TETRA TECH

DOCKET	
08-AFC-13C	
DATE	May 28 2011
RECD.	May 31 2011

May 28, 2011

Calico Solar, LLC
295 Madison Avenue
New York, NY 10017.
Attn: Mr. Dan O'Shea

and

Mr. Keith Heffelfinger
15550 S 5th Ave. #121
Phoenix, AZ 85045

RE: Proposal for Hydrology Study and other support for Calico Solar Project

Dear Messrs. O'Shea and Heffelfinger:

Tetra Tech, Inc. is pleased to submit this proposal to perform a hydrology study to support the design and permitting for the Calico Solar Project. Based on your May 12, 2011 email, the proposed work will include the following general tasks that are specified in the California Energy Commission (CEC) Soil and Water (S&W) conditions of certification for the project:

1. Preparation of an infiltration report (S&W-13),
2. Geomorphic and hydraulic analysis (S&W-8),
3. Geomorphic and biologic analysis (S&W-8),
4. Scour analysis (S&W-3),
5. Pole foundation stability report (S&W-3), and
6. All studies necessary for the DESCP (S&W-1), which will be produced by Calico.

In your email request, you provided the draft language for the relevant conditions of certification related to the hydrologic analysis, and you requested that we provide a schedule of the order, estimated time and cost to complete each of the above items.

Assumptions and Understanding of Issues

Following is a brief description of relevant background issues that we feel need to be considered in the work, based on our review of the available information, including the documents that you provided to us last week:

1. A rainfall-runoff analysis was previously conducted by Huitt-Zollars (2009) using the prescribed modeling procedures. Based on the available information, the previous modeling appears to only represent existing watershed conditions, and therefore, does not reflect the potential effects of the project. S&W-13 requires *a calculation of the amount of storm water runoff for 1) the existing soil conditions, 2) the temporarily disturbed conditions resulting from*

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construction, and 3) the final conditions after the installation of PV modules and SunCatchers and the construction of roads and buildings is complete. S&W-13 also includes a list of other specific factors that must be considered, including all factors that affect infiltration characteristics of the site and worst-case vegetation conditions over the life of the project. As a result, it will be necessary to develop at least two additional rainfall-runoff models by modifying the existing conditions model to reflect conditions during construction and after construction is complete, with the parameters adjusted to represent changes in infiltration and runoff efficiency associated with each of the identified factors.

It is assumed, for purposes of this proposal, that the model input files from the previous hydrology analysis will be made available to Tetra Tech for use in this work. We will verify the input parameters, including the watershed delineations, to insure that they are consistent with the available information, make any appropriate adjustments, and use the adjusted models for the existing conditions analysis.

2. The Huitt-Zollars (2009) analysis considered the 10-, 25- and 100-year, 24-hour duration storms. S&W-13 specifies that the analysis shall be conducted for the 2-, 5-, 10- and 100-year storms with durations of both 6 and 24 hours. In addition, the procedures that we typically use for estimating the long-term sediment delivery through the site to support the geomorphic and hydraulic analysis also requires hydrographs for the 25- and 50-year storms. As a result, the rainfall-runoff models should be run for the 2-, 5-, 10-, 25-, 50- and 100-year storms for each of the two durations (i.e., a total of 12 different storm events).

3. The portion of S&W-8 that you have asked us to address requires, among other things, *a geomorphic and hydraulic analysis to determine the maximum design storm that can be routed through the site utilizing existing fluvial washes that will not result in significant damage to proposed site infrastructure. S&W-8* also requires a determination of *the ability of the proposed site infrastructure to withstand the storm at the proposed location of said site infrastructure.* In some ways, this requirement is in conflict with the additional requirement to use FEMA Guidelines for Determining Flood Hazards on Alluvial Fans, with the project design *based on the assumption that the primary flow from the apex of the alluvial fan may flow to any single location within the site*.

