Appendix A

Responses to Comments on the Draft Monitoring Special Study

APPENDIX A
RESPONSES TO COMMENTS ON THE DRAFT MONITORING SPECIAL STUDY

On April 28, 2022, the California Department of Water Resources (DWR) and U.S. Bureau of Reclamation (Reclamation) sent for review and comment the draft Monitoring Special Study (MSS) Plan pursuant to the *2018 San Francisco Bay/Sacramento–San Joaquin Delta Estuary Water Quality Control Plan* (2018 Bay–Delta Plan). During the review period, DWR and Reclamation received comments on the draft MSS Plan from the State Water Resources Control Board (SWRCB), South Delta Water Agency (SDWA), and Contra Costa Water District (CCWD). Responses to these comments have been provided in this Appendix A.

Previously, in December 2020, DWR and Reclamation sent for review and comment the draft Comprehensive Operations Plan and Monitoring Special Study (COPMSS), which described plans for the MSS. During the review period for the draft December 2020 COPMSS, some comments received from the SWRCB and CCWD were directly applicable to the draft MSS. Responses to those comments have been included in Section A.3, *Comments on December 2020 Draft Comprehensive Operations Plan and Monitoring Special Study (COPMSS)*, of this Appendix A in the interest of having a complete record of comments on the draft MSS.

A.1. MASTER RESPONSE – LONG-TERM MONITORING PROTOCOLS AND MSS OBJECTIVES

DWR and Reclamation have provided the following Master Response to address the same or similar issues raised in multiple comments on the draft MSS and the December 2020 draft COPMSS.

Multiple commenters inquired about the development of long-term monitoring protocols to measure compliance with performance goals of the Comprehensive Operations plan (COP). Long-term monitoring protocols will be established based on data collection and analysis conducted during the MSS. By better understanding the variability of salinity, flow, and stage conditions in the interior southern Delta, DWR and Reclamation can then identify and assess which, if any, performance goals of the COP could be achieved based on analyses of the MSS.

DWR and Reclamation have identified four technical studies that are in line with the requirements of the MSS. The technical studies, described in the MSS, are designed to characterize salinity, flow, and water levels in the southern Delta. The data and analysis obtained from the MSS will be used to inform the COP of potential project management actions and a Long-term Monitoring and Reporting Plan (LTMRP) that will identify potential solutions to noncompliance with existing salinity standards. The goal of the MSS is to better characterize hydrodynamic and water quality conditions in the southern Delta. Data collection and analysis of the MSS is a prerequisite that will inform the development of a COP and LTMRP.

Finally, some commenters have expressed interest in analysis of potential Project impacts. To this end, DWR and Reclamation have included modeling and monitoring elements in all four proposed technical studies that will result in either data collection, modeling, or analysis of potential project impacts to water levels, flow, and salinity in the southern interior Delta. Intended objectives of the MSS have been described in the introduction section of the Draft MSS Plan (see pp. 1 and 2). One of the MSS objectives is to better understand salinity, flow, and stage conditions in the interior southern Delta, including data collection and/or analysis of the following.

- Flow and salinity levels measured at and downstream of Vernalis
- A range of interior southern Delta export pumping scenarios at C.W. Jones Pumping Plant and H.O. Banks Pumping Plant (Banks)
- Flows during and after temporary agricultural barrier season
- Interior southern Delta processes (i.e., land use patterns, measurement of agricultural and municipal discharge, and specific conductance [EC])

Although potential impacts of the Projects is one element that will be assessed, it is not the only one. The MSS is intended to develop a better understanding of all variables affecting salinity conditions in the interior southern Delta, including, but not limited to Project exports, local land use practices, municipal practices, and seasonal, tidal, and water year-type variabilities.

Individual comments, along with individual responses to these comments, are presented below in Section A.2, *Individual Responses*.

A.2. INDIVIDUAL RESPONSES

The Response to Comments portion of this section presents the comment letters received on the Draft MSS Plan. Each letter, as well as each individual comment within the letter, has been given a number for cross-referencing. Responses are sequenced to reflect the order of comments within each letter.

Table A-1 lists all parties that submitted comments on the Draft MSS Plan.

Table A-1
List of Commenters

Letter	Commenter	Date of Comment(s)
SWRCB	State Water Resources Control Board	May 28, 2022
CCWD	Contra Costa Water District	June 14, 2022
SDWA	South Delta Water Agency	June 25, 2022

A.2.1 SWRCB LETTER

Hello Ibraheem-

Thank you for sharing the draft study plans for the MSS. I have appreciated the extended time for review and comments. It is evident that a lot of effort went into pulling all this information together.

One important component not yet included in the Monitoring Special Study (MSS) is development of the long-term monitoring protocols to measure compliance with the performance goals of the Comprehensive Operations plan (COP). As the draft MSS study plan precedes the performance goals of the COP, this component will need to be addressed. One option would be to either include elements in the draft COP or as an addendum to the MSS study plan that will be tailored to specific performance goals identified in the COP. I am also copying Grace and Bill as the leads on the updates to the draft COP. 1

The below list is a summary of staff-level comments from the Division of Water Rights, and the Office of the Delta Watermaster. Staff had limited time for review the draft study plans, and there may be additional comments in the future. Please do not hesitate to reach out with any questions related to these review notes.

Best regards,

Jelena

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#1 High-Speed Salinity Transect Mapping

The four proposed transect routes are appropriately selected, with a well-reasoned purpose. The study design will support assessment of salinity distribution throughout the south Delta channels, as well as develop information for future reach-based compliance.

1. **Fabian Perimeter transects should include both ebb and flood flows.** Ebb flows are indeed the best time for identifying contribution from sloughs and tributaries as water from sloughs and tributaries is drawn into the confluence. However, the study should also help better understand the general flow and other factors that will affect salinity. Sampling during flood flows would provide important information about source/sink dynamics and fate of salinity plumes (if any). A more complete picture of processes and dynamics would help understand not only whether salinity plugs reach the primary waterway, but also what happens and where they move once in the primary waterway. 2
2. Salinity moves both upstream and downstream, and for assessing the influence of local discharges, it is important to understand dynamics during both flood and ebb flows. On occasion, stations in the Old River experience elevated salinity brought by flood tide from a downstream point. Drains or pipes that contribute drainage are less likely to be affected by the tidal cycle (discharge pattern driven by the activity that generates drainage), and their salinity signal should be detectable regardless of the cycle. While easier to detect EC signals during low tide, the study should also 3

investigate the fate of those EC signals, in particular - how far downstream and how far upstream the salinity and the sphere of influence extends (even if an EC signal might be muted at high tide). 3 con't

3. **Route 3 should be done in its entirety and should not be modified to target only sloughs and tributaries.** Multiple studies in the southern Delta have demonstrated that upper reaches of sloughs and tributaries often have EC well above 1.0 dS/cm. Sampling the entirety of Route 3 will help to better understand the extent to which salinity from sloughs and tributaries reaches the primary waterway and compliance points, and where it moves under different conditions. The value from Route 3 would be greatly diminished or entirely lost if modified to only include Paradise Cut and Sugar Cut. Sampling in the primary waterway should go as far downstream as possible with floating vegetation, at least down to TWA. 4

4. **Feedback should be actively solicited and target elements that project leads could receive input on.** Effectively soliciting this feedback will require planning and sharing preliminary findings/results to actively solicit and elicit meaningful discussion. It was very encouraging to hear at the May 17 meeting that initial outcomes would be shared. 5

#2 MSS Salinity Point Source and Ion Sampling

Background information included as a part of this study plan is one of the more comprehensive summaries of findings and studies related to southern Delta salinity. The spatial scope in Figure 2 seems appropriate and relevant. However, detailed descriptions of the six study tasks suggest emphasis on the backwater channels which have been shown to have less exchange with main channels. The study plan needs to be modified to achieve the objective of better understanding of spatial and temporal salinity source contributions, transport, and the dispersal into adjacent channels upstream and downstream of the OLD compliance station. The study focus should be on the primary waterways, especially the ones with most monitoring gaps or with conflicting monitoring or modeling results. 6

5. **Drone imagery survey areas should include Doughty Cut and the secondary meander channel.** Doughty Cut conveys the majority of Old River flow to Grant Line Canal;] DGL observation station is located in Doughty Cut. The secondary meander channel near Sugar Cut and upstream of OLD station was described in the 2012 transect study (Montoya 2012). 7

