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1832 Second Street
Berkeley, CA 94710
(510) 649-8008
www.concurinc.com

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To: Interested Parties
From: Scott McCreary, Ph.D., Principal, CONCUR Inc.
Re: SUMMARY OF THE CALIFORNIA COASTAL COMMISSION-POSEIDON WELL INVESTIGATION TEAM PROCESS

Introduction: At the conclusion of Phase 1 of the Independent Scientific Technical Advisory Panel (ISTAP) Process, the Conveners (Tom Luster of the California Coastal Commission, and Stan Williams of Poseidon Water) agreed to form a Well Investigation Team (WIT) to develop additional information about the potential effects of using wells to provide source water for Poseidon's proposed desalination facility in Huntington Beach. The wells would be located along the shoreline and would be intended to draw from the offshore extension of the Talbert Aquifer, which is managed by the Orange County Water District. This WIT review was to be conducted in parallel with Phase 2 of the ISTAP process. This memorandum summarizes the charge to the WIT, the structure of the WIT's review process, and the sequence of review steps. It also forwards associated documents generated during this process, which constitute the WIT's findings and conclusions.

Charge to the Well Investigation Team: Commission staff specifically requested additional information about the effects of shoreline wells on the Talbert Aquifer in order to evaluate and help complete Poseidon's Coastal Development Permit application. The charge to the WIT was to provide advice to the Conveners on the selection or development of a supplemental model to determine the effects of alternative well intake methods and extraction volumes associated with Poseidon's proposed desalination facility on the Talbert Aquifer and regional groundwater resources.

Well Investigation Team Members: At the request of the Conveners, CONCUR convened the Well Investigation Team to provide advice on the direction and scope of potential modeling investigations. Recognizing that expertise in hydrogeology and familiarity with the structure of the ISTAP process would be an asset to this effort, the Conveners jointly chose Hydrogeologists Martin Feeney and Bob Maliva, who had both served as members of the Phase 1 ISTAP process, to serve on the (WIT).

Other Participants in the WIT Process: In addition to the WIT members, other participants in this process included the Conveners Tom Luster and Kate Huckelbridge of the California Coastal Commission; Stan Williams and Jon Loveland of Poseidon Water; and staff of the Orange County Water District. CONCUR facilitated and organized this

review as a component of the overall ISTAP process. These participants provided guidance and information to the Team.

Recruitment and Selection of Gordon Thrupp to Conduct Supplemental Modeling
The WIT noted that, as part of Poseidon's feasibility assessment of Subsurface Seawater Intakes (SSIs), geohydrologist Gordon Thrupp of Geosyntec had used geotechnical data obtained from that process and developed a groundwater flow model to simulate pumping from a series of slant wells beneath the beach (Attachment 1). The WIT invited Dr. Thrupp to present a summary of his work to the WIT participants in February 2015. After this presentation, the WIT recommended to the Conveners that the most straightforward approach to accomplishing the desired modeling would be to retain Dr. Thrupp to extend and build upon his prior modeling efforts, and develop a supplemental memorandum detailing his findings.

Planned Incorporation of Third Party Review
Concurrent with the selection of Dr. Thrupp to conduct the supplemental modeling, the Conveners also jointly agreed that once completed, the Conveners should arrange a Third Party Review of the work to evaluate and confirm the appropriateness of the model structure, assumptions, and key parameters.

