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**Kevin Buchan**  
Manager, CA Climate Policy and State Water Issues

**VIA ELECTRONIC MAIL**

May 29, 2015

**Subject: Comments on the State Water Resources Control Board's Draft Model Criteria for Groundwater Monitoring in Areas of Oil and Gas Well Stimulation**

Dear Board Chair Marcus, and Members of the Board,

The Western States Petroleum Association (WSPA) is a trade association that represents the majority of petroleum related interests in the western United States. These interests include production, transportation, refining, and marketing of petroleum and petroleum-based products.

WSPA appreciates the opportunity to provide comments on the development of groundwater monitoring criteria as set forth by SB 4.

We have provided our comments in two sections: General and Specific comments. Our Specific comments cite draft Model Criteria language and provide underline/strikeout recommendations for incorporation.

**GENERAL COMMENTS**

**General Comment 1 – Groundwater Monitoring Design Should be Commensurate with Risk**

Groundwater monitoring design criteria should be commensurate with both the risk for potential loss of WST fluid containment and the risks related to these fluids impacting protected groundwater.

The proposed program contains no risk based criteria, rather assuming a 100% probability of exposure and simply offers a surface spatial model for laying out monitoring wells. Such an

approach is tremendously over conservative and inefficiently adds program cost, which when multiplied across the many wells and fields being managed will create a significant burden for both the Board and operator without commensurate benefits for the public.

### **General Comment 2 – Potential Pathways to Protected Groundwater Should be Used to Evaluate Risk**

The concept of the “axial dimensional stimulation area” (ADSA) was developed by the California Division of Oil, Gas, and Geothermal Resources (DOGGR) to provide a means for conservatively evaluating the presence of potential flow pathways within an area around a stimulation. ADSA is defined in 14 CCR 1781(f) as

*“the estimated axial dimensions, expressed as maximum length, width, height **and** azimuth of the area(s) stimulated by a well stimulation treatment”*. [Emphasis added].

For each proposed WST, DOGGR requires the evaluation of such pathways within a volume that is twice the predicted spatial extent of propagated fractures, or two times ADSA (“2xADSA”).

The use of ADSA is a scientifically sound method that can be used to define a spatial boundary for which the risks from potential pathways of WST fluids can be evaluated for monitoring protected groundwater. The presence or absence of potential pathways within 2xADSA should be a key factor in designing a risk based groundwater monitoring approach.

Although the ADSA screening is required by the draft Model Criteria, the required groundwater monitoring components are independent of the results of this analysis. The draft Model Criteria do not specify if and how the information from the 2xADSA analysis would be used in the monitoring plan.

Therefore, the draft Model Criteria do not take advantage of a technically sound approach for evaluating risk to protected groundwater.

### **Recommendation**

WSPA recommends that the Board focus the monitoring efforts to where there are potential impacts, and incorporate the 2xADSA approach to develop a tiered monitoring program reflecting the risks of potential aquifer contamination within the program criteria.

### **General Comment 3 – Real-time Monitoring of WST Wells Should be Used to Evaluate Monitoring Needs**

The parameters monitored during a well stimulation treatment (WST) are the best indicators of the potential for loss of fluid containment related to WST, and therefore the best predictor of potential fluid migration to a protected aquifer.

As such, they should be used as criteria for frequency, location/depth, and duration of monitoring.

DOGGR regulations require the monitoring of the stimulation well during WST. A stimulation stage takes place over a short duration. Detailed, real-time measurements of pressure, volume, and flow rate of the WST fluid during the time that the well is being stimulated will be collected and reported for every stimulation performed in California.

In the event that anomalous conditions, such as a pressure drop or an unexpected increase in WST fluid flow rate are detected, the operator is required to immediately discontinue the injection. In most cases, an automatic shut-off occurs, significantly limiting fluid volumes that are pumped after the event. The operator can detect and locate a well casing breach in real time, and to within a few vertical feet.

Therefore, real-time monitoring of the WST well provides by far the best indication of a potential release of WST fluids through a casing breach and can provide a direct indication of the need for additional groundwater monitoring and the depth at which monitoring should take place.

