DRAFT

Delta Conveyance Project Draft Environmental Impact Report Review

Delta Independent Science Board
Interim Draft – December 1, 2022
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Contents

1. Summary of Major Findings

The Delta Independent Science Board (Delta ISB) review of the Delta Conveyance Project draft Environmental Impact Report (EIR) assesses the scientific rigor used therein and provides suggestions for improvements. We address two basic topics in our review of the draft EIR:

1. Quality of the science: Does the EIR use robust, up-to-date, and comprehensive scientific approaches to evaluate project alternatives and their effects? Are the statements and conclusions supported by current scientific information and understanding? Are the time and space scales appropriate? Are assumptions and uncertainties clearly stated?
2. Completeness of the science: Are the analyses complete for understanding the impacts of the proposed project? Are the analyses missing key scientific approaches or scales of application that would provide further/better insight? Are additional analyses needed?

In general, we find that the quality of the science varies by the impact type evaluated. Several impact analyses are missing elements, thereby increasing the uncertainty of findings. There are multiple overall and chapter-specific analytic omissions, particularly regarding effects of operational decisions, mitigation effectiveness, and climate change uncertainty. Collectively, these omissions lead to an inadequate representation and discussion of potential project impacts and benefits.

The draft EIR uses a wide variety of analytical methods and detailed performance metrics to compare the performance and impacts of nine alternatives for a proposed Delta conveyance project. The draft EIR asserts multiple improvements in water supply reliability, relative to the “no project” alternative, by increasing operational flexibility and mitigating risks from sea level rise, earthquakes, and levee breaches. The potential impacts identified include some substantial environmental and social impacts, but the draft EIR concludes that due to “environmental commitments and mitigation measures,” all ecosystem impacts evaluated will be reduced to “less than significant”. The draft EIR concluded that some substantial social impacts are expected to persist, despite offsetting mitigation.

We find that the draft EIR is generally thorough in identifying the range of potential ecological and social impacts for the nine proposed project alternatives. The thematic chapters (Chapters 5 to 35) often provide detailed, descriptive background on current conditions of the California Delta's water, ecological, economic, social, and physical systems. Many chapters include robust analyses of construction and maintenance impacts, but some key chapters do not comprehensively assess operational impacts. The analyses are often based on peer-reviewed, but not necessarily comprehensive scientific methods, models, and understanding. The draft EIR shows some improvement in analytic approaches relative to EIRs conducted for prior proposed Delta conveyance projects. A notable improvement is the assessment of climate change on the performance of the alternatives, albeit with a short time frame of 2040 for most effects and with only limited application of 2070 conditions to assess flood risk and some sea level rise impacts.

Despite these strengths, the draft EIR has major limitations in that it lacks information necessary to fully support conclusions regarding impacts. The draft EIR lacks 1) clear illustrations of how the proposed project achieves the water supply and environmental benefits claimed; 2) clear evidence to support some of the findings of less than significant impacts; and 3) identification and description of effects of uncertainty stemming from climate effects, mitigation effectiveness, analytic methods, and incomplete scientific knowledge of quantitative and mechanistic understanding of some underlying processes and relationships. Some concerns stem from a lack of attention to operations effects, which are admittedly challenging to predict. Nevertheless, more detailed and comprehensive analyses could be supported by the available science. For instance, methods to adaptively manage environmental and social impacts are not rigorously defined nor planned in all chapters, especially those needed to address operational decisions and responses to extreme and unexpected conditions.

We also find that the presentation of results creates multiple interpretation challenges. In particular, the Executive Summary does not fully reflect the impacts and benefits detailed in specific chapters because the findings are largely limited to performance metrics specified by the California Environmental Quality Act (CEQA). The CEQA criteria generate analytical summaries that are often insufficient for assessing some important scientific and social impacts. Specifically, the criteria often fail to fully characterize expected performance under the climatic variability that can be reasonably anticipated for the future Delta. We are also concerned about the degree to which multiple interacting and additive system drivers and cumulative temporal effects, have been captured by the impact indicators. Many indicators narrowly measure effects on individual species and stakeholder groups and report annual average system conditions.

The most relevant information for understanding potential benefits and impacts is often widely dispersed through multiple chapters and appendices, making a synthesis of impacts and an evaluation of scientific rigor difficult. Impacts identified in the Executive Summary and in specific chapters often fail to provide clear and concise answers to the most relevant scientific and social issues.

Our major concerns about the draft EIR, ones that span thematic impacts, are described in this main body of our review. More targeted analytical reviews and questions are described chapter-by-chapter in Appendix A. Because information is not always well synthesized in the report, some Delta ISB concerns may reflect a lack of clarity in the draft EIR presentation of analytic results.

1.1. Major Concerns

The Delta ISB has eight major concerns for the draft EIR:

1. The draft EIR does not include a sufficiently diverse set of alternatives that fully explore and compare options for achieving stated water supply goals, while minimizing impacts.
2. Ecologically and socially relevant impacts are obscured in summary metrics that use mean conditions averaged over space and time to estimate or characterize effects from water flow changes, instead of more relevant time/space scales of analyses.
3. The summary of impacts embeds optimistic assumptions about the reliability of mitigation performance, making risks to ecosystems difficult to assess.
4. Uncertainty due to climate change is inadequately evaluated. The use of the year 2040 to represent potential future weather is insufficient for understanding the range of potential future benefits and impacts over the long operational lifespan of the proposed tunnel.
5. Adaptive management planning is not given adequate or rigorous attention, given the potential effects caused by operations and mitigation efforts.
6. Impacts driven by interactions across ecological or social systems, impact types, and space, or by accumulated effects through time are largely missing.

7. Multiple sources of scientific and analytic uncertainty are incompletely described or evaluated, despite being necessary to understand the reliability of findings.
8. The draft EIR could more clearly and succinctly compare project alternatives in terms of benefits, impacts, and tradeoffs across alternatives.