Gordon Thrupp's Extended Modeling Inquiry Submitted June 2015
Based on discussions at the 25 February 2015 meeting at California Coastal Commission Offices, the WIT requested the following expansions to Geosyntec's groundwater flow model:

- Revision of the groundwater model to represent a portion of the coastal marsh and wetland areas with constant sea-level water table because some of these areas are connected to the ocean through surface water channels, and
- Performance of a sensitivity analysis to evaluate uncertainty in the simulated results, based on:
    - The location of the slant wells
    - Variation of horizontal hydraulic conductivity (Kh)
    - Variation of vertical hydraulic conductivity (Kv)
    - Pumping rate (Q)

Based on this request from the WIT, Geosyntec was engaged by CONCUR to conduct these steps:

- Modify the model grid to accommodate a more detailed representation of the wetland areas and variation of the slant well locations,
- Perform eight model sensitivity runs with variations in the specific parameters listed above to assess the full range of potential impacts,
- Generate drawdown and pathline figures to illustrate results of the additional model simulations, and
- Prepare a technical memorandum.

Memoranda on Sensitivity Analyses from Gordon Thrupp

Gordon Thrupp's developed an initial memorandum and associated data files, dated June 3, with the understanding that the WIT may seek revisions and elaborations. As requested by the WIT, the following model runs were conducted in order to bracket this sensitivity analysis:

1. Move slant wells 240 ft landward
2. Move slant wells 240 ft seaward
3. Reduce Kh & Kv of overlying strata (Layers 2-4) by a factor of ten (from 10 & 1 to 1 & 0.1 ft/d)
4. Reduce Kh & Kv of overlying strata (Layers 2-4) by a factor of 50 (from 10 & 1 to 0.2 & 0.02 ft/d)
5. Reduce Kh and Kv of Talbert Aquifer (Layers 5-8) by a factor of two (e.g. from 300 & 30 ft/d to 150 and 15 ft/d)
6. Increase Kh and Kv of Talbert Aquifer (Layers 5-8) by a factor of two (e.g. from 300 & 30 ft/d to 600 and 60 ft/d)
7. Reduce pumping rate by factor of 2 (63.5 mgd: 2200 gpm from 20 instead of 40 wells)
8. Reduce pumping rate by factor of 4 (31.75 mgd: 1100 from 20 wells)

Discussion of G. Thrupp Memorandum by Conveners and Request for Revision.

As planned, on a September 1, 2015 conference call, the WIT reviewed the initial model run and requested (1) an additional figure showing model groundwater contours and flowpaths without slant well pumping and (2) documentation of model groundwater flow rate from the Talbert Injection Barrier to the ocean for the non-pumping case. The additional two requests by the WIT are addressed in the final memorandum dated November 9, 2015. (Attachment 2)

Letter from Orange County Water District - September 28, 2015.

The Orange County Water District was also a participant in the WIT process, represented by Chief Hydrologist Dr. Roy Herndon. The attached (Attachment 5) letter from Dr. Herndon primarily addresses the findings of the June 3 modeling study on the modeled proportion of inland source water drawn into slant wells constructed in the Talbert Gap. The letter stated that Water District staff would not be in favor of continued consideration of a slant well subsurface intake option for the Huntington Beach Seawater Desalination Project based on the unacceptable amount of inland groundwater lost to the slant well system that would reduce the benefits of the OCWD Groundwater Replenishment System and the yield of the groundwater basin.

Recruitment/Charge to Third Party Reviewer

In October, 2015, the Conveners chose Dr. Russ Detwiler, Associate Professor of Civil and Environmental Engineering at UC Irvine to complete the third party review. Dr. Detwiler's expertise includes *"fluid flow processes in porous and fractured media,*

including multiphase flow and transport, and the chemical/biological/mechanical alteration of subsurface properties, and understanding the scaling behavior of these often-coupled processes."

His charge was to review a series of documents generated during this investigation with a focus on these questions:

1) Is the conceptual model, (including the underlying assumptions used for combining the two prior models and the selected boundary conditions that were used in the current model), appropriate for simulating expected groundwater flows resulting from intake wells at the proposed locations?

- Is the model built at the correct scale?
- Are the underlying assumptions appropriate?
- Are its boundary conditions appropriate?
- Were elements of the OCWD model properly incorporated into Poseidon's model?

2) Do the numerical simulations adequately represent the conceptual model for determining expected groundwater flows?

