DEPARTMENT OF CONSERVATION

Managing California's Working Lands

DIVISION OF OIL, GAS, & GEOTHERMAL RESOURCES

801 K STREET • MS 20-20 • SACRAMENTO, CALIFORNIA 95814

PHONE 916 / 445-9686 • **FAX** 916 / 323-0424 • **TDD** 916 / 324-2555 • **WEB SITE** conservation.ca.gov

SB 4 WELL STIMULATION TREATMENT REGULATIONS

DISCUSSION OF CALCULATED ACID VOLUME THRESHOLD

Background

The Department of Conservation, Division of Oil, Gas, and Geothermal Resources (Division) has prepared this document to provide background and explanation for proposed regulations that would quantify the distinction between acid matrix stimulation treatment and the use of acid for wellbore cleanout, maintenance, and removal of formation damage. As discussed in more detail below, the SB 4 Well Stimulation Treatment Regulations, First Revised Text of Proposed Regulations ("Revised Regulations") establish an Acid Volume Threshold, which is calculated on a case-by-case basis, factoring in the wellbore volume and the porosity of the formation. Calculation of the Acid Volume Threshold will return a number of gallons per treated foot of the wellbore, which will be used to distinguish what is and is not acid matrix stimulation.

This distinction is necessary because the requirements of Public Resources Code section 3160 only apply to "well stimulation treatments," and not all well treatments that use acid meet the definition of a "well stimulation treatment." Public Resources Code section 3157 defines "well stimulation treatment" to mean a treatment of a well that is designed to enhance oil and gas production by increasing the permeability of the formation. The definition of "well stimulation treatment" expressly excludes routine well cleanout work, well maintenance, removal of formation damage, bottom hole surveys, and other activities that do not affect the integrity of the well.

In addition to the distinction between routine wellbore operations and well stimulation treatments designed to enhance the permeability formation, the statute calls on the Division to make a second distinction based on the amount of risk associated with the treatment. Although Public Resources Code section 3158 expressly identifies acid matrix stimulation as a form of well stimulation treatment, the statute calls for a threshold volume of acid, below which an acid matrix stimulation treatment is not subject to regulation because it does not pose a significant risk. (Pub. Resources Code, § 3160, subd. (b)(1)(C).) For acid matrix stimulation treatments to be excluded under

the acid volume threshold, the threshold must be based upon a quantitative assessment of the risks posed by acid matrix stimulation treatments. (*Ibid*.) Therefore, this second distinction under Public Resources Code section 3160, subdivision (b)(1)(C), calls for acid treatments to be excluded from regulation because the risk associated with the volume of acid are low, and this exclusion would apply even if the acid treatment is designed to enhance the permeability of the formation.

As explained below, the Division has determined that the quantitative assessment of risks contemplated in Public Resources Code section 3160, subdivision (b)(1)(C) is not feasible given the limited data presently available and the timeframe during which the Division must promulgate regulations regarding well stimulation treatment. For this reason, the proposed Acid Volume Threshold is not intended to be a basis for making the risk-based distinction called for under Public Resources Code section 3160, subdivision (b)(1)(C). That is, the proposed Acid Volume Threshold is not intended to be a basis for acid matrix stimulation treatments that will enhance the permeability formation to be excluded from regulation. Instead, the sole purpose of the proposed Acid Volume Threshold is to distinguish acid matrix stimulation treatment from the routine uses of acid that are already expressly excluded from the definition of well stimulation treatment under Public Resources Code section 3157.

A complete quantitative assessment should clearly describe the potential risks and benefits that might result from a particular course of action. This is necessary so that each course of action can be evaluated and prioritized based on the actual reduction in risk that would be achieved. In every risk assessment, it is important to understand the sensitivity of the risk-based decisions to the assumptions made in order to determine how robust the evaluation is and the circumstances that might justify the use of different assumptions.

