memo

DATE

3/3/2022

ABOUT INDEPENDENT TECHNICAL REVIEWS (ITRs) FOR DELTA CONVEYANCE DESIGN AND CONSTRUCTION AUTHORITY (DCA)

Independent technical reviews (ITRs) are third-party evaluations of a project's engineering and design work for the purposes of providing expert input on specific technical aspects of a proposed project. It is important to note that ITRs ***do not*** *represent a decision on a project or process, nor do comments/opinions in the document consider anything other than technical information. ITRs are a best practice for industries that engage in complex, technical work such as large-scale public infrastructure projects.*

DCA enlisted world-renown engineers with specific expertise for each ITR conducted during the development of the preliminary conceptual plans for the proposed Delta Conveyance Project.

These ITR teams were tasked by the DCA with review and input on major aspects of the proposed project as outlined in the introduction section of each ITR report.

The following information is contained in each ITR:

- Name and association of ITR team members
- Technical aspects of the proposed project that are being reviewed
- Observations and technical recommendations of the ITR team
- DWR and DCA's response to the recommendations of the ITR Team

ITRs address technical processes and are merely one point of consideration for DCA and/or the Department of Water Resources in considering the proposed design and possible approval of the proposed project. There are many factors that must also be weighed when considering whether to approve the proposed Delta Conveyance Project, such as the outcome of environmental impact analysis in compliance with the California Environmental Quality Act that includes consideration of the proposed project and alternatives ability to meet the project objectives, and required compliance with other laws and regulations, such as the Endangered Species Act and Delta Reform Act.

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March 31, 2020

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DELTA CONVEYANCE INDEPENDENT TECHNICAL REVIEW PANELS (ITR)
DWR AGREEMENT NO. 4600013418, TASK ORDER ITR-02

INTAKES ITR PANEL REPORT – MEETING 1
MARCH 17-19, 2020

Dear Sir:

This letter report presents the findings of the Delta Conveyance Intakes Independent Technical Review (ITR) Panel from its March 17-19, 2020 Skype meeting. In addition to the Intakes ITR Panel, representatives from the Department of Water Resources (DWR), the Delta Conveyance Office (DCO), Jacobs Engineering (Delta Conveyance Authority's, DCA's, Engineering Design Manager/Contractor), and ICF (DWR's Environmental Services Contractor) participated in the meeting. The meeting agenda is included as Appendix 1. A daily listing of meeting attendees is included as Appendix 2. A table comparing the characteristics of vertical flat plate, and cylindrical Tee, screens in on-bank structural configurations is included in Appendix 3. Appendix 4 presents information on possible slide-in/lift-in construction methodology for the intakes, while Appendix 5 presents information on possible float-in construction methodology for the intake structures. Finally, Appendix 6 presents a short list of suggested action items to be completed before the next Intakes ITR Panel meeting; while Appendix 7 contains a table for requested responses to the Panel's feedback/considerations.

Due to the size of this letter report an index with hyperlinks is provided to facilitate access to the Panel comments/considerations in the body of the report and to supplemental information in the appendices.

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Appendices

1.0 Introduction

Prior to the March 17-19, 2020 Skype meeting, the ITR Panel was provided with the following additional documents:

- 5-Agency Technical Recommendations for the Location of BDCP Intakes 1-7, December 13, 2011.
- California Salmonid Stream Habitat Restoration Manual, Appendix S – Fish Screen Criteria – Department of Fish and Game, December 2002.
- Draft Memorandum from Jason Hassrick, IFC to Gardner Jones, DWR, Fish Consideration for Comparison of Tee-Screen and Flat Plate Screen Designs, March 7, 2020.
- EDM ITR Intakes Packet v1 20200309, assembled by Darryl Hayes and the Engineering Design Manager.
- BDCP Fish Facilities Technical Team Technical Memorandum – Fish Facilities Technical Team Bay Delta Conservation Plan, July 2011.
- Draft NOAA Technical Memorandum NWFS-NWFSC-1xx, NOAA Fisheries West Coast Region Anadromous Salmonid Passage Design Guidelines, August 16, 2018

In addition to the above listed documents, Panel Members are receiving periodic update documentation including:

- Ch 6 Effects Analysis USFWS Species BA 6.1-6
- Geotechnical Exploration Data Intakes 2, 3 and 5 (WaterFix)
- Intake Location Map (WaterFix)
- Temporal Distribution in the Delta
- Conceptual Engineering Report – Byron Tract Forebay Option, Volume 1/3, July 2018
- Conceptual Engineering Report – Byron Tract Forebay Option, Engineering Drawings, Volume 2/3, July 2018
- Conceptual Engineering Report – Byron Tract Forebay Option, MapBook, Volume 3/3, 7-18-2018.

Specific feedback requested from the Panel in advance of the First Meeting were to provide feedback on:

- Minimizing intake footprint
- Construction sequencing
- Cofferdam and deep foundation constructability
- Operations and Hydraulic control issues
- Sediment management
- Maximum screen panel height and
- Other relevant issues (including: Refugia, modeling and field studies)

RESPONSES TO SPECIFIC FEEDBACK REQUESTED FROM THE PANEL

The ITR panel reviewed the above documents and developed responses to these categories in the form of ideas, suggestions or recommendations followed by commentary on the benefits or challenges associated with each concept or consideration.

2.0 "Minimizing intake footprint"

Screen footprint impacts site requirements, facility O&M, fish protection and likely project cost. The Team developed a number of ideas to reduce the intake footprint ranging from minor modifications to proposed designs to major changes that could yield significant reduction in the footprint. All ideas presented are based on existing technology but would require further evaluation.

2.1

Consideration: Reduce Length of vertical flat fish screen sweeper parking area.
Benefits: • May be able to reduce length of sweeper parking area by offsetting the drive rails vertically to allow end of trolley to extend over the downstream panel.
Challenges: • May require a customized design for the sweeper. • Parked sweep arms must be far enough from downstream screens to allow flow turbulence generated by the arm to dissipate.

2.2

Consideration: The fact that the existing flood control levee will be abandoned, and a new Project levee constructed around the perimeter of the intake facility affords the opportunity to encroach into the existing levee alignment. That is, if deemed worthwhile, the intake facility could be "setback" more into the existing streambank.
Benefits: • Reduces overall project footprint by moving entire facility closer into river into existing streambank. Conversely, it could also allow the intake structure to either be inclined or setback into the existing streambank.
Challenges: • This could impact road width if it remains on levee. (See additional comments regarding road relocation). Additionally, steeper slopes than the standard levee

prism configuration may require additional ground improvement or reinforced earth/retaining wall structures. A CFD or 2-D model would inform designers of the effects of this. Model would show the effects of this idea on the sweeping velocities along the screen face.

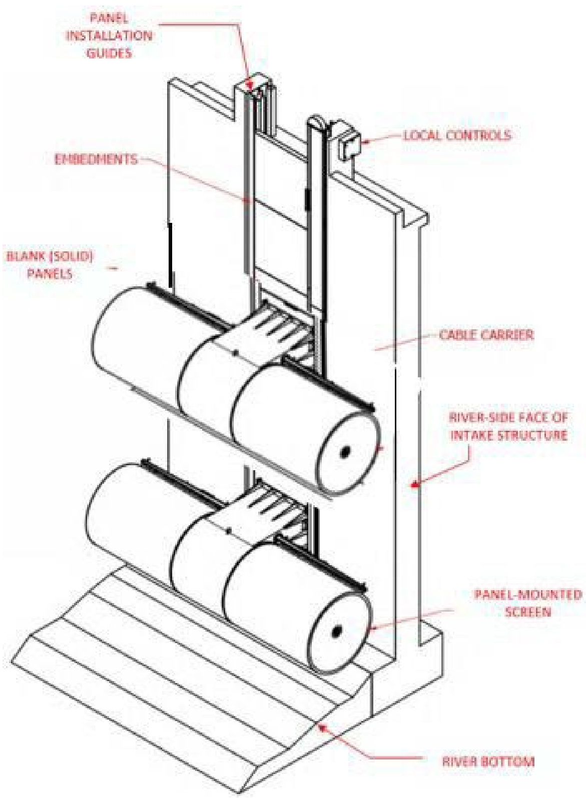
2.3

Consideration:

Dual stacked Tee Screens could reduce length of screens

Benefits:

- Vertically stacked Tee screens with diameters of about 5-ft dia. by 25-ft long could decrease intake length by 10% to 20%;
- Inclined stacked Tee screens of about 8-ft dia. could decrease intake length by 30% to 48%. (see consideration 2.6 and Appendices 4 and 5)



Representative Example of Vertically Stacked Tee Screens

Challenges:

- There are a multitude of pros and cons with Tee and stacked Tee screens, which are discussed further in Appendix 3.