2. Delta ISB's Review Mandate, Process, and Approach

The Delta ISB is evaluating the draft EIR in accordance with our responsibilities under the Delta Reform Act of 2009 to evaluate the broad range of scientific programs that support adaptive management of the Delta, including review of major Delta conveyance proposals. The Delta ISB review is a technical/scientific assessment of the quality and scope of the scientific analyses used for informing decisions. We include recommendations for analyses that may not be required under CEQA but that the Delta ISB feels are necessary to adequately evaluate and compare alternatives and understand the reliability of impact assessments.

The Delta ISB brings advantages of independence and broad perspectives on the adequacy of the scientific approaches, methods and topics and their value for making water and environmental management decisions with long-term pervasive impacts. As a result, the Delta ISB is well-positioned to evaluate the adequacy of the scope and general methods of the scientific and technical analyses applied to the Delta Conveyance Project. However, given the draft EIR's extensive breadth, depth, length, and complexity, our review cannot examine all location-specific details in the draft EIR document, nor fully address some questions that require specific and detailed knowledge of the systems being evaluated. Therefore, this review evaluates whether the analyses conducted support the conclusions, using our experience in applying accepted analytic methods across diverse socio-ecological systems.

The Delta ISB reviewed 29 of the 35 substantive chapters (excludes 36 to 39), the Executive Summary, and accompanying appendices of the draft EIR. Comments on the overall document and individual chapters were collected from individual members, then discussed at public meetings, categorized, and refined to create a draft report that will be offered for formal approval at a Delta ISB public meeting on December 8, 2022. Two drafts of this report (including this draft) were made available for public comments before being finalized.

3. Some Strengths of the Draft EIR

The draft EIR brings extensive information and analyses about potential project impacts. The document addresses a wide scope of potential impacts and thoroughly describes current socio-ecological conditions. Analyses often apply peer-reviewed techniques and "models of record" (i.e., models documented to be standard practice by agencies) to evaluate potential impacts. These analyses use an array of modeling tools operating at different scales, covering tributary watersheds of the Delta and downstream service areas. Many chapters (e.g., Geology and Seismicity, Water Supply) use state-of-the-practice analytic methods and models to evaluate potential impacts. Some chapters (e.g., Agricultural Resources) thoroughly summarize impacts as the combination of construction, maintenance, and mitigation activities, which aids in understanding the likely magnitude of additive impacts across these activities.

The authors of the draft EIR appear to have invested considerable time addressing prior issues identified with previous conveyance project documents (reviewed by Delta ISB in 2014, 2015, and 2017). This draft EIR shows improved overall writing and summaries, and provides generally adequate details regarding many impacts. The report is more advanced than many past and recent EIR analyses in examining the alternatives under a future that includes climate change, which provides some insights, in addition to generating more questions. The development of both 2020 and 2040 conditions for evaluating the project, and 2070 for a few conditions, enhance understanding of some future project risks and benefits (although see limitations identified in comments below).

4. Major Review Comments

While many of the analyses in the draft EIR apply appropriate scientific methods and understanding, we found several areas to be incomplete or insufficient to fully characterize potential impacts and their uncertainty. We outline our major concerns below. Additional chapter-specific strengths, weaknesses, and recommendations for improvement, including important analytic concerns not detailed here, are described in Appendix A.

4.1. Diversity of project alternatives is narrow

The alternative conveyance structures considered in the draft EIR are conceptually similar and do not fully reveal the rationale behind the selected alternative. While the alternatives cover a reasonable range of Delta tunnel capacities, they only consider three tunnel alignments (central, east, and east + Bethany PP) and omit several western Delta alignments and through-Delta canal alternatives that have been discussed in past planning. Although it is not feasible or desirable to compare all possible alternatives, a comparison of a broad range of project options is consistent with an objective approach to finding the most environmentally and socially beneficial solution.

For example, two of the major purposes for the conveyance structure are to reduce risk to water supply from seismic events and sea level rise. Both hazards could cause levee failures that would threaten State Water Project deliveries. An alternative approach to address these threats, such as extensive remediation to improve levee stability in the Delta, was not evaluated. At a minimum, the rationale for omitting popular or earlier versions of project alternatives would help stakeholders and decision makers understand the full range of options available and constraints to meeting the objectives.

4.2. Metrics or analyses that use mean conditions averaged over space or time obscure relevant impacts and variability

In the draft EIR Executive Summary much of the CEQA criteria used to calculate or represent project impacts summarizes conditions over relatively long-time intervals and coarse spatial scales. Such summary criteria smooth over variability and can fail to adequately represent ecologically and socially relevant effects that may occur over short durations or fine spatial scales. Among our multiple concerns with the summary criteria is the classification of construction impacts as short term, even though impacts can last up to 15 years or more. Fifteen years of disruptions to transportation, business operations, recreation, and other activities have the potential to be socially and economically meaningful to those affected. Several examples presented below (e.g., water supply reliability, ecological effects, and social effects) highlight the mismatch between what was assessed and the scientific questions.

4.2.1. Water supply reliability

Taken as a whole, the EIR lacks clear and compelling evidence of how the proposed project operationally meets the beneficial objectives of improving water supply reliability across diverse water years, while minimizing the projects impacts and the risks from sea level rise, earthquakes, and levee breaches, in comparison to a future without the project. Importantly, the quantitative assessment of increased water supply reliability that is attributable to the increase in total Delta exports is examined on average, which lacks the temporal detail needed to fully understand benefits and constraints. The average volumes can be uninformative without information on interannual variability, particularly during droughts. These averages were applied to characterize important effects on conveyance capacity, storage capacity, water demands, water availability, water rights, habitat effects, and environmental requirements. Many constraints on water diversions to the tunnel appear to have been included in the analytic details, but the net effects of operational rules and climate variability on tunnel usage and water supply are poorly summarized.

