



(This page intentionally blank.)

4.4 Base Fluids

This section discusses the sources, volumes, and suitability for domestic or irrigation purposes of water used for WST. All WSTs completed during this reporting period exclusively used water as a base fluid. Although nitrogen, hydrocarbons, and acid have been used as base fluids in the past, they were not used during the 2020 reporting period.

4.4.1 Base Fluid Sources

Operators are required to report the sources of water used for WST base fluid in their WST permit applications and also as part of required post-WST reporting. In these submissions, operators may refer to the same source in different terminology. Therefore, water sources used as base fluid sources during the reporting period have been categorized below under three distinct categories to provide a clear breakdown of WST base fluids based on the original water source:

Domestic Water System:

- California Aqueduct – reported by Aera

Produced Fluid:

- No produced fluid was used during this reporting period

Operator-Owned Water Production Well:

- Tulare Water – reported by Chevron
- Water Source Well – reported by Aera

Base fluid sources are further categorized for reporting by their suitability for irrigation or domestic purposes, meaning that the water source is of a quality that would be suitable to irrigate agricultural land or be used for indoor/outdoor household purposes, with minimal processing required. Base fluid water sources based on suitability of use is as follows:

Suitable for irrigation/domestic uses:

- Domestic Water System:
  - California Aqueduct

Unsuitable for irrigation/domestic uses:

- Operator Water Production Well (operator owned water production well):
  - Tulare Water – reported by Chevron
  - Water Source Well – reported by Aera

Figure 10 illustrates the volumes of base fluids used in well stimulations by water source. The fluid volumes displayed for prior years are the total volumes reported in CalGEM's annual report for that year. Note that the 2016 and 2017 reports covered time periods greater than one calendar year, as detailed in the chart. In Appendix B, **Table B2** presents reported base fluid volumes by source, and **Table B3** presents base fluid volumes based on fluid suitability.

As shown in **Figure 10**, water used as part of WST was at the lowest it has been since 2016, largely driven by the drop in WST activity.

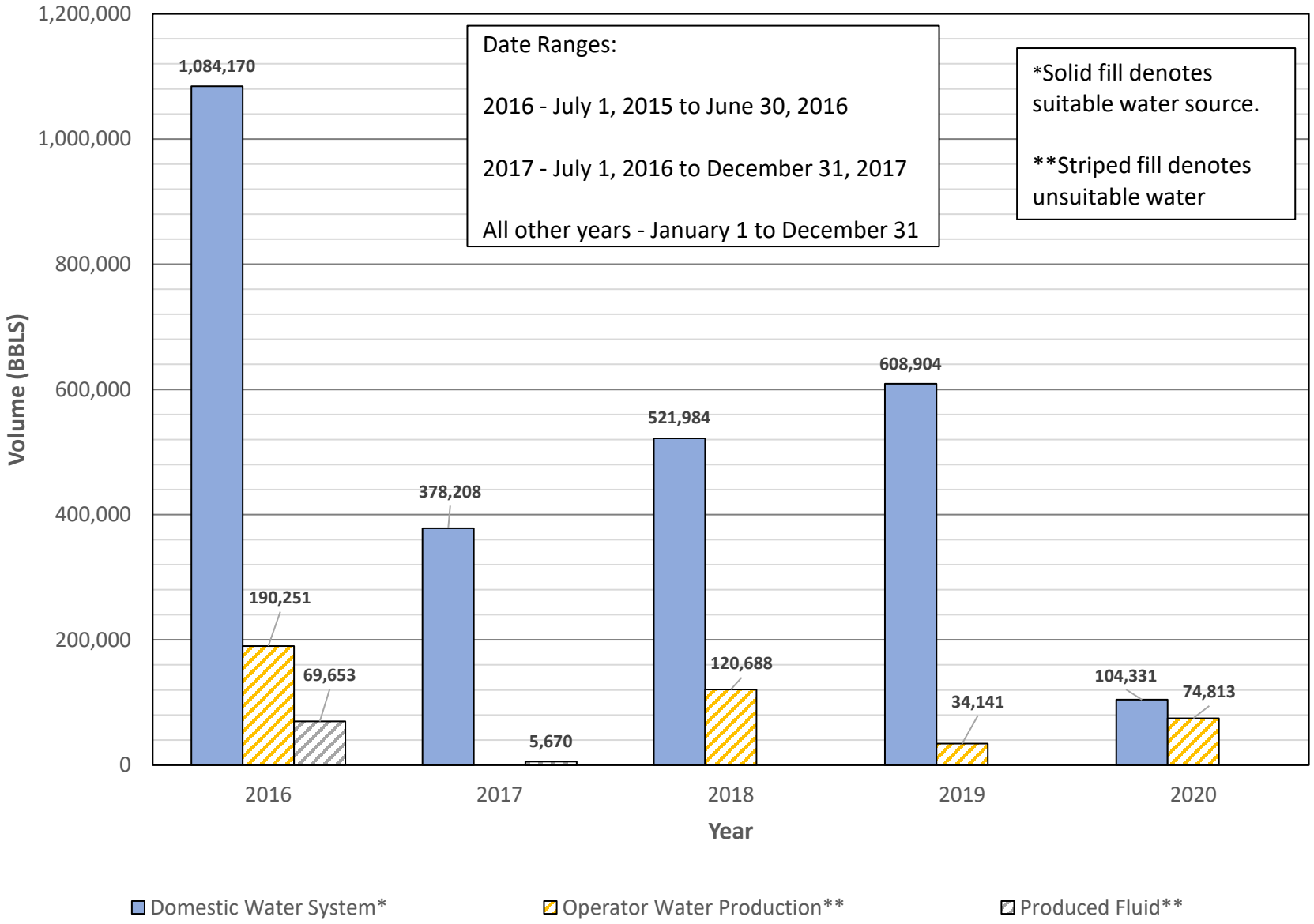
While base fluid volume taken from operator-owned wells increased 119% from the prior reporting period, in 2020, domestic water system usage was relied on more than operator owned production well water. Produced fluids were not reported as used and have not been reported as used since the 2017 reporting period.

4.4.2 Base Fluid Composition

To satisfy CalGEM's reporting requirements, operators must submit base fluid composition data, which result from chemical analyses performed on water sources used as a base fluid for a WST. For base fluid water sources used in multiple WSTs within a proximal time frame, CalGEM accepts a representative sample of the water source collected and analyzed on a biannual basis (twice per year).

Tables B4 through B7 in Appendix B document the average chemical concentrations by mass of required analytes in sampled base fluid sources based on suitability type. These tables also present the percentage of samples with detections for each chemical based on the total number of samples analyzed.

Figure 10: Water Usage in Well Stimulation by Water Source (2016 – 2020)



(This page intentionally blank.)

4.5 Additive and Chemical Usage

PRC Section 3150 defines an additive as a substance or combination of substances added to a base fluid for purposes of preparing a WST fluid. An additive may, but is not required to, serve additional purposes beyond the transmission of hydraulic pressure to the geologic formation. An additive may be of any phase and includes proppant. Each additive is comprised of a unique combination of chemical constituents, and therefore, a full disclosure of the chemical constituents is required for each WST. Discussions of additives and chemicals utilized in WST fluids during the reporting period are presented below.

4.5.1 Additives

The additives used in WSTs are typically supplied by the contractor performing the operation such as Halliburton. The following companies supplied additives for WSTs in California during the reporting period:

- Halliburton
- Operators: Chevron

Fifteen different additives, not including water, were reportedly used in WST fluids during the reporting period. **Figure 11** provides a graphical representation of the average composition of a WST fluid based on additive types used during the reporting period. It must be noted that this chart presents an average of the concentrations of all uses for an additive type and is not specific to any operator or other factor.

However, the depicted additive concentrations are relatively consistent amongst WST operators, with WST fluids being comprised primarily of water and proppant. As is shown, base fluid (water) and proppant (sand) account for over 99% of the average composition of WST fluids used during the 2020 reporting period.

Table B8 in Appendix B provides a listing of all additives used in WST fluids during the reporting period, including the number of times each additive was used, the additive supplier, and the purpose for using the additive.

Additive data specific to each WST can be accessed through CalGEM's WellSTAR disclosure database: https://wellstar-public.conservation.ca.gov/.

4.5.1.1 Radiological Components

There were no radiological components or tracers used in WST during the reporting period.

