



Via Electronic Transmittal

January 27, 2017

Mr. Aaron Yue, Project Manager
Department of Toxic Substance Control
5796 Corporate Avenue
Cypress, CA 90630

Ms. Pamela Innis, CHF Remedial Project Manager
U.S. Department of the Interior
Bureau of Land Management State Office
One North Central Avenue, Suite 800
Phoenix, Arizona 85004

Re: *Recommendations Concerning Future Topock Flow and Contaminant Transport Modeling*

Dear Mr. Yue and Ms. Innis:

The Tribes (Cocopah Indian Tribe, Fort Mojave Indian Tribe, Hualapai Indian Tribe, signatories, below) are pleased that the Department of Interior (DOI) and the Department of Toxic Substance Control (DTSC), collectively referred to herein as the Agencies, have considered many modeling-related issues that we consistently raised through various technical reviews, presentations, site visits and discussions.

The two Agency modeling-related directives identified problems that needed to be fixed, and the Tribes appreciate the opportunity for limited participation in the current round of model revisions through engagement in the modeling sub-committee. The Tribes are also pleased to see that many previous issues identified by their representatives were addressed in the 2nd Agency Modeling Directive letter.

In offering comments at this time, we point out that this letter and its contents are NOT a review of the January 2017 Arcadis Addendum to the Development of Groundwater Flow and Solute Transport Models. However, we believe it is important to comment on some remaining issues that are still of concern.

First, outside of the immediate plume area, we believe that both conceptual and numerical model uncertainty still remains high, especially beneath the Colorado River and immediately east of the river, in Arizona. Though Arcadis updated and re-calibrated the model, we believe the calibration to localized (plume area) steady-state groundwater levels produces a highly non-unique solution. As such, many alternate combinations of model input parameter values and model boundary conditions can produce equally well-calibrated results. This non-uniqueness produces high uncertainty in model predictions, particularly outside of the immediate plume area.

Despite the high predictive uncertainties inherent in the model, we continue to believe that the model can and should be used to address several remaining concerns that the Tribes have raised for several years. In particular, we feel strongly that the model needs to be sufficiently accurate and robust to be able to address various conceivable scenarios and contingencies as have been expressed during the course of our technical discussions. Our primary concerns include:

- **Potential for Arizona Groundwater Contamination.**
 - Given high model uncertainty outside the existing plume area, what is the potential for contamination of Arizona groundwater? What is the maximum possible magnitude and extent of contamination in Arizona? This is a sensitive cultural area for one or more Tribes and has been determined eligible as a Traditional Cultural Property (TCP) by BLM and Arizona SHPO, which are in the process of setting a boundary that includes this area (MW-X and MW-Y). We believe the updated model can easily be used to evaluate the potential for Arizona groundwater contamination.
 - What are Agency plans if contamination occurs? Should Arizona groundwater become contaminated, it would be clear that the California remediation wells (i.e., riverbank extraction wells) will have failed to contain the plume under currently proposed operations, a key Remedial Action Objective (RAO). We believe the model can also be used to evaluate mitigation of impacted Arizona groundwater, and to demonstrate the infeasibility of attempting to

draw back contaminated groundwater from Arizona to California, using for example, the existing California riverbank extraction wells.

- If Arizona groundwater becomes contaminated, we are concerned that another investigation and characterization, followed by remediation would then be required, resulting in further negative impacts to the TCP.
- **Maximum Project Duration.** If contamination occurs in Arizona, PG&E will likely reduce Arizona freshwater pumping and reduce IRL freshwater injection, thereby reducing the enhanced “flushing” gradient, intended to reduce overall treatment time. As a result, remedy duration would likely increase considerably beyond 30 years. Under these circumstances, how long would the system need to be operated to achieve remedy goals? The duration of remediation system operation has not been adequately considered, but should be using the updated model. Scenarios ranging from minimal reductions in Arizona pumping and IRL injection to the complete elimination of such should be considered.
- **Maximum Number and Location of Future Wells.** Given the high uncertainty in model predictions:
 - how many more wells than currently planned in the 100% Basis of Design Report could be required in the worst case in both Arizona and California?
 - what would be the anticipated locations of these wells? We are very concerned that, once constructed and operational, project-momentum will override the long-standing protocol not to place wells in our culturally-sensitive areas.