2.4

Consideration:

Using the Tee screen gives you the option to follow the curve of the bank.

Benefits:

- Potentially improved sweeping velocities and potentially reduce overall footprint/environmental impact. (long straight screen could extend into river increasing sweeping velocities rather than conform to bank).
- This idea could also be applied to the vertical flat plate screens. Glenn Colusa fish screens have slight bends in their approximately 1100 feet of length.

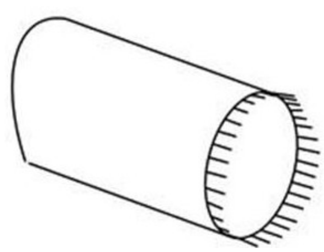
Challenges:

- The sweeping velocity challenges are not fully known at this time without additional modeling. Additional pros and cons of Tee Screens discussed in Appendix 3.

2.5

Consideration:

For Tee screen alternative, consider moving screens closer together and using brushes or rubber fingers on the ends of the screens to reduce the potential for predator holding between screens.



Schematic Example of a Tee Screen Drum with End Filaments or Wire Brushes used to eliminate predator holding areas between Tee screens.

Benefits:

- Could potentially shorten the overall screen length
- Potentially reduce predation potential between screens and or provide Refugia.

Challenges:

- The potential for juvenile fish predation with Tee screens is largely speculative and uncertain at this time.

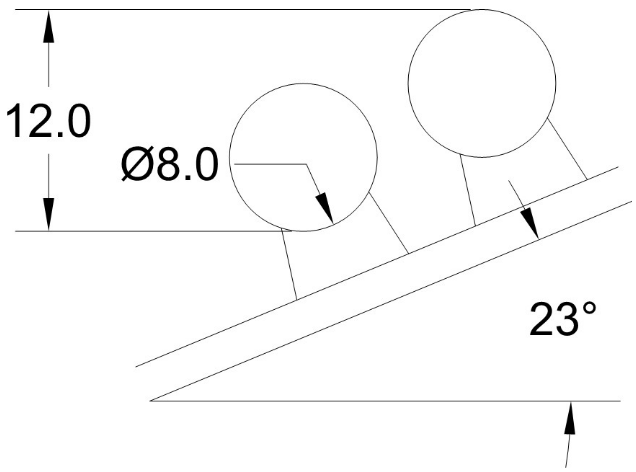
2.6

Consideration:

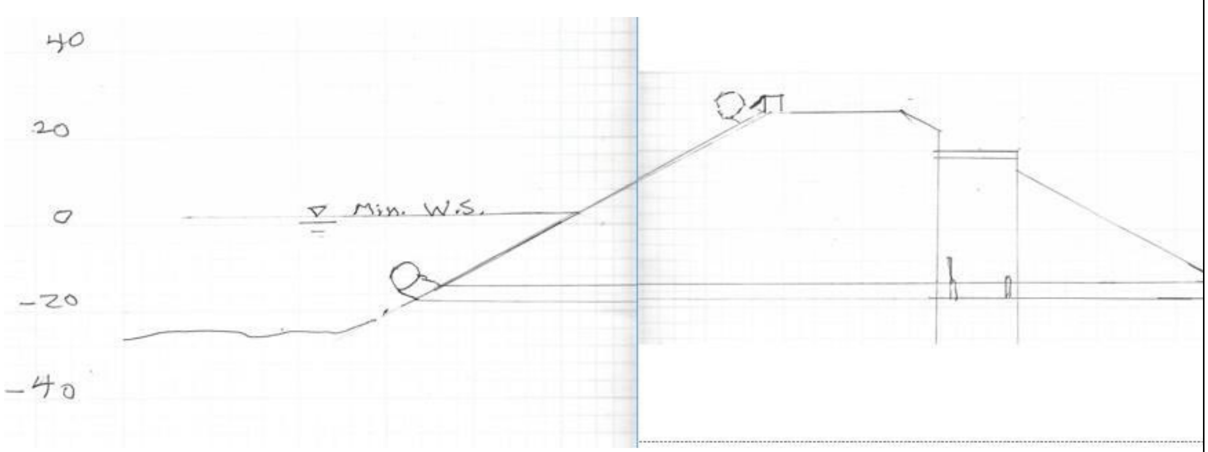
Consider Tee screens (either single or double Tee's) installed on the riverbank slope.

Benefits:

- This could reduce the structure footprint by concentrating more screen area in shorter distance.
- Could reduce impacts to upstream movement of adult Delta Smelt by creating more slower velocity water near surface away from screens.

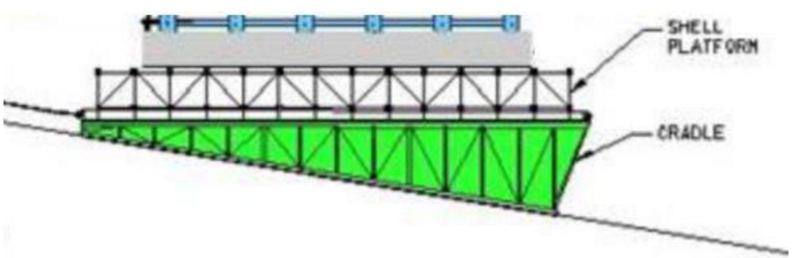


Representative Example of Inclined Stacked 8-ft dia. Tee Screens



Schematic Example an Inclined Tee Screen on a Levee Slope with a Control Gate on the Protected Side of the Embankment

Example of Inclined Tee Screens on Levee Slope



Schematic Representation of a Cradle on an Inclined Trackway on a River Bank for the Olmsted Dam Construction Project. A Comparable Approach Could be Used to Lower/Raise a Service Cradle Along an Inclined Tee Screen Track to Facilitate Maintenance of Underwater Tee-screens.

Challenges:

- This might require steepening the river side bank behind the structure to between 2:1 to 1:1. This could be done with a ground improved/reinforced earthen slope to interface with the current sedimentation basin.
- Alternatively, the embankment would have to be widened and the sediment pond set back further.
- A relocatable service cradle could be lowered down different inclined tracks to facilitate cleaning and debris removal from submerged Tee screens without interrupting operations.

3.0 "Hydraulic control issues"

3.1

Consideration:

Need to build a minimum flow velocity of about 2 to 2.5 fps into conduits behind screens to keep sediment moving in conduits.

Benefits:

- For tee screens this velocity would need to be maintained in the pipe manifold by control valves
- If available head allows, an 8 by 8 ft conduit would provide a 2-fps velocity at about 125 cfs in each conduit. Therefore, this would provide greater flow control in each conduit.

Challenges:

- Some modeling may be required to ensure these velocities are maintained in either design. If the conduit contains deposited sediment, can it be cleaned by mechanical means in an 8 by 8 ft conduit?

3.2

Consideration:

Work with system modelers to try to reduce the 18 inches of drop at radial gates at one or both intakes (e.g.: via operations).

Benefits:

- This might significantly reduce the pumping requirements/costs.

Challenges:

- Need to be careful that this reduced head is consistent with maintaining high enough velocities in the conduits to move sediment.

3.3

Consideration:

On flat plate screens use 12 modules instead of 6.