   To evaluate the maximum storm that can be safely passed by the *existing washes* and address the other hydraulic factors in the S&W conditions, we believe that a FLO-2D model of the site will be the most efficient and technically defensible approach. FLO-2D was specifically developed for modeling of uncertain flow paths on alluvial fans, is a FEMA-approved model, and has been successfully applied to many similar projects. It may also be necessary to develop localized one-dimensional (1-D) HEC-RAS hydraulic models of specific, significant washes and the various drainage crossings of the BNSF Railroad grade to adequately address the issues in those areas. The model(s) will be used to predict channel capacities and associated hydraulic conditions throughout the site under both existing and project conditions. The effect of the project on channel capacity and channel stability will be assessed by comparing results for existing and project conditions. The potential for local scour around and lateral erosion into site infrastructure will be assessed using this information.

   In contrast, the FEMA hazard evaluation will be conducted using the relationships in Appendix G of the FEMA guidelines to estimate the channel dimensions and hydraulic conditions for the 100-year storm, under the assumption that all flow could potentially be carried in a single channel that could be located anywhere on the fan. We assume the agencies intend the first requirement of conditions in the *existing washes* to help understand

the potential consequences and design requirements for building the site with minimum impact to the existing drainage patterns, while the second requirement for the Appendix G hazard evaluation is to provide an assessment of the overall flood and scour hazards at the site for use in designing site infrastructure recognizing the possibility that existing drainage patterns on the fans could change in response to a large storm.

4. With the understanding that BNSF Railway Company is very concerned about the potential impacts of the project on their railroad grade that runs through the site, the models will incorporate the existing trestles and culverts that cross under the grade, and their approach and exit channels, to facilitate evaluation of the effects of changes in runoff conditions on the grade (and, if appropriate, the effects of the grade on runoff conditions at the site).

5. S&W-8 also requires a *geomorphic and biologic analysis to determine the minimum design storm that can be routed through the site utilizing existing fluvial washes that will provide the necessary sediment load through the site and "downstream areas" to maintain existing sensitive habitat needs, as described in the Geomorphic Assessment of Calico Solar Project Site*. We assume the Geomorphic Assessment that is referred to in this clause is the document prepared for the CEC by Phillip Williams & Associates, Ltd (PWA, July 9, 2010), which focuses primarily on the presence and physical processes that form and maintain aeolian sand dunes that are critical habitat for the Mojave Fringe-toed Lizard (MFTL). PWA (2010) concluded that the existing MTFL dune habitat is formed and maintained by alluvial sediment that is primarily brought onto the site by the washes during surface-runoff events; thus, this sediment supply must be maintained to, and through, the site to protect the habitat. For this reason, PWA (2010) also concluded that the detention basins that were proposed in the original Tessera plan would not be compatible with the need to protect MTFL habitat. Under the assumption that the PWA (2010) conclusion that the sand for MTFL habitat is, in fact, of alluvial origin, is correct, we are uncertain what is meant by the *minimum design storm that can be routed through the site…* to accomplish this purpose, since the overall sediment load is the integrated product of all of the runoff-producing storms that carry sediment onto the site. We tentatively propose to use the results from the hydrology analysis for the various storm hydrographs, the hydraulic analysis of existing washes discussed in Item 3 above, and appropriate sediment transport relationships to estimate the quantity of sand carried onto, and through, the site on an individual storm basis and on an annual basis using the probability-weighted sediment volumes for the individual storms, under both existing and project conditions. Comparison of the existing and project conditions volumes will provide a basis for assessing the effect of the project on the sediment load through the site, the likely response of the existing washes to these changes, and the likely effect of those changes on the amount of fine sand that is available for aeolian entrainment from the washes and deposition on the dunes that comprise MTFL habitat.

6. The Scour Analysis for S&W-3 will be performed using Equation 6.1 of the Federal Highway Administration Hydraulic Engineering Circular (HEC-18), as specified, using the worst-case hydraulic conditions for the existing washes or those resulting from the FEMA alluvial fan analysis.

