California Division of Oil, Gas and Geothermal Resources

Well Completion Regulatory Summary

Coastal Onshore Oil and Gas Operators Group

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What follows is a review of the DOGGR's mandated authority to protect useable freshwater in California. As the provided information illustrates, the DOGGR State Oil and Gas Supervisor (Supervisor) has broad and specific powers (as provided for in both statues and regulations) to protect these valuable resources.

The first section is an overview of these powers and the methods used by industry to protect useable fresh water (freshwater) that is located both on the surface and subsurface of the earth. The second section is a more detailed review of specific laws and regulations that grant these powers to the Supervisor.

Section One:

While drilling a well, operators are required to use a fluid called drilling mud in the open hole. Drilling mud serves several purposes. It is thick enough to remove drill bit cuttings from the bottom of the hole yet complex enough to jell when circulation stops so those entrained drill cuttings are frozen in place so they do not drop back down to the bottom of well bore. Significant heat is created due to friction at the bit-formation contact. The circulation mud serves to cool and lubricate the drill bit. Probably the most important function of drill mud in our discussion concerning freshwater protection is its ability to "plate out" against the well bore formation wall. Once a "filter cake" or thick mud plate is formed on the well bore wall (it happens quickly), this impermeable barrier prevents fluid from infiltrating permeable formations such as fresh water zones. The filter cake invades the formation a short distance around the well thus permanently reducing permeability so additional fluid is prevented from infiltrating further into these zones. The invaded zone in each permeable formation is no more than a few feet and causes no harm to zone fluids or the zone's ability to transmit fluid through the zone. Think of the well as a sign post in the middle of a street. Other than sign's message, the sign post does nothing to impede traffic flow.

Once the upper portion of a well is drilled; usually to a depth of a competent rock formation, casing is run into the well. After the casing is in place cement is plunged down the center of the casing and out around the bottom of the casing string (casing shoe) and up between the casing and drilled well bore all the way to the surface. The cement is then allowed to cure before additional well drilling takes place. This first string of casing is called a surface casing and is used to anchor the blow out preventer. In some cases, where the depth to the base of freshwater (BFW) is shallow, it is also used to seal off the freshwater zone with mud, cement and casing. Usually though, the freshwater zone is deeper than the shoe of the surface casing. So after the well is drilled deeper using drilling mud, the next string of casing is run into the well and cemented in place. Sometimes cement is not circulated all the way to the surface so the DOGGR requires the operator to circulate or squeeze cement well above the BFW of the known freshwater zone. Once this is accomplished the freshwater zones are sealed off by mud, cement and casing. After that, drilling commences again and the well is completed.

Freshwater protection is a primary objective of DOGGR engineers. To ensure casing cement volumes are adequate, DOGGR engineers calculate the volumes needed to fill the required annular spaces to ensure operators in fact use adequate cement. In cases where old wells do not have adequate cement in the annular space between casing strings or the formation-casing annular space, DOGGR engineer require operators to squeeze cement these areas when wells are used for injection purposes or are being plugged and abandoned.

All underground injection wells have at least two lines of steel defense against leaks in areas where freshwater is present. In most cases freshwater zones are protected by at least one string of cemented casing and an inner string of tubing with a set packer. Fluid is injected down the center of the tubing. The packer in set just above the zone of injection in the tubing-casing annular space so no injected fluid actually comes in contact with the cemented casing. The DOGGR requires operators to run periodic tests on the tubing, packer and cemented casing to ensure no holes have formed and seals are adequate to prevent leakage into freshwater zones. Additionally, nearby wells in the injection zone should be in a condition to prevent fluid flow from the injection zone up to the freshwater zone. In cases where old wells exist that don't meet current well plugging or cementing standards, comprehensive monitoring plans are put in place to ensure zone pressures are kept low enough near the problem wells to ensure zonal fluid is unable to threaten freshwater zones.