However, WST well monitoring during injection is not mentioned in the draft Model Criteria.

The draft Model Criteria does not take advantage of this real time monitoring. Real time monitoring provides technically sound input to evaluate risk to protected groundwater and the need for additional groundwater monitoring wells, and is also far more effective in determining whether a leak of WST fluids has occurred, hence allowing the operator to respond immediately.

As stated during the May 19<sup>th</sup> public workshop, WSPA members support the need to monitor groundwater aquifers. However, monitoring should recognize existing regulatory frameworks that are currently in place to protect groundwater (i.e., wellbore monitoring in real time) and the level of risk associated with a WST event.

## **Recommendation**

WSPA recommends the Board incorporate language to clarify monitoring well requirements when multiple aquifers are penetrated. Specifically, in the event of a well casing breach as demonstrated by a pressure drop, additional monitoring of the effected aquifer would be required.

## **General Comment 4 – Perimeter Groundwater Monitoring Would Provide Important Benefits**

As mentioned in the General Comment 1, the program carries no risk based criteria but only a standard parameter for the surface array of monitoring wells. Groundwater monitoring programs typically fall into two categories: compliance monitoring and detection monitoring.

Compliance monitoring, which addresses a known release, is performed to evaluate whether a release has resulted in unacceptable impacts to groundwater and whether those impacts are physically spreading or stable.

In the case of compliance monitoring, groundwater monitoring wells are installed close to the known source. By contrast, detection monitoring is performed to evaluate whether a release to groundwater has occurred, and uses wells that are typically installed at an area boundary or perimeter.

As WSPA presented at the SWRCB's public workshop held on December 11, 2014 and included in our comments on February 4, 2015, in the case of WST, detection monitoring would provide a perimeter well network for long-term groundwater monitoring to ensure zonal isolation.

Such an approach would be commensurate with the very low risks associated with WST.

The draft Model Criteria should be revised to clearly identify and define the use of a perimeter monitoring approach that would satisfy the requirements in SB 4.

In addition, the Model Criteria should provide flexibility for the operator to propose an alternative approach, approvable by the Board, that reflects the individual characteristics of the field, local geology, and hydrology.

This acknowledgement of perimeter monitoring is critical for areas where there are a large number of WST wells located in proximity to each other and that penetrate the same aquifers in order to avoid unnecessary monitoring wells.

### **Recommendation**

WSPA recommends the Board incorporate language into the Model Criteria that allows the use of perimeter monitoring and alternative approaches acceptable and approved by the Board.

### **General Comment 5 – Regulatory Review Period**

The draft Model Criteria do not specify a regulatory process and schedule for Board review of groundwater monitoring plans. The final Model Criteria should provide the agency parameter and timeframe for a regulatory review process to allow operators to plan stimulation and production activities.

This review period should coincide and be bounded within the DOGGR permit review period.