7. It is assumed that the Pole Foundation Stability Analysis Report is to focus primarily on the potential effects of local scour on the stability of the foundations for the photovoltaic cells and SunCatchers, and that the structural aspects of the foundation design are being addressed by others. As a result, we assume that seismic analysis and assessment of earthquake faulting is not required for this report. For purposes of this proposal, we also assume that the following information will be provided to Tetra Tech for use in the analysis:

- Vertical and lateral loading on the foundations,
- Size and type of foundation being considered (e.g., diameter, steel, concrete etc.), and
- Maximum allowable lateral deflection.

8. We assume that most, if not all, of the information related to the site hydrology, hydraulics and sedimentation for the DESCP (S&W-1) that you will be preparing will be available from the analyses for the Infiltration Report (S&W-13), Geomorphic and Hydraulic and Geomorphic Biologic Analysis (S&W-8) and the scour analysis (S&W-3). As a result, a relatively minor effort will be required for additional studies for the DESCP.

9. Given the uncertainty and potentially conflicting requirements in the CEC conditions of certification, we suggest that a meeting be held with technical representatives from the appropriate reviewing agencies to discuss the proposed approach to insure that we have correctly interpreted the requirements and our proposed approach to meeting those conditions will be acceptable.

Scope of Work

Based on the information in your request for proposal and the information and assumptions spelled out in the previous section, Tetra Tech proposes to perform the following specific tasks:

1. Tetra Tech's Technical Project Manager will perform a site visit with K Road's Project Manager and/or other representative(s) to gain an understanding of specific conditions at the site, clarify the elements of the project that affect runoff and sediment movement at the site, and the relationship between the project site and the BNSF Railroad Grade and other existing affected infrastructure. If appropriate, the meeting with reviewing agencies discussed above could be held in conjunction with the site visit.

2. Prepare Infiltration Report (S&W-13)

   a. Obtain and review the previous existing-conditions hydrology model input files.

   b. Adjust the input files for consistency with the available information, including any new mapping and soils information that has become available since the previous work was completed, if any.

   c. Develop individual storm hydrographs for existing conditions at key locations including the fan apices, the upstream and downstream boundaries of the site, and key locations within the site for the 2-, 5-, 10-, 25-, 50- and 100-year storms with durations of 6 and 24 hours (total of 12 individual hydrographs).

   d. Modify the existing-conditions model to reflect the effects of temporary construction activities on the runoff characteristics of the site, and re-run the resulting interim-construction-conditions model for each of the 12 storm events.

   e. Modify the model to reflect the final build-out conditions at the site, including the effects of all project-related factors listed under S&W-13. As part of this task, an assessment of the likely long-term effect of the project on vegetation conditions at the site will be made. If the identified, long-term conditions would have an adverse effect on runoff or erosion and sedimentation conditions at the site, the initial, project-conditions model will be modified to represent worst-case vegetation conditions, and both the initial and worst-case models will be run for the 12 storm events.

f. Prepare the Infiltration Report describing the methods, data sources, assumptions, and results of the analysis. The report will identify all areas on the project site where permeability of the ground surface may be changed by the project, and the potential effects of those changes.

3. Perform Geomorphic and Hydraulic Analysis (S&W-8)

a. Estimate the discharges and associated water, debris and sediment volumes at the apices of the alluvial fans under existing watershed conditions. This will be accomplished using results from the rainfall-runoff model and an appropriate sediment yield relationship. Previous estimates were made by WEST Consultants (2009). The WEST (2009) approach and resulting estimates will be considered in performing this analysis.

b. Develop a FLO-2D hydraulic model of the site. The model will be developed based on the best available site topography, and will include all of the significant washes[1] that cross the site. The model will also include the flow paths that run parallel to the BNSF Railroad grade, and the trestles and culverts that pass under the grade. It is assumed for purposes of this proposal that the existing mapping is of adequate resolution to support the modeling effort.

c. Using the FLO-2D models, supplemented with local HEC-RAS models, as necessary, determine the approximate existing bankfull capacity of each of the significant washes under existing conditions, and estimate the anticipated frequency of flows of this magnitude based on the hydrologic modeling results from the analysis for the Infiltration Report.

d. Perform a sediment transport continuity analysis for each of the 24-hour duration storm hydrographs and on an average annual basis using the hydraulic model results with the existing bed material gradation data and an appropriate bed material transport capacity equation. Results from the continuity analysis will provide a basis for assessing the overall sediment balance in the primary washes within the site. The bed material (i.e., sand and coarser) supply to the site will be estimated by considering an appropriate length of each wash upstream from the project boundary in the analysis.

e. Modify the hydraulic model(s), as appropriate, to represent changes in channel geometry and hydraulic roughness associated with the proposed project features, and repeat both the channel capacity and sediment continuity analysis for the modified conditions. Based on the site plans that have been provided, to-date, it appears that the stanchions for many of the PV arrays will need to be placed within existing washes and primary flow paths. If this is, in fact, the case, these stanchions may have a significant impact on hydraulic roughness and channel capacity, a factor that will be accounted for in the modeling. Comparison of the existing- and project-conditions results will provide a basis for assessing potential impacts of the project on channel stability and sediment delivery across the site, including potential changes in hydraulic and sediment-transport conditions at and through the BNSF Railroad grade.

f. Assess the potential for local scour around, and lateral migration into, proposed project features that are located within or adjacent to the primary washes using results from the project-conditions model.

[1] For purposes of this proposal, it is assumed that the *significant washes* are the main drainage pathways for each of the subbasins that were included in the Huitt-Zolars (2009) model.

g. Prepare a technical memorandum describing the methods, data sources, assumptions, and results of the analysis. The report will specifically address the maximum design storm that can be routed through each of the primary washes at the site that will not result in significant damage to proposed site infrastructure and an assessment of the ability of the proposed site infrastructure to withstand the storm at the proposed location of said site infrastructure.

4. Perform Geomorphic and Biologic Analysis (S&W-8)

   a. Assess results from the sediment-transport continuity and channel stability analysis to determine the amount of sediment carried onto and through the site in the existing washes during each of the individual storm events and on an average annual basis. Also, assess the likely response of the existing washes within the site to predicted changes in sediment load under project conditions, if any. Based on the results of this assessment, evaluate the potential for changes in the supply of fine sand that would be available for aeolian transport to support existing sensitive (i.e., MFTL) dune habitat. The potential episodic nature of dune complex evolution that depends on El Nino events that cause wetter-than-normal winters on a 3- to 7-year cycle during which sediment is delivered to the lower fan complex, and the accompanying dry winters associated with La Nina events that occur on about the same frequency during which the fine sand is transported from the washes onto the dune habitat will be addressed in the analysis. The sediment transport calculations will be done on a by-size-fraction basis to directly quantify the movement and availability of fine sand.

   b. Prepare a technical memorandum describing the methods, data sources, assumptions, and results of the analysis. In addition to the assessment of on-site sensitive habitat, the memorandum will also address amount of sediment expected to pass through the site to maintain existing sensitive habitat in downstream area.

5. Perform a scour analysis to support design of the PV and SunCatcher arrays (S&W-3)

   a. Apply the procedures in the FEMA Guidelines for Determining Flood Hazards on Alluvial Fans and Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix G, Guidance for Alluvial Fan Flooding Analyses and Mapping to estimate the potential hydraulic conditions under the assumption that the primary flow from the apex of the fan may flow to any single location on the site.

   b. Estimate the potential scour depth at the foundations of individual elements based on the hydraulic conditions from the FEMA-based analysis, the proposed geometry of the foundations, and the surface conditions at the site. The scour estimates will be made using Equation 6.1 from FHWA (2001). To account for the variability in conditions and designs, it is assumed that the analysis will be performed for four different foundation configurations/locations, similar to the following:

      - PV stanchions within of existing washes (modeled hydraulic conditions will be applied),
      - PV stanchions outside existing washes (FEMA Appendix G methods will be applied),
      - SunCatcher supports within of existing washes (modeled hydraulic conditions will be applied), and

- SunCatcher supports outside of existing washes (FEMA Appendix G methods will be applied).

c. Where the PV or SunCatcher arrays are within, or in close proximity to, existing primary washes, assess the potential lateral channel migration into individual foundations and the local scour depth at these foundations, and compare with the depths estimated from the previous tasks. The worst-case depth among these two estimates will be recommended as part of the basis of design for the foundations.

d. Provide the resulting potential scour depths to the Project Geotechnical Engineer and/or Professional Geologist for use in the pole foundation stability analysis.