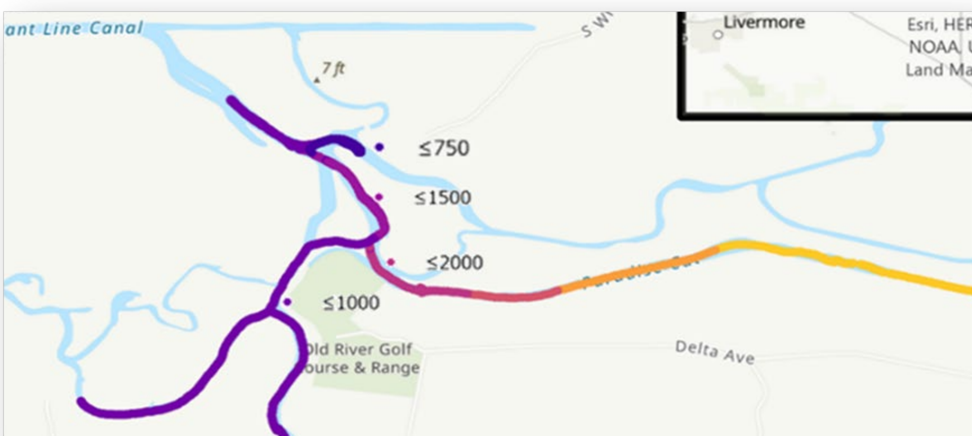
6. **Continuous EC Monitoring should include Doughty Cut and the secondary meander channel.** These locations would be filling a more critical data gap than a multitude of additional continuous EC monitoring stations in upper reaches of sloughs and tributaries or placed at wastewater treatment plant outfalls. DWR staff working on this study task should further discus placement of proposed continuous EC monitoring stations with State Water Board staff and stakeholders. 8

   - DGL monitoring station is missing from figures, tables, and text. Given that DGL is a part of the critical region, it should be acknowledged. 9
   - At a minimum, flow measurement at DGL should be added. Additional monitoring in the Doughty Cut area would be critical to better characterize circulation. 10 con't The 2016 ICF report (Brown 2016) and more recent analyses suggest that most of the flood-tide flows entering Sugar Cut and Paradise Cut likely are coming from Doughty Cut and Grant Line Canal. The 2016 ICF report further hypothesized that during ebb tide flows from Sugar Cut and Paradise Cut are more likely to flow downstream towards OLD (with the net flow). However, this is not known and may not hold under some conditions.

- If the secondary meander channel is not navigable, consider alternative means of characterizing the role of this feature on the flow and salinity exchange. 11
- Background information on the study plan states that municipal wastewater facilities are some of the largest salinity point sources. However, wastewater effluent is typically a small fraction of 12
overall flow; even accounting for some variation, the incremental EC change due to wastewater discharges is small (Brown 2016). Flow and EC monitoring of effluent from regulated point sources (all NPDES permit holders) is available through Electronic Self-Monitoring Reports (eSMR). This data source should be incorporated in the study. If eSMR data can replace field sampling and/or wastewater facilities are confirmed to be a small source, resources could be directed elsewhere.

7. **Ion Sampling should include Doughty Cut (conveys the majority of Old River flow to Grant Line**
Canal). Redirecting some of the resources to the primary waterways (Old River and Doughty Cut 13
towards Grant Line Canal) would give us more actionable information. For example, Figure 19 shows <u>eight</u> ion sites (added ions only, or WQ EC + ions) proposed in sloughs and tributaries for the Pescadero Tract Circulation. DWR staff working on this study task should further discus proposed ion sampling locations with State Water Board staff and stakeholders.
   - Ion sampling should, at a minimum, be added to DGL station.
   - The study plan should include a plan for addressing areas that may be too shallow or have too
much aquatic vegetation. 14

8. **Paradise Cut Salinity Tidal Dispersion should capture the full tidal variation**, not focus on capturing
only the low-low tides when the highest volume of water is tidally pumped from Paradise Cut into 15
Old River. One of the most important questions should be how much of the salt from the upper reach of Paradise Cut makes it downstream to the PDC station, to Old River, and what the fate is of the salt in the primary waterway.
   - Shown in Figure 27 of the study plan, the timing of Run 1 is possibly a bit early to detect the 16
maximum Paradise Cut discharge. However, the most notable observation is that higher EC in 17
the Doughty Cut during ebb flow suggests discharge from Paradise Cut mostly flows up towards Grant Line Canal. The Old River EC is below 1,000.



9. **Rhodamine Dye Tracer Monitoring should encompass downstream locations of sloughs and**
tributaries, rather than upper reaches. For instance, the tracer at PDC might give us more 18

actionable information than tracer at PDUP as it is critical to understand the fate of water from tributaries once it reaches the primary waterways. The same for SGA rather than DAR or SUR.

- The study should help better understand where water goes after it reaches the primary waterway. If there is a known monitoring gap at the confluence of side channels with Old River, as wells as conflicting model results for both flow and salinity in this region, then those should be the highest priority areas for additional study. Better characterizing net transport and dispersal rates in upper reaches of sloughs and tributaries will still leave a gap in understanding null zones near the confluence and in the primary waterways. 19
- Additionally, consider a dye tracer study in the 5-point confluence region, as a place where mixing happens as the tides traverse back and forth but where only sparse monitoring data have been collected. 20

Pescadero Tract Circulation Investigations should include DGL. Eight ion sites are proposed, although it is not yet clear if samples will have unique ion fingerprints to distinguish from each other. Denton 2015 hypothesized that local discharges of agricultural drainage from lands that had been irrigated with Delta water with higher salinities make for a narrow range of variation. However, paired with robust ion sampling in the primary waterways (OLD, TWA, ORM, ODM, ORX, GLE, GLC), it might be possible to infer the fate of these sources once in the downstream reaches. 21

- Adding ion sampling to DGL will be an important piece for this study as well. 22
- To the extent that sampling can characterize flows and EC of groundwater and agricultural runoff, redirecting some of the resources for this effort would be worthwhile. 23

10. **Quarterly Stakeholder and regular Technical Workgroup meetings will need to be specific in seeking input.** These meetings will require planning and sharing preliminary findings/results to actively solicit and elicit meaningful discussion. 24

#3 SCHISM 3D Hydrodynamic and Water Quality Modeling

SCHISM is envisioned to play a role as a monitoring, compliance, and real-time operational tool. The study plan is designed to help calibrate SCHISM to the southern Delta. Once calibrated and validated for use in the southern Delta, there could be further applications of the model. 25

11. **Efforts most likely to answer critical questions should be prioritized**. In the interim, until SCHISM becomes skilled for use in the southern Delta, other approaches should be used to assess management actions, and salinity and water level outcomes of various operations scenarios that could improve water quality. 26
    - Even if coarse, DSM2 is appropriate for the tight channels and avoids some issues that arise in reaches with bed variation on the same scale as the channel depth. 27
    - Accounting for aquatic vegetation could improve modeling ability to the extent that it affects flow, circulation and, thus, EC. However, given the complex configuration of channels, tidal influence, operations, and a variety of sources, the incremental improvement is uncertain. Identify the extent of low or null flow conditions and any associated concentration of local salt discharges 28
    - As a validation step, model representation of depletions and rebalancing the sources and sinks should be cross-checked with data analysis based on observations from available CDEC data (auto-sampling stations). 29

12. **Clifton Court Forebay radial gates operations should be included** in the 2021 simulation and analysis of export and inflow effects, rather than just the export at Banks. The slated modeling of the calendar year 2020 could also be an informative analysis. 30

13. The draft MSS indicates that modeling pointed to a potential need to recalibrate existing flow stations within the southern Delta. Has recalibration already been completed? **A summary of what the prior calibration was like compared to re-calibrated instruments should be provided.** 31

#4 Water Quality Data Assimilation Modeling

This effort should result in a more realistic model of salinity. As data on local sources become available, they will be integrated into the modeling, allowing better prediction of water quality.

1. **Questions should be more broadly defined.** Focus seems to be on salinity sources *per se*, but overlook other factors that affect salinity accumulation, such as circulation and null zones. While there is a need to understand direct sources, equally important are tidal pumping and flow dynamics. For instance, we need to better understand how and why null zones move and what mechanisms affect the location. Both sources and circulation contribute to water quality. EC source inference alone will not give us information about events that lead to freshening, that is, what contributes to lowering the EC once it has been elevated. Better understanding what contributes to increased EC, and what contributes to improvements in EC are two important and interlinked aspects of managing salinity. 32

2. **Initial findings in Figure 4 suggest either an error** in estimating upper limit of EC sources, or a plotting artefact. Overall, the ensemble results are also questionable given one or both errors and should be reviewed carefully. 33

    - **Observations at the CDEC station ORI should be evaluated** for use as a boundary condition station instead of modeling everything to the north of ORI. 34

SWRCB-1 See A.1, *Master Response – Long-Term Monitoring Protocols and MSS Objectives.*

SWRCB-2 The Fabian Tract Perimeter transect will be reconfigured to be performed more frequently and with the goal of capturing both tides. See also SDWA-5 comment in the responses to Section A.2.3.