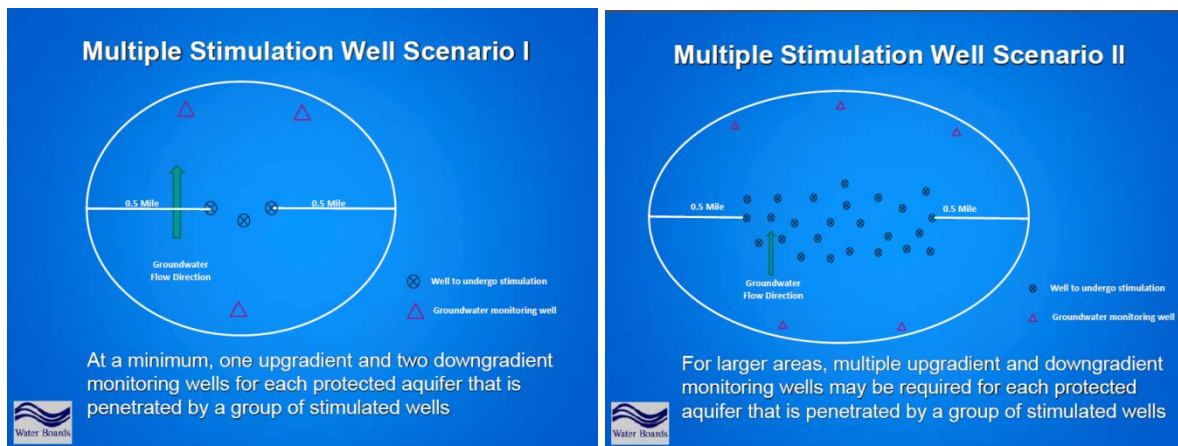
## SPECIFIC COMMENTS

### Specific Comment 1 – Section 2.1.1 Groundwater Monitoring Design; Number and Locations of Monitoring Wells

WSPA is seeking clarification with regard to the implementation of an area-specific monitoring plan where there are multiple wells that undergo WSTs located in relatively close proximity to each other and that penetrate the same aquifer(s).

The draft Model Criteria also require that the monitoring wells must be located within 0.5 miles from the “surface projections of the zone(s) of stimulation.” WSPA recommends the Board incorporate the ADSA reference into Part 1, thereby making clear that monitoring well locations must be located within 0.5 miles of the ADSA of the stimulation zone.

At the public workshop on May 19, 2015, Board staff delivered a presentation including the two slides below (Slides 18 and 19). Based on the slides below, WSPA’s understanding is that the Board is viewing a group of wells, together, as forming the boundary for which the area-specific monitoring plan criteria (e.g., placing monitoring wells at 0.5 miles of the ADSA) is to be applied.



Finally, the draft Model Criteria require that if multiple protected aquifers are penetrated, each aquifer needs to be monitored separately. Depending on the interpretation, the mandate could result in multiple monitoring wells for each WST without providing any additional environmental protection.

Given the potential source of contaminants is the zone of stimulation, it would logically follow that the deepest protected aquifer would provide the first indication that there is a lack of zonal isolation, which would trigger addition monitoring.

Nowhere in the model program does the question of access to surface and subsurface enter into the issue of siting monitoring wells. The program assumes that access is a given. This may not be

the case for many reasons, primarily that the operator does not have surface or water rights to where a monitoring well would be dictated.

## **Recommendation**

WSPA recommends the following changes to the draft Model Criteria text in Parts 1 and 2 on page 5 to address these concerns (text changes as underline/strikeout):

1. *At a minimum, one upgradient and two downgradient monitoring wells will be required for each ~~protected aquifer that is penetrated by the~~ stimulated well, or group of stimulated wells. ~~Upgradient~~Downgradient groundwater monitoring wells shall be located within 0.5 mile of the surface projection of the well ADSA or the perimeter of a group of wells being stimulated, provided permission to install and sample wells is granted by the landowner(s). The operator may propose an alternative number and locations of monitoring wells, provided that the proposed monitoring well or wells afford a similar or higher level of monitoring effectiveness relative to the minimum requirements.*

WSPA recommends staff incorporate additional language in Part 1 that would codify well casing integrity pressure monitoring during WST operations that is currently required and conducted, and in the event a WST well penetrating multiple protected aquifers indicates a well casing breach as demonstrated by a pressure drop, additional monitoring of the effected aquifer would be required. In the event the well casing maintains integrity, monitoring will be conducted at the base of the deepest protected aquifer above the ADSA.

2. *When multiple protected aquifers are present, each the protected aquifer nearest the WST zone of stimulation activities shall be monitored separately. At a minimum, one monitoring well is required for each the protected aquifer within 0.5 mile of the surface projection of the zone(s) of stimulation. Wells are to be screened at discrete depths in separate aquifers. The operator shall provide an analysis of potential risk to protected groundwater to support the proposed monitoring design. Various well construction options may be proposed for State Water Board staff approval.*

## **Specific Comment 2 – Section 2.1.2 Groundwater Monitoring Plan Requirements**

WSPA recommends the following revisions for Part 1 on page 6:

*“A map of the oilfield area to be covered by the groundwater monitoring plan and a 0.5 mile buffer surrounding the oilfield covered area, that shows the following:”*

This proposed revised language meets the true spirit of an area-specific groundwater monitoring plan. The proposed language greatly reduces the administrative burden on both the State Water Board and the operator, while providing equivalent environmental protection.