In light of these concerns, the Tribes recommend that the following actions be taken as the Topock Groundwater Remediation Project proceeds:

- **Uncertainty Analysis.** We continue to believe an uncertainty analysis should be performed now to address our immediate concerns, particularly an analysis that evaluates conceptual parameter and boundary condition uncertainty in model predictions. At the June 2017 TWG meeting, the Tribes referenced the Santa Susana – Ventura County (Boeing, NASA, DoE) project in California, a similar high profile environmental site with DTSC oversight that is conducting such a predictive uncertainty analyses. Effects of major changes to model boundary conditions and hydraulic properties on predictions (and calibration), should be evaluated as described in ASTM D 5611 – 94 (2016).

- **Model Calibration.**
 - **Demonstrate unique solution.**
 - Though the model has been updated and now incorporates more appropriate boundary conditions (i.e., river cells, ET rates, ET locations, Sacramento or Warm Springs Wash inputs, etc.), we strongly feel that a unique calibration solution needs to be clearly demonstrated. In particular, the model needs to be calibrated to more regional data outside the plume area. Standard modeling protocol¹ requires that modelers show how the final set of parameters and boundary conditions produce the best calibration over the entire model area. The recently observed lack of change in mean local calibration performance (mean residuals) only confirms that the solution is non-unique, and/or the riverbed conductance, which controls flux between river and aquifer, is set far too high, effectively isolating the remediation system performance from the rest of the model domain.
 - **Historical Plume Development.** We strongly feel that the recently updated and re-calibrated model should have its performance and credibility demonstrated by reproducing historical plume development, exactly as done previously for earlier model versions by CH2M Hill. This would help confirm that the solution is indeed unique within the remediation area. If it cannot reproduce the historical plume like before, we would find it difficult to believe future fate and transport predictions during remedy operation. We also believe that calibration should include fate / transport calibration. Nearly 10 years of system performance data for IM-3 and total mass removal and concentration trends are available.
 - **River-Aquifer Flow.** Riverbed conductance is a critical calibration model parameter that we believe strongly governs existing flows between California and Arizona, beneath the river and more so

¹ For example, see Anderson & Woesner, 1992, Section 8.4 “Evaluating the Calibration” – Figure 8.10 - Figure 8.11, standard error with simulation number, and Figure 8.12, calibration level and distribution of error; *Methods and Guidelines for Effective Model Calibration*, USGS WRI 98-4005 [see Table 1]; *Approaches to Highly Parameterized Inversion: A Guide to Using PEST for Groundwater-Model Calibration*, USGS SIR 2010-5169.

during remedy operation. We are unaware of any field data to support assigning uniform values assigned to this parameter throughout the model, which makes the parameter highly uncertain. Although lower conductance values were assigned in lower velocity areas like Topock Marsh/Bay based on our recommendations, values throughout the model and especially within the River could easily be further reduced. We are concerned that over-specification of conductance values, which the non-unique calibration appears insensitive to, will under-predict future groundwater transport of contaminants from California to Arizona during remedy operation. We believe this requires further evaluation and efforts should be made to base model values on field measurements, for example using shallow piezometers in Colorado River and Topock Marsh areas.

- **Independent Peer Review.** The Agencies should consider conducting an external independent model peer review by a noted modeler with extensive expertise in calibration and uncertainty analyses. The TRC can provide names of experts external to the project who could provide unbiased industry-standard assessment of model calibration and predictions.


We understand the interest in expediency to complete modeling and obtain Agency approval of the 100% Basis of Design Report. We do not believe that implementing our recommendations would hold up the approval, but we do request the following:

- Implement our above recommendations now. These actions can be addressed during the interim period and prior to construction and startup.
- Continue the modeling sub-group meetings to permit sustained involvement of Tribes and Stakeholders towards addressing our concerns.
- Provide updated model input files upon request by interested Tribes and Stakeholders. This would permit us to fully understand how the system behaves and how it will be impacted by the remedy operations, rather than relying on overly-simplified graphics and tables that we do not believe adequately convey the complexity of the natural system or the planned remediation system.

We greatly appreciate the creation of the modeling sub-committee as a working forum. This forum provided an opportunity for technical interaction among the Tribes, Stakeholders, and the Agencies with PG&E and its consultants. This forum offered the chance to provide and receive feedback and input regarding the ongoing model revision effort in real time and to provide recommendations on how to best proceed with the modeling. This is the type of working relationship the Tribes have been asking for throughout the remedy design process, and we believe this serves as a model for and demonstration of the success that can be realized through such collaborative fora.

Please let us know if there are questions about this letter or its content.

Sincerely,



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