- Was the model set up properly?
- Was the model calibrated properly?
- Were the input files set up correctly?
- Were the model results interpreted and presented correctly?
- Do the numerical simulations adequately allow the model to determine expected groundwater flows?

At the request of the Conveners, a final question addressed was:

- Given the findings of the review, what additional investigations might be performed to further narrow data gaps.

Memorandum Review of groundwater flow modeling by Russ Detwiler.

Russ Detwiler's initial review Technical Memorandum was completed on November 22, 2015 in which he addressed his review of the groundwater flow models developed by Geosyntec. As described above he responded directly to the series of guiding questions.

1) Is the conceptual model, including the underlying assumptions used for combining the two prior models and the selected boundary conditions used in the current model, appropriate for simulating expected groundwater flow resulting from intake wells at the proposed locations?

- *Is the model built at the correct scale?*

  Finding: The areal extent of the model domain is reasonable and incorporates reasonable natural or induced boundaries.

- *Are the underlying assumptions appropriate?*

  Finding: Most of the underlying assumptions are appropriate and well supported by available data. Two possible exceptions are the assumptions that: 1) the Talbert aquifer is contiguous and homogeneous offshore and 2) the hydraulic conductivity of the bed sediments in the inshore marshes is identical to the hydraulic conductivity of shallow sediments elsewhere in the region.

- *Are its boundary conditions appropriate?*

  Finding: The boundary conditions are reasonable.

- *Were elements of the OCWD model properly incorporated into Poseidon's model?*

  Finding: The main elements of the OCWD model incorporated into the current model are the inshore details of the Talbert aquifer and the boundary applied at the Talbert Gap injection barrier. These elements are properly incorporated into the inshore region of the model.

2) Do the numerical simulations adequately represent the conceptual model for determining the expected groundwater flows?

- *Was the model set up properly?*

  Finding: The MODFLOW model is consistent with the conceptual model described in Geosyntec, 2013, Feasibility Assessment of Shoreline Subsurface Collectors, Huntington Beach Seawater Desalination Project and Technical Memorandum from Geosyntec with the subject "Revision and Sensitivity Analyses of the Slant Well SSI Model Feasibility Assessment of Shoreline Subsurface Collectors Huntington Beach Seawater Desalination Project"

- *Was the model calibrated properly?*

  Finding: The model was not calibrated. The parameter values in the model are based on measurements from a range of different sources and reflect the current understanding of both the extent and hydraulic properties of the Talbert aquifer and underlying and overlying sediments. Uncertainty remains regarding the exact values of some parameters (e.g., hydraulic conductivity) and the extent of the Talbert aquifer, particularly in the offshore region of the model where data is limited. To account for these uncertainties, Technical Memorandum from Geosyntec with the subject "Revision and Sensitivity Analyses of the Slant Well SSI Model

Feasibility Assessment of Shoreline Subsurface Collectors Huntington Beach Seawater Desalination Project" presents a set of model runs in which different parameters were varied to determine the sensitivity of the results to different important parameters.

- *Were the input files set up correctly?*

  Finding: The input files are set up correctly and are consistent with the conceptual model.

- *Were the model results interpreted and presented correctly?*

  Finding: The primary results presented from the latest modeling effort presented in Technical Memorandum from Geosyntec with the subject "Revision and Sensitivity Analyses of the Slant Well SSI Model Feasibility Assessment of Shoreline Subsurface Collectors Huntington Beach Seawater Desalination Project" are details regarding the water budget from different sources and head contours and pathlines for the different realizations carried out in the sensitivity analysis. These results are consistent with the results of my test runs.