In most production, idle and idle deserted wells, the actual fluid level, in these wells, is below the BFW. Consequently, there is little if any threat to the BFW by zonal fluid in these wells. When the fluid level is above the BFW in idle and idle deserted wells, the DOGGR's Idle Well Program mandates various tests to ensure the BFW is not endangered.

The Supervisor (or a District Deputy using the Supervisor's authority) can order tests to ensure no damage is occurring to freshwater zones if in their judgment there is cause for concern. If the test provide evidence that the freshwater zone is threatened, the Supervisor may order remedial action to eliminate the threat. If a complaint of harm or potential harm is filed with the supervisor concerning a particular well by a land owner or owner of a well within a mile of the subject well, the Supervisor will

conduct an investigation and provide a written report of findings and specify any remedial actions, if any, that need to be implemented.

To prevent threats to freshwater by idle wells, the DOGGR has an aggressive Idle Well Program that requires operators to test wells, pay fees or purchase bonds or plugged and abandon a percentage of these wells. The DOGGR also has money set aside annually to plug idle deserted (orphan) and hazardous wells. Each year many orphan wells are plugged and abandoned under DOGGR contracts. Some times DOGGR will plug and abandon active operator's wells using their bonds if they fail to comply with certain orders given by the Supervisor. These wells are usually old and in bad shape, so plugging and abandoning them significantly reduces future threats to freshwater and other resources. Under very tightly constructed rules, cities and counties can ask the Supervisor to order particular long term idle wells to be plugged and abandoned. The city or county must hire and pay for a consultant to demonstrate that a well has no future value. After an operator has had the chance to rebut the consultant's findings in writing, the Supervisor makes a judgment as to the viability of the well or wells.

When a well reaches the end of its useful life it has to be plugged and abandoned to very specific standards are outline in the DOGGR Code of Regulations. Productive zones must be isolated by plugging the well with cement and heavy drilling mud. The BFW is protected by casing cement between the formation and outside casing wall either when the well was drilled or during by well abandonment process. If an older well does not have cement across the BFW outside the exterior casing string, the operator will have to either shoot holes in the casing and squeeze enough cement through the perforations in order to fully seal the annular space or they will blow a cavity into the casing string and then displace a cement plug into the cavity which seals the annular space. Subsequently a long cement plug is placed inside the casing across the freshwater zone that will permanently protect the freshwater zone. After this plug hardens and is inspected by a DOGGR field inspector, the upper part of the well is plugged with cement and heavy mud. Plugged wells that meet current well plugging standards are unlikely to pose a threat to freshwater zones in the future.

Many municipal water source lie above actively produced oil and gas zones in California. A standard practice of all water companies is to regularly test their water supplies to ensure they are not contaminated. Few if any of these water supply zones have been damaged by leaking oil and gas wells. While many of these resources have been severely degraded by other industrial operations, wells related to oil and gas production have a good track record when it comes to protection of freshwater supplies.

Lastly, DOGGR engineers and inspectors regularly visit oil and gas fields to inspect wells and facilities and check injection pressures on injection wells to make sure they are not above prescribed levels. They are looking for a whole variety of problems. Included among these are derelict wells or well conditions that would pose a hazard to freshwater resources. If they find any of these situations, they recommend that the wells be made candidates for well plugging and abandonment by the operator or the DOGGR and require any hazardous condition be immediately remedied.

Considering the hundreds of thousand wells that have been drilled in California since the late 1800s using a variety of evolving technologies, the number of confirmed freshwater contamination incidents involving wells related to the oil and gas industry is remarkably low. The DOGGR has a strong program to ensure this track record remains intact.

Section Two

California Laws for Conservation of Petroleum and Gas – The Laws

This section will skim over specific parts of the onshore State laws and regulations that are used to ensure freshwater protection.