Benefits:

- This would reduce the flow in each module to 250 cfs to provide finer flow control at the baffles to obtain more uniform approach velocities to the screens. The number of screen cleaners would not be increased. One cleaner would serve two bays.
- To maintain or repair fish screens or baffle panels, half as many screen panels would have to be taken out of operation.

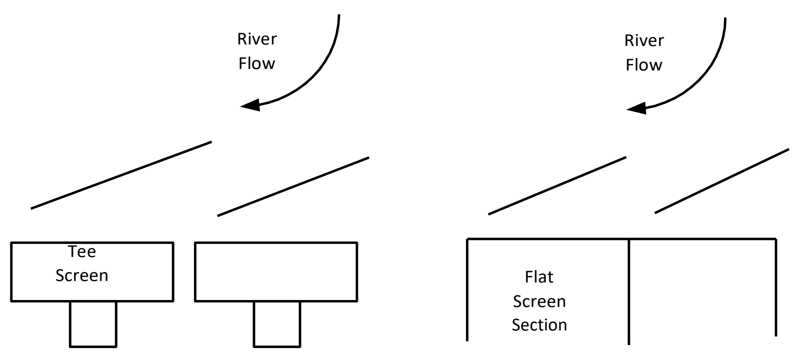
Challenges:

- This would require six additional transverse walls.

3.4

Consideration:

Has there been any consideration to training walls or training vanes in front of the screens to force the flows in a parallel sweeping direction and prevent river flow from trying to pass through the screen perpendicularly (for tee screen) or cause too high of an approach velocity for flat screen?



Schematic Representation of the Potential Use of Hydraulic Training Vanes in Front of Tee Screens or Flat Screens.

Benefits:

- For high approach velocity from river at bend, vanes could channel the water to more of a sweeping direction

Challenges:

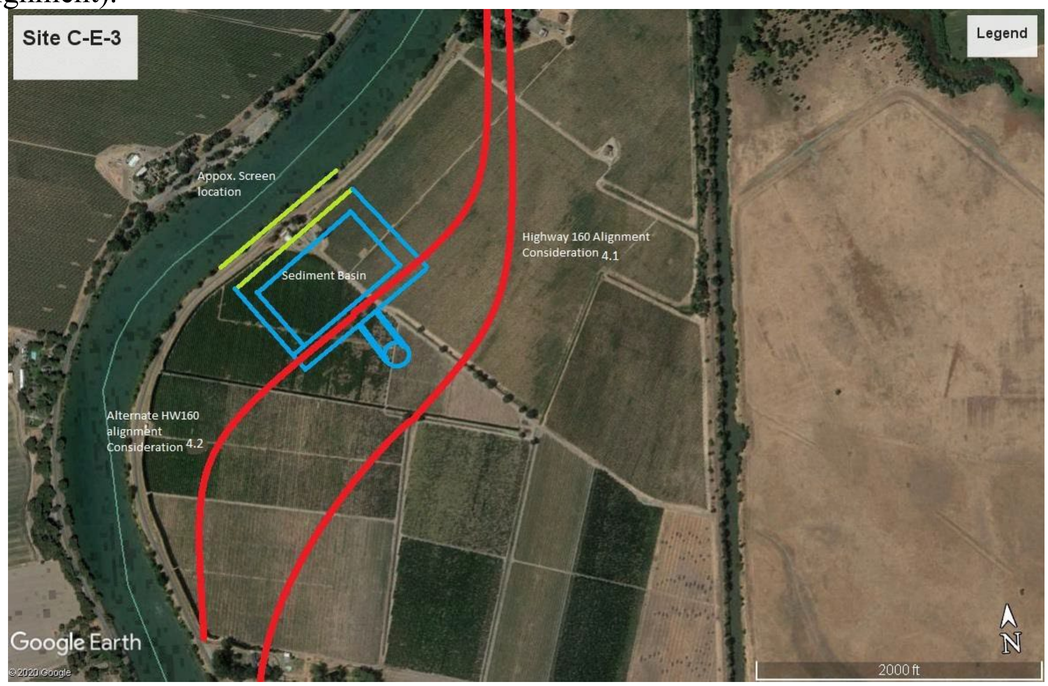
- Vanes have the potential for other issues such as trapping large debris or could alter scour patterns in front of screen structure. This concept would only be considered if modeling indicated too high of an approach velocity due to river flow at a bend.

4.0 "Construction sequencing"

4.1

Consideration:

The preliminary construction sequencing plan indicates a potential temporary relocation (with associated ground improvement) of State Highway 160 across the project site. In later stages of construction, the roadway would be restored to near the current alignment. Consider temporarily, or permanently, moving State Highway 160 to the existing grade around entire construction site as first step. (see diagram for 4.1 alignment).



Benefits:

- This could eliminate the need for an intermediate levee which would have to be built and removed during construction.
- This could also help in moving soil during construction. This may reduce levee material and slurry wall material demands.
- This option could potentially shorten the valve gallery behind the screens and pipe sections (because there would be no highway above them) and therefore reduce the overall footprint of intake.
- This may also afford opportunities to narrow/steepen the remnant levee (no longer the Project levee) along this reach.
- If favorable hydraulics could be maintained within the structure, the structure could be narrowed.

Challenges:

- Would require more land acquisition and significant work to tie in at the ends and which could actually increase the overall footprint. If the highway is considered an essential evacuation route, it may have to elevated above any interior flooding water stage elevation.

4.2

Consideration:

A second option would be relocating road to rest on the eastern berm of the sediment basin. This section could be built early in construction with dirt from the excavated basin, with a bridge over what would become the flow control structure. (See diagram in consideration 4.1)

Benefits:

- This could eliminate the need for an intermediate levee which would have to be built and removed during construction.
- This could also help in moving soil during construction. This may reduce levee material and slurry wall material demands.
- Would require somewhat less land purchase than 4.1, but more than original concept of replacing highway back in nearly original position.
- This option would potentially shorten the valve gallery behind the screens and pipe sections (because there would be no highway above them) and therefore reduce the overall footprint of intake.
- If favorable hydraulics could be maintained in the structure, the structure could be narrowed.

Challenges:

- Consideration would have to be given for construction access to both sides of highway such as an over/under pass at each side of the sediment basin.
- There may also be security concerns with roadway through the middle of project.
- Would require more land acquisition and significant work to tie in at the ends, which could actually increase the overall footprint.
- If the highway is considered an essential evacuation route, it may have to be elevated above any interior flooding water stage elevation.

4.3

Consideration:

It appears that the sediment drying basins are roughly at the current grade of the existing agricultural land. There is the potential to use excess soil from excavating the sediment ponds to raise the elevation of the drying basins instead of having to haul off that material. Some of the material could also be used to make the "levee"/berm around the sediment basin wider/flatter than shown.

Benefits:

- Reduce the amount of sediment spoils that needs to be hauled off site.

Challenges:

- May impact the ability to dredge sediment basin.

4.4

Consideration:

Working In-the-Dry Results in: a) risk of up to one-year delay due to cofferdam installation; and b) a congested work site that could delay construction by many months. Thus, it is recommended that either the construction schedule be revisited with this risk considered and/or that a construction risk matrix be developed for the baseline/assumed construction method. Potential offsite prefabricated construction alternatives are discussed in Appendices 4 and 5; and it is understood that the Construction Logistics ITR Panel will evaluate the logistics of material handling vs river transport.

Benefits:

- Recognition of construction risks in advance allows for the provision of sufficient float-time to resolve unexpected challenges.
- Recognition of construction risks in advance could allow for changes in the construction plan to incorporate more marine staged construction activities in order to reduce both risks and construction congestion.

Challenges:

- Including more marine staged construction activities might either restrict the qualified contractor pool to larger contractors; or might necessitate dividing construction solicitations for the intakes into smaller packages.

