(5/19/15) Public Workshop- Item 6
Model Criteria for Groundwater Monitoring
Deadline: 5/29/15 by 12:00 noon

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Environmental Consulting Services

RECEIVED
5-7-15
SWRCB Clerk

Jeanine Townsend, Clerk to the Board
State Water Resources Control Board
1001 I Street, 24th Floor
Sacramento, CA 95814
7 May 2015

Re: Proposed Draft Model Criteria for Groundwater Monitoring, California SB-4

Greetings,

My name is Dr. Mark Kram and I am a Hydrogeologist/Environmental Geochemist with over 30 years of experience assessing and remediating groundwater contaminant related issues. I am the recipient of the National Ground Water Association's Technology Award as well as the ASTM International D-18 Technical Editors Award for my efforts to improve subsurface monitoring techniques. I've had the opportunity to review the *Proposed Draft Model Criteria for Groundwater Monitoring* document prepared to meet requirements associated with implementation of California Senate Bill 4. As such, I am submitting the following comments for your consideration:

1) I want to first commend the group that compiled this document, as the challenges associated with appropriate monitoring, particularly when site-specific geology and hydrology and field operations are involved, are formidable. While I believe there is room for incorporation of newer technologies to help facilitate and streamline both the monitoring as well as the reporting components, I am of the opinion that the group did an exceptional job.

2) Use of three wells may be inadequate, and distance between active stimulation wells and monitoring wells may be too large, as many natural flow regimes exhibit a relatively low gradient and velocity. As such, it could be far too long (and too late) before any detection is recorded. Furthermore, it is imperative that additional downgradient wells be used, as many solute groundwater plumes are narrow (e.g., the extremely narrow MTBE plume in Port Hueneme has been studied extensively for many years). If the downgradient wells are not positioned perfectly to intercept a migrating plume, potentially negative impacts will go undetected. In addition, flow direction can easily change when the natural gradient is low. As such, it is recommended that one upgradient well as well as an array of downgradient wells oriented in the shape of an arc be required to increase the chances of plume capture. These monitoring wells should be designed to allow for conversion to extraction wells in case a remedial response will be required in the future. In addition, zones with the highest mass flux capacity should be selected for screening, as capture of the leading edge of plumes is essential. Note that for the Port Hueneme MTBE plume, I designed and implemented a sentry well strategy that included a similar approach. Had we not appropriately accounted for changes in flow direction ahead of the leading edge of the plume via placement of appropriately designed wells and high frequency monitoring of water levels (and

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associated determination of gradient, direction and velocity changes), the plume would have passed our well network and entered a nearby residential neighborhood. If we implemented the type of design being advocated under the currently proposed SB-4 strategy, the plume would have most definitely reached the development. Given that downgradient extraction wells could be involved, dynamic flow regimes are inherent and as such it behooves those managing the resources to carefully consider the most appropriate ways to document and respond to changes in the hydraulic setting.

3) How are you proposing that the entities determine direction of groundwater flow? It is recommended that if insufficient data exists, at least three wells be installed, hydraulic testing of these wells be performed, and at least one month of continuous water level monitoring (via transducers) be performed to derive an estimate of natural flow direction and velocity over that duration, followed by installation of the remaining downgradient wells in an attempt to intercept the flow pathway of any potential releases caused by subsurface stimulation activities.

4) Proper placement and appropriate monitoring of sentry wells between water supply wells and stimulation wells is critical. It is highly probably that if the system is not well characterized due to a lack of appropriate information and preferential pathways (the rule rather than the exception), the flow path for ideal placement of this well will not be sufficiently determined. As a result, it is likely that with only a few wells and water level readings every 6 months, sentry wells will miss solutes released to the groundwater supply that could threaten the extraction wells. For instance, if the gradient and flow direction are not sufficiently understood, one can install a sentry well in a location that does not intersect the flow path, and then when the plume gets closer to the extraction well, it could be drawn into the capture zone without detection until it is too late to respond. The level of characterization and simulation required to sufficiently characterize this type of complex system would be cost prohibitive. In lieu of a comprehensive study for every site, it is recommended that an array of sentry wells be installed and continuously monitored for key dynamic parameters such as water level (which should be converted to gradient and velocity), conductivity and potentially other parameters (e.g., ORP) for all stimulation projects and regions.