Section 3013 – This is a General Provision that gives the Director of Conservation and the State Oil and Gas Supervisor broad latitude in their efforts to regulate the oil and gas industry. "This Division (the whole oil and gas statue) shall be liberally construed to meet its purposes, and the director and the supervisor, acting with the approval of the director , shall have all powers, including the authority to adopt rules and regulations, which may be necessary to carry out the *purposes* (my highlighting) of this division". In other words the legislature realized they could not think of everything now and in the future to write into law so they gave the director and supervisor powers to ensure the purposes of the laws were enforced. This is a powerful statue as demonstrated by how often it is cited as the basis for various regulations.

Section 3106 – Charges the supervisor to so supervise the drilling, operation, maintenance and abandonment of wells to prevent damage to several things including "damage to underground and surface waters suitable for irrigation and domestic purposes by the infiltration of, or the addition of, detrimental substances." Again this is a powerful statue because it is cited often as the basis for various regulations.

Section 3107 – Charges each district deputy to collect certain technical information including information regarding water suitable for irrigation and domestic purposes. Each district office has maps or other information regarding the depth and location of the BFW mainly in known oil fields. This information is used, as prescribed in the section, to advise operators concerning the best methods to protect these water resources while operating below them and to aid the supervisor in ordering tests or repair work on wells. Because the district staff knows the location and depth of the BFW they can ensure this zone is protected by cemented casing when wells are drilled. This information also aids district engineers in determining where BFW plugs and perforation squeezes should be done during rework and well plugging and abandonment operations.

Section 3203 – This section requires an operator to notify the supervisor in writing before a well is drilled, redrilled reworked or plugged and abandoned. The operator is required to supply a variety of technical information on these notices such as the type and cementing depth of various strings of casing. The district engineers use this information to determine if proper protection of freshwater zones

and oil and gas zones is planned. If not, the proper protection is prescribed on the Permit to Conduct Well Operation.

Sections 3204 to Section 3205.5 – These sections describe required bonding for financial assurance that well drilling or alterations will be performed properly and provides the State with a financial instrument to immediately remedy hazardous situations or well desertion by the operator. These bonds are not releasable until the supervisor is certain all appropriate standards have been met and no threats to the environment, such as damage to freshwater zones, exist. These bonds will not be release if an operator has not fully complied with the provision in the permits and other state laws and regulations.

Section 3206 to Section 3206.5 – Idle wells in California can pose a threat to freshwater zones. This statue establishes fees, bonds or well plugging requirements for operators of long term idle wells. The purpose of the program is to encourage operators to plug and abandon wells that are no longer useful so they will not deteriorate to the point of causing a threat to freshwater zones. Fees recovered from the statue are used by the DOGGR to plug and abandon orphan wells.

Section 3208 - Requires operators to plug wells in a manner that satisfies the supervisor and protect freshwater, oil and gas resources.

Section 3208.1 – If the supervisor or district deputy questions the integrity of a previously plugged and abandoned well, they may order it replugged and abandoned to prevent damage to life, health, property.

Section 3210 to Section 3216 – All information regarding well drilling including a history of the operation, logs, cores and various test results must be filed with the appropriate district office within 60 days after drilling or well operations cease. This data is used to evaluate fluid distribution in a well such as the presence or absence of freshwater and oil and gas zones. District staff is also able to make sure these resources were correctly isolated during the well operation.

Section 3220 – Requires operators to use adequate casing that is cemented at depths to ensure freshwater protection and oil and gas zone isolation.

Section 3224 – Gives the supervisor the power to order tests and remedial work that they deem necessary to prevent damage to natural resources including the freshwater strata.

Section 3226 – Requires an operator to perform worked ordered by the supervisor within 30 days or the supervisor will hire agents to enter a property or well and perform the work.

Sections 3228 to Section 3232 – Directs operators to inform the supervisor before commencing well plugging and abandonment work. It also requires DOGGR to issue a permit to conduct well operation that the operator must use and comply with while performing the well plugging and abandonment work. Among the provisions on the permit are the depths of various cement plugs which will prevent damage to freshwater zones and isolate oil and gas resources.