4.3

Consideration:

The design proposes the soils excavated for the settling basin be used for construction of the new perimeter Project levee. Based on the preliminary waterside borings completed to date, if similar conditions are present landside, it is likely these soils will be sandy and not meet either CVFPB Title 23 or USACE levee embankment material requirements. Will need to consider either select fill materials will need to be imported or the excavated materials will need to be blended/modified to meet embankment fill requirements

Benefits:

- Material will meet current standards and can be dewatered and readily excavated and placed as levee embankment fill.

Challenges:

- Likely to require soils testing

- May need selective excavation/placement practices to maximize use of on-site materials
- Possibly need to haul in additional materials if existing is inadequate.
- Clay borrow pits may need to be identified.

5.0 "Cofferdam and deep foundation constructability considerations"

See Appendices 4 and 5 for conceptual representations of possible construction means, methods, construction sequences and examples of prior projects relevant to the construction of the intakes using offsite prefabrication technology.

5.1

Consideration: Evaluate constructing the deep foundations using a slide-in sunken caisson system (200' to 300' long), see Appendix 4.
Benefits: • Would not require any dredging in the Sacramento River as excavation would occur in the confined caisson. • Would not require installation of either drilled shafts nor sheet piles that might disturb marine life.
Challenges: • Would need to identify qualified contractors. • Would need to identify potential offsite prefabrication/staging areas.

5.2

Consideration: Evaluate a stay-in-place prefabricated slide-in concrete cofferdam (200' to 300'), see Appendix 4.
Benefits: • Regardless of what foundation type is used, prefabrication of a precast concrete shell (either infilled after installation or not) for the intakes could accelerate the construction schedule and eliminate the risk of flooding a cofferdam.
Challenges: • Would need to identify qualified contractors. • Would need to identify potential offsite prefabrication/staging areas.

5.3

Consideration: The option for off-site fabrication and float-in of a precast screening structure should be maintained as a potential construction option, see Appendix 5.

Benefits:

- This method offers very significant potential for reducing construction schedule by allowing multiple critical path activities to be performed concurrently and thereby lower the total project duration.
- The precast construction option also helps to ensure a higher quality of the final structure.
- The precast off-site fabrication float-in option would also help significantly to reduce the number of in-water work activities that would have to be performed during the relatively short annual fish windows (typically June 1st to Oct 31st).
- Offsite prefabrication would reduce local site congestion.

Challenges:

- The concern with water depth and clearance under bridges can be overcome by locating the precast/launch facility close to the installation site. Finding acceptable sites and permitting (including dredging permits) them could be difficult.
- The number of qualified contractors would be smaller than for in-the-dry construction.

5.4

Consideration:

Consider use of a Construction Manager at Risk, CMAR, contracting mechanism for offsite prefabrication.

Benefits:

- In a CMAR contract the designers remain under direct control by the State rather than the contractors.
- If the CMAR price quote is unacceptable the State can put the design out for open competitive bidding.
- The total design/construction schedule is typically reduced.
- The CMAR contractor can provide design recommendations that could improve constructability and/or construction cost.
- The State would likely not be surprised by contractor contingencies associated with design uncertainties as the CMAR would interact with the designer during the design process.

Challenges:

- More complicated design and contracting processes.
- Not suitable for small contractors.

5.5

Consideration: The preliminary geotechnical information presented for the vicinity of the intake structures indicates problematic soil conditions. These include potentially liquefiable soil deposits and compressible organic materials. Ground improvement to mitigate these conditions as indicated will likely be required. Typical ground improvement measures may include jet grouting, deep soil mixing, deep dynamic compaction, and/or other methods such as stone (or sand) columns.
Benefits: • Possible cost savings.
Challenges: • Some ground improvement methods can increase local soil pore pressures during seismic events, so a careful evaluation process is merited.

5.6

Consideration: In some locations there are dense sands/gravels and stiff clays present. This will present difficult sheet and pipe pile driving conditions. Similar hard driving conditions at other intake cofferdam locations along the Sacramento River has resulted in split sheet pile containment walls that required special additional sheet piles and grouting options. This should be anticipated in the design concept. Predrilling, as proposed, may be required.
Benefits: • Advance identification of hard driving materials will enable the contractor to anticipate these conditions and use means/methods for installation of the required water and soil retention systems.
Challenges: • Hard driving conditions will likely have associated noise/vibration impacts to surrounding areas.

5.7

Consideration: Seepage cutoff walls are favorable features to reduce seepage beneath the new levee embankments. Suggest optimization of various methods be considered including both Soil-Bentonite (SB) and Slag Cement-Cement-Bentonite (SCCB) for open trench construction methods and Soil-Cement-Bentonite (SCB) for deep soil mixing methods.

Benefits: • Having local contractors experienced with the various methods of seepage cutoff wall construction allows flexibility for the design engineer to select the optimum system for the intended use. • Using self-hardening slurry (SCCB) will help expedite project scheduling.
Challenges: • In some cases, the relatively tight site conditions will complicate construction of these linear features. Penetrations of the cutoff walls will need to be properly sealed.

5.8

Consideration: BMPs such as attenuation of pile driving using an impact hammer, predrilling to reduce pile installation sound pressure, etc. should apply to all in-water construction activity.
Benefits: • Reduced impacts on marine life during construction.
Challenges: • Costs and logistics.

6.0 "Sediment management"

6.1

Consideration: Evaluate disposal of treated sediment by river barge from July to October 1.
Benefits: • Potential to reduce long term hauling and disposal costs
Challenges: • This would require provision of a sediment out-loading berth (possibly by pumping from the dredge).

6.2

Consideration: Allow more scour at base of screens by lowering the elevation of the rock scour protection design.
Benefits: • During high flows this would put the highest concentration of sediment at the bottom below the screen sill and decrease suspended sediment concentration near the bottom of the screen and reduce through-screen sediment entrainment. • This could reduce the effect of any sand dunes traveling down river past the screen structures.
Challenges: • Design of shoring/dewatering systems will need to anticipate the effects of localized scour.

6.3

Consideration: The concept of a gravel lined sediment settling basin is of concern to the Panel - especially along the waterside of the new Project levee. Suggest consideration of revetment (6" to 8" cobbles), soil cement lining/facing, or other hard features (e.g. articulated concrete mats).
Benefits: • This would provide a facing such that dredge removal of sediments does not encroach into the new levee embankment prism. • A hardened slope facing could also be useful for wind/wave erosion protection

within/outside the basin.
Challenges: • Any lining system selected will need to be compatible with the underlying subgrade soils.

6.4

Consideration: Sediment must be managed below screens (river side) regardless of which screen is used. Jets below screens may be effective but will require frequent operation. Traveling "toothbrush" type screen is extremely sensitive to this sediment, and it could result in major maintenance issues. At PG&E's Philadelphia diversion the oscillating brush mechanism frequently lodged in sediment bar resulting in significant damage and high maintenance. Sweep arm will need to be very robust, have good access for repair and have plenty of spare parts.
Benefits: • Effective sediment management in front of screens will reduce maintenance issue for wiper brush.
Challenges: • If sediment is not managed in front of the screens, the bottom of the screen sweeper mast would run into sediment and stop the sweeping operation.

6.5

Consideration: Consider baffles or "S" walls in sediment pond to force the water/sediment to travel further increasing settling time before entering tunnel.
Benefits: • Potential to reduce size of sediment pond or dredging frequency.
Challenges: • This is speculative at this point and would need modeling to prove.

6.6

Consideration: Consider permanent boom for suction dredge.

Benefits: • Potential to eliminate/reduce the need for someone to be on the barge for dredging
Challenges: • Control of a large boom might be difficult to achieve.

6.7

Consideration: Consider mounting the jetting system pipes on the intake floor surface, (i.e. do not embed the jet pipes in the floor). The CER describes the system as "The sediment jetting pump will pressurize water from the pipe manifold located behind the back wall of the intake structure and deliver it to the spray nozzles, which will spray the bay floor".
Benefits: • Placing the jet piping and nozzles on the surface rather than embedding will allow flexibility in moving them around if operations show spots that are not getting cleaned. • Maintenance of jetting system will be easier with pipes exposed.
Challenges: • Could result in additional maintenance if pipes get damaged.