4.5.1.2 Trade Secret Protection

There were no trade secret claims made by any operator for wells stimulated during this reporting period. Therefore, withholding of public disclosure based on a trade secret did not occur.

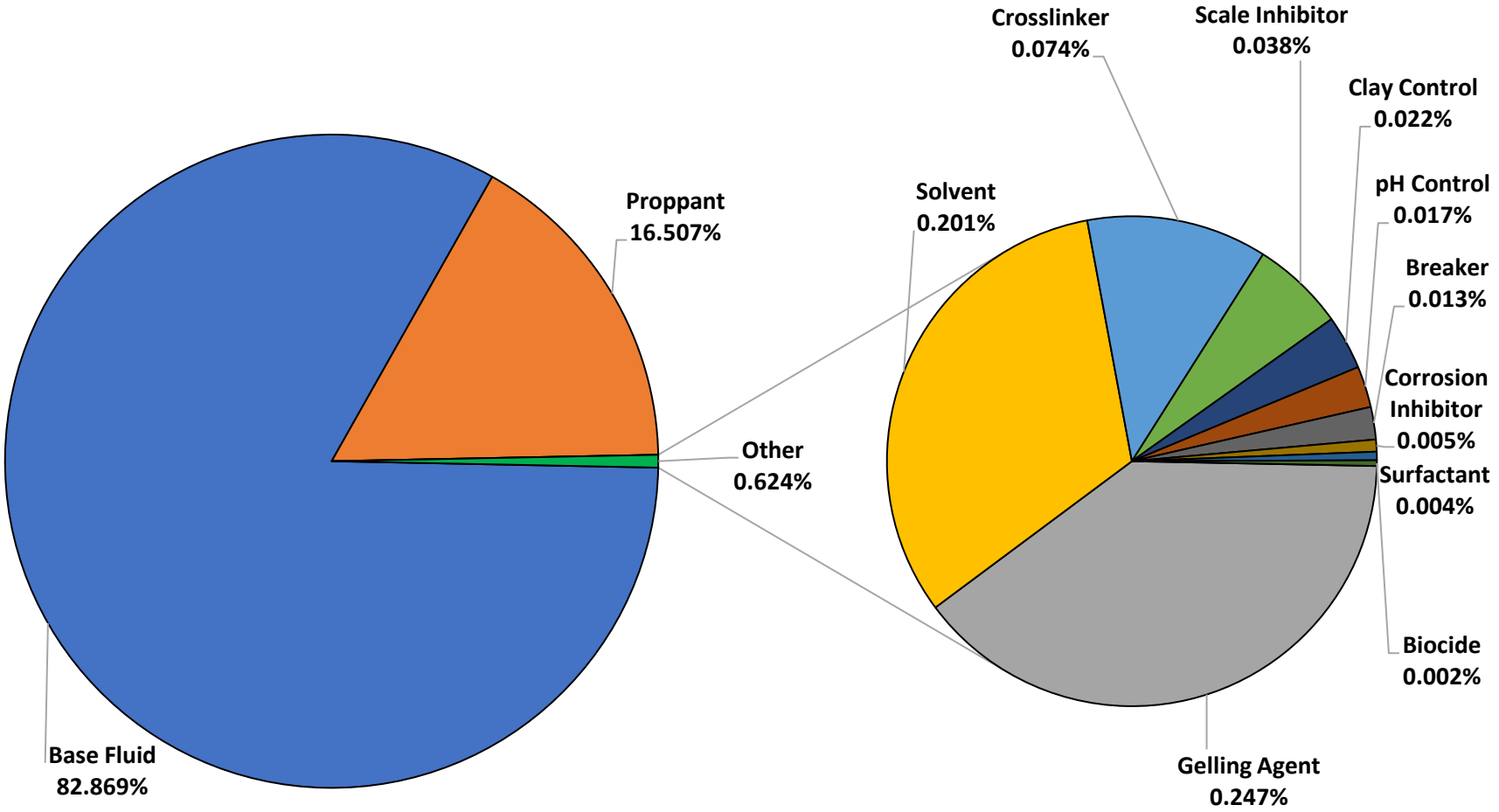
4.5.2 Chemicals

Not including water, a total of 31 chemical constituents were reportedly used in WST fluids during the reporting period. A complete list of disclosed chemicals, sorted by the chemical constituent, is provided with the number of times each constituent was used. Note that some of the chemical constituents were used as a component in various combinations for multiple purposes and therefore may be reported used more than once per stimulation. Water was used in every WST.

Table B9 in Appendix B provides a listing of all chemicals used in WST fluids during the reporting period, including the number of times each was used in a WST fluid, as well as a listing of the type or types of additives each chemical is commonly associated with when used in a WST fluid.

Chemical data specific to each WST can be accessed through CalGEM's WellSTAR disclosure database: https://wellstar-public.conservation.ca.gov/.

Figure 11: Average Well Stimulation Treatment Fluid Composition by Additive Type Concentration



**Values have been normalized to sum to 100%.

(This page intentionally blank.)

4.6 Recovered Fluids

Fluids produced from wells that undergo WST include petroleum, formation water, base fluid, and remaining chemical additives. Produced fluids are predominately composed of hydrocarbons and formation water, occurring in greater quantity than fluids associated with the stimulation, such as base fluid or additives. Operators are required to collect, when possible, two recovered fluid samples for analysis after a WST has been completed. The first sample (a recovered fluid one sample [RF1]) is collected after a calculated wellbore volume has been produced from the well but before three calculated wellbore volumes have been produced, typically after the well is placed on production. The second sample (a recovered fluid two sample [RF2]) is collected after the stimulated well has been producing for 30 days. A total of 113 recovered fluid samples were analyzed and reported to CalGEM during the 2020 reporting period, consisting of 56 RF1 samples and 57 RF2 samples.

Not every WST well can be sampled after stimulation, as some wells may not have enough pressure to generate flow back of WST fluids. Such situations frequently require cleanout operations prior to putting the well on production. In other instances, some of the WST fluid may have leaked off into the formation. As such, chemical analysis data of recovered fluids cannot be compared on a one-to-one basis against reported base fluid volume to establish an accurate ratio. Recovered fluid analytical data are provided in **Tables B10 through B15** in Appendix B, respectively. All chemicals detected are associated with naturally occurring petroleum compounds, produced water, and WST fluids.

All fluids recovered from WSTs completed during the reporting period were disposed of by injection into Class II injection wells, regulated separately under CalGEM's UIC program. Recovered WST fluids were not reused for subsequent treatments. There were no waste fluids other than water and petroleum-related fluids recovered during the reporting period.

4.7 Stimulation Dimensions

Fracture zone lengths and heights may be estimated by well operators according to sophisticated hydraulic fracturing models or previous field measured data. These estimations provide the basis for the Axial Dimensional Stimulated Area (ADSA) boundaries used during risk assessment reviews. One of the key factors in estimating the fracture zone is the type of formation involved at the point of stimulation.

Figure 12 below is a visual representation of the fracture length and height generated by a WST into the formation. These are key data points used to establish safety factors which denote areas in which surrounding wells are reviewed for risk (2xADSA review) and geologic features are reviewed for risk (within five times the ADSA [5xADSA review]). Safety factors are established by reviewing features within areas bounded by two times and five times the proposed fracture dimensions, thus creating a protective area around the proposed fracture zone that is used to make risk management and mitigation determinations. Fracture zone dimensions are also referred to in regulation as the ADSA. The safety factors in regulation consist of evaluating wellbores or other possible migration pathways within the 2xADSA and geological features within the 5xADSA. In this report and in California's WST statutes and regulations, the terms "length" and "height" of stimulation mean the following:

Length: Generally, a hydraulic fracture is propagated in two sides of a wellbore. The horizontal length of a fracture on each side is called the fracture half-length. However, in this report, a fracture length is equal to a fracture half-length (**Figure 12**).

Height: For both vertical and horizontal wells, fracture height is the maximum vertical extent of fracture growth. In other words, fracture height is the distance between the top and bottom of the fracture (Figure 12).

Fracture dimensions (as average lengths and heights) are presented in Appendix B, **Tables B16 and B17**, respectively.