Section 3235 – The supervisor may make an investigation of a well or wells on his own initiative or at the request of a land or a well operator within one mile radius of a suspect well or wells. The section requires the supervisor to issue a report concerning the suspect well or wells, outlining what, if any work needs to be done on the well or wells.

Section 3236.5 – If an operator violates the law or regulations, this section gives the supervisor the authority to issue a civil penalty of up to $25,000 per violation. Well operations that damage or threaten to damage freshwater zones would be considered a major violation subject to substantial penalties.

Section 3237 - This section give the supervisor the power to order current operators to plug and abandon certain idle wells that meet specific criteria. If the operator fails to plug and abandon the wells as ordered, the supervisor can use all or part of the operator's bond moneys to plug the well. If no bond money is available the supervisor can use funds set aside for these purposes in the DOGGR budget and then place a lien on the operator's property to recover the cost of the well plugging operation.

Section 3250 to Section 3251.5 and Section 3258 – These sections direct the supervisor to expend specific allocated funds to plug and abandon orphan and hazardous wells. These well would be the ones likely to pose the most significant threat to freshwater resources.

Section 3254 – "This article (concerning orphan and hazardous well plugging by the state) shall be liberally construed and applied to promote its purposes." Again the legislature wanted to make sure there was no ambiguity regarding their intent to have these wells plugged and abandoned promptly and to have the cost of these well plugging and abandonments charged to the oil and gas operators in the State – not to poor land owners who derived no financial gain from the wells. They did not want details to get in the way of the supervisor taking action.

Section3261 to Section 3266 - These sections create an Acute Orphan well fund to deal with dangerous or critical orphan wells that pose an immediate threat to life, health or natural resources. This is a separate fund for plugging and abandoning these perilous wells that members of the Conservation Committee have the opportunity to help select.

California Code of Regulations – Onshore Well Regulations

Section 1712 – The scope of regulations indicates that these general regulations apply statewide and that site or field specific regulation, called field rules (Section 1722 k), can be established by the Supervisor. The reportable spill volume is different in Kern County than the rest of the State because of a field rule.

Section 1714 – Requires operators to get written approval from the Supervisor before commencing operations down-hole in a well. This provides the DOGGR with the opportunity to ensure nothing is done in a well that would damage or threaten resources such as freshwater.

Section 1722 – These general requirements set basic standard for operator performance. Operators must use good oilfield practices at all times. Operators must file notices with the supervisor before conducting significant down-hole well work. This gives the supervisor a chance to review an operator's plan and alter it if down-hole resources are not protected properly. An inspection program is mandated and the operators must call the DOGGR well before certain tests or activities are performed so a field inspector can witness or evaluate the operation. This sections mandates that any use of radioactive material in a well must comply with State laws and regulation of the California Department of Health Services. The loss of this material, other than for injection well testing (which uses a short half life substance) must be reported promptly to the DOGGR and California Department of Health Services. Subsection (k) allows the supervisor to establish field rules in specific fields once sufficient geologic and engineering data is available from previous drilling and production operations. For instance, for years operators were required to perforate their cemented well casing above an oil zone and conduct a flow test of an impermeable formation (water shut off test or WSO test). The purpose of the test was to show than little or no fluid was present. This demonstration showed that the primary cement job on the casing prevented hydrocarbons from migrating into an underground water resource. After thousands of these test showed that modern casing cement operations did an excellent job of isolating both oil/gas and freshwater zones, it was determined that the damage done by the perforation was a much more significant threat to resources than fluid migration after a well casing was cemented. The WSO test can still be used but is more of an investigative tool than a normal well testing procedure.