The report would be strengthened by an analysis of the proportion of actual water demands that would be met by the project, relative to a future without the project that includes the likely development of alternative water sources. We suggest that the Water Supply chapter provide temporally and spatially disaggregated model results to better characterize potential project outcomes under varying hydrologic conditions at demand locations. For instance, a monthly analysis of CalSim model output data provided by the California Department of Water Resources shows that much of the tunnel diversions occur during the high flow months of December through March (Figure 1). From April to November, occasional high discharge events occur, providing the opportunity to divert a high percentage of river flow through the tunnel (as indicated by circles in Figure 1 for Alternative 5). On average, the percent of Sacramento River flows diverted ranges from zero to about 40 percent. Relevant to understanding the cost-effectiveness of the proposal, even in high flow months, tunnel use is below 40% for about half of the time (Figure 2).

Further, the model data suggest that available winter and spring reservoir capacity may limit the ability to meet water supply demand during summer months particularly under climate change. This effect is not well characterized in the draft EIR. Increased exports will only be able to improve water supply reliability if it improves supply when demand exceeds supply. Given a higher demand during the summer months, the benefit of the exported water will be realized largely from storage of water in winter and spring. However, the seasonal storage pattern in the receiving San Luis reservoir in the CalSim model output shows that its capacity may not be adequate to store the increased exports during February and March and that the carryover storage may not last through September and October (Figure 3).

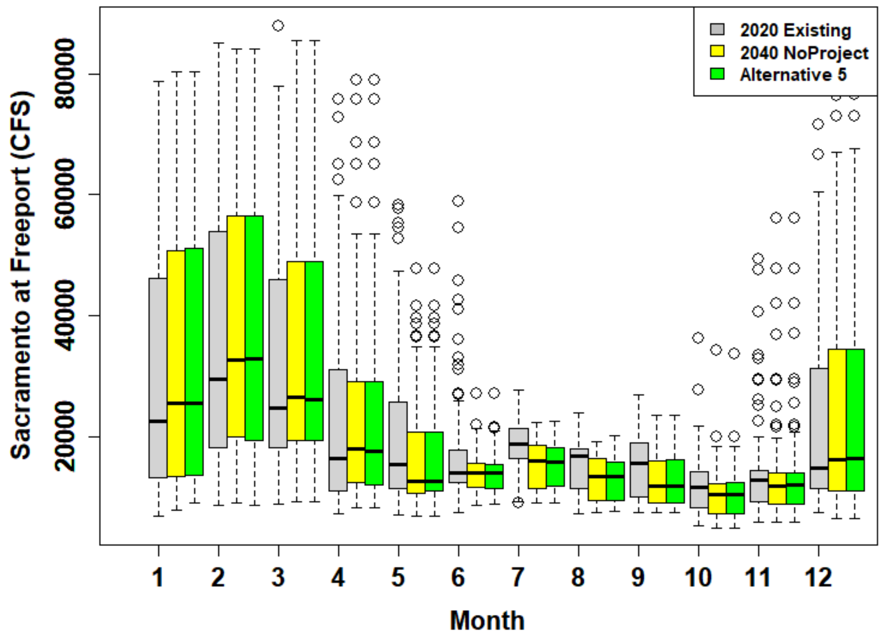

Figure 1. Seasonal variation in the percentage of Sacramento River Discharge diverted via the North Delta Diversion facility and the tunnel for Alternative 5 (2040), No project (2040) conditions, and Existing conditions (2020). The boxes in the figure represent the 25th and 75th percentile of flow by scenario and the horizontal black line inside the box shows the median flow. Whiskers and circles represent the broad range of flows (5th-95th percentiles) and outlier values, respectively. Both 2020 Existing Condition, and 2040 No Project scenarios are shown, although no pumps would be present at this location for either condition. Data source: Two Microsoft Excel spreadsheets (*DCP EIR water supply_2020Data.xlsx and DCP EIR water supply_2040Data.xlsx*) provided by the California Department of Water Resources at the request of the Delta ISB.

