Appendix T – Lookout Slough Tidal Habitat Restoration and Flood Improvement Project – Potential Tidal Water Levels and Tidal Prism Impacts Assessment, Environmental Science Associates, June 2019.

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memorandum

date	June 30, 2019
to	David Urban, Ecosystem Investment Partners
from	Matt Brennan, PE; Daniel Huang
subject	Lookout Slough Tidal Habitat Restoration and Flood Improvement Project – Potential Tidal Water Levels and Tidal Prism Impacts Assessment

The proposed Lookout Slough Tidal Habitat Restoration and Flood Improvement Project (Project) will restore approximately 3,000 acres of freshwater tidal marsh in the Cache Slough Complex of the Sacramento-San Joaquin River Delta (Delta). The Delta is an estuary which is influenced by continuous tidal exchange. Estuarine areas can experience markedly different tides compared to those experienced along the nearby ocean coastline due to the shape of the estuary and its bathymetry. The Delta experiences a mixed, semi-diurnal tidal cycle which corresponds to two unequal tides each day, including: higher-high, high, low, and lower-low. The purpose of this memorandum (memo) is to briefly summarize the effects of the Project on tidal hydraulics in the Delta predicted by hydrodynamic modeling results and to interpret the potential implications of those modeling results for the Environmental Impact Report (EIR) to be prepared for the Project.

At Lookout Slough, the proposed Project would involve breaching and lowering existing levees and excavating a tidal channel network, thereby re-introducing daily tidal flows to the Project site. This restored tidal exchange has a possibility to change tidal hydraulics in the Delta channels outboard of the Project site. These alterations in tidal hydraulics could affect water levels, or the tide range, as well as the tidal prism, the volume of water exchanged with each portion of the Delta during a typical tidal cycle, and salinity levels in the Delta. Changes in these tidal parameters could be a concern to various municipalities, industries, agricultural interests, and resources agencies that depend on the availability of tidal water levels and tidal exchange to maintain existing beneficial uses. The effects of how these tidal parameters specifically change salinity levels in the Delta is discussed and analyzed in a previous memo completed by ESA in April 2019.

As described in more detail below, tidal hydraulic modeling predicts that the effects of the Project on tidal water levels and tidal prism would be less than significant. This finding applies to impact analyses of off-site diversion intakes for Delta agricultural users, as well as on-site and off-site habitat conditions from changes in tidal hydraulics resulting from the Project. Furthermore, the incremental impact of the Project on tidal hydraulics would not be considered cumulatively significant when also considering other tidal marsh projects in the Delta being planned concurrently with the Project.

Overview of Tidal Hydraulics Modeling

The propagation of tidal exchange is commonly evaluated by considering values for several key tidal parameters, such as:

- Mean higher high water (MHHW) – the average elevation of the higher of the two high tides from each day
- Mean lower low water (MLLW) – the average elevation of the lower of the two low tides from each day
- Tide range – the difference in elevation between MHHW and MLLW
- Tidal prism – the volume of water passing through a specified cross-section during the period when water levels change from MHHW to MLLW

The parameters change in space, in response to the ocean tides interacting with the geometry of estuarine channels and embayments. These parameters help determine aquatic and wetland habitat, since the depth and duration of inundation affects what species can and cannot flourish. Tidal hydraulic modeling uses fundamental equations of motion to predict the propagation of tidal exchange and how the tidal exchange may be affected by a proposed project. Tides are a result of gravitational forces exerted by the moon and sun which cause slight bulges in the surface of the ocean.

Resources Management Associates, Inc. (RMA) was tasked with modeling the Project's effects on MHHW, MLLW, their difference (tide range), and tidal prism using their RMA Bay-Delta model. This model simulates the flows in the Bay and Delta that are driven by ocean tides, riverine inputs, and water diversions. The model then uses these flows to predict the distribution of tidal water levels throughout the Delta.

In the following sections, after describing the likely CEQA thresholds of significance, the modeling results are interpreted in terms of CEQA impacts analysis.