4.7.1 Fracture Depths

This section presents aggregated information regarding the depths at which WSTs were performed during the reporting period. The minimum depth provided is the true vertical depth (TVD) from ground surface to the top of the uppermost stage. The maximum depth provided is the true vertical depth from ground surface to the bottom of the deepest stage.

In Appendix B, Table B18 presents data related to the depth to the top of proposed fractures, and Table B19 presents data related to depth to the bottom of proposed fractures.

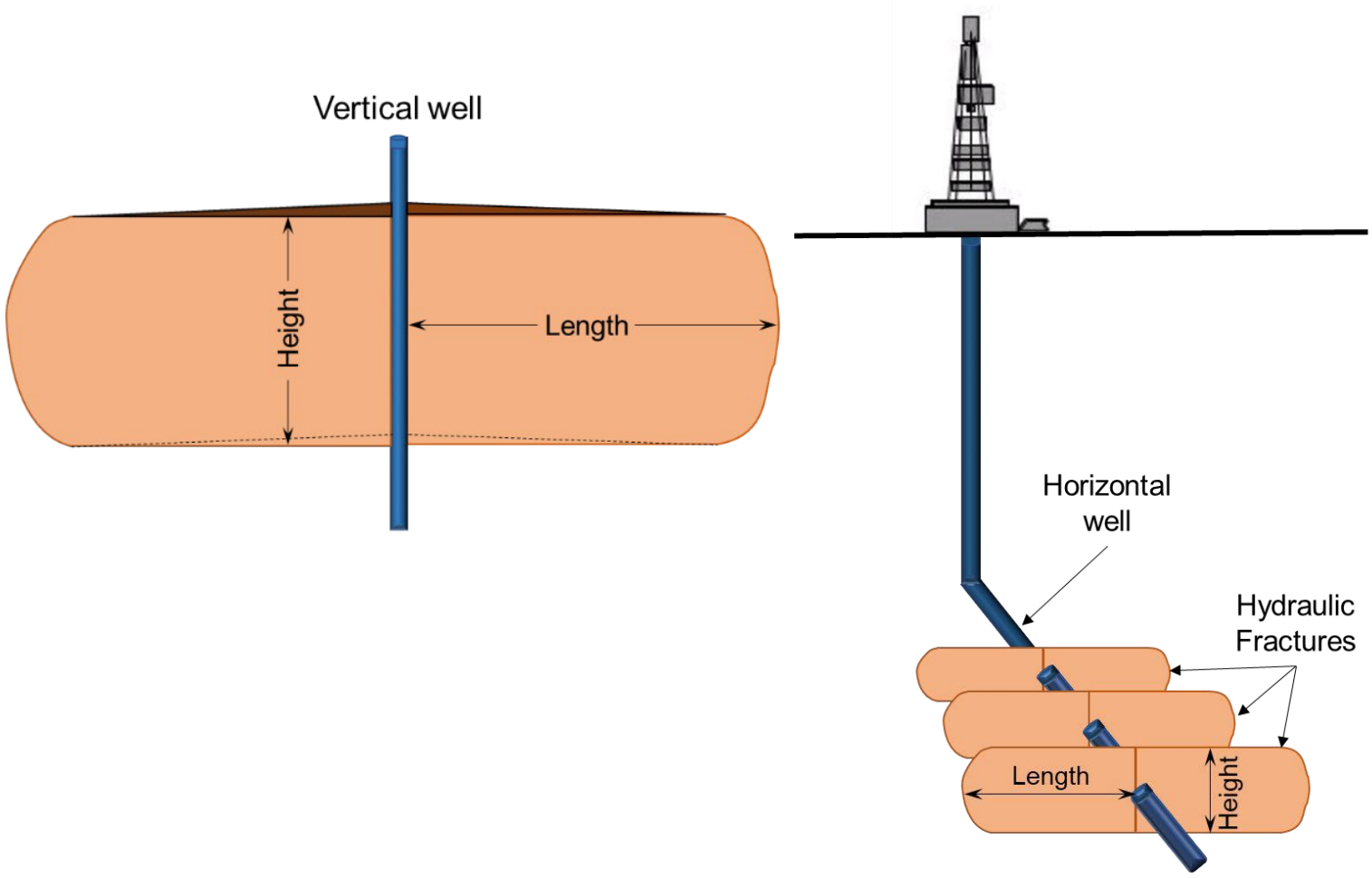


Figure 12: Use of "Height" & "Length" in describing WST Fractures in California

(This page intentionally blank.)

4.8 Stimulated Formations/Zones

Oil and gas "zones" refer to the areas within a geologic formation where oil, gas, and water are trapped due to a geologic structure such as a fault, variable stratigraphy, or other feature that traps a resource in an area. For the purposes of this report, the stimulated formations and zone names reported by operators during the reporting period are as follows:

- Reef Ridge Formation – Reported zones:
  Reef Ridge-Diatomite

- Etchegoin Formation – Reported zones:
  Etchegoin-Diatomite

These formations/zones are comprised of low permeability rocks that, while they contain oil, do not readily transmit or readily allow the flow of oil and oil-bearing fluids. Therefore, these formations must be stimulated to be produced. A stimulation treatment creates pathways for oil-bearing fluids to migrate through and hydrocarbon extraction becomes feasible.

Table B20 in Appendix B provides the number of times each of the formations listed above was stimulated during the reporting period.

5.0 NEIGHBOR NOTIFICATIONS

After receiving a WST permit, but before stimulation, operators are required to hire an independent third-party contractor to provide neighbor notification to surface owners and tenants of properties that are either located within a 1,500-foot radius of the wellhead receiving WST (as depicted on the WST location maps, **Figures 6 through 8**), or within 500 feet of the surface projection of the horizontal path of the subsurface parts of the well. Notified neighbors who have an existing water well or surface water on their parcel suitable for drinking or irrigation purposes may request water quality testing. Operators are required to send a copy of the water quality testing results to CalGEM.

The third-party notice provider also sends information to CalGEM detailing the surface owners and tenants notified, the date of notification, and delivery method. Operators may not perform a stimulation on a well until after 30 calendar days from the date surface owners and tenants are notified. CalGEM retains neighbor notification data and checks for reporting compliance prior to the well stimulation. Performance of the independent entities is reviewed and subject to random audits conducted by CalGEM. The last audit conducted in 2019 showed full compliance with neighbor notification requirements. The audit for 2020 was incomplete due to the COVID-19 restrictions limiting the correspondence with the recipients of the notifications.

In 2020, there were 100 neighbor notifications sent related to 45 WST permits out of the 58 stimulations completed. Though there are no nearby population close to the stimulated wells, any surface owners or tenants, including other oil field operators, will receive a neighbor notification if they are located within the notification area. The remaining 13 WST permits did not require neighbor notifications due to no neighbors residing near the stimulation area. Details regarding the 13 permits that did not require neighbor notifications are presented in **Table B21** of Appendix B. There were no requests for water sampling by surface owners or tenants during the reporting period.

6.0 SEISMIC MONITORING

Pursuant to the provision of California Code of Regulations (CCR), Title 14, section1785.1, operators are required to monitor the California Integrated Seismic Network during and 10 days after the well stimulation for any indication of an earthquake of magnitude 2.7 or greater within the five times ADSA. If an earthquake of specified 2.7 magnitude or greater is detected, the operators must notify the Division for further evaluation.

There have been no reports of any seismic activities triggered by well stimulation activities during the reporting period. CalGEM's WST unit has reviewed 2020 earthquake data from the United States Geological Survey for the periods of hydraulic fracturing to verify the lack of correlating seismic activities. There has been no report of any seismic activities related to WST under the permanent WST program.

7.0 ENFORCEMENT

In order to help ensure oil and gas operators comply with California statutes and regulations, CalGEM's enforcement office works to identify and verify possible violations; and take actions to bring violators into compliance with the law and prevent harm. Enforcement actions CalGEM takes include issuing notices of violation, taking civil or criminal enforcement action, and assessing penalties. CalGEM did not identify or take action on any violations associated with WST in 2020.

7.1 Well Stimulation Treatment Witnessing

Witnessing is the term used for a site visit made by CalGEM district staff to evaluate aspects of a WST operation, including, but not limited to:

- Casing and tubing pressure testing to ensure well integrity prior to WST;
- WST surface equipment pressure testing prior to WST; and
- Observation of WST activities on the day of stimulation.