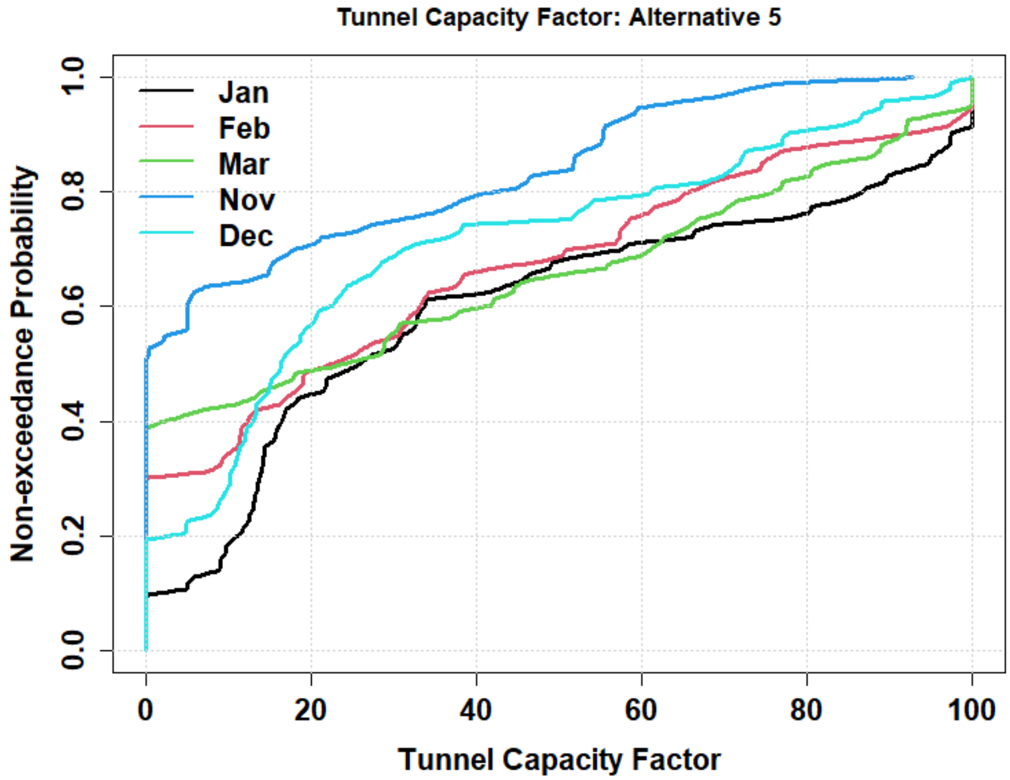

Figure 2. Tunnel capacity use for high river flow months. The figure shows that projected average monthly tunnel use is often small relative to its maximum conveyance capacity. Lines in the figure show how often a given tunnel capacity is expected to be used for months that typically have high river flow. Numbers on the vertical axis show the likelihood that a given tunnel capacity (capacity factor = use/capacity in percent) will be achieved. For example, the likelihood that 40% of the tunnel's capacity (factor = 40) will be used in March is about 60% (probability = 0.6). Data source: Two Microsoft Excel spreadsheets (*DCP EIR water supply_2020Data.xlsx and DCP EIR water supply_2040Data.xlsx*) provided by California Department of Water Resources at the request of Delta ISB.

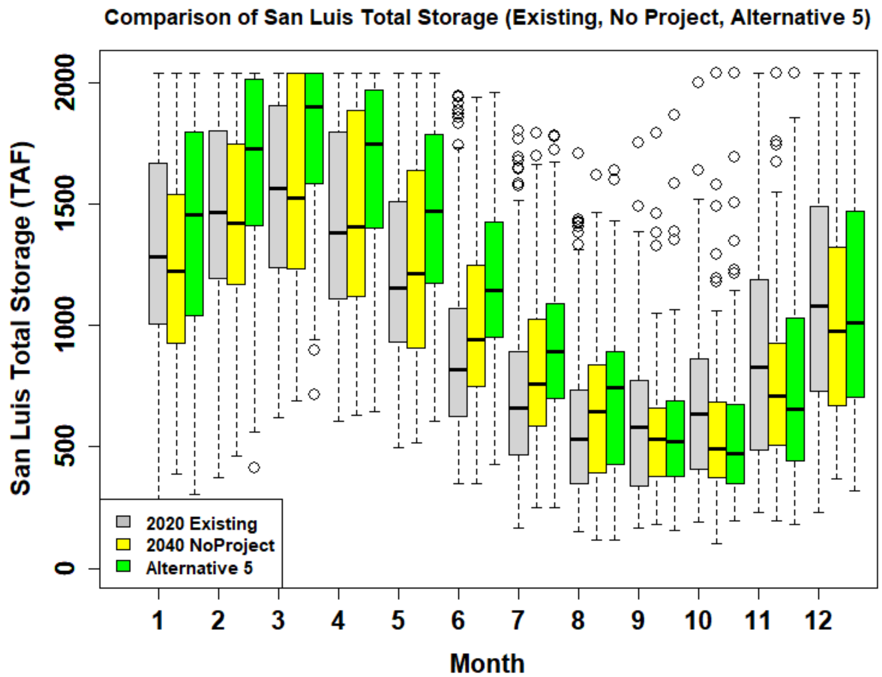

Figure 3. San Luis Reservoir capacity under the 2020 Existing, 2040 No project, and 2040 Alternative 5 conditions. The figure suggests that reservoir storage will sometimes limit useable tunnel capacity. For Alternative 5, the green bars or the whiskers marking the possible range of water storage are at or near maximum total storage capacity (2028 TAF) in the spring, which is the critical storage period for improving summer water deliveries. The boxes in the figure represent the 25th and 75th percentile of volume by scenario and the horizontal black line shows the median volume. Whiskers and circles represent the broad range of volumes (5th-95th percentiles) and outlier values, respectively. Increased exports during wetter periods are expected to improve reliability of water supply obligated under contracts. Data source: Two Microsoft Excel spreadsheets (*DCP EIR water supply_2020Data.xlsx and DCP EIR water supply_2040Data.xlsx)* provided by the California Department of Water Resources at the request of the Delta ISB)

4.2.2. Ecological effects

We question the validity of assessing downriver operational impacts on fish and aquatic resources using monthly mean values for calculations. Monthly values smooth the data and reduce the highs and lows of daily changes, and may obscure important impacts resulting from short-term fluctuations. Kimmerer (2004) points out how many critical biological processes are responsive to short-term changes in drivers on the order of days or less. By examining the dailyflow with tunnel diversions mentioned in Appendix 5A-B (page B-59) the change in frequency and duration of low flow conditions by alternative can be adequately assessed. A statement made in the EIR Appendix 5A-B states that, “Initial comparisons of monthly versus daily operations at these facilities indicated that diversion potential was likely overstated…using a monthly time step.” (Appendix 5A-B, B.7.1, page B-59, lines 6-8). Monthly analyses can both overestimate and underestimate diversion quantities and daily downstream flows (at different times), compared to a more realistic daily application of diversion flow rules. Therefore, an explicit analysis of daily vs. monthly downstream flow and diversion estimates over a period of several years (up to the entire hydrologic record) would allow a better assessment of the daily biological impacts from of a north of Delta diversion.

As well, the relationships between instream flows and temperatures might be improved by considering daily ranges and the relative influences of different temperature drivers. Given the large effectsof temperature on fish physiologic functions (e.g., metabolic and growth rates), and the sensitivity of those rates to temperature duration and thresholds , the use of monthly mean temperatures needs to be re-assessed for this important variable. In addition, analyses in the draft EIR assume that water temperatures are largely driven by atmospheric temperatures rather than flow. They base this assumption, in part, on correlations of monthly water and atmospheric temperatures in the San Francisco estuary (Kimmerer 2004). However, other studies clearly demonstrate a relationship between flow (and residence time) and temperature based on shorter (e.g., daily) time steps (e.g., Wagner et al 2011, Vroom et al 2017). A daily time-step model of how flow diversion affect downstream temperatures, residence times and stratification is warranted.