CEQA Thresholds of Significance

For CEQA purposes, a threshold of significance is an identifiable quantitative, qualitative or performance level of a particular environmental effect. An effect will normally be determined to be "significant" by the CEQA lead agency when a project results in non-compliance with this threshold. Compliance means the effect normally will be determined to be "less than significant." As the CEQA lead agency, the California Department of Water Resources (DWR) can develop and publish their own thresholds of significance. However, DWR typically uses a slightly re-phrased version of the standard checklist questions included in Appendix G of the CEQA guidelines, by converting the language from Appendix G from interrogative sentences to declarative sentences. As appropriate, DWR may add additional significance criteria that expand upon those specifically identified in the CEQA guidelines. For example, in the hydrology section of the Prospect Island EIR, DWR added an additional significance criterion of "substantial alteration of agricultural water supply and drainage in the vicinity of the Project."

There is no known formal policy, guidance, or regulations regarding thresholds of significance for changes in tide range and tidal prism and the potential effects of changes to these parameters is nuanced. For example, while a reduction of tidal height at MLLW has the possibility of increasing strain on agricultural pumping capacity, an increase in tidal height during MHHW has the possibility to reduce energy costs during high tides by decreasing the amount of head the pump would have to overcome to lift water from the channel onto the site. Therefore, best

professional judgement and consultation with project stakeholders is recommended to determine whether an impact should be considered significant or less-than-significant.

CEQA Impact Analysis

In March 2019, DWR released a Notice of Preparation (NOP) for the Project with a 30-day comment period which ended on April 22, 2019. DWR received a few comment letters requesting analysis of the effects of changes in tidal prism and tidal range resulting from implementation of the Project and their associated effects on factors such as agricultural intakes and drainage. As such, this memo anticipates that the EIR hydrology section will include a discussion regarding how the Project will affect agricultural water users. It is also expected that the EIR's biological resources will provide a discussion regarding changes in tidal prism and tidal range affect biological resources, including existing wetland and riparian habitat.

This memo presumes that for the EIR, DWR will use an analytical approach similar to that used in CEQA analysis for other tidal wetland restoration projects in the Delta, such as Prospect Island and Dutch Slough, and analysis conducted during planning of the Bay-Delta Conservation Plan (BDCP). The Prospect Island EIR analyzed the effects that changes in tidal range would have on agricultural water supply and drainage. The Dutch Slough EIR and the Prospect Island EIR both included analysis of the increased erosion of nearby sloughs and levees due to the increased tidal prisms resulting from the respective tidal wetland restoration projects. The BDCP technical analyses included assessments of the potential erosion in Delta channels from planned wide-scale tidal wetland restoration.

Potential Changes in Agricultural Water Supply and Drainage Due to Alteration in Tidal Range

As a result of the restoration of tidal wetland habitat at the Lookout Slough Project site, there will be a reduction in tidal range with an increase to the heights of low tides and a reduction in the heights of low tides. The modeling predicts there would be a reduction in MHHW of up to 0.2 ft in the immediate vicinity of the Project (i.e., along Shag Slough) and an increase in the levels of MLLW of up to 0.1 ft. These slight changes in tidal height diminish in channels located further away from the Project site. Large changes to the tidal range have the potential to affect agricultural water management.

Agricultural intakes can either operate using gravity or through powered pumps. For powered intake pumps, an increase in the height of the low tide elevation would reduce the amount of head needed to be overcome by the pump and thus has the possibility to reduce energy consumption cost, while a reduction in the elevation of high tides would increase those energy consumption costs. For intakes operated using gravity, an increase in the elevation of low tides has the possibility to increase the duration and flow of water onto agricultural fields while a decrease in high tide elevation has the possibility to conversely decrease the duration and flow of irrigation water onto agricultural fields. During the NOP scoping process, some stakeholders expressed a concern that intakes operated solely using gravity may become ineffective due to the lowering of water surface elevations, and costs to upgrade these intakes with powered pumps could be prohibitively high because many of these intakes are not in close proximity to existing electric utility lines.