During the reporting period, 90% (52 of the 58) stimulations completed in 2020 were witnessed by CalGEM staff. This is more than double the level of witnessing conducted in 2019 (39% of stimulations witnessed). In 2019, the Cymric field surface expression incident and new UIC testing requirements created a shortage of personnel in the Inland district available to witness WST operations.

In 2020, CalGEM staff were able to meet the majority of witnessing obligations despite the COVID-19 pandemic health and safety measures put in place by CalGEM to protect staff and limit exposure to potential sources of the disease. CalGEM staff continue to strive to meet the goal of witnessing all stimulations during a reporting period. **Table B22** in Appendix B presents the number of stimulations witnessed during the 2020 reporting period.

7.2 Chemical Spot-Checking

Spot-checking is an onsite assessment made specifically to verify that the additives comprising the WST fluid conform to the additive composition approved by CalGEM during the application review.

The ability to complete chemical spot-checks was impacted by social distancing restrictions/remote witnessing protocols implemented by CalGEM in response to COVID-19. However, 17 chemical spot-checks were performed during the reporting period (33% of the 52 stimulations witnessed in 2020). All spot-checks performed confirmed that the additive composition of the fluids used in the witnessed WSTs was consistent with the composition proposed in the application for that WST. CalGEM's goal remains to perform chemical spot-checks at all witnessed stimulations. **Table B23** in Appendix B presents the number of chemical spot-checks performed during the 2020 reporting period.

8.0 REPORTS OF INCIDENTS/EVENTS

For public health and safety, any loss of well or casing integrity for wells that have undergone a WST is reviewed and reported by CalGEM in this annual report along with other losses of well or casing integrity issues of all wells in California. Spills and releases associated with WSTs are also reported per the requirements stated in PRC section 3215(c).

A loss of well or well casing integrity in wells that have undergone WST is defined as a breach in any casing string utilized in WST operations or a breach of the geologic or hydrologic isolation of the formation. Loss of well or well casing integrity for all other wells is identified by any incident involving damage to a well's permanent construction indicated by inspection and/or mechanical integrity testing (MIT).

Integrity losses typically develop over time, making it difficult to identify the precise point at which a loss first occurs. A failure of an integrity test is not always conclusive evidence of casing integrity loss. A determination of actual loss may require additional testing and review.

A query of CalGEM's records yielded 1,060 instances of possible loss of well or well casing integrity during the reporting period, which includes failed mechanical integrity tests, pressure tests, and reported anomalies. Records of possible well/well casing integrity loss were cross-referenced with wells that had undergone stimulation in 2020. Based on this analysis, there were no well, or casing integrity losses associated with WSTs identified during the reporting period. There were no emergency responses to spills or releases of any liquids or regulated substances associated with WSTs performed during the reporting period.

The total number of wells experiencing casing integrity loss in 2020 has increased compared to the 440 recorded in 2019. This is believed to be due, in part, to the following factors:

- Utilization of WellSTAR, which now captures all well integrity-related data within the Division, providing a more complete data set.
- More stringent regulations for UIC, Idle Wells, and Underground Gas Storage programs requiring increased testing of related wells.

APPENDICES

APPENDIX A – REFERENCES/DATA SOURCES

The following were used as data sources for this report:

CalGEM Statutes and Regulations (January 2020):
https://www.conservation.ca.gov/index/Pages/California-Geologic-Energy-Management-Division-Statutes-and-Regulations.aspx

Well Statewide Tracking and Reporting System (WellSTAR):
https://wellstar-public.conservation.ca.gov/

CalGEM WST Unit's WST Tracker.xlsx.
This is an internal Excel workbook developed by WST unit staff specifically to track the progress of requests to perform WSTs, through notices/applications, actual stimulations, and disclosing of stimulations.

CalGEM Inland District's WST_Tracking1.xlsx.
This is an internal Excel workbook developed by Inland District staff to schedule and track staff witnessing of WST-related operations.

APPENDIX B – DATA TABLES

Table B1: Well Stimulation Treatment Permit Status - 2020 Reporting Period

WST Permit Number	Permit Issue Date	Stimulation Completion Date	API	Operator	County	Field	Permit Status
19-0126-0	05/09/2019	04/16/2020	0403043117	Aera Energy LLC	Kern	Belridge, South	Completed
19-0132-0	05/09/2019	04/21/2020	0403048931	Aera Energy LLC	Kern	Belridge, South	Completed
19-0190-0	07/02/2020	09/20/2020	0403062989	Chevron U.S.A. Inc.	Kern	Lost Hills	Completed
19-0191-0	07/02/2020	09/22/2020	0403062990	Chevron U.S.A. Inc.	Kern	Lost Hills	Completed
19-0192-0	07/02/2020	09/16/2020	0403062991	Chevron U.S.A. Inc.	Kern	Lost Hills	Completed
19-0193-0	07/02/2020	09/25/2020	0403063007	Chevron U.S.A. Inc.	Kern	Lost Hills	Completed
19-0194-0	07/02/2020	09/27/2020	0403063008	Chevron U.S.A. Inc.	Kern	Lost Hills	Completed
19-0195-0	07/02/2020	09/24/2020	0403063010	Chevron U.S.A. Inc.	Kern	Lost Hills	Completed
19-0196-0	07/02/2020	09/18/2020	0403063011	Chevron U.S.A. Inc.	Kern	Lost Hills	Completed
19-0197-0	07/02/2020	09/26/2020	0403063012	Chevron U.S.A. Inc.	Kern	Lost Hills	Completed
19-0198-0	07/02/2020	10/02/2020	0403063013	Chevron U.S.A. Inc.	Kern	Lost Hills	Completed
19-0200-0	11/20/2020	--	0403063048	Chevron U.S.A. Inc.	Kern	Lost Hills	Active
19-0201-0	11/20/2020	--	0403063049	Chevron U.S.A. Inc.	Kern	Lost Hills	Active
19-0202-0	11/20/2020	--	0403063050	Chevron U.S.A. Inc.	Kern	Lost Hills	Active
19-0203-0	11/20/2020	--	0403063051	Chevron U.S.A. Inc.	Kern	Lost Hills	Active
19-0204-0	11/20/2020	--	0403063052	Chevron U.S.A. Inc.	Kern	Lost Hills	Active
19-0206-0	11/20/2020	--	0403063054	Chevron U.S.A. Inc.	Kern	Lost Hills	Active
19-0209-0	11/20/2020	--	0403063058	Chevron U.S.A. Inc.	Kern	Lost Hills	Active
19-0230-0	07/02/2020	10/01/2020	0403063014	Chevron U.S.A. Inc.	Kern	Lost Hills	Completed
19-0231-0	07/02/2020	10/03/2020	0403063015	Chevron U.S.A. Inc.	Kern	Lost Hills	Completed
19-0232-0	07/02/2020	09/29/2020	0403063017	Chevron U.S.A. Inc.	Kern	Lost Hills	Completed
19-0233-0	11/20/2020	--	0403063059	Chevron U.S.A. Inc.	Kern	Lost Hills	Active
19-0249-0	04/03/2020	10/23/2020	0403065751	Aera Energy LLC	Kern	Belridge, South	Completed
19-0250-0	04/03/2020	10/16/2020	0403065752	Aera Energy LLC	Kern	Belridge, South	Completed
19-0251-0	04/03/2020	10/21/2020	0403065753	Aera Energy LLC	Kern	Belridge, South	Completed
19-0252-0	04/03/2020	10/16/2020	0403065754	Aera Energy LLC	Kern	Belridge, South	Completed
19-0253-0	04/03/2020	10/17/2020	0403065760	Aera Energy LLC	Kern	Belridge, South	Completed