Seasonal flows, including periodically high discharges, are needed as cues for migration, reproduction, and other life stages, and the draft EIR has not fully assessed nor clearly summarized potential impacts of reducing high flows. Although the analysis using CEQA criteria suggests that, with mitigation, fish impacts will be less than significant, the siphoning of ~30% or more of some river flows throughout the year (calculation based on Figure 3-37 and Tables 3-14 and 3-15 of the draft EIR; see also Figure 1 above) into a tunnel would be expected to have ecological consequences. The draft EIR does not provide strong evidence that the proposed mitigation would compensate for this key modification to the aquatic systems.

The finding of a less than significant (LTS) impact on riparian habitat (Impact BIO-3: Impacts of the Project on Valley/Foothill Riparian Habitat) appears inconsistent with this criterion from Chapter 13 of “a substantial adverse effect on a sensitive natural community is defined as a net loss of habitat function, including a net loss of acreage." (p. 13-74, Lines 10-11). Riparian habitat is scarce throughout the Delta and riparian habitat's influences extend well beyond their footprint. An impact to 2.7% of the riparian areas, or a loss of 23 – 75 acres (Table 13-0), can be ecologically significant. Riparian habitat supports a wide variety of wildlife species, as documented in the report. These areas are also important for their spatial positions in the landscape and for additional ecological reasons (Naiman et al. 2005).

4.2.3. Social effects

Other concerns about calculations that use coarsely aggregated data to determine impact significance arise in some of the social effects. The CEQA criteria frequently summarize effects over large areas (counties) in ways that could be inconsistent with a local user perspective, as would typically be explored in social analysis. Impacts to communities or populations that are deemed to be no impact (NI) or less than significant (LTS) using CEQA criteria could still represent substantial concerns to particular communities within the Delta. An example is that the land use effect "Impact LU-1: Displacement of Existing Structures and Residences and Effects on Population and Housing" has an NI rating, despite that "Between 61 and 93 permanent structures would be removed within the water conveyance facility footprint" (Chapter 14, p. 14-22). Similarly, by assuming that recreation areas are largely substitutable, the CEQA recreation impact criterion fails to address the harms from lost use or inability to make low-cost (e.g., nearby) substitutes specific to a lost recreation type. While the shortcomings of the summary performance criteria are explained in the detailed chapter analyses where local issues are considered, the true effects are not well represented in the draft EIR Executive Summary.

4.3. Optimistic assumptions about mitigation reliability obscure risks to ecosystems

The findings of "less than significant" impacts for many ecological outcomes are based on assumptions that mitigation will fully offset the anticipated ecological impacts. The impact summaries rarely provide separate quantitative measures of the magnitude of ecological effects prior to mitigation. Further, result summaries often omit information about the level or type of mitigation that will be used to offset impacts. Accordingly, the manner by which analysis results are presented makes it difficult to independently assess how an underperforming mitigation project could lead to a net loss of ecological benefits. Similarly, summaries do not provide an opportunity to evaluate the degree to which the planned mitigation is an adequate substitute for lost ecosystem structures and functions.

With great effort the Delta ISB was able to assess which mitigation actions will be used to offset specific impacts. We note that some aquatic system mitigations substitute different ecological functions or species to offset impacted ones. In several cases, no specific analysis of the equivalency of impacts and mitigation is offered. Specific discussions of the tradeoffs associated with creating ecological structures and functions that differ from the impacts, such as using tidal wetland restoration to mitigate loss of flows on specific fish populations, are needed.

The uncertainty of mitigation effectiveness is not adequately discussed, addressed, or prepared for in the EIR, despite ample scientific evidence that mitigation is often less than fully effective at replacing lost ecological structures and functions (NRC 2001; Hough and Harrington 2019). What is discussed in the EIR is a variety of methods to minimize or mitigate project impacts, including avoidance, on-site mitigation, and off-site (and out-of-kind) mitigation, sometimes achieved using mitigation credits. Even if the uncertainty of mitigation cannot be well characterized, the EIR should provide impacts prior to mitigation to give readers the opportunity to qualitatively weigh uncertainty and the equivalency of anticipated ecological losses and gains. Uncertain mitigation performance and impact outcomes should be discussed and prepared for, such as outlining methods for confirming whether target species occupy new habitat, as well as compensating for delays in achieving comparable functional equivalency.

4.4. Uncertainty of future weather conditions due to climate change is inadequately evaluated

The draft EIR acknowledges the expected effects of climate change, including higher temperatures, changing seasonality of wet and dry periods, increased wildfire risks, saltwater intrusion, higher sea levels, and decreased water quality during droughts. However, the analyses in the draft EIR do not fully consider effects of changes in frequencies of extreme events and use inconsistent future projections across outcomes, both of which could alter the findings of potential impacts on water supply reliability, aquatic ecosystems, and social conditions. Even when effects have been analyzed, such as projected impacts for flood risk under 2040 and 2070 conditions, the results are buried in appendices (such as Appendix 3A and Appendix 4A) rather than incorporated into the main findings. , This approach inhibits comparison across the project alternatives relative to the “no project” alternative.

In most cases where climate change is considered, the year 2040 is used, which is inadequate for judging future project performance. A key reason being that 2040 is expected to be the first year of a long operational lifetime. Climate model results suggest that impacts of climate change will substantially increase after mid-century and therefore will be poorly represented by the year 2040. Further, the method used to generate the 2040 streamflows applied in the CalSim model is a simple adjustment based on the “central tendency” of 20 potential climate scenarios (2040 CT). This scenario represents average seasonal shifts in runoff but does not represent the wider range of potential future climate risks and omits the potential for future changes in inter-annual variability of inflow/drought patterns. The evaluation of a range of potential 2070 climate conditions in Appendix 4A shows some important uncertainties, and their implications for water flows, but has not been linked to the performance of project alternatives. In addition, feedbacks between climate change and changes in water demand (e.g., residential use, vegetation evapotranspiration) seem absent in the water supply modeling.

It is not clear if flooding has been adequately evaluated under changing climate conditions, even though projected conditions for the year 2072 have been examined. Project alternatives are compared using conditions of 100-year and 200-year floods in 2022 and 2072, and include sea level rise projections. However, it is unclear why there was no consideration for changing the magnitude of more extreme floods, given the evidence of changing hydrology, including amplification of atmospheric rivers in the coming decades. Further, changes in floods may extend beyond the limited area analyzed (Sacramento River between American River and Sutter Slough) and to Delta islands with implications for levee stability and the operation of upstream reservoirs.