6.8

Consideration: Sediment removed from the intakes should, to the extent possible, be used beneficially in the Delta to reverse effects of island subsidence, in combination with carbon sequestration, as well as support shallow water aquatic habitat restoration in the Delta.
Benefits: • Delta island restoration • Carbon sequestration • Support shallow water aquatic habitat restoration in the Delta. • Additionally, this material could also be favorable for seepage berm construction which could enhance levee safety • This potentially helps provide sustainability.

Challenges:

- Would require more testing of potential sediment contamination.
- Would require more truck trips or transport with a barge from the screen site to the Delta.

6.9

Consideration:

With regards to sediment disposal it would be important to anticipate whether the solids may likely contain contaminants (mercury, ag chemicals, etc.) that may impact the ability to dispose of the materials. Additionally, local groundwater conditions should be investigated for adverse chemical conditions. The construction of the Northwest Interceptor in West Sacramento encountered naturally occurring boron which complicated the disposal of dewatering fluids. This consideration merits testing for contaminants in the sediment and groundwater.

Benefits:

- Knowledge of characteristics of decanted spoils will allow greater flexibility in consideration of disposal options.
- Groundwater quality issues can be anticipated in advance.

Challenges:

- Discharge of either spoils or dewatering groundwater may require advance agency permitting. Disposal may only be allowed for limited uses.

7.0 "Maximum screen panel height"

This issue only applies to vertical flat plate screens. Screen height is also linked to site selection, screen length and site footprint.

7.1

Consideration: Evaluate allowing the tops of the vertical flat plate screens to extend above design water level.
Benefits: • During times of higher water levels, this would allow greater flexibility of water withdrawal locations within a long screen structure or between screen structures.
Challenges: • Political distrust of violating water withdrawal requirements.

7.2

Consideration: The Panel believes that it would be difficult to clean a 20-ft high vertical flat plate screen located 25 to 30 feet below the deck of the structure due to cleaner arm and brush length required. The panel suggests evaluating panel height, screen length and cleaner arm size (diameter and length) together. Evaluate whether the trolley rail can be located lower on the structure to reduce the length of the brush arm.
Benefits: • Could potentially reduce the length of cleaning arm
Challenges: • Having the trolley mechanism too high could make screen too difficult to operate and maintain. • Would place the trolley below the water surface at high flows.

7.3

Consideration: Determination of the design screen sill elevation would be impacted by both intermittent mobilized sediment sand dune height and frequency. More data will be required to know the impacts of dune migration and its impact on sill elevation.

Benefits: • Might be able to know in advance of dune migration and alter screen operations to mitigate dune affects.
Challenges: • Jets in the sill may not be effective to eliminate interference from large infrequent sand dunes.

8.0 "Operations"

The team believes that developing operational flexibility within each intake and between intakes is an important design component. New and greater operation challenges will impact screen operation in the future that will require operational flexibility.

Comments:

8.1

Consideration: Evaluate developing two intake sites, at Sites 2 and 3, with a maximum diversion capacity of 3,000 cfs each. Isolate diversion within each intake to 100 to 500 cfs increments. Preferentially operate (December1-May 31) the most upstream diversion first before initiating operations downstream. Preferentially operate the upstream diversion to the lowest diversion rate needed to meet existing demands).
Benefits: • Consolidating diversions to two sites reduces the intake footprint and reduces construction impacts that would occur if three sites were developed. • Preferential operations of the most upstream intake can reduce the risk to delta smelt (delta smelt have reduced densities as a function of distance upstream in the Sacramento River). • Preferential operation of the upstream intake also reduces the risk and magnitude of reverse flows in the Sacramento River and multiple exposure of fish to the intakes (consideration should be given to variable diversion rates within a day based on tidal conditions and sweeping velocities
Challenges: • The diversion may be limited to operations only when sweeping velocity exceeds a 2:1 ratio with approach velocities). The frequency and magnitude of reverse flows is greater downstream of Hood. • Variable diversion rates within a day might be difficult for the entire pump and tunnel system.

8.2

Consideration: Site Location/selection – Sites 2, 3, and 5 appear to be the locations under consideration. Sites 3 and 5 are the likely favorites based on the screen and constructability. However, the selection of the two sites may be driven more by local input than based on preferred screen/river hydraulics. Screens could be constructed and operated successfully at each of the sites. Screen design should account for the river hydraulics at the chosen sites. This may result in some differences in the screen design for the different sites. Tee screens are likely less impacted by site conditions compared to the longer and taller vertical screen options. Hydraulic 2-D and CFD

modeling might show that some sites are better than others among the three final site choices. This could also inform the choice of vertical or tee screen structures.
Benefits: • Better operation and success of screen operations.
Challenges: • Proper calibration of the hydraulic models.

8.3

Consideration: Limit diversion rates to 0.2 ft/sec approach velocity between December 1 and May 31 to protect adult delta smelt, juvenile salmonids, and other fish. Diversion operations during October 1-November 30 and June 1-15 would be 0.33 ft/sec or less unless a pulse of juvenile salmonids is detected moving toward the intake site when diversion rates should be reduced to 0.2 ft/sec (see near real-time operations below). Between June 15 and October 1 diversion rates should be limited to 0.33 ft/sec for juvenile salmonids and other fish.
Benefits: • Would allow for higher diversion rates during "safe" fish population times and reduced flows when fish are present determined by real-time or near real-time monitoring. • Increasing diversion rates to 0.33 ft/sec will reduce the active diversion footprint during the summer and fall. This would allow seasonal variations of intake throughput. • By increasing approach velocities during safe periods, you would run less screens, thus effectively reducing overall active screen area and exposure.
Challenges: • Increased operational complexity, as different intakes could be operated with different throughputs in different seasons. • If adopted, this recommendation resulted in higher water throughput capacities it would require redesign of the conduits and control gates.

8.4

Consideration: Unless tied to reductions in export rates or curtailment, real-time biological monitoring offers potential benefits only during the October 1-November 30 and June 1-15 periods. If real time data (e.g., Knights Landing, Sacramento trawl, acoustic tagging) shows a pulse of juvenile salmonids approaching the intake sites when diversion rates would be reduced to 0.2 ft/sec or curtailed there could be biological

benefit from reduced diversion exposure. Diversion operations during the periods October 1-November 30 and June 1-15 can be coordinated with Delta Cross Channel (DCC) gate closures for fishery protection based on near real-time monitoring so that diversion rates are reduced to 0.2 ft/sec when the DCC gates are closed for fishery protection.
Benefits: • Greater range of operational control.
Challenges: • More complex operations.

8.5

Consideration: Acoustic tag survival studies should be conducted using juvenile Chinook salmon and steelhead (and white sturgeon surrogates) released upstream of the intake reach and immediately upstream and downstream of each intake site to assess baseline predation losses before and after intake construction over a range of river hydrologic conditions.
Benefits: • Know the possible extent of predator populations at the different sites to inform choice of sites and design of screen structures.
Challenges: • Fish behavior during operation may differ from that of the study period.

8.6

Consideration: Restoration of shoreline juvenile rearing habitat should occur a minimum or five miles upstream of the most upstream intake site to improve habitat conditions and growth of juvenile salmonids before migrating downstream and encountering the intakes as well as to avoid an attractive nuisance in the immediate area of the intakes.
Benefits: • Could provide healthier larger fish at the intakes.
Challenges: •

8.7

Consideration:
Control of Aquatic Weed Impingement: Assume increased occurrence of and concentration of aquatic weeds in the future as river flow may warm and new exotic species show up. This a critical issue to maintaining screen performance for both delivery and fish protection. The cleaners must be capable of removing debris from the screen along its length during heavy aquatic debris loads.
• Possible ways to minimize impact –
  • Maximizing Sweeping/Approach velocity ratio.
  • Frequent screen cleaning. Provide flexibility to increase cleaning cycles.
  • Minimize screen length.
  • Reduce diversion during high concentrations of aquatic weeds.
  • Avoid exceptionally tall screens that may require long cleaner sweep arms.