### **Specific Comment 3 – Section 2.1.1 Groundwater Monitoring Design; Number and Locations of Monitoring Wells – Water-supply well monitoring**

The draft Model Criteria require the installation and monitoring of a “sentry” monitoring well between the WST and any downgradient water-supply wells located within one mile of the surface projection of the zone(s) of stimulation.

The Criteria also state that if a water-supply well is screened across multiple protected aquifers, then each protected aquifer shall be monitored separately.

As discussed above in General Comment 3, such requirements are not commensurate with the level of risk. If multiple protected aquifers are present, the monitoring should be focused on the aquifer that is nearest the WST stimulation zone.

The draft Model Criteria also requires the use of real-time monitoring in the water-supply well sentry wells. The duration of a typical WST stage ranges from 30 minutes to 2 hours, following which the WST well becomes a production well and the pressure introduced during the WST is quickly released through the flow of fluids up the WST well.

The rate of groundwater flow is commonly on the order of tens to hundreds of feet per year. As stated in the draft Model Criteria, the sentry wells would be located up to half a mile upgradient of a water-supply well.

Therefore, given the short duration of each WST and the rate of groundwater flow, real-time monitoring of sentry wells is not necessary, and would result in an enormous amount of data of little value.

The required semi-annual sampling frequency will provide sufficient warning to protect the water-supply well in the event that WST fluids are detected in the sentry well.

### **Recommendation**

WSPA recommends the following changes in underline/strikeout to the draft Model Criteria text in Part 5 on page 5:

*5. For any water-supply well located within one mile and downgradient of the surface projection of the ~~zones~~ stimulation (s), a sentry monitoring well shall be located between the stimulated well(s) and the water supply well. The monitoring well shall be located within 0.5 mile of the surface projection of the zone(s) of stimulation. If the water-supply well is screened across multiple protected aquifers, then ~~each~~ the protected aquifer that is at highest potential risk due to WST activities shall be monitored separately. Monitoring shall include, to the extent possible, changes in water level and electrical conductivity (e.g., specific conductance) ~~using real-time monitoring technologies (e.g., transducers)~~. In some cases, one sentry monitoring well may be used*

*to monitor multiple water supply wells. Downgradient ~~and upgradient~~ monitoring wells, as described above, may act as the sentry well.*

#### **Specific Comment 4 – Section 2.1.2 Groundwater Monitoring Plan Requirements**

Part 4d on page 7 of the draft Model Criteria requires that groundwater monitoring plans include two scale cross-sections that show:

*e) The distribution of groundwater salinity, and gas presence and composition, in aquifers along the stratigraphic section between the water table and target formations (emphasis added)*

The draft Model Criteria does not specify the relevance of gas presence and composition to WST groundwater monitoring. Data on gas presence and composition in groundwater aquifers is not readily available and is not collected as part of oil field development.

#### **Recommendation**

If deemed necessary, WSPA recommends an evaluation of potential gas impacts to protected groundwater using the downgradient groundwater monitoring wells.

#### **Specific Comment 5 – Section 2.1.2 Groundwater Monitoring Plan Requirements**

Part 9 on page 9 of the draft Model Criteria summarizes the requirements for the evaluation of the presence of wells within 2xADSA of any stage of the WST. As stated in General Comment 2, the ADSA analysis should be a factor in establishing risks to protected groundwater and in designing a groundwater monitoring program. However, the draft Model Criteria does not state the purpose and potential outcome of the required ADSA analysis.

#### **Recommendation**

WSPA recommends the Model Criteria allow operators to submit an ADSA analysis to determine potential pathways between the WST and the protected aquifer, thereby focusing monitoring on the aquifer that is at risk of potential impacts from WST.