Within some social impact chapters, future conditions for 2040 are evaluated for a “future without project” scenario only and not included in the evaluation of alternative conveyance projects. Many identified impacts are based only on qualitative assessments. This treatment makes it difficult to assess the likely magnitude of future effects relative to a baseline. The inconsistent evaluation of future social impacts could lead to misleading conclusions since factors such as changing regulations, community behaviors, and increasing scarcity of resources may influence future project impacts.

4.5. Adaptive management planning is inadequate

Adaptive management is critical for this type of project and is invoked in several places in the draft EIR without providing sufficient detail to assess its rigor. ; Having the opportunity to evaluate a proposed approach is important because of the degree to which the quality of the adaptive management plan influences the impact analysis. Among the concerns was that the description of how (and who) would do the adaptive management was not well described. With a project this large and complex, it is also highly likely that there will be impacts missed or mis-estimated in an EIR analysis. One would expect the authors to provide, at a minimum, a working "blueprint" or draft decision-tree of their adaptive management structure and process.

The adaptive management coverage in the draft EIR needs sufficient detail to evaluate whether determinations of the significance of impacts were adequately estimated. To provide assurance that the adaptive management plan will be adequate, it should identify funding sources, expertise, and administrative capacity to monitor and manage potential effects or impacts from the project, including those currently deemed less than significant. Details should also include establishing "Thresholds of Probable Concern" for biological responses, which would initiate the adaptive management process and actions if specific thresholds are exceeded. Similarly, social impacts that were deemed less than significant, based on limited qualitative data, should be monitored for concerning (and pre-determined) levels of change. Establishing management goals, performance metrics and key decision triggers are essential parts of an effective adaptive management plan/program (Wiens et al. 2017) and should be outlined in the EIR to provide the opportunity for scientific scrutiny, even if detailed plans or modifications will be produced later.

It would be reassuring to see realistic plans for providing adaptive capacity in response to unexpected events and outcomes, in both construction and operating phases. For instance, some adaptive management plans that are described could prove impossible to execute. Specifically, the project objective to minimize the 'down river' impact of operations caused by reduced flow, does not provide a feasible and specific adaptive management approach. The stated plan to detect changes in fish abundance, which are projected to be of concern at 5%, seems challenging given that changes of 5% or less is likely to be indistinguishable from the natural variability of fish populations or from fish sampling variability. An adaptive management plan for the downstream effects needs to identify an amount of measurable change in a biological response, sustained over a specific period of time, that would trigger a change in flow intake or other operations. The plans for impingement management also raise concerns since the modeled relationship between flow and fish effects is based only on salmon, rather than species-specific models. The uncertainty of measuring the ecological effects and how such uncertainty could be addressed would need to be a part of any initial adaptive management plan not only for fish but also for other environmental components.

4.6. Impacts driven by interactions across ecological or social systems, impact types, and space, or by accumulated effects through time are largely missing

A better reflection of interactions and feedbacks among individual components and system-level responses to changes is critical for anticipating impacts and for designing effective adaptive management. By taking a species-by-species approach to examining effects (see Table ES-2 of draft EIR), the community-scale impacts from individual, interactive, and incremental changes are not adequately evaluated. From a systemic perspective, there is virtually no discussion of species interactions, food webs or ecosystem productivity. Those interactions include the prospect of thresholds in system behavior that may produce dramatic changes. We suggest that an evaluation of aquatic ecosystem effects that includes additive and cumulative effects on fish populations at the community/ ecosystem level would improve impact conclusions. The analyses should include impacts on ecological functions including primary and secondary productivity, decomposition, and biogeochemical processes. Adding analyses of the effects of small population reductions that may compound over time to generate large population level effects would also improve the aquatic system impact analysis.

A more thorough analysis is needed to put new changes into context of the past changes in the Delta that have severely reduced the aquatic ecosystem's ecological productivity and resilience. Although the cumulative impacts of the project's activities added to the ongoing stresses in the Delta are impossible to measure precisely, some effort to analyze the effects of accumulation of stressors and system-level analysis would improve understanding of potential impacts. A thorough analysis would also include impacts due to changes in inflows to the San Francisco Bay estuary and any gains in environmental resiliency from moving water through existing channels, rather than diverting it into a tunnel.

In terms of potential threshold effects, a thorough risk assessment would include the potential for unintended consequences. For example, the potential for the tunnel to result in invasive species transfers among water bodies, such as quagga and zebra mussels or non-native copepods, has not been assessed. Although a screening process is used to limit the potential transport of larger invasive species from the Sacramento River to the lower Delta and beyond, the risk is low but not eliminated. A thorough risk analysis would ask," Will the tunnel be able to transport smaller, invasive larvae, veligers, or seeds to the lower Delta and beyond? Would Zebra mussel veligers survive in the tunnel transport system and beyond? What would happen to conveyance operations if they are discovered in the Sacramento River?

An example external to aquatic ecosystems is that a systems perspective is lacking when greenhouse gas emissions are estimated. The analysis for some project activities does not include the potentially substantial greenhouse gases created during the manufacture of the large amount of cement for concrete and grout needed for project construction. The potential magnitude is such that it requires exploration and, if found to be significant (or unacceptable), mitigation actions proposed.

The lack of consideration of multiple drivers on outcomes is apparent in the water quality and public health analyses. Water quality impacts are almost entirely addressed from a drinking water perspective, rather than recognizing that biota are also affected by water quality changes. A prominent example is that changes in nutrient concentrations are largely ignored in the water quality analysis, despite their potential to lower dissolved oxygen levels or exacerbate harmful algal bloom (HAB) frequency or intensity, with potentially severe consequences for fish. HAB issues were mentioned in impacts under the "no-project" alternative, but only assessed for drinking water quality impacts, rather than recognized for potentially broad effects on ecosystems, wild and domestic animals, human health and recreational activities. Similarly, in the Public Health chapter, most impacts assessed were water-related (including the Vector-Borne Diseases), with no assessment of other potential public health impacts such as air quality, noise, and climate change. The impacts to biota or people could be better linked, similar to the approach taken in the Environmental Justice chapter of summarizing all sources of harm, chapter by chapter.