WST Permit Number	Permit Issue Date	Stimulation Completion Date	API	Operator	County	Field	Permit Status
19-0254-0	04/03/2020	--	0403065762	Aera Energy LLC	Kern	Belridge, South	Active
19-0255-0	04/03/2020	10/21/2020	0403065763	Aera Energy LLC	Kern	Belridge, South	Completed
19-0256-0	04/03/2020	10/19/2020	0403065764	Aera Energy LLC	Kern	Belridge, South	Completed
19-0257-0	04/03/2020	10/19/2020	0403065771	Aera Energy LLC	Kern	Belridge, South	Completed
19-0258-0	04/03/2020	10/26/2020	0403065774	Aera Energy LLC	Kern	Belridge, South	Completed
19-0259-0	04/03/2020	10/23/2020	0403065775	Aera Energy LLC	Kern	Belridge, South	Completed
19-0260-0	04/03/2020	10/24/2020	0403065776	Aera Energy LLC	Kern	Belridge, South	Completed
19-0262-0	04/03/2020	10/31/2020	0403065831	Aera Energy LLC	Kern	Belridge, South	Completed
19-0263-0	04/03/2020	11/02/2020	0403065832	Aera Energy LLC	Kern	Belridge, South	Completed
19-0264-0	04/03/2020	10/29/2020	0403065833	Aera Energy LLC	Kern	Belridge, South	Completed
19-0265-0	04/03/2020	10/20/2020	0403065835	Aera Energy LLC	Kern	Belridge, South	Completed
19-0266-0	04/03/2020	10/31/2020	0403065850	Aera Energy LLC	Kern	Belridge, South	Completed
19-0267-0	04/03/2020	10/27/2020	0403065851	Aera Energy LLC	Kern	Belridge, South	Completed
19-0316-0	04/03/2020	04/23/2020	0403065886	Aera Energy LLC	Kern	Belridge, North	Completed
19-0317-0	04/03/2020	10/15/2020	0403065888	Aera Energy LLC	Kern	Belridge, North	Completed
19-0318-0	04/03/2020	04/27/2020	0403065893	Aera Energy LLC	Kern	Belridge, North	Completed
19-0319-0	04/03/2020	04/24/2020	0403065896	Aera Energy LLC	Kern	Belridge, North	Completed
19-0320-0	04/03/2020	10/14/2020	0403065897	Aera Energy LLC	Kern	Belridge, North	Completed
19-0321-0	04/03/2020	10/13/2020	0403065909	Aera Energy LLC	Kern	Belridge, North	Completed
19-0325-0	05/28/2020	11/05/2020	0403065902	Aera Energy LLC	Kern	Lost Hills	Completed
19-0326-0	05/28/2020	11/09/2020	0403065907	Aera Energy LLC	Kern	Lost Hills	Completed
19-0327-0	05/28/2020	11/17/2020	0403065927	Aera Energy LLC	Kern	Lost Hills	Completed
19-0328-0	05/28/2020	11/13/2020	0403065933	Aera Energy LLC	Kern	Lost Hills	Completed
19-0329-0	05/28/2020	11/05/2020	0403065934	Aera Energy LLC	Kern	Lost Hills	Completed
19-0330-0	05/28/2020	11/16/2020	0403065935	Aera Energy LLC	Kern	Lost Hills	Completed
19-0331-0	05/28/2020	11/16/2020	0403065936	Aera Energy LLC	Kern	Lost Hills	Completed
19-0332-0	05/28/2020	11/11/2020	0403065937	Aera Energy LLC	Kern	Lost Hills	Completed
19-0333-0	05/28/2020	11/18/2020	0403065938	Aera Energy LLC	Kern	Lost Hills	Completed
19-0334-0	05/28/2020	11/13/2020	0403065956	Aera Energy LLC	Kern	Lost Hills	Completed

WST Permit Number	Permit Issue Date	Stimulation Completion Date	API	Operator	County	Field	Permit Status
19-0335-0	05/28/2020	11/12/2020	0403065960	Aera Energy LLC	Kern	Lost Hills	Completed
19-0336-0	05/28/2020	11/11/2020	0403065966	Aera Energy LLC	Kern	Lost Hills	Completed
19-0338-0	11/24/2020	12/31/2020	0403065961	Aera Energy LLC	Kern	Belridge, South	Completed
19-0341-0	11/24/2020	12/30/2020	0403065964	Aera Energy LLC	Kern	Belridge, South	Completed
19-0342-0	11/24/2020	12/08/2020	0403065965	Aera Energy LLC	Kern	Belridge, South	Completed
19-0343-0	11/24/2020	12/29/2020	0403065974	Aera Energy LLC	Kern	Belridge, South	Completed
19-0346-0	10/16/2020	12/02/2020	0403065955	Aera Energy LLC	Kern	Belridge, North	Completed
19-0348-0	10/16/2020	12/04/2020	0403065958	Aera Energy LLC	Kern	Belridge, North	Completed
19-0349-0	10/16/2020	12/07/2020	0403065959	Aera Energy LLC	Kern	Belridge, North	Completed
19-0351-0	10/16/2020	12/03/2020	0403065971	Aera Energy LLC	Kern	Belridge, North	Completed
19-0352-0	10/16/2020	--	0403065972	Aera Energy LLC	Kern	Belridge, North	Active
19-0353-0	10/16/2020	12/01/2020	0403065973	Aera Energy LLC	Kern	Belridge, North	Completed
90316408	12/03/2020	--	0403066111	Aera Energy LLC	Kern	Lost Hills	Active
90316436	12/03/2020	--	0403065940	Aera Energy LLC	Kern	Lost Hills	Active
90316438	12/03/2020	--	0403066026	Aera Energy LLC	Kern	Lost Hills	Active
90316587	12/30/2020	--	0403066181	Aera Energy LLC	Kern	Belridge, South	Permitted
90321250	12/30/2020	--	0403066177	Aera Energy LLC	Kern	Belridge, South	Permitted
90321251	12/30/2020	--	0403066178	Aera Energy LLC	Kern	Belridge, South	Permitted
90321252	12/30/2020	--	0403066179	Aera Energy LLC	Kern	Belridge, South	Permitted
90321253	12/30/2020	--	0403066182	Aera Energy LLC	Kern	Belridge, South	Permitted
90321254	12/31/2020	--	0403066187	Aera Energy LLC	Kern	Belridge, South	Permitted
90321255	12/30/2020	--	0403066188	Aera Energy LLC	Kern	Belridge, South	Permitted
90321256	12/30/2020	--	0403066189	Aera Energy LLC	Kern	Belridge, South	Permitted
90321257	12/30/2020	--	0403066190	Aera Energy LLC	Kern	Belridge, South	Permitted
90321258	12/30/2020	--	0403066191	Aera Energy LLC	Kern	Belridge, South	Permitted
90321259	12/30/2020	--	0403066192	Aera Energy LLC	Kern	Belridge, South	Permitted
90321260	12/31/2020	--	0403066193	Aera Energy LLC	Kern	Belridge, South	Permitted
90321261	12/30/2020	--	0403066194	Aera Energy LLC	Kern	Belridge, South	Permitted
90321262	12/30/2020	--	0403066195	Aera Energy LLC	Kern	Belridge, South	Permitted

Table B2: Base Fluid Volumes by Operator and Source

Well Operator/County – District	Domestic Water System (BBLS)	Operator Water Production Well (BBLS)	Produced Fluid (BBLS)	Total Base Fluid (BBLS)
Aera	104,331	38,498	0	142,829
Chevron	0	36,315	0	36,315
TOTALS	104,331	74,813	0	179,144
Kern County – Inland District	104,331	74,813	0	179,144

Table B3: Base Fluid Volumes by Operator and Suitability

Well Operator/County – District	Suitable for Irrigation/Domestic Use (BBLS)	Not Suitable for Irrigation/Domestic Use (BBLS)	Total Base Fluid (BBLS)
Aera	104,331	38,498	142,829
Chevron	0	36,315	36,315
TOTALS	104,331	74,813	179,144
Kern County – Inland District	104,331	74,813	179,144

Table B4: Inorganic Compounds in "Suitable" Base Fluid

Required Analytes	Average Concentration Detected (mg/L)	Percentage of Samples with Detection
Alkalinity, Total	61	100%
Antimony	0	NOT DETECTED
Arsenic	0	NOT DETECTED
Barium	0.03	100%
Beryllium	0	NOT DETECTED
Boron	0.11	100%
Bromide	0.16	33%
Cadmium	0.0012	33%
Calcium	16	100%
Chloride	36	100%
Chromium	0.0019	33%
Cobalt	0	NOT DETECTED
Copper	0.003	67%
Lead	0	NOT DETECTED
Lithium	0	NOT DETECTED
Magnesium	8.9	100%
Mercury	0	NOT DETECTED
Molybdenum	0.003	33%
Nickel	0	NOT DETECTED
Nitrate	0.3	100%
Potassium	2.1	100%
Selenium	0	NOT DETECTED
Silver	0	NOT DETECTED
Sodium	31	100%
Strontium	0.16	100%
Sulfate	23	100%
Thallium	0	NOT DETECTED
Total Dissolved Solids	163	100%
Vanadium	0.0031	100%
Zinc	0.0024	33%