- *Do the numerical simulations adequately allow the model to determine expected groundwater flows?*

  Finding: The numerical simulations adequately reflect expected groundwater flows caused by pumping from the proposed slant wells assuming the conceptual model are correct. Three simplifying assumptions made in the development of the conceptual model have potential implications on the calculated flow rates from different sources and were not considered in the sensitivity study: 1) the offshore extent and hydraulic conductivity of the Talbert aquifer; 2) the hydraulic conductivity of bed sediments in the wetland areas; and 3) the constant head boundary applied along the entire north end of the model domain, including in the aquifer underlying the Talbert aquifer adjacent to the Talbert Gap injection barrier.

The Conveners discussed the technical memorandum and asked for additional analysis, which resulted in a revised version dated December 18, 2015 (Attachment 4). Russ Detwiler reviewed the potential implications of these three assumptions (listed above) on the estimates of flow rates from the ocean and the inshore injection barrier.

1) The combined impact of variability in the offshore aquifer extent, thickness, and hydraulic conductivity will be to reduce the flow from the ocean from that predicted by the results of the sensitivity study.

2) All of these simulations suggest the total contribution from these regions is a small fraction of the total flow rate, suggesting that the relative amounts of flow from the ocean and the injection barrier are insensitive to the hydraulic conductivity of the bed sediments.

3) Management of the Talbert injection barrier largely controls the heads along the inshore boundary of the model. Supplemental information from OCWD provided during initial discussions of this memo suggests that the Talbert aquifer and underlying aquifers are well connected in the region of the injection barrier. This supports representation the barrier as a constant head boundary that spans the depth of the model. However, the actual head values will be sensitive to both management of the injection barrier and pumping and recharge within the OC basin. Due to the extensive head depression created by the proposed intake wells, it is reasonable to expect that the seawater/freshwater interface will move coastward under all of the simulation scenarios. This suggests it would be feasible to reduce heads along the injection barrier without increasing the risk of saltwater intrusion. Managing the heads along the injection barrier in this way would reduce the contribution of flows from the injection barrier to the intake wells.

Conclusion from Dec 21 Conference Call: On their December 21 conference call, WIT reviewed and discussed Russ Detwiler's Technical Memorandum, and the Conveners concluded that the components of the WIT should be deemed complete, that no further modeling investigation will be requested at this time, and that CONCUR should proceed to draft this summary memorandum for Convener review with the intention of finalizing and posting the memorandum on the Commission's FTP site in early January, 2016**.**

Next Steps/Uses of this Set of Documents: This cover memo and the attached documents will be part of Poseidon's Coastal Development Permit application.

Conclusion of the ISTAP process/Contacts for Further Information: This memorandum and the attached set of documents concludes the WIT investigation and CONCUR's involvement with this effort. Accordingly, interested parties with questions or comments should contact Tom Luster at the California Coastal Commission or Stan Williams at Poseidon.

Available Documents: The following documents are available at the Commission's FTP site, which can be accessed at http://ftp.coastal.ca.gov/

From that link, go to the General Public folder with user name "public" and password "ocean03" then to the Expert Panel Public Review folder, then to the Well Investigation Team folder.

1) Geosyntec, 2013, Feasibility Assessment of Shoreline Subsurface Collectors, Huntington Beach Seawater Desalination Project, Huntington Beach, California, September 2013.

2) Technical Memorandum from Geosyntec, 2015 with the subject "Revision and Sensitivity Analyses of the Slant Well SSI Model Feasibility Assessment of Shoreline Subsurface Collectors Huntington Beach Seawater Desalination Project" and associated Figures 1-27. November 2015.
3) Modflow input and output files associated with the sensitivity analyses described in (1)
4) Memorandum from Russ Detwiler to Scott McCreary December 18, 2015. Re: Review of groundwater flow modeling developed by Geosyntec to simulate pumping from slant wells beneath the beach in Huntington Beach
5) Memorandum from Roy Herndon to Scott McCreary September 28, 2015. Re: OCWD Staff Comments on Modeling Evaluation of Huntington Beach Ocean Desalination Subsurface Intake Option Using Extraction Wells in the Talbert Aquifer.