4.7. Uncertainty and risk need to be explicitly evaluated to understand reliability of findings

Given that there is always uncertainty in scientific assessment or prediction, we find the draft EIR sometimes lacks disclosures, discussions and assessments of how uncertainty may alter assessments of potential project impacts, mitigation effectiveness, and tradeoffs. These uncertainties should be fully embraced and discussed uniformly by stating assumptions and differentiating scientifically supportable conclusions from inferences, expert opinion and hypotheses.
Some sources of uncertainty can be calculated or estimated statistically. Other types of uncertainty can be explored by using alternative scenarios or models to compare projections. It is also useful to characterize the state of the science, particularly in terms of the degree of mechanistic understandings of cause and effect, to describe the level of confidence in projections. These different sources of uncertainty and confidence in findings can be clarified by using consistent definitions. For example, the Intergovernmental Panel on Climate Change (IPCC) has developed categories of uncertainty and confidence in findings to support clear communication (Reisinger et al. 2020).

Although some sources of uncertainty are explored in the draft EIR, we find that model results are not used effectively to bracket a range of potential outcomes. Further, how uncertainties may accumulate or propagate across coupled analyses and models to influence the confidence in results has not been explored. Some major gaps are that changes in ecosystem function at the landscape scale, such as reduced runoff from snowpack runoff during critical drought conditions or increased fire risk, are not represented. Similarly, changes in built infrastructure (levee failure) and human behavior (water demand) under a changing climate are not consistently applied to interpreting project effects.

Some specific examples where a discussion of uncertainty would be useful are in the possible effects of reduced flows in the lower Sacramento River on water supply benefits and impacts to ecological endpoints and environmental flows. The effect of flow variability on aquatic habitat or persistence of species of concern under existing or future climate were not addressed in the Surface Water (Chapter 5) nor in Appendix 3C (Defining Existing Conditions, No Project Alternative, and Cumulative Impact Conditions). Similarly, uncertainties of changing conditions on harmful algal blooms (HABs), with and without the project were not well characterized. HABs are becoming increasingly common in the Delta and warmer temperatures, reduced flow, high residence time, and more concentrated nutrients are likely to exacerbate the problem.

The analyses of fish impacts seem to assume that mechanistic relationships between flows and fish populations are well established rather than recognizing the substantial scientific uncertainty that currently exists (Delta ISB 2015). Similarly, scientific understanding is limited for understanding species interactions, including food web effects or predator-prey interactions. This lack of a reasonably complete understanding causes estimates of some relationships to have low confidence such as how changes in abundance of one species can influence another species. This limitation may be particularly relevant for exploring impacts of species that are not considered in the draft EIR (e.g., aquatic invertebrates). The uncertainty of system behavior, which is not acknowledged in the analyses, includes the potential for thresholds or other non-linear system behaviors that can lead to precipitous biological responses.

Another major concern is whether the uncertainty of seismic risk was reflected in the estimates of potential project outcomes and benefits. The seismic hazard in the Delta has significant uncertainty because of the difficulty in characterizing the activity of geologic faults in the Delta. The activity of the West Tracy Fault, a significant potentially active fault in the Delta, is proposed to be assessed by exploration late in the preconstruction period. This belated investigation is a concern given the potential for this fault to expose the project to strong ground motion (Chapter 10, page 10-46, lines 30-34). Understanding seismic risk is also critical to evaluating one of the four justifications for the Delta Conveyance Project, i.e., minimizing disruption to State Water Project (and potentially Central Valley Project) water deliveries south of the Delta by earthquake induced breaching of Delta levees (page ES-7, lines 9-13). The West Tracy Fault, along with other blind potentially active faults in the Delta, are the primary seismic threats to levee stability. Estimating their activity is essential to evaluating the potential range of seismic hazard in the Delta and threats to levee stability.

In addition, multiple seismic risk assessments are cited throughout the draft EIR but not clearly used to characterize overall uncertainty of impacts. Whereas the primary assessment in the draft EIR of the seismic hazard in the Delta (Chapter 10) is based on a comprehensive probabilistic seismic hazard analysis described in the earlier DWR Delta Risk Management Strategy (DRMS) report, the draft EIR also cites 30-year earthquake probabilities for the San Francisco Bay Area from two U.S. Geological Survey reports (Chapter 1, page 1-17, lines 5-7 and page 7-23, lines 3-5). The two reports focused on the greater Bay Area and the high event probabilities (62 and 72%) primarily derive from highly active faults in the urban areas well west of the Delta. These probabilities do not add much to the understanding of seismic hazard in the Delta, and misleadingly imply an overstated seismic hazard in the Delta.

We suggest that the draft EIR could be more robust by clearly stating the uncertainties, unknowns, and the specific assumptions made in light of assessments and conclusions.

4.8. The EIR would be a more effective decision support document by clearly and succinctly comparing project alternatives in terms of benefits, impacts, and tradeoffs

This document is not well structured or written to achieve the purpose of providing clear guidance for selecting a project alternative, despite a large volume of relevant information and analyses. In particular, the summary tables used to compare alternatives do not systematically compare benefits relative to costs and impacts, across alternatives. Benefit-cost analysis is an approach to assess whether a project's benefits exceed costs, using monetized public and private benefits. Although many benefits are difficult to monetize, even a partial analysis can suggest whether a project is likely to be socially desirable. Alternatively, a cost-effectiveness analysis uses benefit indicators to compare relative benefits per dollar spent across alternatives. Metrics to support a quantitative cost-effectiveness analysis are limited in the current report since the main benefits of water supply reliability and flood damage avoided are not clearly quantified.