SWRCB-3 This comment is useful and has been incorporated into route planning for transects in Lower Old River and Grant Line Canal. Future transects will be planned to incorporate flood tides in Route 1.

SWRCB-4 In the workplan, the route will be adapted to show that OLD is the downstream target for this transect. In previous years, navigation in this section of Old River has been restricted by floating vegetation. Doughty Cut and Old River upstream and downstream of the confluence will always be included in this transect, unless physically impossible.

SWRCB-5 DWR and Reclamation are currently working on the technical aspects associated with the work flow of data processing and map creation for transect data. Once a data-processing work flow is established, maps from previous transects will be made available, and future monthly transect data will be available much sooner after each transect is completed. In addition, a technical workshop is being planned to discuss and solicit feedback on highspeed transect results.

SWRCB-6 Past studies and associated reports (Montoya 2007, *Sources of Salinity in South Sacramento-San Joaquin Delta*; Montoya 2012, *South Delta Salinity Transect Study*; Brown [ICF] 2016, *Evaluation of Salinity Patterns and Effects of Tidal Flows and Temporary Barriers in South Delta Channels*) have suggested that these backwater channels are periodically contributing to higher salinity in Old River. We view these side channels as potential sources of higher salinity to Old River noncompliance under certain conditions, but recognize this is not the only potential contributor to noncompliance at the OLD compliance station. We have also expanded the monitoring station network primarily in lower Old River both upstream and downstream of the OLD compliance station (See MSS Plan Attachment 2, *Point Source and Ion Sampling Work Plan*, Figure 22 and Table 3).

SWRCB-7 The secondary meander channel was not navigated, nor included as part of Montoya's transects, likely due to the same reason it was not included in our planned transects. This channel is very shallow and full of both submerged and floating aquatic vegetation, which makes it difficult or impossible to navigate during most of the season. The meander channel can be included as a significant location of interest (due to Montoya's findings that this channel may dilute the salinity prior to reaching OLD, p. 24 of the report) in transect-profile graph analysis to determine effects on salinity under varied seasons, tides, and water-operation conditions.

SWRCB-8 Continuous stations currently exist at DGL and nearby, at GLE. In addition, two temporary stations have been added as part of the MSS, further downstream near the confluence of Paradise Cut both upstream and downstream (see Figure 22 and Table 3) sites: Paradise Cut and Old River Confluence Upstream (POCFLU) and Paradise Cut and Old River Confluence Downstream (POCFLD). Station SOR16 is downstream of the meander channel and upstream of OLD compliance station. Additionally, high-speed transects are performed within the Five-Points Confluence region (i.e., Doughty Cut, Grant Line, Old River Paradise Cut, and Sugar Cut intersection). As an alternative way to monitoring the meandering channel, DWR and Reclamation are proposing to note the location of this channel along the transect profiles and perform a few transects that navigate at least partially up these channels throughout the field study years.

SWRCB-9 DGL will be added to the study's analysis. Text edits have amended Table 4, Figure 22, and Figure 26 to include the DGL station. In the past, DWR's Water Quality Evaluation Section operated a continuous multiparameter Yellow Springs Instruments (YSI) sonde at this spot, but the location was not ideal as it is in a shallow backwater within a heavily vegetated part of Doughty Cut. The YSI sonde, which collected dissolved oxygen (DO), chlorophyll, and turbidity data, in addition to EC, was discontinued on August 8, 2018.

SWRCB-10 Although monitoring flow in Doughty Cut is important to characterizing circulation in the region, the existing location of DGL is often obstructed by vegetation, and data collection at DGL has proven to be difficult by DWR personnel in the past. To capture reliable flow data in Doughty Cut, a new station in a location other than DGL would likely have to be established. Note that permanent stations are difficult to install and potentially could take up to 2 years to establish due to permitting requirements to place instream attachments in structures such as piles. One alternative would be to initially verify the 2016 ICF hypothesis by placing a temporary station (and calibrating it for flow) within Doughty Cut during the 2023 Temporary Barrier season or another future season. This alternative will be considered and planned for during the course of the MSS.

SWRCB-11 See feedback on comments SWRCB-8 and SWRCB-9.

SWRCB-12 We will be including the eSMR data in the report as a data resource. These data are being used in the Water Quality Data Assimilation process, but these data are not always continuous, and supplemental continuous data is helpful in determining higher-resolution contributions to the channels. Wastewater inputs, although considered low contributions, cannot be ignored.

SWRCB-13 Sampling sites are currently stationed at GLE, ORX, PDC, SGA, and TWA. Considering the proximity of DGL to GLE, it is not clear how this will add to the spatial relationships in ion ratios and in answering questions related to trying to differentiate between water sources.

SWRCB-14 There are alternatives, such as using other watercraft, such as kayaks and/or remote boats, but there are limitations in staff time and staff resources for performing this additional data collection. Ultimately, we have to weigh the cost-benefit analysis of these shallow-water ventures in how much more meaningful information we will gain.

SWRCB-15 This can be performed under different tides, however, continuous specific conductance station data at PDC, and now additional station data at the Five-Points Confluence sites (see Figure 22 and Table 3), should also provide full tidal variation data on salt fate. Observed EC data at PDC has been analyzed to show that higher-salinity water does not typically move out of Paradise Cut downstream during all tidal conditions. The intention of this idea is to look at windows when tides are moving higher salinity out and understanding where that salinity goes—upstream to Grant Line or downstream into lower Old River and (Sugar Cut).

SWRCB-16 Figure 27 is intended to provide an example (i.e., snapshot) of the type of geographic information system (GIS) analysis that will be performed as part of the Paradise Cut Salinity Tidal Dispersion study task. This transect is planned to be conducted over multiple different tidal periods within a day (i.e., repeat transects of same channels on flood and ebb tide scenarios).

SWRCB-17 This has been observed during high-speed mapping transects, but this may not be the case under all seasons, water years, and water-operation conditions.

SWRCB-18 Alternative dye-tracer study areas within the south Delta have not been ruled out and will be considered during the course of the MSS. The initial objective of using the dye-tracer studies has been to inform low flow channel areas where flow monitoring is much more difficult and/or nonexistent and to improve modeling outputs.

SWRCB-19 This is where the SCHISM three-dimensional (3D) model and integration of new data-collections efforts will help characterize these transport and dispersal rates. In addition, two additional continuous flow monitoring and co-located EC monitoring stations have been installed in Lower Old River below the OLD station to both improve model predictions and develop salinity flux estimates. Note that the exact locations of these stations have not been included in this work plan, although a description of convergent flows at Old River is included in Figure 4 of MSS Plan Attachment 3: *SCHISM 3D Hydrodynamic and Water Quality Modeling Work Plan*.

SWRCB-20 Please see the response to comment SWRCB-18.

SWRCB-21 Please see the response to comment SWRCB-10.

SWRCB-22 Please see the response to comment SWRCB-15.

SWRCB-23 Groundwater investigations have not been entirely ruled out, although DWR and Reclamation have prioritized resources to focus on characterizing surface-water flow and EC. Due to limitations associated with access to groundwater wells and data, groundwater investigations would require significant participation from participating organizations to acquire groundwater data. Please also see the response to comment SDWA-18 in Section A.2.3, *SDWA Letter*.

SWRCB-24 In addition to quarterly participating organization Coordination Meetings that provide project updates and milestones, DWR and Reclamation began conducting technical workgroup meetings designed to share preliminary findings and analysis of the MSS technical studies and solicit discussion and feedback. Participating organization meetings are planned to continue for the duration of the MSS and will be planned in advance to share preliminary findings and solicit discussion.

SWRCB-25 This is a fundamental point, although no action would be taken. Bay–Delta SCHISM is not a new model as far as the larger Delta system is concerned, and it is an infrastructure-level investment. Since 2016, the DWR has used it to study restoration projects in Franks Tract and elsewhere, impacts of the Emergency Drought Barrier and Suisun Marsh, sea-level rise threats under DCP, and conveyance in the Clifton Court Forebay (CCFB). One of the goals of using SCHISM in the MSS is to connect operational and planning models used in the south Delta and the rest of the Delta.

SWRCB-26 The current priorities are focused on the development of assumptions, such as improved characterization of null zones and circulation and a first-cut estimate of sources. More information will be included about how model preparation and fundamental data analysis are coupled and how reporting can be completed on this front. Please see also response to comment SWRCB-30, below.