A complete quantitative assessment of risks associated with acid matrix stimulation treatment would involve identifying the types of chemicals and the volume of chemicals of potential concern at a site, simulating their release and movement in the environment, estimating their uptake by both human and environmental receptors (a receptor is an exposed person, animal, plant, or freshwater zone), and predicting the potential effects of the exposure. In order to conduct such an assessment, there needs to be a data set available to analyze the rate of detrimental occurrences for a large number of applications of acid. Because reporting requirements for acid matrix stimulation have only been in place since January 1, 2014, data regarding acid treatments is limited, and an appropriate data set does not otherwise exist for operations in California.

Public Resources Code section 3160, subdivision (b)(1)(C)(ii), requires the Division to reevaluate the acid volume threshold by 2020, taking into account newly available data, and making revisions to the regulations if appropriate. To that end, the proposed regulations will require reporting of all well treatments that use acid, even if the treatment does not meet the definition of a well stimulation treatment. (*See* Revised Regulations, § 1774.4.) Once accumulated, this data will enable the Division to analyze the data over time. This analysis will in turn enable the Division to establish the relationship between risk and volume (i.e., a volume of acid used would be a proxy for relative risk). Information in the independent scientific study being conducted under

Public Resource Code section 3160, subdivision (a), may also be a resource for the reevaluation.

For the purposes of present regulation, the Acid Volume Threshold will be a determining factor in distinguishing between well stimulation treatments designed to enhance the permeability of the formation, versus uses of acid for wellbore cleanup, wellbore maintenance, and removal of formation damage. Over time, with the increased accumulation and analysis of data, the Division will be able to quantitatively assess the risks associated with the use of acid for well stimulation. At such time, the Division will propose amendments or additions to the well stimulation regulations that are based on a quantitative assessment of risk, as contemplated under Public Resources Code section 3160, subdivion (b)(1)(C)(ii).

Following is a discussion of how the Division developed the Acid Volume Threshold calculation to identify the routine uses of acid excluded from the definition of well stimulation treatment under Public Resources Code section 3157.

Basis for Acid Volume Threshold

Although data regarding acid treatments in California is limited, there is an abundance of research and evidence showing that the area around the wellbore impacted by drilling would be considered wellbore damage caused by the drilling fluid (often called "drilling mud") used while drilling the well, the area of influence for well cleanout work, and therefore the area associated with routine well maintenance.

The amount of acid used in the well can be used as an indication of the design and purpose of the use of acid in the wellbore. Acid used to increase the permeability of the formation must come into contact with the formation and is designed to alter the formation, typically to dissolve constituents in the formation, in order to increase the formation's permeability. Therefore, the amount of acid used is directly related to the area that is anticipated to be altered, i.e. the more acid placed in the well for every treated foot, the larger the area that will be impacted by the acid.

The amount of acid and the pressure applied to wellbore fluids in a well affects the distance to which the fluid may penetrate away from the wellbore. This distance is a function of the porosity and permeability of the formation in relationship to the applied pressure. If the pressure is maintained below the fracture pressure, the acid will not be allowed to migrate outside of the intended zone through fractures or cracks caused by the emplacement of the acid. In addition, there is a limit to the distance fluid will flow over a period of time, based upon the formation's permeability and the consistency of the fluid.

The Division has evaluated several different variables that could affect the radius of penetration of acid placed in a wellbore. Factors that influence the extent of acid penetration during a routine well cleanout include, but are not limited to: formation porosity, formation permeability, changes in lithology, viscosity of the wellbore fluid, thickness of formation treated, and the formation verses wellbore pressures. Any one of these factors, or combination thereof, could alter the extent of penetration during an

acid treatment to clean up the well perforations or remedy near-wellbore formation damage. Many of these variables are not physically measured in a wellbore, but inferred from local or regional data analysis and experience with the formation. Further, in some cases there is only limited information available and assumptions must be made. Additionally, as acid penetrates the formation and reacts with minerals and wellbore deposits, its strength declines with distance from the wellbore and duration of the well stimulation treatment.