#### **Specific Comment 6 – Section 2.1.2 Groundwater Monitoring Plan Requirements**

Part 10 on page 9 of the draft Model Criteria states:

*10. For any geologic features within or intersecting five times the ADSA of any stage that have the potential to constitute a leakage pathway (including faults, fractures, and changes in stratigraphy), the operator shall identify the potential risk where the geologic feature may act as a conduit and impact protected water.*



As stated in General Comment 2, the ADSA analysis should be a factor in establishing risks to protected groundwater and in designing a groundwater monitoring program. However, the draft Model Criteria does not state the purpose and potential outcome of the required ADSA analysis.

### **Recommendation**

WSPA recommends that the Model Criteria clarify the purpose of the ADSA analysis to establish risks to protected water in designing a monitoring program.

### **Specific Comment 7 – Section 2.1.2 Addendum to an Approved Groundwater Monitoring Plan**

WSPA recommends the Addendum to an Approved Groundwater Monitoring Plan on page 10 be revised to read:

*“An area –specific groundwater monitoring plan applies only to the stimulation well(s) identified by the operator in the areas identified in its proposal and approved by State Water Board staff. Where an operator proposes to stimulate additional wells outside the area that has been approved by the State Water Board staff for area-specific groundwater monitoring based on these model criteria, the operator is required to submit an addendum to the approved area-specific groundwater monitoring plan, that includes as a minimum, the following:”*

This proposed revised language meets the true spirit of an area-specific groundwater monitoring plan, and would measurably reduce the administrative burden on both the State Water Board and the operator, while providing equivalent environmental protection.

### **Specific Comment 8 – Section 2.1.3 Sampling and Testing Requirements**

The groundwater monitoring frequency requirements are stated as follows on Page 11:

*Collect samples before well stimulation. Following well stimulation, area-specific groundwater monitoring wells shall be placed on a semi-annual monitoring schedule.*

The Model Criteria should provide flexibility relative to the monitoring frequency, based on case-specific conditions. The final Model Criteria should also address the duration of groundwater monitoring following WST, in consideration of the very short timeframe of well stimulation.

### **Recommendation**

WSPA recommends that the parameters of successful containment during the WST, risk factors relating the WST and nearest aquifer & supply well, and monitoring trend result be factored into both the frequency and duration of testing post well stimulation.

## **Specific Comment 9 – Section 2.1.3 Sampling and Testing Requirements**

Groundwater monitoring analytes are listed on pages 12 and 13 of the draft Model Criteria. The analyte list, which is extensive, is presented in two parts. The first part (Part 5) requires the analysis of 78 analytes on a routine basis. The second part (Part 6) requires the analysis of an additional six families of compounds in the event that concentrations of analytes listed in Part 5 indicate potential impact from WST.

The 78 analytes listed in Part 5 include a wide range of general groundwater parameters, indicators of petroleum hydrocarbons, indicators of WST fluids, and other parameters that are not direct indicators of petroleum hydrocarbons or WST fluids.

The analyte list for routine monitoring should be substantially reduced and focused on analytes and parameters that will serve as the best indicators of potential impacts from stimulation treatment. The evaluation of analytical results needs to be considerate of the many geochemical changes that can occur naturally (e.g., due to seasonal groundwater fluctuations) or as a result of impacts unrelated to WST.

### **Recommendation**

WSPA recommends the following is a list of recommended analytes and parameters, and the justification for their selection.

pH – A geochemical master variable and reflects general changes in water composition. The pH of oil formation fluids and brines is likely to differ from the pH of the overlying groundwater. pH is easily measured in the field and can be used as field screening parameter.

Total dissolved solids (TDS) and specific conductance – TDS is the primary drinking water quality parameter. TDS could be used as an indicator of the potential impact from high-TDS WST fluids or formation fluids. TDS is stable and not significantly affected by biological, physical or chemical degradation/attenuation. Specific conductance is a proxy for TDS. It is easily measured in the field and could serve as a field screening parameter during post-WST events to evaluate the need for the analysis of additional parameters.