Section 1722.2 to Section 1722.4 – Operators must install appropriate casing and cement it into the drilled hole in such a manner that it is able to withstand all potential down-hole pressures and to segregate oil and gas zones from freshwater zones. The section specifies that cement must be lifted 500 feet above oil or gas or anomalous pressure zones behind casing and 100 feet above the BFW behind casing. It also requires the operator to essentially centralize their casing in the drilled hole so that cement circulated behind it is evenly distributed around the casing. This prevents casing-borehole contact that would create a corrosion problem and potential leakage issue. These sections mandate that fluid flow behind cemented casing is prohibited. By doing so the petroleum resource is protected from unintended fluid incursion and the freshwater zones are isolated from detrimental substances.

Section 1722.6 – Requires operators to drill well with appropriate drilling mud or fluid that has the characteristic of being heavy enough to prevent uncontrolled fluid flow from the well and to seal permeable formations encountered in the well bore to prevent fluid loss. This fluid (which forms a filter cake on the well bore wall) prevents significant infiltration of fluids into freshwater zones that are penetrated during the well drilling process. Operators are required to regularly test their drilling fluids to ensure the appropriate characteristic are always present. As

mentioned in the first section, drilling fluids have multiple purposes. It is the first line of defense against blowouts and prevents fluid infiltration into permeable zones such as fresh water zones. Highly trained individuals called mud engineers supervise and continuously monitor this fluid to ensure it meets appropriate standards.

Section 1723 to Section 1723.8 – These sections provide a very comprehensive set of standards for plugging wells with cement and mud. By following these well plugging standards, operators do a very good job of protecting down-hole resources such as freshwater zones. The sections establish where cement plugs must be placed, how long they are and which ones have to be inspected or tested by DOGGR field engineers.

Section 1723.9 – Idle wells can deteriorate due to down-hole corrosion and become a threat to underground resources such as freshwater zones. The DOGGR has a comprehensive idle well testing program that prevents damage to freshwater zones and encourages operators to plug and abandon wells with no future useful life. Many of these tests are witnessed by DOGGR staff. In some cases the DOGGR will order wells plugged and abandoned, if during the idle well tests, it is determined that the wells likely pose a hazard to underground resources.

Section 1724.7 to Section 1724.10 – These sections provide a comprehensive set of standards for permitting an underground injection (UIC) project for enhanced oil recovery, water disposal or gas storage purposes. The primary goals of the DOGGR regarding the regulation of these UIC projects is to allow operators to significantly increase (and maximize) the ultimate recovery of the State's oil resources while at the same time ensuring that damage to underground and surface resources is prevented. Much of the UIC program is mandated by the Federal EPA to protect freshwater resources. These sections outline data that must be provided to the DOGGR before a project can be evaluated and the testing and oversight standards that must be met in order to continuously operate a UIC project. Many pieces of data must be evaluated by DOGGR staff and various tests must be witnessed by their field engineers. Periodically the Federal EPA audits the DOGGR to program to ensure it is functioning properly. These sections of the regulations allow the DOGGR to do an excellent job of monitoring UIC projects.

Section 1995 to Section 1997.5 – "The policy of the Division (DOGGR) is to make all well records that are open to public inspection readily available to the public." Almost every record of well activity submitted to the DOGGR is available for inspection by the public in some form or another. This section describes what records are, and establishes which records can be withheld from public review due to the fact that they are experimental in nature or interpretive data. These exceptions to full disclosure standards are very hard to get. Operators must make a clear case for their requests because most oil field operations are similarly conducted in fields around the world. Only a very unique set of data will be granted confidential status for any length of time. The purpose of this full disclosure standard is to allow the general public to

review data about wells or operations that impact or could potentially impact their lives or lands that they own. The DOGGR's primary mission is to prevent damage to life, health, property and natural resources. The public can ensure this mission is being carried out by reviewing data that is accumulated in each DOGGR district office. All records the DOGGR accumulates are subject to the state's Public Record Act. This is a powerful law that allows the public to confirm for themselves that their resources are being protected properly.

In Conclusion:

As this short review of the DOGGR's laws and regulation demonstrates, DOGGR has a comprehensive set of standards that they use to ensure underground freshwater resources are protected from the introduction of detrimental substances.