Benefits: • Better screen operation
Challenges: • Preventing debris from rapidly re-impinging on the downstream screen during cleaning. Cleaning the screen will cause debris concentration to increase downstream near the screen as debris is removed from the upstream portions of the screen. • There is little direct guidance on this. However, long sweep arms are inherently more difficult to maintain consistent brush pressure over the length of the brush. Small horizontal offsets in screen panels or support structure can affect brush performance. This can be minimized with additional pivot points in the screen length more like a long windshield wiper (see Appendix 3 for additional discussion).

8.8

Consideration: Control of Biofouling: Control of aquatic organisms that will attach to the front or back of the screen. Mussels, freshwater sponges and snails are known to impact screen operation when they occur in abundance. Filter feeders are particularly problematic as the back side of screens with low approach velocity are ideal habitat for these organisms. Possible ways to minimize impact – i. Use Tee screens with internal brushes. ii. Close one module of the vertical screen to remove and clean all screens sequentially. Installation of blank panels should maintain a smooth screen face to prevent introduction of excessive near screen turbulence.
Benefits:

- Design for biofouling can mitigate effects on screen operations when biofouling does occur.

Challenges:

- Cleaning the front, back and slots of the screen on a frequent basis. For the flat plate this will require removal of panels. This process must be as easy as possible and not interfere with diversion or fish protection. Based on mussel growth/colonization rates experienced in the lower Colorado River this could require bi-monthly cleaning.

8.9

Consideration:

Mechanical Equipment: Minimizing the impact to diversion of mechanical failures on large screens will be needed. Major components that directly impact operating the screen within design criteria should be identified and ranked as to potential impact on diversion.

Possible ways to minimize impact –

i. Compartmentalize screen operation to the degree possible.
ii. Stock key components on site.
iii. Maximize diversion flexibility between diversion sites.
iv. Plan for access to perform O&M of screen cleaners during high flows.

Benefits:

- Reduce screen outage times.

Challenges:

- Identifying key components, identifying potentially better alternatives and planning for mechanical outages.

9.0 "Screen Type"

The ITR panel team members have substantial experience with the design, operation and maintenance of large Vertical Flat Plate and Tee Screen facilities. While the team was in agreement in most areas, there were some areas where the team was not in complete alignment. Therefore, in addition to the Team's comments given below the Team developed a matrix of screen type pros and cons by adding our comments to previously published comparison charts. The draft memorandum "Fish Considerations for Comparison of Tee screen and Flat Plate Screen" provided to the ITR comparing the alternatives does a good job of identifying the differences between the screens. The matrix allowed the team to comment on pros and cons of specific features of each screen and is given as Appendix 3.

Based on our collective experience we find:

1. Both provide State-of-the-Art screening technologies.
2. Both screen types could be designed to meet all fisheries criteria.
3. Both facility footprint and flow per screen bay favor the Tee screen option.
3. Screen cleaning favors the Tee screen option.
   i. Tee screens offer superior screen cleaning via the external and internal brush system.
   ii. The most common problems experienced with large Vertical Flat Plate screens are related to the brush cleaners, brush arms and pully systems especially for the long brush arms required at these sites. These systems generally are difficult to access. Observation of screen streaking during screen removal will indicate poor brush contact. Identifying the problem can require dive inspections of brush/screen contact.

4. Both screens will provide inflow structure creating hydraulic shadows downstream that predators could use for holding. The team believes relatively minor modifications can be made to both screen types that would reduce predator holding areas. Several ideas developed by the team are presented in the comments that follow. Assuming efforts were made to reduce predator holding during design the team has no clear screen favorite for limiting predation. Further studies would be needed to differentiate between the two.
   i. The vertical screens option has six brush cleaner arms that extend the full height of the screen. These will be large steel members with vertical brushes that have been shown to be used by predators holding next to the screen.
   ii. Tee screens would create hydraulic shadows downstream of the center leg of the 30 Tee screen cylinders extending from the wall and between the ends of the screens. These are possible predator holding areas.

Screen Type Considerations

9.1

Consideration:

Minimizing the screen footprint is important for reducing environmental impacts and improving operation of the screen. The Tee screens offer a major advantage on this issue and should be given strong consideration.

Benefits:
- Tee Screen option can be condensed into shorter structure reducing exposure.

Challenges:
- Both flat plate and Tee screens have the same area of screen exposed to fish.

9.2

Consideration:

Predation is a major concern no matter what type of screen is selected. Flat Plate screens could harbor predators behind the 6 sweeper masts, along the log boom, and downstream of the structure. The Tee screen could harbor predators behind the base of the tees projecting from the structure, downstream of or under the cylinders, along the log boom, downstream of the structure.

Benefits:
- Reference appendix 3 for more detailed discussion on Screen selection.

Challenges:
- Small fish swimming along the screen may be more vulnerable to predation due to expenditure of energy to avoid screen impingement and the lack of natural river structure for hiding. Predation impacts due to the screens cannot be definitively answered although more research would be beneficial. Identifying the flexibility of each screen design to adaptively manage predation is likely more valuable than trying to estimate the potential difference of predation between screen types.
- Many behavioral fish guidance/barrier systems have been installed to control fish behavior near water intakes. In general, the effectiveness of such devices can be summed up as “partially effective”. Electric pulse systems are widely tested behavioral devices. They have been tested on many predator species including striped bass in laboratory and field trials. Electric pulses used for shocking fish affect larger fish more than smaller fish and therefore offer the ability to irritate larger predators while causing little effect on small fish. Installing electrodes in areas thought to be predator holding areas near screens could likely scatter predators taking advantage of screen structure. Other methods of managing predation should also be evaluated. These include, but are not limited to, reducing water visibility along the screen by pumping turbid water from a settling ponds into the river near the surface when large numbers of smolts are migrating downstream (likely most effective for Tee screens that draw water lower in the river), evaluate predator response to operation of sediment jetting in front of the screen, installing a bubble curtain to reduce/obscure predator visibility in the upper water column (likely most effective for Tee screens that draw water lower in the river).
- Fish may become tolerant of deterrent method over time.

- Evaluating effectiveness will be difficult
- Requires O&M of additional equipment
- Ensuring fish deterrence system does not provide a hazard to the public.

9.3

Consideration: The smaller module approach offered by the Tee screen concept would likely provide greater control of near screen hydraulics thus allowing better compliance with screen criteria.
Benefits: • Baffling a large flat plate screen to meet 0.2 ft/s criteria over its full length and height will be difficult at best.
Challenges: • Tee screens can be very problematic in this regard also since their baffling system is fixed plates inside the screen cylinders. If they do not meet approach velocity criteria, making the necessary adjustments could be difficult.

9.4

Consideration: Measuring approach velocities at vertical flat plate, and Tee, screens could be difficult especially in areas of high sweeping velocities. The flat plate screen approach velocities would be measured from meters on a boom hung from a dolly on the sweeper trolley rail. Adjustments to the baffling would be mad from the deck of the structure. The Tee screens would likely require divers to position the velocity meters on all sides of the screen. Baffling would be determined from large scale laboratory tests. Field adjustment of Tee screen baffles would be difficult.
Benefits: • Measuring approach and sweeping velocities are required by fish agencies
Challenges: • Flat plate screen: cleaning the screens would be difficult during measurement operations; high flows could cause vibration in the mast degrading measurements. • Velocity measurements in the 0.2 ft/s range are difficult to make with ADV's mounted on long booms suspended in flow. Measurement position, meter orientation and vibration of the mast/meters are difficult to control. • Using divers to mount meters directly on the screen should be considered. • Tee screens: measurements at high flows would be very difficult for divers to hold in position; turbidity could make it difficult to for divers to locate themselves;

adjusting baffling would require removing the screen cylinders, opening them up, and replacing the baffle plate with a new one.

9.5

Consideration: Avoid screen designs that could require intermediate bypass collection and conveyance systems in the intake design. V screens should be avoided to eliminate the need for fish bypass pipes and fish handling and exposure to concentration and turbulence and the discharge location.
Benefits: •
Challenges: • Experience has shown these types of bypasses to be problematic especially for predation where the bypasses are discharged into the river.

9.6

Consideration: A key element of intake design will be regulatory acceptance of the design configuration. Unless there is a strong rationale for an alternative design the preferred intake configuration supported by CDFW, USFWS, and NMFS should be the preferred design concept. Either the flat plate or Tee screen intake configurations appear to be functional at the selected sites so that the preferred intake design would be the design approved by the regulatory agencies.
Benefits: • Letting the Agencies select the type of screen system would reduce effort in trying to sell a different concept or carrying two different system further into design.
Challenges: • Whatever screen is currently acceptable with the agencies would be selected without consideration to many of the advantages or disadvantages discussed in Appendix 3.

9.7

Consideration: Screen Brush on Vertical Flat Plates – add more pivot points to more evenly distribute forces on the brushes. See Appendix 3 for additional details.
Benefits:

• Provides a more even brush pressure on the screen over its height. This prevents uneven cleaning in the vertical or "striping" on the screen.
Challenges: • Brush could extend out further from the screen.

10.0 "Screen Refugia"

The team believes opportunities for including refugia as an adaptive management component should be considered during design.

10.1

Consideration: Evaluate fully designing a continuous horizontal refugia with continuous horizontal bars mount on the bankside of the piles for the floating boom. Also, design a shroud that could be installed underwater to cover the refugia if it does not prove beneficial.
Benefits: • Would not impact either screen design
Challenges: • Could be difficult to remove or modify after installation

10.2

Consideration: Refugia mechanisms could be incorporated on non-screen sections of Tee screen which would not add to overall length.
Benefits: • Could help with agency acceptance • These refugia could be easily pulled out with the screen to be inspected, repaired or modified. • Several different types of refugia could be tested and modeled in this fashion but does not require divers to inspect or modify
Challenges: • Limited to individual screen and not available for entire distance.

10.3

Consideration: Refugia should include horizontal bar configuration and extend, to the extent practical giving screen modules and cleaning, across the entire length of each intake. The refugia bars should be spaced to allow fish less than 3 inches in length to enter and exclude all Tee screen intake modules should be located as low in the water column as possible while avoiding bed load sediment transport.

Benefits: • Horizontal bars appear to perform better than vertical bars
Challenges: • Use of horizontal bars imposes some design requirements.

10.4

Consideration: For the Tee screen option, cones should be placed on the upstream and downstream screens to provide smoother hydraulic conditions and reduce velocity refugia and turbulence that encourage potential predation.
Benefits: • Could reduce predator holding areas
Challenges: • Need to store addition replacement Tee screens with end cones.

10.5

Consideration: Design refugia to exclude fish greater than 16 inches in length. If debris loading, excessive eddies or turbulence, predation, etc. are observed the refugia should be covered and no further consideration of application of refugia given to intake design or operation (adaptive decision).
Benefits: •
Challenges: • Sizing the refugia entrance racks to provide refuge for prey while excluding smaller predators could be difficult.

10.6

Consideration: There is no definitive data as to the benefit or dis-benefit of refugia. Are refugia safe locations for prey or small predators?
Benefits: • Designs based on experience and judge can be customized to the current situation.

Challenges: • Designs may need to be either removed or shrouded if they provide net dis-benefits.

10.7

Consideration: For design look at wider horizontal refugia built into fish screens or at bottom of blank panels above screens. Consider designing in removable camera locations inside refugia to assist in adaptive management decisions.
Benefits: • Horizontal bars at refugia entrance have been found to work better than vertical bars. • Cameras in the refugia would aid in determining if the refugia are providing a benefit
Challenges: •

11.0 "Other relevant topics"

11.1

Consideration: Do 2-D river modelling early enough to inform decision of final screen placement.
Benefits: • There are many factors that will rely on this modeling
Challenges: • To get maximum benefit such modelling should be done sooner rather than later.

11.2

Consideration: Potentially, screens could be moved slightly closer to outer bend to increase sweeping velocities,
Benefits: • Would help in screen cleaning and quicker passage of fish.
Challenges: • This might not be the best for Delta Smelt, nor for verification of the 0.2 ft/sec maximum diversion flow velocity. This may require adjustment of the baffles and/or increased screen design area

11.3

Consideration: More information is needed for screen contact and predation.
Benefits: • This data could better inform the design of the screens and refugia.
Challenges: • The sooner such data is gathered the more useful it would be.

11.4

Consideration: Need studies of fish presence and distribution at the screen sites. Needed for baseline studies anyway.

Benefits: • Could aid in design and operating rules for water withdrawals.
Challenges: • The sooner such data is gathered the more useful it would be for the design.

11.5

Consideration: Study predator use of piles and log booms at existing screens.
Benefits: • Could inform design of log booms and refugia.
Challenges: • The sooner such data is gathered the more useful it would be for the design.

11.6

Consideration: Non-physical fish deterrents/guidance can be considered.
Benefits: • Could keep some fish away from the screen structures.
Challenges: • Studies of such systems have shown them to be partially effective.

11.7

Consideration: On a sustainability basis, you may want to consider installing solar panels to augment power usage.
Benefits: • Simple step to gain sustainability credit.
Challenges: •

11.8

Consideration: If Tee screens are used, consider using electric motor in lieu of hydraulics
Benefits: • Reduce the potential for oil entering water way. This action should be considered for any hydraulic equipment that could leak into the river water.
Challenges: •

11.9

Consideration: 1. Suggest confirmation of project hydraulics in light of the recent adoption of the Folsom Dam operating manual. Additionally, the widening of the Sacramento Weir will affect the frequency and flow characteristics of the Sacramento River downstream of the American River confluence. Potential changes in hydraulic grade lines as well as sediment transport conditions may affect project operations.
Benefits: • Potential changes to anticipated discharge frequency and potential sediment transport conditions can be incorporated into the design.
Challenges: • Proceeding without this confirmation creates risk of future operations difficulties.

3.0 CONCLUSIONS

The Intakes ITR Panel is impressed with progress made on the conceptual design of the Intakes for Delta Conveyance Project to date, but also realizes that there are many key design parameters that still need to be determined before the conceptual Intakes design is ready for solicitation for final design. Appendix 6 contains a short list of Action Items that should be accomplished prior to the next Intakes ITR Panel meeting.

4.0 NEXT INTAKES ITR PANEL MEETING

The participants agreed that at this point it would be premature to set a firm date for the next Intakes ITR Panel Meeting.

5.0 CLOSURE

This was an exceptionally productive meeting. The Intakes ITR Panel acknowledges the efficiency with which the First Meeting was organized and conducted. We compliment the presenters and project manager and also note the willingness of individuals from all parties to present findings and opinions, and to provide technical and strategic leadership to the project.

Respectfully submitted,

Dale E. Berner | Raymond Costa | Brent Mefford | Mark Nunnelley

Robert Bittner | Charles Hanson | Dennis Dorratcague

Appendix 1: Daily Agendas

Delta Conveyance
Intakes ITR Panel Meeting – March 17-19, 2020

BONDERSON CONFERENCE ROOM 422: 901 P Street, Sacramento, CA Skype Sessions

TIME: 8:00 AM Start each day

Meeting Goal and Objectives

1. Develop Common Understanding of Intake Facilities and Identify Critical Issues
   - Project description; Facility needs/features; Fish protection; Hydraulics; Operations; Project scope; Major assumptions
2. Screen-Type Selection Issues – Plates vs. Tees
3. Intake ITR Feedback on Proposed Facilities
   - Minimizing intake footprint; Hydraulic control issues; Construction sequencing; Cofferdam and deep foundation constructability considerations; Sediment management; Maximum screen panel height; and, Other relevant topics

Day 1 AGENDA for March 17, 2020

8:00- 8:05 Introductions - Safety Moment – *Darryl Hayes*

8:05- 8:15 Opening Remarks – *Tony Meyers*

8:15- 8:30 Delta Conveyance Project Overview (including Intakes) – *Phil Ryan / Darryl Hayes*

8:30- 9:30 Proposed Intake Facility Presentations – *Phil Ryan*

- Site information, Hydraulics, Sediment management, Operations, Etc.

- Plates vs. Tees (Engineering Considerations)

9:30- 10:00 Fisheries, Fish Protection, and Fish Passage Issues – *Gardner Jones*

- Downstream and Upstream Passage, Predation issues, Fish Refugia, Baseline studies, and Data gaps
- Plates vs. Tees (Biological Considerations)

10:00- 10:15 ----- Break ------

10:15-11:00 Geotechnical Setting – *Andrew Finney*

- Subsurface conditions
- Conceptual structure foundation and cofferdam construction

11:00- 11:45 Levee Modifications – *Phil Ryan*

- Sequencing
- Flood protection considerations
- State Highway 160 realignment (Temporary/Permanent)

11:45-12:15 Discussions and Questions - *All*

12:15- 12:45----- Lunch Break -----

12:45- 4:30 Field Trip – DCP Proposed Intake Sites, ISI Shop (Large Tee Screens), RD2035 or Freeport Intake Visit

Day 2 AGENDA for March 18, 2020

1. ITR Panel Review and Discussions – *ITR Panel and Selected DCA and DCO Reps*
2. Summary Recommendations and Presentation Preparation – *ITR Panel and COWI*

Day 3 AGENDA for March 19, 2020

10:30- 12:00 ITR Panel Summary Presentation – *ITR Panel*

12:00 Adjournment

Appendix 2: Lists of Daily Attendees

March 17, 2020 Skype Session Attendees

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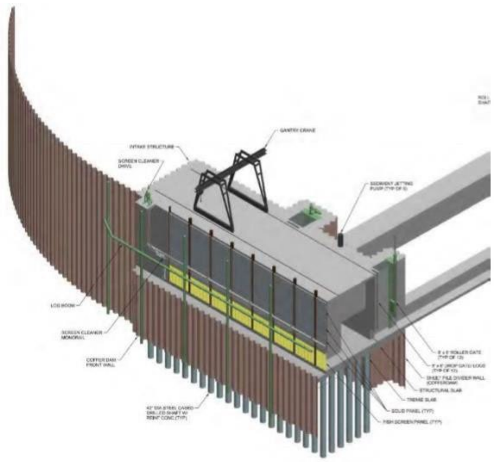
Appendix 3: Comparison Table of Vertical Flat Plate, and Cylindrical Tee, Screens

Adaptation from Table 2. Comparison of Vertical Flat Plate and Cylindrical Tee Screens Characteristics in On-Bank Structural Configuration –

Taken from Delta Conveyance Design & Construction Authority Draft Technical Memorandum, section 3.4.2 – Intake Structural Configuration and Fish Screen - Dated November 22, 2019 –

This table was revised by the ITR panel to include more current information based on the experience of the ITR. The middle column lists the features of each screen and the right-hand column provides panel commentary by the ITR members for the design team to get a full understanding of the issues experienced by this team. The first table discusses vertical flat plate screens, and the second discusses Tee screens.

Vertical Flat Plate Screen Discussion:



Comparison Factor	Vertical Flat Plate Screens	ITR Commentary
Screening Cleaning	• Counterweighted brush moves both directions on wire rope and pulley system.	• Cleaning occurs by two methods: 1) back eddy behind moving brush lifts debris off screen to be carried downstream in sweeping flow; and 2) brush pushes debris downstream to end of travel. The brush is then lifted off screen by traveling up a ramp, so sweeping flow can carry loose debris off the brush and downstream
	• Effective cleaning if properly maintained and adjusted.	• This was questioned by the some of the ITR and found that cleaning is not completely effective and potentially leaves uncleaned areas. Inspection and adjustment of screen cleaners may require divers. • Although some members had not experienced this and suggested that *Usually the brush arm is removed and checked/modified on the*

		structure deck.
	• High maintenance requirements: frequent adjustments needed	• This is mainly for the drive cable tension system, however some felt that the overall cleaning mechanism will require frequent maintenance due the long moment arm of the assembly.
	• "Striping" is common; this is bands on the screen face that are not fully cleaned.	• This can be mitigated with multiple pins arrangement for better articulation of brush segments, like a windshield wiper. This would more evenly distribute the force on the brushes. • Design could add adjustable wheels at top and bottom of the brush arm to adjust and even the distance out from the screen.
	• Biofouling will require more O&M	• Clean the screens of biofouling as follows: Use gantry crane to place blank panels behind the screens, remove blank panels above screens, remove screens, pressure wash back of screens, then replace screens then blank panels.
	• Subject to debris collection and damage.	• Large debris usually travels on the surface in high flows and debris that passes the log boom is floating above the screen panels and would strike the blank plates and could strike the screen sweeper arm.
	• May want to consider a break-away section at the bottom of cleaning brush to prevent damaging the entire structure if it connects with sediment below the screen.	• Alternately, a current-rising or other type of relay could sense that the brush is being stopped by sediment/debris. This would then shut off the drive. This system has been used on other projects.
	• Traveling "toothbrush" type screen is extremely sensitive to sediment and it could result in major maintenance issues. Will need a very robust design.	• Sensors mentioned immediately above would prevent damage.
	• The Panel believes that it would be difficult to clean a 20-ft high	• This is true for sweeping flows greater than about 3 fps due to the

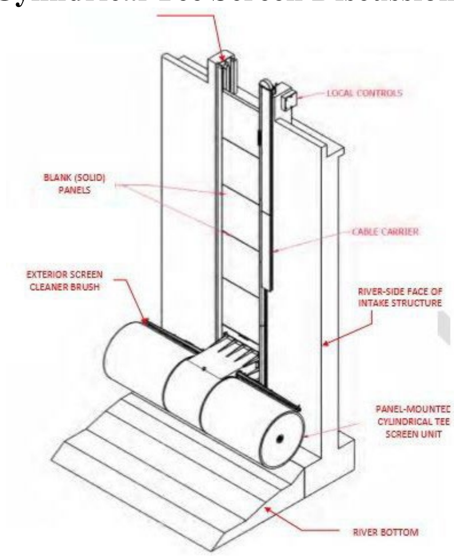
	vertical flat plate screen.	long brush arm. It isn't the 20-foot screen height but the brush arm length, which equals 20 feet of screen height plus the 30 feet above that up to the height of the trolley at about the 100-year flood level. • Lowering the screen trolley rails could alleviate this problem. But this would put the rails and screen cleaner trolley under water at high flows. • Some panel members believe brush length and cleaning effectiveness/maintenance are inversely related as for brush lengths greater than ~15 ft.
Fish Protection	• Flat structure surface, and little opportunity for predator holding along screen face.	• Predators could hold behind brush sweeper arms which will be parked most of the time. • Striped bass longer than 6" have a sustained swim speed of >2 ft/s. Predator holding areas may be less important than screen length and lack of surface complexity along a screen.
	• Requires longer structures; therefore, longer fish exposure – possibly too long for Delta smelt.	• Assuming a 3,000 cfs screen and a flat plate screen 17.5 feet high the difference in length between flat plate and Tee screens is: Site2 616 feet (39%); Site3 310 feet (24%); Site5 412 feet (30%). • Continuous screen length should be also be considered.
	• Opportunities for refugia are minimal without adding to overall length.	• Possible refugia solutions without adding to length are: horizontal refugia built into screen panels, refugia in the 26-foot long blank sections at the screen cleaner brush parking area. Building refugia into the screen piers could lengthen the structure 20 to 50 feet in length.
	• Flat Screen does not allow preference to pull from different elevations in the river. