

MEMORANDUM

To: Jim Well
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From: Yantao Cui, Ph.D.,
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Date: 29 May 2013
Number of pages: 3
Subject: M&T Pump Intake Relocation to the West Bank of the Sacramento River

Introduction

In this technical memorandum I provide a technical review of the technical memorandum authored by Dai Thomas, Bob Mussetter, and Mike Harvey of Tetra Tech dated 27 May 2013 titled “Evaluation of the Proposed M&T Pump Intake on the West Bank of the Sacramento River, Project No. US-CA-62-5” (the Tetra Tech Memo hereafter), as you requested.

Review of the Tetra Tech Memo

The Tetra Tech Memo first provided a review of hydrology in the study reach, a review of previous work, including previous topographic surveys, 2-dimensional (2D) sediment transport modeling, CSU scaled physical model, and an evaluation of the 1,500 ft rock toe installed on the west bank in October 2007. The Tetra Tech Memo then proceeded to present the adaptation and application of the 2D hydraulic/sediment transport model for the evaluation of scenarios related to a relocation of the pump intake to the west bank followed with discussions and conclusions.

Four scenarios were explored in the Tetra Tech Memo with the 2D model: (a) a base line model based on 2012 topography; (b) a bank fill model that realigns the west bank by smoothing the bank line through the apex of the bend; (c) a 1996 Bar model that assumes the gravel bar will eventually grow back to the 1996 pre-dredging condition; and (d) a bank fill + 1998 Bar model that relines the west bank and assumes the bar grows back to the 1996 pre-dredging condition.

Based on my past experiences, 2D hydraulic modeling such as presented in the Tetra Tech Memo is very reliable if conducted appropriately. The modeling presented in the Tetra Tech Memo seems to have been conducted appropriately, the choice of modeling scenarios are excellent, and modeling results should provide important reference for the design work if the project is to move forward.

As for the 2D sediment transport modeling conducted in the Tetra Tech Memo, the modeling seems to have been conducted appropriately. It is, however, my personal opinion that 2D sediment transport modeling results in general, are far less reliable than hydraulic modeling results due to limitations in our understanding of sediment transport process and limitations in the resources available to conduct such modeling (Cui et al. 2011). Major limitations of 2D sediment transport modeling such as the one presented in the Tetra Tech Memo include: a short study reach, and thus, modeling results (in terms of channel aggradation or degradation) are dictated by the boundary conditions; short modeling time, and thus cumulative effect was unable to be examined (and the most important geomorphic effect at the project site will be cumulative effect, i.e., what will happen 10, 20 years from implementation). Because of these limitations, modeling 2D sediment transport modeling results should only be used for qualitative references and any design relying on the sediment transport modeling results should add adequate safety factors and take precautions.

The Tetra Tech Memo concluded that while two locations (XS1 and XS4) have water depths that exceed the minimal requirement, it is unlikely that the minimum depth criteria will continue to be satisfied over the 40 year design life because the channel is aggradational in the vicinity of both cross sections during high peak flow events.

While I share the concern of potential risks relocating pump intake to the west bank with Tetra Tech staff, I do not believe the reasons provided in the Tetra Tech Memo (i.e., minimum depth criteria will not be satisfied due to

channel aggradation during high flow events) is convincing enough. My interpretation of the survey data presented in Figures 6 and 7 of the Tetra Tech Memo, for example, is that the cross sections near the west bank has been fairly stable with some annual local variations and without a clear aggradational trend. Based on observations of the recent channel alignments, the current river alignment has a tendency to migrate west and stopped at the current location only by a combination of the dredging of the gravel bar and the installation of the rock toe (Figure i). Assuming the rock toe is to stay in place, and the gravel bar is allowed to grow in the future in the absence of continued dredging, the flow should be pushed farther west, theoretically carving the channel bed near the west bank deeper than what is observed today. If vegetation, especially trees, grow on top of the rock toe and matures in time, it should also help to contain the flow within the main channel, and theoretically help maintain the water depth near the west bank.

My concerns with the risks associated with a relocation of the pump intake are as follows:

- (a) **The long-term stability of the rock toe:** the premises of relocating the pump intake is that the rock toe will continue to be stable and hold the river in the current location. A failure of the rock toe will likely result an accelerated westward river migration, leaving the relocated pump intake dysfunctional. The Tetra Tech Memo stated that *“Although the interim toe rock was not designed as a long-term structure, it has been subjected to greater than bankfull flows and it is apparent that it is performing well. It is therefore anticipated that with continual monitoring and maintenance, that the rock toe will continue to function well over the 40-year design life of the M&T pumps.”* This statement does provide some comfort, knowing that, with some maintenance, the rock toe is likely going to continue to function over the 40-year design life of the M&T pumps. It would be helpful if the Tetra Tech Memo can provide some discussion on the following two concerns:
- (1) Once the gravel bar is growing back in the absence of dredging, the flow will be pushed more against the west bank, putting more pressure on the rock toe. An assurance that the rock toe will still perform well will be helpful.
 - (2) A rock toe can fail due to local excessive erosion, and I believe that is what the Tetra Tech assessment had focused on. There may also be concerns that an extremely high flow would cut a channel on the west side of the rock toe and completely abandon the rock tow, leaving it in the center of the river. A discussion of whether such an event is potentially possible will be helpful.
- (b) **The implication of continued channel migration:** Although the rock toe has fixed the river in the current location temporarily, the Sacramento River continues to migrate in the upstream and downstream reaches away from the rock toe. Comparison of the 2012 aerial photograph with the 1999 bank alignments obtained from 1999 aerial photograph (Figure i), for example, indicates eastward migration in area labeled A, westward migration in area labeled B, and southward migration in area labeled D. The vicinity of the current and planned west bank intake locations (area labeled C), however, is relatively straight, largely due to the dredging of the gravel bar and the installation of the rock toe. As the channel migration upstream and downstream of the study reach accumulates over time, we are unsure what will be the local effects on water depth and what time will it take to have these known effects to take place. A discussion about such risks will be helpful.
- (c) Relocating the intake to the west bank requires an extension of the pipelines to cross the entire Sacramento River. A discussion of the feasibility and risks associated with such a river crossing will be helpful.