Table B5: Organic Compounds in "Suitable" Base Fluid

Required Analytes	Average Concentration Detected (µg/L)	Percentage of Samples with Detection
Benzene	0	Not Detected
Ethyl Benzene	0	Not Detected
Toluene	0	Not Detected
Xylenes	0	Not Detected

Table B6: Inorganic Compounds in "Not Suitable" Base Fluid

Required Analytes	Average Concentration Detected (mg/L)	Percentage of Samples with Detection
Alkalinity, Total	864	100%
Antimony	0	NOT DETECTED
Arsenic	0	NOT DETECTED
Barium	0.9	100%
Beryllium	0	NOT DETECTED
Boron	19	100%
Bromide	16	100%
Cadmium	0	NOT DETECTED
Calcium	195	100%
Chloride	2,835	100%
Chromium	0	NOT DETECTED
Cobalt	0	NOT DETECTED
Copper	0	NOT DETECTED
Lead	0.01	50%
Lithium	1.6	100%
Magnesium	42	100%
Mercury	0	NOT DETECTED
Molybdenum	0.02	100%
Nickel	0.05	50%
Nitrate	0	NOT DETECTED
Potassium	48	100%
Selenium	0.074	50%
Silver	0	NOT DETECTED
Sodium	1,955	100%
Strontium	2.8	100%
Sulfate	475	100%
Thallium	0.01	50%
Total Dissolved Solids	6,100	100%
Vanadium	0.007	50%
Zinc	0.06	50%

Table B7: Organic Compounds in "Not Suitable" Base Fluid

Required Analytes	Average Concentration Detected (µg/L)	Percentage of Samples with Detection
Benzene	320	50%
Ethyl Benzene	49	50%
Toluene	250	50%
Xylenes	160	50%

Table B8: Additives Used in Stimulation by Supplier & Purpose

Supplier Name	Additive Trade Name	Purpose	Number of Times Used in WST Fluid
Chevron	Water	Base Fluid	12
Halliburton	Acetic Acid	pH Control	26
Halliburton	BC-140C	Crosslinker	58
Halliburton	BE-3S BACTERICIDE	Biocide	57
Halliburton	DCA-13002	Breaker	58
Halliburton	DCA-14005	pH Control	58
Halliburton	DCA-16002	Clay Control	58
Halliburton	DCA-17002	Corrosion Inhibitor	8
Halliburton	DCA-25005	Gelling Agent	58
Halliburton	DCA-30001	Scale Inhibitor	12
Halliburton	DCA-32005	Surfactant	8
Halliburton	DSC-04, 16/30	Proppant	12
Halliburton	GBW-30 BREAKER	Breaker	58
Halliburton	HYDROCHLORIC ACID	Solvent	8
Halliburton	SAND-PREMIUM WHITE-16/30	Proppant	58
Halliburton	SAND-PREMIUM WHITE-20/40	Proppant	31
Halliburton	Water	Base Fluid	46

Table B9: Chemical Constituents Used in Stimulation by Constituent Name

Constituent Name	CAS Number	Number of Times Used in WST Fluid
1-Eicosene	3452-07-1	7
1-Hexadecene	629-73-2	8
1-Octadecene	112-88-9	8
1-Tetradecene	1120-36-1	8
2,2 Dibromo-3-nitrilopropionamide	10222-01-2	57
2-Monobromo-3-nitrilopropionamide	1113-55-9	57
Acetic acid	64-19-7	26
Alcohols, C14-C15, ethoxylated	68951-67-7	8
Alkenes, C >10 alpha-	64743-02-8	8
Ammonium chloride	12125-02-9	58
Ammonium; diallyl dimethyl-; chloride; polymers	26062-79-3	58
Crystalline silica (Quartz)	14808-60-7	58
Guar gum	9000-30-0	58
Hemicellulase enzyme	9012-54-8	58
Hydrochloric acid	7647-01-0	8
Lactose	63-42-3	58
Lauryl dimethyl hydroxysulfobetaine	13197-76-7	8
Methanol	67-56-1	8
Mixture of dimer and trimer fatty acids of indefinite composition derived from tall oil	61790-12-3	8
Monoethanolamine borate	26038-87-9	58
Pigment Red 48:2	7023-61-2	12
Polyoxyethylene (12) polyoxypropylene (66) glyceryl ether	9082-00-2	12
Polyurethane Resin	57029-46-6	12
Propargyl alcohol	107-19-7	8
Reaction product of acetophenone, formaldehyde, thiourea and oleic acid in dimethyl formamide	68527-49-1	8
Sodium bisulfite	7631-90-5	12
Sodium chloride	7647-14-5	58
Sodium hydroxide	1310-73-2	58
Sodium persulfate	7775-27-1	58
Sodium polyacrylate	9003-04-7	12
Sodium sulfate	7757-82-6	58
Water	7732-18-5	58

Table B10: Average Concentration of Inorganic Compounds Detected in Recovered Fluid by Operator

Required Analytes	Aera (mg/L)	Chevron (mg/L)
Alkalinity, Total	2,838	3,930
Antimony	47.1	NOT DETECTED
Arsenic	0.14	NOT DETECTED
Barium	12.1	3.4
Beryllium	0.002	0.019
Boron	99	102
Bromide	103	53
Cadmium	0.042	0.023
Calcium	214	209
Chloride	16,777	28,204
Chromium	0.023	0.035
Chromium, Hexavalent	0.013	NOT DETECTED
Cobalt	0.0039	0.0215
Copper	0.043	0.016
Fluoride	NOT DETECTED	NOT DETECTED
Hydrogen sulfide (H2S)	0.08	0.30
Iron	40	66
Lead	0.086	0.015
Lithium	8.8	6.2
Magnesium	164	163
Manganese	0.62	1.07
Mercury	0.0012	NOT DETECTED
Molybdenum	0.038	0.016
Nickel	0.030	0.103
Nitrate	14	NOT DETECTED
Nitrite	0.068	NOT DETECTED
Potassium	274	209
Selenium	0.49	0.12
Silver	0.04	NOT DETECTED
Sodium	10,309	7,526
Strontium	11.2	7.5
Sulfate	43	113
Thallium	NOT DETECTED	0.02
Total Dissolved Solids	29,267	20,565
Vanadium	0.003	0.030
Zinc	0.092	0.194

Table B11: Average Concentration of Inorganic Compounds Detected in Recovered Fluid by County & District

Required Analytes	Kern County – Inland District (mg/L)	Percentage of Samples with Detection
Alkalinity, Total	3061	100%
Antimony	47.1	19%
Arsenic	0.14	44%
Barium	10.3	100%
Beryllium	0.006	8%
Boron	99	100%
Bromide	93	99%
Cadmium	0.041	13%
Calcium	213	100%
Chloride	19103	100%
Chromium	0.03	35%
Chromium, Hexavalent	0.013	6%
Cobalt	0.0057	18%
Copper	0.041	55%
Fluoride	NOT DETECTED	NOT DETECTED
Hydrogen sulfide (H2S)	0.23	27%
Iron	45	100%
Lead	0.052	20%
Lithium	8.3	100%
Magnesium	164	100%
Manganese	0.71	100%
Mercury	0.0012	17%
Molybdenum	0.035	41%
Nickel	0.050	69%
Nitrate	14	1%
Nitrite	0.068	14%
Potassium	261	100%
Selenium	0.37	64%
Silver	0.04	1%
Sodium	9742	100%
Strontium	10.5	100%
Sulfate	63.6	64%
Thallium	0.02	1%
Total Dissolved Solids	27496	100%
Vanadium	0.012	5%
Zinc	0.113	56%

Table B12: Average Concentration of Organic Compounds Detected in Recovered Fluid by Operator

Required Analytes	Aera (µg/L)	Chevron (µg/L)
Benzene	2,115	153
Ethyl Benzene	300	99
Guar Gum	109,349	48,000
Methane	1,438	1,408
Toluene	2,491	187
Xylenes	1,495	253

Table B13: Average Concentration of Organic Compounds Detected in Recovered Fluid by County & District