Proper drainage of soils in agricultural fields is also necessary to ensure crop productivity is not hindered by excessively wet soils. Sometimes agricultural fields can be drained passively via natural gravity outlet. In

circumstances when a natural gravity outlet is not available, which is a common situation in the Delta, excess water can be collected at the lowest elevation in the drainage system (which can be underground depending on drainage infrastructure) and removed via a pump which lifts the water to the discharge location (e.g., the nearby slough or river). The changes in tidal ranges are not expected to affect drainage pump operations.

The modeling predicts there would be a reduction in MHHW of up to 0.2 ft in the immediate vicinity of the Project (i.e., along Shag Slough); this slight reduction in MHHW levels is not expected to appreciably affect the operations of agricultural intakes in the Delta. Since there would also be a concomitant increase of up to a 0.1 ft increase in the levels of MLLW in the immediate vicinity of the Project (i.e., along Shag Slough), there would be small but offsetting benefits and negative impacts for local agricultural water pumping over the course of a tidal cycle. Furthermore, there would be no effect of changes in tidal range on agricultural drainage operations since they are typically not influenced by changes in tidal height. Thus the effects on agricultural water supply and drainage would be less than significant.

Long-term Impacts on Existing Wetland and Riparian Habitat Types Due to Changes in Tidal Range

The Project would permanently convert existing non-tidal wetland and terrestrial habitat to tidal freshwater wetlands and open tidal water habitat through reintroduction of daily tidal inundation to the Project site. The site currently contains approximately 975 acres of seasonal non-tidal and semi-permanent managed freshwater wetlands which were created to provide improved habitat conditions for wildlife species, particularly waterfowl. Implementation of the Project would result in a mosaic of approximately 3,000 acres of tidal wetland and open water subtidal habitats which are intended to promote benefits to native species, particularly special-status fish species through increased productivity and food resource availability for species such as delta smelt and increased quality and accessibility of rearing habitat for juvenile salmonids. Once restored, the Project site will provide wetlands with higher functional values compared to existing conditions, because the habitat will not only be accessible to terrestrial wildlife such as waterfowl, but also to accessible to native fishes and many tidal marsh adapted species. The overall increase in the extent of total wetland habitat and improvements in functional values of existing on-site wetland features are expected to more than offset the loss of existing freshwater non-tidal wetland functions present within the Project site.

Since the Project will involve tidal wetland restoration of thousands of acres, reintroduction of daily tidal inundation to the Project site will slightly mute tidal range in surrounding Delta channels. The effect of tidal muting resulting from implementation of the Project has the potential to affect nearby off-site habitat such as tidal wetland habitat. Specifically, within areas in close proximity to the Project site, the narrow band of elevations between the currently MHHW and the slightly (up to 0.2 ft) lower MHHW for with-project conditions are expected to experience slightly less frequent daily tidal inundation with the localized tidal muting effects caused by the Project. However, the change in tidal range with the Project in place is expected to be fairly minor, as predicted by RMA's modeling, minimizing the potential for these effects. The overall increase in tidal wetland habitats within the project site, including a net gain of more than 2,000 acres of wetlands within the Project site, are expected to more than offset any minor effects on off-site habitat due to tide muting.

The extent of riparian forests in the vicinity of the Project site is limited because the Project occurs within the Yolo Bypass, in which most woody vegetation is removed to prevented from establishing to ensure adequate flood conveyance capacity. There is limited riparian vegetation (mostly scrubby vegetation) along channels

throughout the area, including areas along the Sacramento River downstream of the Yolo Bypass. Most of this vegetation is on ground surface elevations above MHHW. Although there would be a modest localized reduction in the elevation of the MHHW resulting from the Project, it is expected that the waterside vegetation, via its roots, would still have adequate access to groundwater resources.