Reference

Cui, Y., Dusterhoff, S.R., Wooster, J.K., and Downs, P.W. (2011) Practical considerations for modeling sediment transport dynamics in rivers. Stream Restoration in Dynamic Fluvial Systems: Scientific Approaches, Analyses, and Tools, Simon, A., Bennett, S.J., and Castro, J. eds., 503-527, American Geophysical Union, ISBN 978-0-87590-483-2.

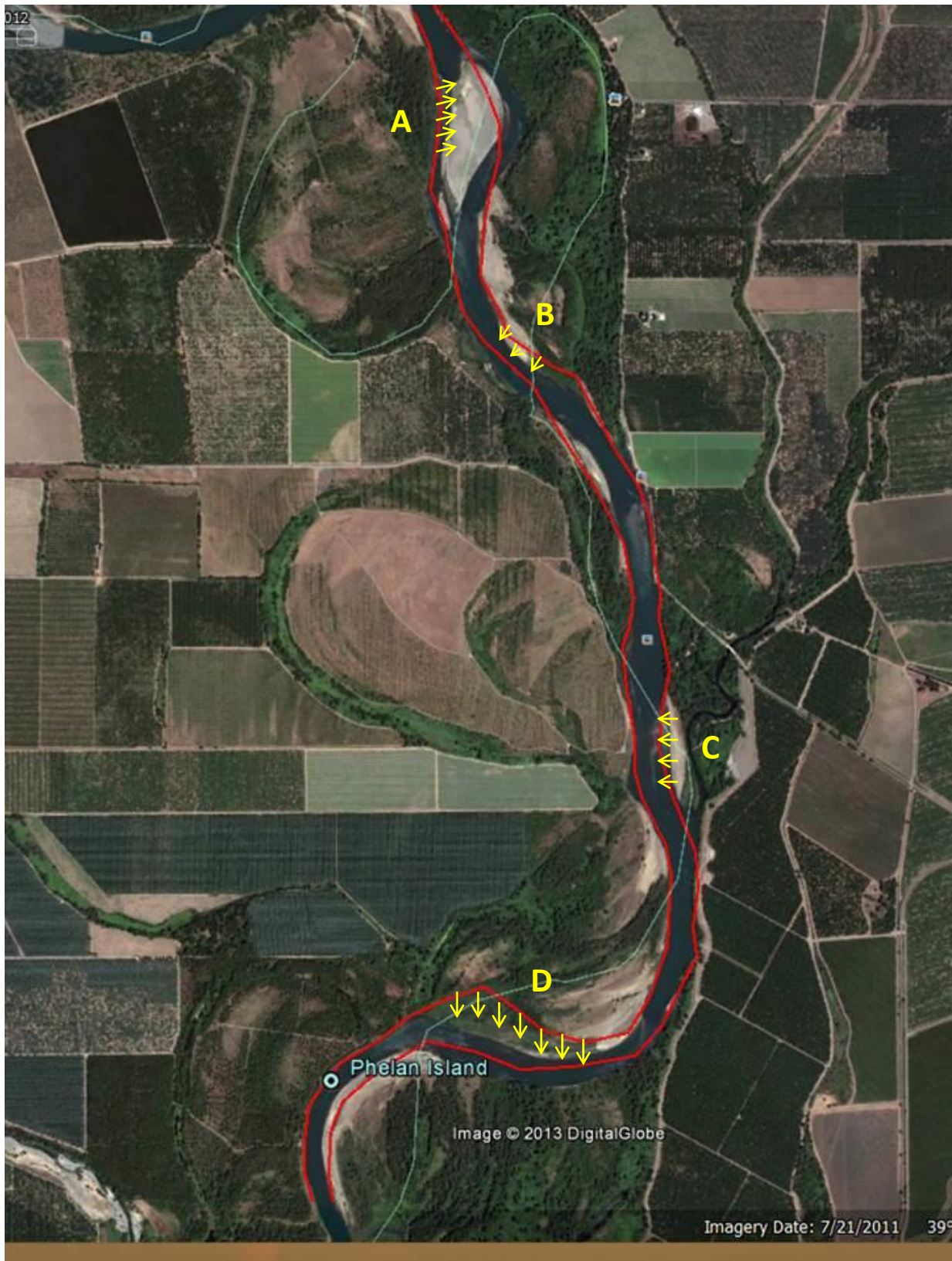


Figure i. 2012 aerial photograph of the study reach, showing the 1999 channel alignment of the two banks (red lines) and the direction of channel migration (yellow arrows) over the 13-year period.