Required Analytes	Kern County – Inland District (µg/L)	Percentage of Samples with Detection
Benzene	1715	100%
Ethyl Benzene	259	99%
Guar Gum	108,853	88%
Methane	1432	100%
Toluene	2022	100%
Xylenes	1243	100%

Table B14: Average Concentration of Radioactive Compounds Detected in Recovered Fluid by Operator

Required Analytes	Aera (pCi/L)	Chevron (pCi/L)
Alpha, Gross	71.6	4.7
Beta, Gross	164.6	109.1
Radium-226	26.8	13.0
Radon	67.9	6.9

Table B15: Average Concentration of Radioactive Compounds Detected in Recovered Fluid by County & District

Required Analytes	Kern County – Inland District (pCi/L)	Percentage of Samples with Detection
Alpha, Gross	58.0	100%
Beta, Gross	153.3	100%
Radium-226	24.0	100%
Radon	55.5	100%

Table B16: Average Length of Stimulation

Well Operator/ County-District	Minimum (FT)	Maximum (FT)	Average (FT)
Aera	46	100	66
Chevron	20	220	191
Kern County - Inland District	20	220	114

Table B17: Average Height of Stimulation

Well Operator/ County-District	Minimum (FT)	Maximum (FT)	Average (FT)
Aera	75	171	129
Chevron	50	225	217
Kern County - Inland District	50	225	163

Table B18: Top Depths of Stimulation

Well Operator/ County – District	Minimum (TVD FT)	Maximum (TVD FT)	Average (TVD FT)
Aera	525	1,861	1,177
Chevron	1,085	1,507	1,199
Kern County – Inland District	525	1,861	1,182

Table B19: Bottom Depths of Stimulation

Well Operator/ County – District	Minimum (TVD FT)	Maximum (TVD FT)	Average (TVD FT)
Aera	1,441	2,651	2,041
Chevron	1,173	1,999	1,695
Kern County – Inland District	1,173	2,651	1,969

Table B20: Number of Stimulations in Each Formation by County & District

County/District	Formation Name	Number of Stimulations
Kern County - Inland District	Etchegoin/Reef Ridge-Diatomite	16
	Reef Ridge-Diatomite	42
	TOTAL	**58**

Table B21: Well Stimulation Permits Not Requiring Neighbor Notification

WST Permit Number	API	Operator	County	Field
19-0132-0	0403048931	Aera	Kern	Belridge, South
19-0195-0	0403063010	Chevron	Kern	Lost Hills
19-0250-0	0403065752	Aera	Kern	Belridge, South
19-0262-0	0403065831	Aera	Kern	Belridge, South
19-0316-0	0403065886	Aera	Kern	Belridge, North
19-0318-0	0403065893	Aera	Kern	Belridge, North
19-0319-0	0403065896	Aera	Kern	Belridge, North
19-0342-0	0403065965	Aera	Kern	Belridge, South
19-0346-0	0403065955	Aera	Kern	Belridge, North
19-0348-0	0403065958	Aera	Kern	Belridge, North
19-0349-0	0403065959	Aera	Kern	Belridge, North
19-0351-0	0403065971	Aera	Kern	Belridge, North
19-0353-0	0403065973	Aera	Kern	Belridge, North

Table B22: Number of Stimulations Witnessed by CalGEM

County – District	Number of WSTs Witnessed
Kern County – Inland District	52

Table B23: Number of Chemical Spot-Checks Performed by CalGEM

County – District	Number of Chemical Spot-Checks Performed
Kern County – Inland District	17

APPENDIX C – STATUTORY REQUIREMENTS FOR ANNUAL REPORTS

As defined in Public Resources Code (PRC) section 3157(a), "Well stimulation treatment" means a treatment of a well designed to enhance oil and gas production or recovery by increasing the permeability of the formation. Well stimulation is a short- term, and non-continual process for the purpose of opening and stimulating channels for the flow of hydrocarbons. WSTs include, but are not limited to, hydraulic fracturing, acid fracturing, and acid matrix stimulation.

The data presented in this report are derived from operator disclosures submitted to CalGEM per the requirements stated in PRC section 3160(b)(2). Operators have one year from the date of issuance of a WST permit to begin a stimulation, and 60 days from the completion of the well stimulation to submit the WST disclosure form to CalGEM (PRC sections 3160(d)(4) and 3160(g)).

PRC section 3215(c)(1)-(8) requires that this report address the following items:

1. Aggregated data detailing the disposition of any produced water from wells that have undergone WST.
   - Review Section 4.6 of this document.

2. Aggregated data describing the formations where wells have received WSTs, including the range of safety factors used and fracture zone lengths.
   - Review Section 4.8 of this document

3. The number of emergency responses to a spill or release associated with a WST.
   - Review Section 8.0 of this document.

4. Aggregated data detailing the number of times trade secret information was not provided to the public, by county and company, in the preceding year.
   - Review Section 4.5.1.2 of this document.

5. Data detailing the loss of well and well casing integrity in the preceding year for wells that have undergone WST. For comparative purposes, data detailing the loss of well and well casing integrity in the preceding year for all wells shall also be provided. The cause of each well and well casing failure, if known, shall also be provided.

- Review Section 8.0 of this document.

6. The number of spot-check inspections conducted pursuant to PRC section 3160(l), including the number of inspections where the composition of well stimulation fluids was verified and the results of those inspections.
   - Review Section 7.2 of this document.

7. The number of WSTs witnessed by CalGEM.
   - Review Section 7.1 of this document.

8. The number of enforcement actions associated with WSTs, including, but not limited to, notices of deficiency, notices of violation, civil or criminal enforcement actions, and any penalties assessed.
   - Review Section 7.0 of this document.

PRC section 3215(c) also calls for inclusion of "aggregated data of all the information required to be reported" under PRC section 3160, consisting of the provisions described under PRC 3160(b)(2)(A)-(G) which are addressed in this report:

A. The date of the WST.
   - WSTs completed between January 1, 2020 and December 31, 2020. This is the reporting period covered in this report.

B. A complete list of the names, Chemical Abstract Service (CAS) numbers, and maximum concentration, in percent by mass, of each and every chemical constituent of the WST fluids used.
   - Review Section 4.5.2 of this report.

C. The trade name, the supplier, concentration, and a brief description of the intended purpose of each additive contained in the WST fluid.
   - Review Section 4.5.1 of this report.

D. The total volume of base fluid used during the WST, and the identification of whether the base fluid is water suitable for irrigation or domestic purposes, water not suitable for irrigation or domestic purposes, or a fluid other than water.
   - Review Section 4.4 of this report.

E. The source, volume, and specific composition and disposition of all water, including, but not limited to, all water used as base fluid during the well stimulation treatment and recovered from the well following the well stimulation treatment that is not otherwise reported as produced water pursuant to Section 3227. Any repeated reuse of treated or untreated water for well stimulation treatments and well stimulation treatment-related activities shall be identified.
   - Review Section 4.6 of this report.

F. The specific composition and disposition of all WST fluids, including waste fluids, other than water.
   - Review Section 4.6 of this report.

G. Any radiological components or tracers injected into the well as part of, or in order to evaluate, the WST, a description of the recovery method, if any, for those components or tracers, the recovery rate, and specific disposal information for recovered components or tracers.
   - Review Section 4.5.1.1 of this report.

H. The radioactivity of the recovered well stimulation fluids.
   - Review Section 4.6 of this report.

I. The location of the portion of the well subject to the WST and the extent of the fracturing or other modification, if any, surrounding the well induced by the treatment.
   - Review Section 4.7 of this report.