Total petroleum hydrocarbons (TPH) – TPH is a primary indicator of the presence of crude oil. However, TPH results need to be carefully interpreted because (a) TPH is naturally present in groundwater in certain areas due to seeps or co-occurrence of oil and groundwater, and (b) TPH may be present due to non-WST impacts, such as surface spills of fuel products.

Benzene, toluene, ethylbenzene, and toluene (BTEX) – BTEX includes components of TPH with stringent regulatory drinking water standards. Low BTEX detection limits would allow for early indication of TPH presence but may also indicate the presence of non-WST impacts.

Metals and metalloids – Concentrations of certain metals are elevated in formation brine. Boron, barium and strontium are particularly good indicators. Some metals are indicators of changing

redox conditions that may result from the presence of crude oil. However, care should be taken to account for natural geochemical cycles that can affect concentrations of redox-sensitive metals. High background concentrations of metals are present in many areas of California (e.g., arsenic, cadmium) and should be documented in pre-WST sampling.

Major Ions – Flowback and produced water tend to contain higher concentrations of sodium, chloride, and iodide than fresh water. Anion/cation ratios are useful to evaluate potential changes in groundwater composition, and help distinguish natural (e.g., seasonal) fluctuations in groundwater composition. Bromide and iodide are particularly useful in evaluating the potential presence of oil formation water/brine.

Guar gum sugars – Guar gum, a non-toxic food product, is often used as a gelling agent in WST fluids. It is usually included at a relatively high concentration as compared to other WST fluid constituents. Detection of carbohydrates in groundwater may be indicative of the presence of WST fluids.

If concentrations of one or more of the above analytes indicate potential impact from a stimulation treatment, the analytical list would be expanded to include additional compounds that are used in WST.

However, the compounds need to be selected on a case-specific basis because the composition of WST fluids varies from stimulation to stimulation.

### **Specific Comment 10 – Section 2.2.1 Exclusion Based on Absence of Protected Water**

Section 2.1.1 of the draft Model Criteria describes conditions under which an exclusion from groundwater monitoring may be obtained:

*Pursuant to Water Code section 10783, monitoring is not required for oil and gas well stimulation where the wells do not penetrate groundwater of beneficial use, or solely penetrate exempt aquifers pursuant to section 146.4 of title 40 of the Code of Federal Regulations.*

The draft Model Criteria define protected water for current and future beneficial use as:

- *Water with less than 10,000 mg/L TDS; and*
- *Within an aquifer of sufficient volume (yields more than 200 gallons per day); and*
- *Outside an exempt aquifer (pursuant to the Code of Federal Regulations, title 40, part 146.4).*

This definition indicates that an exclusion would require one of these conditions **not** to be met. For example, an aquifer with TDS greater than 10,000 mg/L would be excluded, as would an aquifer that yields less than 200 gallons per day. Also excluded would be a previously exempt aquifer.

However, these criteria do not consider the exclusion of groundwater that meets 40 CFR 146.4, even if it is not formally exempted. Exemption criteria for groundwater in 40 CFR 146.4 include:

- Cannot now and will not in the future serve as a source of drinking water
- Mineral, hydrocarbon or geothermal energy producing zone
- Recovery of water for drinking water purposes economically or technologically impractical
- Is so contaminated that it would be economically or technologically impractical to treat for human consumption

### **Recommendation**

WSPA recommends the Model Criteria allow for the exclusion of an aquifer from monitoring if the operator can demonstrate that the aquifer meets one or more of the above exemption criteria.

In particular, the Model Criteria should explicitly allow for the exclusion of hydrocarbon-producing zones, because (a) these meet the above exemption criteria, and (b) these are the target zones for stimulation and oil production activities.

WSPA appreciates the opportunity to work with the Board and staff on this important issue. We look forward to continuing these efforts, and reviewing staff's response to stakeholder comments.

Sincerely,

A handwritten signature in black ink that reads "Kevin Buchan". The signature is written in a cursive, flowing style.