Overall, the Project is expected to have beneficial impacts on on-site wetland resources (and no impacts on on-site riparian habitat) and a less-than-significant impact to off-site wetland and riparian resources.

Potential for Alterations in Off-site Channel Dimensions

The cross-sectional dimensions of a channel are, in part, a function of the amount of flow that passes through that channel. Hence, a change in tidal prism, representing the volume of flow through a channel during a typical tidal cycle, may cause a corresponding change in channel dimensions. Since the Project's largest changes are to increase tidal prism, scour that enlarges channels is the most likely response.

ESA previously conducted an analysis of potential changes in channel dimensions that could result from restoration in the Cache Slough complex. This analysis also relied on modeling by RMA, although for slightly different combinations and designs of restored areas. Although the restored areas were configured somewhat differently than RMA's modeling for this Project, the predicted changes to tidal prism were similar or even larger (because a larger amount of restored area was considered). By comparing these changes in tidal prism with geomorphic relationships between tidal prism and channel dimension, ESA previously found that channel dimensions in Shag Slough and lower Cache Slough, the channels closest to this Project, are already sufficiently sized to accommodate the larger tidal prism and are therefore unlikely to scour. These findings are applicable to the current Project, and therefore, the potential for adverse effects from scour is less than significant. In channels where the relative change in tidal prism is smaller, the potential for scour is also less than significant.

In the lower Mokelumne River channels, when the Delta Cross Channel gates are open, the RMA modeling also predicts tidal prism to increases by about 30%. However, these channels' dimensions are probably more influenced by riverine discharge during flood events, not tidal prism, since discharge during an average tidal cycle is only a fraction of discharge during typical wet season runoff. Since the Lookout Slough will not affect these flood flows, the Project will have a less than significant impact on channel size in the lower Mokelumne River.

Although there are areas where the RMA modeling predicts a decrease in tidal prism, the relative decreases are small, typically 5-10%, which are unlikely to cause a significant response in terms of channel cross-sections decreasing in size via deposition.

Cumulative Impacts

CEQA requires an evaluation of a project's contribution to cumulative impacts, which are two or more individual effects that, when considered together, are considerable or increase other environmental impacts. The Project, when combined with other planned tidal wetland restoration projects in the Delta and Suisun Marsh, has the potential to cumulatively alter tidal hydraulics in the Delta. On a regional scale, tidal habitat restoration projects would collectively compress tidal ranges (i.e., dampen the heights of high tides and increase the heights of low tides) in the Delta with a context of other processes such as seasonal variability, high riverine outflows,

alterations in Delta water operations, and sea level rise. However, modeling by RMA indicates that the change in tidal prism and tide range that is attributed to the Project are similar in magnitude and spatial extent.

Localized tidal range impacts of the Project have the potential to affect the capacity of agricultural water supply intakes. RMA modeling predicts a minor reduction in tidal range, mostly at locations in close proximity to the Project site. The effects generally diminish with greater distances away from the Project site. The implementation of other nearby restoration projects is expected to also contribute to localized reduction in tidal range. As discussed previously, the impact to agricultural intakes capacity from lowered high tide levels is at least partially offset from the benefit resulting from an increase in water levels at low tide. Overall, the Project's incremental effect on altering tidal range which could affect operational effectiveness of agricultural intakes would not be considerable and the cumulative impact is less than significant.

The implementation of other restoration projects throughout the Delta may contribute collectively to changes in Delta channel dimensions from alterations in the tidal prism, either from scour or deposition. Most of these changes to the tidal prism from tidal wetland restoration projects will be fairly localized. Since there would be continued compliance with the State Water Resources Control Board's Water Rights Decision 1641 (D-1641), which regulates flow and water quality standards throughout the Delta, hydrodynamic conditions within Delta channels with regional restoration in place would be expected to fall within a range that either occurs under existing conditions or is acceptable within the current regulatory framework. Thereby, the Project's incremental effect on scour and/or deposition in Delta channels would not be considerable and the cumulative impact is less than significant.