SWRCB-27 The tradeoffs leading to model choice are discussed in the *Roles of SCHISM and DSM2* section of the work plan, including the reasons for choosing the two models. As evaluation metrics roll in, we will compare the models and discuss adequacy for various tasks. This same section of the work plan affirms the point made here about basic suitability.

SWRCB-28 Although not a primary focus, aquatic vegetation will be incorporated into the model in areas that have been shown to affect flow and circulation in the area. Text has been included in the *Vegetation* section of the work plan to read: "The prioritization of localized work on vegetation will be coordinated with participating organizations. The emphasis in the first year will be on developing and disseminating a first-cut set of assumptions for sources and fluxes." Elaborate work on vegetation is not yet scheduled, based on our current objectives, although it is locally important in some parts of the south Delta.

SWRCB-29 Agreed. There are two steps to this. First, we are developing our initial (2022) assumption packages based on numerous sources of data, including continuous stations. This package is described in the *SCHISM* section of the MSS Plan, but is equally applicable to either model. It will be released in early fall. For the inferred sources (i.e., data assimilation), we have added a section describing metrics to be used to corroborate the effort. This is included in the revised study plan and some of the items are listed in the response to comment CCWD-15 in Section A.2.2, *CCWD Letter*.

SWRCB-30 Clifton Court Forebay radial gates are included in all modeling. The revised gate rating documented in the *2016 Delta Modeling Section Annual Report*, is used in both DSM2 and SCHISM for all modeling. Thus far, gate scheduling is either historical or derived based on Banks pumping using the "priority" system (described briefly in the 2016 report) negotiated by participating organizations in the south Delta. The priority system does not account for the spring neap cycle, nor circulation. Although reevaluating the priority system might be of some mutual benefit, the effects on salinity compliance are likely not very great.

SWRCB-31 Verification of flow measurements will begin in summer of 2022 at stations upstream of the temporary barriers to determine if recalibration will be required. Due to constraints associated with timing measurements with tides and staffing shortages, flow measurements will continue through 2023. Once complete, a summary of work completed will be provided, and differences in calibration will be noted.

SWRCB-32 The bulk of the modeling preparation work in 2022 is on first-cut assumptions regarding flow dynamics. This is a prerequisite to source inference, although often the errors are informative when model results are compared to field fluxes. This work on source volume fluxes and null zones is described in the *SCHISM* section of the MSS Plan, but the activities are fundamental to all the modeling. A few paragraphs have been added in the background section (Section 2 of MSS Plan Attachment 3: *SCHISM 3D Hydrodynamic and Water Quality Modeling Work Plan*) to emphasize the important impact of hydrodynamic processes on the modeled EC, particularly on null zones and Pescadero circulation. Visualization and synthesis of tidal dynamics and circulation are aided by the model. These are not unimportant, but they are not the greatest limiters to accuracy.

SWRCB-33 The figure has been updated to reflect our best understanding of the upper limit of EC load taken from Montoya (2007, 2012) observations.

SWRCB-34 Modeling the full system allows us to model the interaction of State Water Project (SWP), Central Valley Project (CVP), Old and Middle River, and general water management. With respect to ORI, this site is not independent of internals of operations at the CCFB gate. This is not an issue when performing hindcasts, but when evaluated policy options reoperate the CCFB gate or pumps, historical ORI conditions would have to be significantly altered. This would require work more cumbersome than using models that are already fully developed. Additionally, having a very small domain can cause problems when the tides (which are very long, hundreds of kilometers), which can get truncated and reflected, are modeled.

A.2.2 CCWD LETTER

Major comment #1: the MSS is disproportionally focused on the search for salinity sources and lack 1
studies for potential solutions to non-compliance. Either new studies should be included or the existing
studies should be broadened to study potential management actions under the projects' control to
improve compliance.

Major comment #2: CCWD is in Delta so CCWD's diversion shall not be referred to as "export". Please 2
correct all mentioning of CCWD diversion in the MSS and attachments.

Specific comments as follows:

- In the draft MSS Section 5, Tasks:
  Reviewing existing data and reports is an individual task, not a component of another task. 3
  To that end, the review should be a full study itself instead of just the background in Appendix 2.
  In addition, the review should include potential solutions to non-compliance from studying past
  examples of successful compliance. The current review is too focused on salinity sources and 4
  does not provide clear directions for future endeavors with regards to the search for solutions.
- In the draft MSS, page 11, Meeting Goal #2:
  The MSS does not explain well how the salinity monitoring could help us identify null and low
  flow conditions. Inference from modeling is an indirect estimate of null/low flow. Instead, direct
  monitoring of flow should be considered for this goal. This is mentioned briefly under the
  SCHISM paragraph, that "temporary flow stations are planned to be installed….". Flow stations 5
  monitoring should be elaborated on and potentially as a study itself, for meeting goal #2. Flow
  monitoring could be coupled with salinity monitoring for estimating the advective salt fluxes as
  well, which can then be compared with estimated dispersion to find out how the dominant
  process of transport may change with time/space, ultimately improving MSS as a whole.
- In the design of EC transect and point source/ion sampling, in addition to tidal considerations,
  Vernalis conditions and project operations (e.g., export conditions, barriers status, etc.) should
  also be considered as factors. The additional monitoring under different Vernalis flow/EC and
  projects operations is important in studying the impacts of the projects and how the projects 6
  could improve compliance with measures within the projects' control. Sampling campaign
  should be design to search for not only potential sources of salinity, but also potential solutions
  by the projects to improve compliance.
- Attachment 4 and figure 3 of Attachment 3, regarding data assimilation and the feedback loop
  between it and SCHISM: Attachment 4 provide far too few details of the coupling of data
  assimilation with DSM2-GTM. A lot more details were discussed and provided in the technical 7
  meetings and stakeholder meetings regarding the limitation of this study, which should be
  explicitly recognized and documented in the MSS and/or attachments. Following that, I
  previously provided comments on the uncertainty and equifinality of inferred sources during the
  stakeholder meeting. This comment should be addressed before any use or interpretation of the
  inferred sources (e.g., applying that to SCHISM as inputs). 8
- A follow-up comment on DSM2 and SCHISM: The models are potential good tools for the search
  of potential management actions to improve compliance. Modeling study on such management
  actions should be included. For such modeling studies, more emphasis is on comparison and 9
  relative effects among actions/no actions, and less is on the value of the modeled EC fields per

se. Thus, these modeling studies could be done in parallel with the search for salinity sources, and could be integrated at a later phase of the MSS. 9 con't

- Technical comments on data assimilation as follows; I will be glad to have more discussions on these technical comments if needed:
    - The ensemble soother is mentioned in section 3.2 in attachment 4. Was the smoother applied in the study? For the purpose of inferring how local sources could potentially explain the difference between DSM2 modeled EC and the observed EC, I don't think future observation should be used. 10
    - Section 3.3 is too concise and missing important details on the implementation of data assimilation. To that end, currently it appears that the study is inappropriate. Specific as follows: 11
        - EC sources is mentioned as part of the state variables. Because there is no direct observation of EC sources (only EC filed is observed), the section is missing detailed explanation on the observation model connecting observed EC field to the unknown state of EC source. Without the observation model, EC source should not be included as state variables. 12
        - Similar to EC field, because EC source is a state variable without direct observation and prior knowledge, it should be treated as a flux flied (same as EC field, except it's salt flux instead of salinity) and inferred together with the EC field, instead of narrowly focused on pre-determined, unjustified time/space. 13
        - Priori knowledge and indirect observations could potentially narrow the time/space of the flux field, yielding a "prior distribution" of the source flux field. If so, all the details should be provided in attachment 4. 14
        - Following the comment of EC source as flux field, because of the availability of DSM2, the inferred flux field should be introduced back into DSM2 after each assimilation step, and let DSM2 simulate the fate and transport given inferred fluxes. Without this step, the data assimilation study is overestimating the accuracy of DSM2 with PDAF sources by disconnecting the state model with one of the state variables. 15

Letter CCWD Response | **Contra Costa Water District**
Ching-Fu Chang
June 14, 2022

CCWD-1 See Master Response A.1, *Long-Term Monitoring Protocols and MSS Objectives*.

CCWD-2 Use of the term "export" has been removed when referring to CCWD's diversion.

CCWD-3 The past data and report review was focused on providing supporting evidence for the decisions made in the study design and areas of primary focus. This review does not end at providing background, but will be used in final reporting and analysis.