The Division consulted standard reference engineering text books, Society of Petroleum Engineering publications, and numerous service company representatives to better determine the impacts and radius of wellbore damage. This research indicates that there is a limit to how deep formation damage can occur as a result of drilling operations. Most of the near wellbore damage occurs as a result of a reaction between the drilling fluid and the formation fluid or minerals in which it comes in contact. Commonly, the salinity, or lack thereof, of the drilling fluid and it's interaction with formation clays can result in clay swelling which adversely impacts the natural formation permeability. Typically, the radius of formation damage is between 20 to 50 inches.

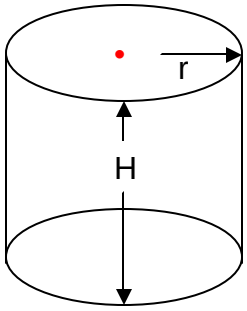
The Revised Regulations include the defined term "Acid Volume Threshold" in section 1761, subdivision (a)(3). Based on the Division's determination that wellbore damage generally extends 20 to 50 inches from the wellbore, the proposed acid volume threshold is designed to calculate the formation bulk volume per treated foot of the wellbore for a 36-inch radius from the wellbore. A distance of 36 inches was selected because it is a conservatively smaller area than the area where wellbore damage could typically occur. If a treatment is below the Acid Volume Threshold, then it is clearly within the range of wellbore cleanout, maintenance, and removal of formation damage. Well treatments using acid that exceed the Acid Volume Threshold are presumed to be well stimulation treatment, unless it is successfully demonstrated to the Division that the treatment will not increase the permeability of the formation. (*See* Revised Regulations, § 1761, subd. (a)(1)(A)(ii).) In order to ensure that there is complete information about the use of acid, operators must submit basic information about all well treatments that use acid to the Division for inclusion in the public well file, even if the treatment does not meet the definition of a well stimulation treatment. (Revised Regulation, § 1777.4, subd. (a).) The required information will include the calculation of the Acid Volume Threshold and a brief description of the treatment. The reporting of all acid use, without regard to volume or pressure, will allow the Division to analyze over time the use of acid in oilfield operations, and subsequently refine applicable regulations.

The Acid Volume Threshold is determined on a case-by-case basis by multiplying bulk volume by formation porosity (void space), and subtracting the wellbore volume which provides an estimated maximum volume of fluid/acid that may occupy the porosity in the formation if all indigenous fluid were to be displaced. In most real world situations, the saturation and strength of the acid declines with distance from the wellbore which effectively serves to reduce any negative impacts the acid may have near the periphery of the penetration zone.

To determine the volume of gallons needed to occupy the 36 inch radius per treated foot, the following formula is being used:

$$\frac{\text{Volume of the cylinder (inches}^3\text{)}}{231 \text{ inches}^3} = \text{gallons}$$

The volume of a cylinder is $\pi r^2 H$



Volume of the cylinder $= \pi r^2 H = 3.14 \times 36^2 \times 12 = 48{,}858 \text{ in}^3$

Volume of the cylinder = 48,858 inches^3

Void space within the cylinder = volume of cylinder x porosity

For example:

Void space within the cylinder = 48,858 inches^3 x 0.45 (porosity)

Void space within the cylinder = 21,986 inches^3

Therefore: $\frac{21{,}986 \text{ inches}^3}{231 \text{ inches}^3} = 95$ gallons/foot

Depending on the size of the casing, the volume of the casing for the number of treated feet is subtracted to fully account for the volume placed into the formation.

This calculation will be used on a case-by-case basis to determine the Acid Volume Threshold, which will be a specific number of gallons of fluid per treated foot of wellbore. This calculated Acid Volume Threshold will allow the public, the regulated industry and the Division to predictably and consistently identify whether a well treatment that uses acid is within the definition of a well stimulation treatment as defined in Public Resources Code section 3157.