APPENDIX D – GLOSSARY

TERM	DESCRIPTION
Acid Fracture Stimulation	The combined use of acid and fracturing to increase the permeability of (stimulate) a portion of rock or sediment formation intercepted by a well.
Acid Matrix Stimulation	The use of acid to dissolve mineral material to increase the permeability of (stimulate) a portion of rock or sediment formation intercepted by a well.
Additive	One or more substances added to a base fluid to make up a WST fluid.
Base Fluid	A liquid (or potentially a gas) into which additives are mixed, to make up a WST fluid.
Base Fluid Source	The source or origin of a base fluid.
Base Fluid Suitability	The suitability of water base fluid for domestic use (e.g., human or livestock consumption) or irrigation (e.g., agricultural use).
California Code of Regulations (CCR)	The official compilation and publication of the regulations adopted, amended or repealed by state agencies pursuant to the Administrative Procedure Act. WST is regulated within title 14, sections 1751 through 1789 of the California Code of Regulations.
Chemical Abstract Service Registry Number	A unique identification number assigned by the Chemical Abstract Service (CAS) for every chemical compound or mixture of chemical compounds described in scientific literature.
Class II (Injection) Well	Class II wells in California are approved and regulated by CalGEM for the injection of fluids produced as byproducts of the recovery or production of oil or gas, or for storage of hydrocarbons pursuant to CalGEM's UIC program. See *Underground Injection Control (UIC)*.
Confidential Well	A temporary well status approved by CalGEM to protect certain information about a well from disclosure to public and presumably competing operators.
Constituent	A chemical used in a WST additive or base fluid; a chemical component of a WST fluid.

TERM	DESCRIPTION
Diatomite	A rock of very high porosity and usually low permeability that may contain oil or gas. Diatomite is found within the Monterey Formation and other petroleum-bearing rock formations in California and elsewhere.
Directionally Drilled Well	A well that has been intentionally constructed away from vertical, on or close to a pre-planned pathway. Some directionally-drilled wells are curved upward during drilling to be finished as horizontal wells.
Disclosure	The electronic report of a WST submitted to CalGEM under WST regulations.
Disposition	Term used in WST statutes for the management or disposal of water or other wastes from WST operations.
District	An administrative regional CalGEM office.
Gas	Natural gas. Natural gas consists of methane and other simple hydrocarbon molecules that are gasses rather than liquids at room temperature and pressure. Natural gas is present both dissolved in oil and in pore space above oil, within the Earth.
Hydraulically Fractured Stimulation	Refers to the intentional, short-term injection of fluid at sufficient pressure to break apart rock to enhance the permeability of (stimulate) a portion of rock or sediment formation intercepted by a well.
Measured Depth	The distance along the actual path of wellbore, from the ground surface, drilling mat, kelly bushing, drill floor, or other aboveground reference point used during drilling. Measured depth can be thought of as the total length of drill pipe in the ground to reach the end of a wellbore, no matter how curved and twisted the well bore path may be from the reference point.
Monterey Formation	The name used in much of California for a portion of the Miocene-aged, fine-grained sedimentary rock (i.e., commonly shale) deposited and still present along the margin of the Pacific Ocean.

TERM	DESCRIPTION
Neighbor Notification	The requirement and process to notify landowners and occupants of parcels of property located within specified distances of a well where a WST is to be performed. The notification allows landowners or occupants to request that ground or surface waters that are suitable for drinking or irrigation be sampled and tested to assess possible impact from WST.
Notice of Violation	Written notification made to an oil or gas well operator from the State Oil and Gas Supervisor of violation of a regulation or statute. A Notice of Violation is commonly the first formal correspondence to an operator preceding an Order or other potential enforcement action.
Notice to Operators	A written clarification, transmission of, or request for information made by CalGEM to oil and gas well operators about a specific topic.
Notification	The process of providing information about an upcoming action, an opportunity, or an action taken, made in writing, to a party. See *Neighbor Notification* for one example of a notification required by SB 4.
Operator	A party that owns or has legal responsibility for the maintenance and operation of an oil or gas well or other well that falls within the jurisdiction of CalGEM.
Permeability	The property of or rate at which a solid can or does transmit oil, water, air, or other fluids. See *Porosity*.
Porosity (Pore Space)	The presence within and amount of a solid that is void (potentially empty) space. Pore space within rocks and soil is filled with oil, water, air or other gasses or fluids. See *Permeability*.
Pressure Testing	The requirement implemented July 1, 2015, that an operator notify CalGEM of and record pressure tests of all well casings and tubings to be used in a WST operation. See *Zonal Isolation* and *Well Integrity*.

TERM	DESCRIPTION
Produced Water	Water that is extracted from beneath the ground surface as a byproduct of oil or gas production. In mature oil fields such as those common in California, most of the fluid that is pumped from the ground is produced water. In California, most produced water is naturally salty.
Public Resources Code (PRC)	One of 29 groupings of California statutes (laws). The Public Resources Code contains key statutes affecting oil and gas resources, wells, and operations. SB 4 added language primarily to the PRC to give CalGEM greater authority and responsibility to regulate WST.
Recovered Water or Fluid	Fluids (e.g., water, oil, and gas) that come out (either naturally or by pumping or other assistance) of an oil or gas well after WST and prior to the routine production or other stabilized use and flow of fluids from a well. SB 4 requires operators to chemically test and provide information to CalGEM about recovered fluids.
Rulemaking Process	The procedure used by any component of the Executive Branch (of the State of California government) in adopting regulations and rules that will have the force of law. CalGEM followed both the emergency rulemaking process and regular rulemaking process in implementing SB 4.
Senate Bill 4 (SB 4)	California State Senate Bill 4 (Pavley, Chapter 313, Statutes of 2013) was passed by the Legislature and signed by Governor Jerry Brown in September 2013 to better regulate WST.
Spot-Check (Inspection)	The term used in SB 4 to describe a visit by CalGEM staff to a WST operation for the specific purpose of comparing the additives, chemicals, and base fluid at the WST location with the information about the additives, chemicals, and base fluid that was supplied in the Notice.
Stage	A subset or smaller portion of the total interval or portion of a well that is stimulated. A typical WST has several to more than ten stages that are performed in rapid succession in a single effort.

TERM	DESCRIPTION
Trade Secret	The withholding of certain information about one or more WST additives from the public and presumably competitors. SB 4 allows an operator to request trade secrecy from CalGEM through a rigorous and formal process.
True Vertical Depth	The straight-line extent of a well vertically down into the Earth, calculated without regard to actual twists, curves or intentional deviations of the well bore. It is measured from the ground surface, drilling mat, kelly bushing, drill floor, or other aboveground reference point used during drilling.
Underground Injection Control (UIC)	CalGEM has responsibility and authority to regulate the injection of any fluid into the ground via any oil or gas or other well under its jurisdiction. CalGEM's UIC regulations and authority conform to and were granted by federal authority in compliance with the federal Safe Drinking Water Act of 1974. See "Class II well."
Wellbore	A hole that is drilled to aid in the exploration and recovery of natural resources including oil, gas, or water.
Well (Casing) Integrity	The reliability of a well to perform its functions. This includes intact and functioning casing and cement that can durably resist all foreseeable changes (such as pressures, corrosive fluids or earth settlement or lateral shift) in conditions within and outside the well and ensure zonal isolation. See *Zonal Isolation*.
Well Stimulation	The brief and intentional application of pressure, chemicals, or other method to rock or sediment intercepted by a well, to increase the rock or sediment permeability to enhance oil or gas production, or potentially to increase water production or the ability of rock or sediment to accept injection water or other fluid.
Well Stimulation Treatment (WST)	Any treatment of a well designed to enhance oil and gas production or recovery by increasing the permeability of the formation. WSTs include, but are not limited to, hydraulic fracturing treatments and acid well stimulation treatments.

Witnessing (Inspection)	The term used in SB 4 to describe a general or all-purpose visit by CalGEM staff to a WST operation to observe, monitor, or verify any regulated or required aspect of the WST.
TERM	**DESCRIPTION**
Zonal Isolation	The principal of constructing, verification-testing, and maintenance of a well to ensure that fluids are not migrating along or inside a well from one zone to another. Zones of concern that are protected from contamination of one another include oil or gas-bearing zones, zones of abnormally high pore pressures, zones of fresh water, zones of water of actual or potential beneficial use, zones of saline water, and zones of water contaminated by human activity.

CALGEM DIVISION CONTACT INFORMATION

HEADQUARTERS
801 K Street, MS 18-05
Sacramento, CA 95814
(916) 445-9686
Fax: (916) 323-0424

INLAND DISTRICT
11000 River Run Blvd.
Bakersfield, CA 93311
(661) 322-4031
Fax: (661) 861-0279

NORTHERN DISTRICT
715 P Street
Sacramento, CA 95814
(916) 322-1110
Fax: (916) 445-3319

SOUTHERN DISTRICT
3780 Kilroy Airport Way, Suite 400
Long Beach, CA 90806
(562) 637-4400
Fax: (562) 424-0166