CCWD-4 The acquisition of reports and other supporting documents that provide evidence for solutions to noncompliance is a great suggestion. DWR and Reclamation are interested in such examples and will aim to research and incorporate such information into final reporting and analysis.

CCWD-5 All three approaches (i.e., comparison to salinity, additional flow monitoring and comparison to modeling) have been contemplated. Improvements in existing flow monitoring and installation of temporary flow stations are tasks planned in the MSS. Additional text has been included in the draft MSS Plan to elaborate on flow monitoring activities planned for the MSS. As the MSS develops, additional memoranda will be released that describe flow monitoring activities designed to meet Goal # 2, identifying low- and null-flow conditions. The supplementary benefit of looking at salinity to bracket null zones will also be described. There are many conditions where the sign of net flow is ambiguous, based on flow data (because it is a tougher measurement), and yet salinity at downstream and upstream stations indicate that water is sourced from two different directions. Memoranda will be presented annually to keep participating organizations informed about fundamental data analysis (including nulls zones). Detailed analyses are undertaken as part of model preparation, and these also will synthesize the purely observational data collected during the project.

CCWD-6 Current monitoring efforts are accounting for Vernalis inflow and EC conditions. Real-time conditions are checked often to determine when we should go out to best align with this type of variability throughout each sampling year. Project export conditions and status of temporary agricultural barriers are factors that can be accounted for when analyzing the post-processed transect data and be included in final reporting and analysis.

CCWD-7 A few new paragraphs in the method and result sections along with Figure 2 were added to better explain the PDAF approach and how it is coupled with DSM2-*General Transport Mode (GTM*). Limitations of the method were expanded in the *Uncertainties and Caveats* section of the MSS Plan.

CCWD-8 The question about uniqueness is important and will be addressed. A microcosm study of equifinality will be provided by studying source terms. In more technical terms, we will describe the null space of the Green's functions responses to the sources to find combinations of sources that are hard to describe.

At the same time, however, the priority will be accomplishing the Analysis of Export and Inflow Effects on Salinity study outlined in MSS Plan Attachment 3: *SCHISM 3D Hydrodynamic and Water Quality Modeling Work Plan.* The most important compliance locations and their neighbors are well monitored under the MSS. In many cases, combinations of sources that are subject to equifinality doubts will also not cause inaccuracy in this bottom-line application concerning project effects. We have attempted to be very circumspect about the fact that some sources will not be distinguishable. This will also vary by reach. For example, the dilution capacity of Grant Line Canal is much greater than that of Old River/Paradise, so a high concentration source term there may mix, remain undetected, and not cause conspicuous compliance issues, whereas the same volume and concentration would register on Old River.

CCWD-9 A significant modeling study (see the section *Analysis of Export and Inflow Effects* in MSS Plan Attachment 3: *SCHISM 3D Hydrodynamic and Water Quality Modeling Work Plan*) has been proposed to describe the effects of Vernalis inflow, Vernalis water quality, Project exports, and CCFB radial gates. To perform scenario tests on the effects of potential management actions on EC, the ability to model EC accurately is a prerequisite. This step requires the assimilated (or observed, if available) EC sources into the system. Without this step, a proper hindcast may not be able to be performed to accurately assess management actions.

CCWD-10 Yes, the smoother was applied to this study, but only with a time lag of 2 days. Our intention is to extend this to about 7 days. Based on how information travels, future observations are theoretically useful for inferring a source (i.e., what enters today only arrives at a station later). This principle of tracing back what arrives at the sensor now is embedded in other inverse methods such as adjoint data assimilation or Green's functions approaches.

CCWD-11 More details have been added in Section 3.3 of MSS Plan Attachment 4: *Water Quality Data Assimilation Work Plan*.

CCWD-12 The sources are connected through the transport equations and DSM2. EC sources are not predicted by DSM2-GTM, but rather by a structural time-series model coupled to GTM (sometimes called a *joint filter*), as depicted in Figure 3 of MSS Plan Attachment 4: *Water Quality Data Assimilation Work Plan*. The Kalman Filter and its variants are by their nature unobserved state methods, routinely used in situations where a missing boundary condition needs to be inferred based on a field monitoring array in the interior. They use physical relationships (embodied in DSM2-GTM transport) to map the source to the observation.

CCWD-13 Inferring a source that is directly observed if it makes a strong imprint in the observations can be accomplished, although it is technically challenging. We will clarify in the study the difficulty of distinguishing between sources with different concentrations and flow volumes but the same mass flux, for instance 1,200 microsiemens per centimeter (uS/cm) at 10 cubic feet per second (cfs) and a source of 2,400 uS/cm at 5 cfs.

CCWD-14 This point has been noted, although prior knowledge is limited at this time.

CCWD-15 Inferred sources are folded into the model at every step of the Kalman cycle (currently 1 hour), so that the next hour's fluxes are inferred with respect to an EC field that is "up to date," There is no iteration. The question of overestimating accuracy is broader and a genuine concern because even a filter that provides little insight will nudge the data toward observations. We have added a section summarizing metrics and methods we have proposed in the study plan and at meetings that will characterize error in a nuanced way or corroborate aspects of the model using outside data. These include prediction without assimilation, comparison with high-speed monitoring data to confirm spatial patterns, testing of the sources in a second model, comparison to direct observations of the sources that might become available, and numerical tests of uniqueness of the inferred sources.

A.2.3 SDWA LETTER

HSI Hydrologic Systems
1588 Sean Drive
Placerville, California 95667
Phone:(415) 454-6056

June 22, 2022

Ibraheem Alsufi
Division of Operations and Maintenance
California Department of Water Resources
P.O. Box 2000
Sacramento, CA 95812-2000

Re: Comments on the April 2022 Version of the Monitoring Special Study Plan

Dear Ibraheem:

Hydrologic Systems (HSI) is pleased to submit these comments in response to the "Monitoring and Special Study Plan" (MSS) that was developed jointly by the Department of Water Resources (DWR) and the United States Bureau of reclamation (USBR). These comments were developed after review of the MSS study plan, dated April 2022, and participation in the stakeholder workshop that was held on May 17, 2022.

Putting this evaluation in perspective requires a brief overview of process that led to the requirement of the MSS, and its subsequent scope.

General Comment

The impetus for the development of the Monitoring and Special Studies plan stems from requirements presented in the 2018 Water Quality Control Plan for the San Francisco-Bay/Sacramento-San Joaquin Delta Estuary (Basin Plan), developed by the State Water Resources Control Board (SWRCB). The Basin Plan requires that DWR's operation of the State Water Project (SWP), and USBR's operation of the Central Valley Project (CVP) continue to meet the southern Delta salinity water quality objectives that are described in Water Rights Decision D-1641.

The Basin Plan requires that USBR and DWR jointly develop a Comprehensive Operations Plan (COP) for the CVP and SWP. In the Basin Plan, the SWRCB acknowledges that DWR and the USBR are partially responsible for the salinity problems in the Southern Delta due to hydrologic changes caused by exporting water from the Delta. The intent of the Board in requiring the COP, is to have DWR and USBR address the impacts of the State and Federal water project operations have on the southern Delta salinity levels.

The Basin Plan calls for two additional plans that will provide data to guide in the development of the COP. Those two plans include the Monitoring Special Study (MSS) to inform the development of the

COP, and a Monitoring and Reporting Plan (MRP) that will assess the results of the COP in meeting the regulatory requirements spelled out in the Basin Plan.

The above paragraphs provide the genesis of what is driving the MSS. I have included this summary, even though it is included in the study plan, because the MSS program as presented in the April report is missing an important aspect of the requirement as specified by the Board. That requirement, is that ultimately, the MSS should be able to inform the development of the COP on what operations the projects should add, change, or delete to reduce their impacts on south Delta salinity levels.

In the MSS Study Plan, there is no reference to project impact on south Delta salinity in any of the proposed studies. The four primary studies make no reference to the two water projects, and they provide no analysis that would synthesize their collected data to evaluate existing or future operations of the projects. There is no evaluation of exports, either magnitude or timing. No discussion on an evaluation of the barrier program or other operational protocols of the two projects. 1

This lack of any direction within any of the study plans that relate back to the primary purpose of the MSS, which is to inform the development of the COP, seems to be a significant gap in the development of the MSS.

The general requirements of the three studies that are called out in the Section IV-B-1 of the Basin Plan are provided below.

<u>Comprehensive Operations Plan (COP)</u>

- Detail the actions that will address the impacts of the water projects on water level, flow, and salinity
- Provide information on the configuration and operations of the facilities utilized in the COP.
- Identify performance goals for water level, flow, or similar measures for these facilities.