5) It is encouraging to learn that transducers and conductance based sensors are being recommended. This data can be tracked automatically (both time series as well as spatial distribution of the information) via regulatory web sites. This should at least be available to the oversight regulatory agency, and criteria should be developed that could automate the triggering of an alert when established thresholds are exceeded. Web based software and sensors for this is now commercially available (see www.groundswelltech.com; http://inwusa.com/; https://in-situ.com/; etc.). It is highly recommended that other sensors also be considered. For instance, tracking methane in the subsurface vapors around the stimulation well can yield very important information regarding well seal and integrity. These can also be integrated into an automated real-

time monitoring, visualization and alerting and response system. Costs for these devices and services have become very reasonable, and the return on investment extremely high, especially if environmental exposure risks can be avoided by affording more response time. Given the number of wells planned, some form of environmental harm is inevitable. As such, it behooves those in charge to require the most innovative approach available to minimize damages caused by potential environmental challenges (natural or man-made).

6) Tracers can be added to the stimulation mixtures and sensors can be deployed to track whether this material has been released to aquifers of interest. For instance, Bromide could serve as a potential tracer.

7) On page 5, there is mention of the use of sensors to track key parameters. However, on page 11, the discussion is limited to semi-annual point-in-time monitoring using traditional sampling methods that only represent the conditions over the duration which a sample was collected. These are highly dynamic settings, as subsurface pore pressures are being altered as fluids are being intentionally injected into relatively consolidated subsurface materials and downgradient extraction wells operate non-continuously. Analogous to the use of traditional methods for vapor intrusion monitoring, the proposed approach has a high probability of yielding false negative conclusions – particularly if the monitoring timeframe is known beforehand and the manager of the well stimulation activities is allowed to know when such monitoring events are to occur. As such, the current monitoring plan is deficient unless continuous monitoring is also ***required***, as continuous monitoring and response systems for at least indicator parameters (e.g., water level, conductivity, ORP, tracers, etc.) can be automatically tracked within an intuitive geospatial framework so that trends can be rapidly evaluated by responsible regulatory authorities (e.g., Water Board representatives) and any changes immediately responded to via implementation of a comprehensive contingency plan or automated trigger. Under the proposed monitoring plan, cause-and-effect of any toxic releases will be debatable and inconclusive. In addition, if a release occurs just after a semi-annual monitoring event, it could be more than 6 months before any harm is detected, and far longer before any response can be implemented.

8) Regarding reporting, time series charts for each of the sensor readings as well as potentiometric maps for each of the regions can be automatically generated and accessible on-line using commercially available web applications. Processing and visualization can be automated to enable regulatory authorities and well stimulators to quickly determine when issues might arise and to allow for rapid reporting (e.g., reducing the burden on the well stimulation entities). For instance, the automatically generated graphical images for time series, potentiometric surface, and sensor contour maps can be accessed, copied and pasted directly into reports. A customized dashboard can also be managed by the Water Board to include all report submissions, laboratory results, well design as-builts, boring logs, and even an automated sensor monitoring dashboard

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built off APIs that are commercially available. This could also serve as a comprehensive document and data repository for the Regional Groundwater Monitoring Program. The California GeoTracker site is a good starting point, but does not currently afford the intuitive features such as automated contouring, playback loops or automated alert and response. The GeoTracker site could be augmented with the features described, as the automated mapping APIs can be embedded directly into GeoTracker.

9) Sampling and testing efforts for evaluating well integrity should also include automated monitoring of methane in the shallow subsurface as well as just above ground surface for the Regional Monitoring Program. A spatial distribution of the concentration of methane should be automatically generated, and when potential explosion risk conditions occur (e.g., greater than 1% methane, or between 5% and 15%) an alert should be automatically delivered to responsible entities to at least monitor changes over time and space and prepare for responses if warranted. Continuous monitoring is recommended, as vapor concentrations are extremely dynamic and have been proven to be influenced by barometric pressure, soil moisture and other variables (http://onlinelibrary.wiley.com/doi/10.1002/rem.21299/abstract, http://www.astm.org/DIGITAL_LIBRARY/STP/SOURCE_PAGES/STP1570.htm).

California remains the hub of innovation. Implementation of a comprehensive SB-4 monitoring program that includes integration of some of the innovative technologies and suggestions described above will benefit many entities including the regulators, the well stimulation workers and the public and will result in tremendous efficiencies while saving money on reporting and response efforts well into the future. In contrast, given the state of the science, the draft model criteria and methods currently under consideration by the California regulators can be classified as "legacy" techniques, and collectively represent a dangerous option that has numerous significant flaws. It will never be a better time to integrate automation based monitoring, processing and response technologies than now. As such, I would greatly appreciate your careful consideration of my comments, and can make myself available to discuss these recommendations and technologies in greater detail.

Thank you for your commendable efforts.

Kindest Regards,

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