6. Prepare a Pole Foundation Stability Report

a. Use results from the scour analysis and the available site soils information to establish the Minimum Depth Stability Threshold for the PV and SunCatcher arrays. The following specific tasks will be completed for this work:

- Evaluate subsurface stratigraphy presented in Terracon (2009),
- Review soil parameters with regard to strength and deformation characteristics,
- Develop a model to assess vertical and lateral deformation of pole (pile) foundations using LPile or other suitable methods, and
- Evaluate deformation for scour and non-scour conditions and develop recommended minimum pile depths to provide a stable foundation.

b. Prepare a technical report describing the methods, data sources, assumptions, and results of the analysis, and providing specific recommendations for the Minimum Depth Stability Threshold. The report will include a description of the scour analysis performed in the previous task.

7. Perform other studies to support the DESCP (S&W-1)

a. Use results from the FEMA-based analysis in Task 5.a, above, to prepare an alluvial fan flood hazard map for the site.

b. Perform other studies, as requested, to address on- and off-site drainage and sedimentation issues.

8. Consult with Calico representatives, as requested, on subsequent engineering plans and reports, including attendance/testifying at hearings

References

Federal Highway Administration, 2001. Evaluating Scour at Bridges, Fourth Edition, Hydraulic Engineering Circular No. 18, Publication Number FHWA NHI-01-001, 380 p.

Phillip Williams & Associates, Ltd., 2010. Geomorphic Assessment of Calico Solar Project Site APPENDIX A (BIOLOGY REPORT), prepared for California Energy Commission, July 9, 32 p.

Stantec Consulting, Inc., 2008. Initial Drainage Report, Solar One LLC, San Bernardino, CA, prepared for Stirling Energy Systems, October 7, 303 p.

Terracon Consultants, Inc., 2010. Geotechnical Engineering Report, Solar One, Pisgah, CA, prepared for Tessera Solar, January 4, 141 p.

WEST Consultants, Inc., 2009. Geomorphic Analysis for the SES Solar One Project, Mojave Desert, CA, prepared for Huitt-Zollars, Inc., April, 17 p.

The Tetra Tech Project Team

Tetra Tech's work on this project will be performed by, and under the technical supervision of, Dr. Bob Mussetter, PE. Bob has a PhD and over 30 years of experience in Hydraulic, River and Sedimentation Engineering, a significant amount of which was gained on a wide variety of projects in the desert southwestern U.S. Notable experience that is directly relevant to this project includes:

- Primary author of Erosion and Sediment Design Guides for the Albuquerque and Southern Sandoval County Flood Control Authorities that are used by local agencies and engineers to guide flood plain analysis, establishment of erosion setbacks and naturalistic channel stabilization measures in arroyos throughout the greater Albuquerque area,
- Guidance, peer review, and member of a Blue Ribbon Panel for development of the Flood Control District of Maricopa County Piedmont Flood Hazard Assessment Manual (PFHAM),
- Presentations and assistance to the National Research Council Committee on Alluvial Fan Flooding for development of an updated definition of alluvial fan flooding and methodology that is now used by FEMA,
- Member of the FEMA Riverine Erosion Hazard Committee that was formed to provide guidance on appropriate methods to account for erosion potential in preparing FEMA flood hazard mapping, and
- Completion of numerous projects involving rainfall-runoff modeling, hydraulic, sediment transport and channel stability analysis and geomorphology in arroyos and washes in desert environments throughout Arizona, New Mexico, Southern Colorado, and Southeastern California that are similar to the project site.