A Monitoring and Reporting Plan is required by the Basin Plan in order to measure water project compliance with the objectives identified in the Basin Plan. The plan should identify the monitoring requirements that will be implemented by the COP.

<u>Monitoring and Reporting Plan (MRP)</u>

- The DWR and USBR will develop long term monitoring protocols to measure compliance with the performance goals of the COP.
- assess the attainment of the salinity objective in the interior southern Delta.
- identify monitoring locations and/or monitoring protocols

The operations identified in the COP and the monitoring and reporting protocols in the MRP shall be based on the information obtained in the Monitoring Special Study and shall include specific compliance monitoring locations for the three river segments that comprise the interior southern delta salinity compliance locations.

<u>Monitoring and Special Study (MSS)</u>

- Characterize the spatial and temporal distribution and associated dynamics of water level, flow, and salinity conditions in the southern Delta waterways.

- The study shall identify the extent of low or null flow conditions and any associated concentration of local salt discharges.
- The State Water Board will request local agricultural water users and municipal dischargers to provide data regarding local diversions and return flows or discharges.
- DWR and USBR will submit a plan for this special study to the Executive Director.
- The monitoring contained in this plan shall be conducted until superseded by the long term Monitoring and Reporting Plan.

<u>Specific Study Plan Comments</u>

Below are comments on the four individual studies.

Study 1 - High Speed Salinity Transect Mapping

- what is the depth of the sensor 2
- The report states that the transect can be run at 25 mph (2,200 ft/min) and the inflow to the sensor is one gal/min. Is this sensor inflow rate able to keep up with the speed of the boat? 3
- Can the Middle River be sampled by a shallow draft boat starting at the high tide and run during the ebb? 4
- Route 1 takes 4 to 6 hours, and the water is moving downstream during an ebb tide. It seems that any pulse of salinity would be moving downstream with the boat. Wouldn't the water flow moving with the boat throw the concentration and location off. It might be useful to run the transect on consecutive days, one day running the transect upstream and the next day running the transect downstream. Then compare the results from the two runs. If your projected travel time is of the same order of magnitude as the ebb or flood tidal cycle, wouldn't you be riding the high salinity wave downstream? Would this paint a picture of higher salinity levels are actually there? 5
- For the long runs, like Rout 1 are you able to complete the route in a single ebb or flood tide? Would mixing the ebb and flood tide periods within a single transect throw the magnitude, location, and timing off. Would it be better to break the run into several pieces that can all be run in the same section of the tide cycle on subsequent days. 6
- It would be beneficial to set a scenario to evaluate the change along a transect due to different export conditions. The scenarios that you have created are designed to evaluate salinity conditions that are independent of the projects. 7

Study 2 - MSS Salinity and ION Sampling

- Page 6, The source of water for the Upper Old River, Dougherty Cut, and Lower Old River and Grant Line Canal is not just the San Joaquin River, it is the San Joaquin River and Central Delta. If inflow from the San Joaquin River were to be stopped, there would still be water in the south Delta channels. 8

A.2.3 SDWA Letter

- Page 6, last paragraph, The text should read during dry and critically dry periods, the western end of Grant Line Canal is influenced by Project Exports, resulting in additional water flowing south from the Sacramento River. 9
- Fig 6-D I would expect PDC and SGA to be different because they are different channels. All the other figures are comparing data from different locations on the same channel. 10
- Page 10, The December specific conductance mean value was lower than most of the months, because for the critically dry and dry years that are shown, the drought continued into the winter months which also had an impact on the salinity level in the rivers. What is typically pumped in winter is the groundwater that is flowing into the drainage ditches. To leach salts from the farmland, they would of had to apply water to their fields, which is something that is not done unless the field is under production. The high winter values in 2015, 2016, and 2018 were critically dry and below normal years when there was no rainfall to leach the fields. During 2017, which was a wet year, rainfall over the fields resulted in a low salinity level, not a high one. The 2012 Montoya Report that is referenced in the study it is no longer at the DWR link. Could that report be made available? 11
- Page 11, Paradise Cut and Sugar Cut have high salinity levels because they are dead end canals where water stagnates, resulting in high salinity. But, also because they are dead end channels, their volume contribution and overall salt mass load to the south delta would expected to be fairly low compared to other channels with continuous flow to Old River. 12
- Page 14, Tom Paine Slough does not flow to Old River. It has a control structure that prevents downstream flow during an outgoing tide. 13
- Page 14, Groundwater is not from discrete point sources, groundwater is flowing into Old River along most of its length. 14
- Page 17, paragraph 3, The ionic similarities of these three samples point towards having a common groundwater component, but the source of the salinity in the groundwater may or may not be the Diablo Range alluvium. More ionic sampling and analysis of other groundwater sources up-gradient of the south Delta channels needs to be conducted. 15
- Page 20, dead end channels will always have less mixing with main channel water than the main channels. 16
- Page 25 what is "on-water drone imagery mapping"? 17
- Ion Data Collection
- The ion data collection should include ion sampling of water sources that drain to the groundwater that is seeping into the south delta. Most of the drains in the south Delta are below the existing groundwater table. As such, they are pumping a combination of groundwater and Agricultural runoff into adjacent rivers and canals. There is no mention of trying to identify the source of the salinity in the groundwater. I would recommend ion sampling in groundwater that is not associated with an agricultural area for comparison with what is being discharged from agricultural drains. There is also salt in the water Project exports to the south that drains into the groundwater which ultimately flows to the south Delta. There is an average of 1.2 million acre-feet per year from the Banks pumping plant alone. How much of that is supplied to water users south of the Delta that ultimately ends up as groundwater in the Delta? Decade after decade, the salt in that water has to build up and make its way back down to the South Delta. It would be beneficial to see an ion sample of exported water compared to groundwater samples 18

at different locations south of the Delta, starting from the point of application north to Tom Paine Slough and Old River. If this study is ultimately intended to guide the COP and MRP, activities of the water projects need to be evaluated. 18 con't

- Paradise Cut salinity tidal dispersion. The low velocities in the dead-end channel may make it hard to evaluate the results from a rhodamine dye study. In these low velocity channels, the wind driven current can often overcome the natural low flow in the channel, resulting in inaccurate dye dispersion. Accurate bathymetry combined with upstream, midstream, and downstream stage data, along with a good hydraulic model may be a more accurate method for evaluating inflow and outflow from the channel. 19

Study 3 - Schism Modeling

We have reviewed the SCHISM modeling work that is proposed for the MSS study. Schism is a good model, and can be accurate if sufficient calibration data is used in its development. But, the flow in the channels throughout the south Delta primarily consist of one-dimensional flow. Applying a 3-d model to this analysis is way beyond what is necessary to evaluate the flow patterns in the south Delta. 20

The first principal in hydraulic modeling is never use a model that is more complex than what is needed to answer the questions that are posed of it. For this analysis, we are not asking questions that require knowledge of the vertical and lateral flow patterns in the channel. We are looking for longitudinal mass flow movement upstream and downstream in the channel network. A two-dimensional model would be overkill, a three-dimensional model goes way beyond that. A three-dimensional model that extends all the way out to the Farallones that takes days and weeks to run is not practical. Given the exponential increase in time and cost to develop a three-dimensional model over that of a 1-, or 2- dimensional model, we are not sure if the SCHISM model is the right choice for this project.

Access to the model for the different stakeholders with interests in the project is important to this collaborative process. The infrastructure necessary to run the SCHISM model consists of a supercomputer, or a cloud service that provides access to a cluster of workstations to run the model. This is likely to be economically and/or technically out of reach for most stakeholders. That effectively eliminates their ability to properly review, check, or contribute to the modeling process. 21

Another important aspect of a multidimensional model is the calibration data that is necessary to make the model accurate in each of the different dimensions. Without getting that type of calibration and validation data, the lateral and vertical hydrodynamics that are simulated will just be a guess. The end result is an extremely expensive model that is no more accurate than DSM2 because you will be calibrating both models to the same data set. 22

We agree that the existing density of computation nodes in DSM2 is not sufficient to get the detail that is necessary to analyze some of the flow characteristics that are important in this study. We recommend updating DSM2, or use a different 1-dimensional model with additional cross-sections rather than creating a whole new model that is more complex than is necessary, and lacks the calibration data to properly use the benefits that it may provide, and is inaccessible to many of the stakeholders. 23

Study 4 - Data Assimilation

We are concerned about the use of data assimilation in the modeling process. It appears to be a way to make your model appear to be more accurate than it really is. The data assimilation process statistically modifies the model data input and output to insure that the final model output has a better fit to 24 measured data. It is structured as an iterative process that smooths and modifies the model input and output repeatedly until a best fit is obtained. It can also infer data where none may exist to make a model appear to be more accurate than it is.