Aspects of the presentation of many key results in the executive summary make it extremely difficult to simply and comprehensively compare the tradeoffs embedded in alternatives. Improving the summary criteria and reducing some of the repetition throughout the report might enhance its readability and accessibility. We recommend that a combination of graphical representations of quantitative metrics, coupled with summary tables of non-quantitative assessments, be developed to better serve decision makers and stakeholders trying to understand project effects within this complex socio-ecological system. Table 1 provides an example of the kind of summary comparison that allows readers to more easily compare alternatives for a few major quantitative performance objectives. Graphics and tables might be used to isolate the subset of significant effects to compare alternatives more succinctly.

Table 1. Example Comparative Summary of Performance across Selected Alternatives. This table is a notional example of how tradeoffs among alternatives could be made more accessible and easier to interpret. Such a table would use selected performance criteria from the EIR to compare representative alternatives across a common footing. A finite number of performance criteria are presented here as an example, taken from the draft EIR or calculated from data provided by the California Department of Water Resources. These criteria are grouped by goals of water supply, ecosystem, and in-Delta objectives. Comparing rows of the table across the columns reveals differences among alternatives. For example, comparing the effect of increase in tunnel size (left to right in Row 3) to effects on modeled average annual water exports (Rows 4 and 5) shows that water exports increase more slowly than maximum tunnel capacity across the presented alternatives.

		2020 Climate and conditions				
	Project Alternative	**Existing Conditions**	**Alt. 4b**	**Alt. 4c**	**Alt 5**	**Alt. 4a**
	Tunnel capacity (cfs)	0	3,000	4,500	6,000	7,500
Water supply* **	Average Total Exports (cfs, CalSim results) *	6,891	7,494	7,631	7,708	7,749
	Avg Exports (MAF/yr) *	4.98	5.42	5.52	5.57	5.60
	% Avg export increase from No Project *	0	8.7%	10.7%	11.9%	12.4%
	Avg North Delta Diversion (cfs, CalSim)*	0	773	935	1,034	1,071
	Avg North Delta Diversion (MAF/yr)*	0	0.56	0.68	0.75	0.77
	Tunnel capacity factor*	-	0.26	0.21	0.17	0.14
Ecosystem	Permanent aquatic habitat loss (ac, Table 12-0)	0	11,600	14,700	8,700	18,300
	Bench inundation loss (ac, Table 12-0)	0	1,600	2,200	2,500	2,800
	Mid. SWP SD Spring Run Salmon Entrainment (%) **	0	-4%	-7%	-8%	-5%
	Mid. SD adult Delta Smelt entrainment change (%) **	0	6	12	16	18
	Lost Terrestrial and Avian Habitat (ac, Table 13-0)	0	3,400	3,700	3,200	4,600
In-Delta objectives	Converted Farmland (acres, Table 15-0, AG-1)	0	4,404	4,813	3,788	5,380
	Land Use Incompatibility (ac, Table 14-0, LU-2)	0	3,361	3,761	2,667	4,342

		2020 Climate and conditions				
	Project Alternative	**Existing Conditions**	**Alt. 4b**	**Alt. 4c**	**Alt 5**	**Alt. 4a**
	Conflicts w/ existing structures (Table 14-2)	0	61	71	71	90
	Noise -Residences exceeding criteria (Table 24-0)	0	79	214	230	230
	Lost Delta ag production (Table 17-0, $\$10^6$/yr)	0	3.1	4.5	4.5	5.7
	Changes in Delta agricultural jobs (Table 17-0)	0	-51	-61	-49	69
	Change in net employment (rows 4+5 Table 17-0)	0	-9	-5	4	-17
	Peak construction employment (Table 17-0)	0	1990	2597	3086	3647

Abbreviations: ac = acres, Alt = alternative, ag = agricultural, avg = average, cfs = cubic feet per second, MAF = million acre feet, SD = south Delta, SWP = State Water Project, Tbl = table, yr = year.

** indicates that the results were calculated by the Delta ISB from CalSim data from the California Department of Water Resources.*

*** indicates that the data originated from Table 12-0.*

****These water supply performance estimates are based on CalSim 3 model runs for 2020 conditions using 1922-2015 historical streamflows to represent hydrologic variability*

Summary tables are common for comparing the relative impacts of alternatives across major evaluation criteria. Such tables are necessarily simplified, but are important for helping people understand and focus on important trade-offs among alternatives (Lund 2021). Because such tables can become incomprehensible for complex problems, as seen in the draft EIR's Executive Summary, further distillation is usually needed. Such overall distillations usually focus on a few criteria that seem most important and often omit criteria where performance differs little across alternatives. Inferior alternatives are also often omitted, as a mercy to readers. To be useful, such distillations are usually fit onto one or two pages, and in no way replace the need for more complete presentations in the body and appendix of planning documents.

For this example table, central tunnel alignment alternatives are eliminated for brevity and because they generally were presented as similar to or lower performing than their eastern alignment variants. The presented alternatives also are ordered by nominal tunnel capacity to ease comparison. A finite number of criteria are presented, taken from the draft EIR or calculated from data provided by DWR. These criteria are grouped by broad goals for the Delta: water supply, ecosystem, and in-Delta objectives. Results for 2020 analyses (CEQA existing conditions) were used for this example to be able to include most outcomes; 2040 outcomes were not quantitatively analyzed for all metrics shown. Ideally, results for 2040 or later periods would be included to capture the period of proposed operation of the project.

Of the hundreds of criteria presented in the draft EIR, many can be eliminated from a summary table because they seem to lack significant differences in performance. Many other criteria are eliminated for this table because the differences are small or seem redundant with other more easily understood criteria. Indicators should be retained when small differences in performance are viewed as important. Additional criteria, such as economic costs and benefits, could be added if available. We hope that this example distilled summary table might be used to improve the final project EIR's summary presentation and discussion.

5. References

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Appendix A: Comments on Individual Chapters of the Draft EIR

The appendix will be posted as a separate document found on the Delta ISB's meetings webpage for the December 8 meeting: https://deltacouncil.ca.gov/delta-isb/meetings.