Bob will be assisted by a group of highly skilled engineers and scientists from Tetra Tech's Surface Water Group, including:

- Mr. Mike Zeller, PE, a Senior Engineer in our Tucson office with over 30 years of experience with hydrology, hydraulics and sediment transport issues in desert environments, who will provide QA/QC support for the work,
- Mr. Chung-Cheng Yen, PE, a Senior Engineer in our Irvine, CA office, who developed the AES software that was used for the Huitt-Zollars (2009) rainfall-runoff study at the project site and has significant experience throughout San Bernardino County,
- Mr. Dai Thomas, P.E, a Senior Engineer, with nearly 15 years of experience with hydraulic modeling, including significant experience with the FLO-2D model, and
- Ms. Merri Martz, a Senior Biologist, who will assist the engineering team in understanding the likely long-term vegetation conditions at the site in response to CEC Condition S&W-13.

Schedule and Budget

A timeline showing the proposed work schedule is provided in **Attachment 1**. Assuming that Tetra Tech receives notice-to-proceed (NTP), the hydrology model input files from the Huitt-Zolars (2009) study and electronic versions of the topographic mapping and site plans by May 25, 2011, we believe this timeline can be met. In the event that NTP and the other information are provided after May 25, we will make utmost efforts to complete the deliverables within 40 calendar days after receipt of said information.

Thank you for the opportunity to assist you with this project. Please call me at 970-223-9600 (ext 4204) or bob.mussetter@tetratech.com if you have questions.

Sincerely,

TETRA TECH, INC.

Robert A. Mussetter, PhD, PE
Program Manager, Hydraulic Engineer

RAM:bbv:Enc.

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ATTACHMENT 1

Proposed Work Schedule

		May									June																												July		
Task #	Task	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	2	3
100	Site Visit																																										
200	Infiltration Report																																										
300	Geomorphic & Hydraulic Analysis																																										
400	Geomorphic & Biologic Analysis																																										
500	Scour Analysis																																										
600	Prepare Pole Foundation Stability Report																																										
700	Other studies for DESCP (Alluvial fan hazard map)																																										
800	Additional Consulting Services																																										

On-going work

Delivery of draft report/memo (**Please see note in schedule section of proposal)**

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BEFORE THE ENERGY RESOURCES CONSERVATION AND DEVELOPMENT
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FOR THE CALICO SOLAR PROJECT AMENDMENT

Docket No. 08-AFC-13C
PROOF OF SERVICE
(Revised 5/25/2011)

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*indicates change

DECLARATION OF SERVICE

I, Doug Larson declare that on May 31, 2011, I served by U.S. mail and filed copies of the attached letter, dated May 28, 2011. The original document, filed with the Docket Unit, is accompanied by a copy of the most recent Proof of Service list, located on the web page for this project at: **[www.energy.ca.gov/sitingcases/calicosolar/compliance/index.html]**.

The documents have been sent to both the other parties in this proceeding (as shown on the Proof of Service list) and to the Commission's Docket Unit, in the following manner:

(***Check all that Apply***)

FOR SERVICE TO ALL OTHER PARTIES:

X sent electronically to all email addresses on the Proof of Service list;

____ by personal delivery;

____ by delivering on this date, for mailing with the United States Postal Service with first-class postage thereon fully prepaid, to the name and address of the person served, for mailing that same day in the ordinary course of business; that the envelope was sealed and placed for collection and mailing on that date to those addresses **NOT** marked "email preferred."

AND

FOR FILING WITH THE ENERGY COMMISSION:

X delivering an original paper copy and sending one electronic copy by e-mail to the address below (***preferred method***);

OR

____ depositing in the mail an original and 12 paper copies, as follows:

CALIFORNIA ENERGY COMMISSION
Attn: Docket No. 08-AFC-13C
1516 Ninth Street, MS-4
Sacramento, CA 95814-5512
docket@energy.state.ca.us

I declare under penalty of perjury that the foregoing is true and correct, that I am employed in the county where this mailing occurred, and that I am over the age of 18 years and not a party to the proceeding.

*indicates change