In this MSS process we are trying to understand hydrodynamics and water quality characteristics of flow in the south Delta. The existing models have specific issues when it comes to describing this process. We see the MSS as a mechanism to better understand the actual physics of the system, so that we can identify data and process gaps, thereby

improving our models. A statistical analysis interjected into this process may smooth over inconsistencies between measured and modeled data can mask unknown processes that our models are not evaluating correctly. If the models are having trouble matching measured data in certain areas, we need to know about it and direct more attention to those areas.

24 con't

If you have any questions on the above tasks or costs, please don't hesitate to give me a call.

Sincerely,

Thomas K. Burke

Thomas Burke, PE
Principal

CC: Dean Ruiz SDWA, John Herrick, SDWA

SDWA-1 See Master Response A.1, *Long-Term Monitoring Protocols and MSS Objectives*.

SDWA-2 The water intake sits approximately 1 foot under the surface of the water. This is limited by the depth of the channels. Lowering the water intake below the hull of the boat can damage sensors in shallow channels, including Paradise Cut, Sugar Cut, and some sections of Old River.

SDWA-3 Inflow rate has been updated in the MSS Plan Attachment 1 work plan to 2 gallons per minute (gal/min). A Tracer experiment will be performed in the lab to calculate the lag between water intake and observable measurement by the sensor in the flow cell. Preliminary runs have shown that there is roughly a 10-second delay between intake and reading. A shift will be applied to transect data to account for lag within the system. During most of our transects, the boat speed is kept well below 25 mph. Calculated boat speed from global positioning system (GPS) readings can be included in transect data.

SDWA-4 This scenario has not been tested, although water hyacinth and shallow depths pose constraints with existing equipment. Based on 2017 bathymetry data, water depths are too shallow to navigate between Head of Middle River and Howard Road, whereas Middle River downstream of the Howard Road Bridge is significantly deeper. If it is shown during the course of the MSS that surveying Middle River could provide valuable data, a reconnaissance could be scheduled for a period when the Middle River agricultural barrier is not installed, and floating aquatic vegetation is not blocking the channel.

SDWA-5 These numbers were estimations before performing the transects and included time for set up and dismantling the system. The time needed to perform each route will be updated in the workplan and only include the actual time it takes to perform the transect during data collection. Route 1 was completed at the end of March, and the total time to circumnavigate Fabian Tract was 2 hours. Splitting up Route 1 into smaller portions needs to be considered, not just for time's sake, but because, most of the year, completing the route is not possible because of vegetation. The route can be split into a transect for Old River and for Grant Line Canal. This will also make it easier for Water Quality and Environmental Services (WQES) staff to append these transects onto field days when we are already in the area servicing water quality equipment. Transects can be rescheduled so that high and low tides are captured in these areas, as SWRCB comments also suggested.

SDWA-6 The goal for a transect route is 1 hour or less. Route 1 will be reconfigured (see comment SDWA-5); Route 2 (Head of Old River to Old River Barrier) will also be reconfigured to address time constraints and inaccessibility due to hyacinth.

SDWA-7 There are limitations on how many variables we can assess when performing high-speed salinity transects. Many of the decisions on timing are related to the constraints of a normal work day and the associated timing of the tidal period throughout a day. Transects will be performed throughout all seasons and for all regions outlined. The assessment of project operations can be a variable included in the final reporting and analysis of these transects. See also response to comment CCWD-6 in Section A.2.2, *CCWD Letter*.

SDWA-8 Some source water from the Central Delta exchanges with Old River, Doughty Cut, and Lower Old River, but the net-flow direction moves east to west in that area. A project operation component may sweep water from east to west when the agricultural barriers are out, but flow is generally upstream at locations like Mountain House (i.e., a null zone) during barrier installations. Ion data further supports that San Joaquin River water is the primary source to Old River, Doughty Cut, and the east side of Grant Line Canal (ICF 2016, *Evaluations of Salinity Patterns and Effects of Tidal Flows and Temporary Barriers in South Delta Channels*; DWR 2004, *Factors Affecting the Composition & Salinity of Exports from the South Sacramento–San Joaquin Delta*).

SDWA-9 The western end of Grant Line is more influenced by Sacramento River-sourced water through Old and Middle River in dry years as a result of low San Joaquin outflow, local diversions, and project operations. This is a combined effect, not just one factor or the other.

SDWA-10 Paradise Cut and Sugar Cut are side channels interconnected to the primary channels of Doughty Cut and Old River. These channels exchange water tidally, and Sugar Cut has intake gates that retain water during flood tides to supply Tom Paine Slough.

SDWA-11 The text has been updated to state "…high discharge can also occur in the winter (December and January) to drain flooded fields and as a management strategy to leach salts accumulated on soil." This text suggests that some, not all, Delta islands perform this practice. Additionally, 2017 was a wet year with record amounts of rainfall that is not typical of most wet years. There were many unique aspects to water exchange in the south Delta in 2017 with substantial Paradise Weir overflow as one example. The Montoya (2012) *South Old River Salinity Transect Study* report can be made available.

SDWA-12 Yes. Because these channels are dead-ends, there is likely less exchange with the other primary channels. However, because salinity levels are higher in these dead-end channels, it is possible that a smaller volume of this higher-concentrated water could be contributing to salinity observed in the primary channel. At this time, we are not certain of the salt mass load of channels to Old River in all seasons, water-operation scenarios, and water years. We seek to determine under what conditions this may be the case.

SDWA-13 Based on conversations with Pescadero Irrigation District manager and documentation in Montoya's 2007 report, it is understood that flows from Tom Paine Slough to Sugar Cut and downstream to Old River are restricted during the growing season via flap gates. Our understanding is that these flap gates are removed after each growing season to prevent flooding within Tom Paine Slough. therefore allowing Tom Paine Slough flow into Old River. There is uncertainty on the timing of when these flap gates are in operation, and records of this information would be helpful.

SDWA-14 It is possible groundwater may be entering Old River through both surface water drains that interact with groundwater and through the channel substrate. Currently, there is not enough information or data to show the latter, although there is some documentation to support the former (Montoya 2007, *Sources of Salinity in the South Sacramento–San Joaquin Delta*). Text in this section has been revised to state: "The groundwater influence in surface water drainage point sources was determined to primarily come from four locations:..."

SDWA-15 The collection of samples for ion analysis up-gradient of the south Delta channels will be included in our study plans. We will be collecting ion samples from a station along the Sacramento River source water corridor to the west, at West Canal at Clifton Court Intake (WCI) and toward the east, going as far as San Joaquin River at Vernalis (VER). Anything further upstream is outside of our study area scope. See draft MSS Plan Attachment 2, Table 4, for a full list of ion samples being collected.

SDWA-16 Agreed, but in our study area there are opportunities for both Paradise Cut and Sugar Cut to exhibit more net outflow, especially during winter high flows: Paradise Cut weir flow or Sugar Cut, Tom Paine overflow. There are also several large drains in Paradise Cut that could aid in net outflow during irrigation season.

SDWA-17 The text has been updated to read "Drone Imagery Mapping Reconnaissance."

SDWA-18 The Pescadero Tract Circulation Investigations study task proposes collecting some ion water sample data within some drains that are likely interacting with groundwater. With participating organization support, we are still hopeful to include that monitoring. With respect to groundwater monitoring, DWR and Reclamation have had challenges identifying accessible groundwater wells within the region of interest. If provided with groundwater data or the opportunity to access existing wells, DWR and Reclamation can include analysis of groundwater salinity sources. Without participating organization support, groundwater data collection and analysis would not be feasible due to constraints outside of DWR and Reclamation's control.

SDWA-19 The dye study is being used to validate the model and improved understanding of circulation under varied seasonal conditions. Based on the way Acoustic Doppler current profilers (ADCPs) are calibrated, the tidal/dispersive flux at PDC is probably more accurate than the net flow. We do not see a pathway to a mean flow based on stage and model-based assessments. Our concern is identifying any fairly large mean velocities/fluxes or simply confirming that they are low and need not be a focus (i.e., the inability to identify a mean flow with magnitude >5 cfs would be important information).

SDWA-20 The factors that went into model scoping are described in the section of the SCHISM model supplement entitled *SCHISM and DSM2*. DSM2 is not treated as a second-class effort; it will benefit from all the work being performed and, in many cases, the improvements are vetted there first. We have added as a deliverable a comparison of the two. The greatest limiters to accuracy in the Delta are generally shared items between the two models, such as the influence of local sources. SCHISM has undergone development in different areas of the Delta, each of which borrows from its capabilities in different ways, but rarely all at once. One region (Suisun area) might require vertical exchange flows; another (Franks Tract) might require its adaptive resolution. The ability of SCHISM to incorporate new bathymetry, wetting and drying, and vegetation collectively and the fact that it has been tuned (using data in all three dimensions, but not the same everywhere) give it important advantages in analyzing systemwide management actions. There is also a need to integrate southern Delta management into the larger system. For example, many planning decisions often require consideration of downstream water quality or sea level rise.

SDWA-21 We will offer a workshop on SCHISM to try to close this gap as much as possible. Some participating organizations in the MSS and other management arenas have requested this. We can also interact with participating organizations collaboratively in other ways, going over flux inputs, gates, and station outputs, all of which are in text formats.

SDWA-22 Bay–Delta SCHISM has undergone development through projects in different areas of the Delta, each of which borrows from its multi-scale strengths in different ways. One region (Suisun area) might require vertical exchange flows, and vertical processes have been carefully checked in that area. Other areas require refinement, because local geometry is complicated, or jets of water are important to local dynamics (False River and Franks Tract), but are not particularly 3D in the vertical dimension. A system-wide model must connect this multi-scale problem, and it must at least equal DSM2, if not out-perform it, for the southern Delta, but we are likely to focus multi-dimensional validation effort on locations and component analyses where the resolution or dimensionality is deployed in a way that is critical to our inferences. This may require local data collection, as has been suggested by participating organizations. It is worth noting that the number of tuned parameters in SCHISM is not larger than the number of tuned parameters in DSM2. Some items that are approximated with tuned closure terms in DSM2 are resolved in fairly simple ways with SCHISM.

SDWA-23 DSM2 will be updated over the course of the project. The version of DSM2 used for work thus far in the MSS is already finer than the default version. Additionally, bathymetry will be utilized when it becomes available. Improving bathymetry in one-dimensional (1D) models is difficult because an appropriately discretized 1D model has reaches much longer than the width and, as such, many of the undulations and features are "subgrid" and subject to issues of overfit when interesting local geometry is introduced. In contrast, SCHISM is more refined, so this is less of an issue.

SDWA-24 We agree that understanding the hydrodynamics and water-quality characteristics of the flow in the south Delta should be a primary focus of the MSS. A new task was added specifically to improve the existing base model to reflect our better understanding of the system (See MSS Plan Attachment 4: *Water Quality Data Assimilation Modeling Work Plan*, Section 6, *Study Plan and Deliverables*).

In acknowledging the importance of correctly modeling the flow, in particular, we have made considerable effort in the last few months to quantify null zones and Pescadero circulation patterns, in particular. This improvement was achieved not by data assimilation, but by collation of data and the SWRCB Electronic Water Rights Information Management System (eWRIMS) database reporting, analysis of monitoring data, and field trips with local experts.

The data assimilation approach, although not as ideal as direct observations (when those observations are available), is the best-available science to derive EC sources. Without this approach, we could not correctly model EC fields in this study during periods when the area is source controlled, including historical years, such as 2021 when south Delta-derived sources provided the only salinity in the system.

We disagree with the statement that data assimilation is simply a method that nudges the model to observations; the method is fundamentally tied to the physics and can only "nudge" in ways that are consistent with the transport system. With a good monitoring network, the fingerprint of candidate sources can be assessed.

We do agree that comparisons of data assimilation results to field data should not be used to assess the performance of the effort. A new *Validation* section has been added to MSS Plan Attachment 4, summarizing the methods by which the model will be corroborated and including validating spatial patterns against high-speed monitoring data, prediction in new periods with the inferred sources extrapolated into the future without assimilation, assessments of uniqueness of the inferences, and comparisons to any directly observed data that might come available during the lifetime of the project.

A.3. COMMENTS ON DECEMBER 2020 DRAFT COMPREHENSIVE OPERATIONS PLAN AND MONITORING SPECIAL STUDY (COPMSS)

The response to comments in this section presents the comments received on the December 2020 draft COPMSS. Since the time of this submittal, the December 2020 draft COPMSS was separated into two standalone COP and MSS documents. Comments received on the December 2020 draft COPMSS that were specific to the MSS have been included in this section. SWRCB and CCWD provided comments using the comment function within the revised draft COPMSS file. Each individual comment within the December 2020 draft COPMSS file has been given a number for cross-referencing. Responses are sequenced to reflect the order of comments within the file.

SWRCB
Comment Number

SWRCB-39 December 2020 draft COPMSS: Section 5.1.1 (*Monitoring Special Study* chapter, p. 2)

Comment
Investigate the practicality and credibility of training participating organizations to take regular samples at specific sites and convey the samples to DWR for analysis.

Response
DWR and Reclamation have not investigated the practicality of having interested parties provide credible samples for further analysis, but would look forward to collaborating with others who are willing to provide regular samples or other credible and relevant data.

SWRCB-40 December 2020 draft COPMSS: Section 5.2 (*Monitoring Special Study* chapter, p. 3)

Comment
The experiment should also examine seasonal (or flow condition dependent) timing implications.

Response
This comment was specific to the proposed Paradise Cut Flushing Study. Due to drought conditions anticipated to occur during the study period and the potential increased salinity loads that flushing Paradise Cut could introduce to Old River, DWR and Reclamation are proposing to delay Study 5, the Paradise Cut Flushing Study, until a preliminary model is conducted to show the effects of this study.

SWRCB-41 December 2020 draft COPMSS: Section 5.2 (*Monitoring Special Study* chapter, p. 3)

Comment
Consider a pre-irrigation-season "flush" to move sequestered salts out of Paradise Cut.

Response
This comment was specific to the proposed Paradise Cut Flushing Study. Due to drought conditions anticipated to occur during the study period and the potential increased salinity

loads that flushing Paradise Cut could introduce to Old River, DWR and Reclamation are proposing to delay Study 5, the Paradise Cut Flushing Study, until a preliminary model is conducted to show the effects of this study.

SWRCB-42 December 2020 draft COPMSS: Section 5.2 (*Monitoring Special Study* chapter, p. 4)

Comment
Please include finger printing that distinguishes Sacramento River-origin salts from San Joaquin-origin salts if that is possible with these techniques.

Response
Ion samples will be collected from a station along the Sacramento River source water corridor to the west at WCI and a station toward the east, going as far as VER. See draft MSS Plan Attachment 2, Table 4, for a full list of ion samples being collected.

SWRCB-43 December 2020 draft COPMSS: Section 5.2 (*Monitoring Special Study* chapter, p. 5)

Comment
What about gathering a suite of updated bathymetry data in the southern Delta possibly in collaboration with SDWA?

Response
New bathymetry in the south Delta was collected in 2022, funded by SDWA and DWR.

CCWD
Comment Number

CCWD-59 December 2020 draft COPMSS: Section 5 (*Monitoring Special Study* chapter, p. 1)

Comment
Should the word "instruct" be replaced with "require" in the first sentence of Section 5. Monitoring Special Study (MSS)? The sentence reads "The 2018 Bay–Delta Plan amendments instruct DWR and USBR to work with Water Board staff and other stakeholders to develop and implement a monitoring special study to characterize the spatial and temporal distribution and associated dynamics of water level, flow, and salinity conditions in southern Delta waterways."

Response
The word *instruct* has been removed from the introduction of the draft April 2022 MSS Plan. The sentence was modified to reflect that DWR and Reclamation are actively working on the MSS Plan.

CCWD-60 December 2020 draft COPMSS: Section 5 (*Monitoring Special Study* chapter, p. 1)

Comment
Should the word "encouraged" be replaced with "required" in the sentence "DWR, USBR, and other Delta stakeholders are encouraged by the SWRCB in the 2018 Bay–

Delta Plan to engage in efforts to synthesize existing information regarding salinity challenges in the southern Delta that may be helpful to revising and updating the COP."

Response
This statement has been removed from the draft MSS Plan and was replaced with direct quotes from the 2018 Bay–Delta Plan. See draft MSS Plan, Chapter 2, *The 2018 Bay–Delta Plan and MSS Requirements*.

CCWD-61 December 2020 draft COPMSS: Section 5.2 (*Monitoring Special Study* chapter, p. 5)

Comment
It is not clear from this description if the proposed study is focused on collecting additional measurements from specific return flows points or if it is a hydrodynamic study or both. Or is this taking the information collected/modeling as described above and further synthesizing it?

Response
This study has been retitled as *Water Quality Data Assimilation Modeling Study* in the draft MSS. The draft MSS clarifies the data sources to be used and the technique for inferring unknown salinity sources. See MSS Plan Attachment 4 for more details.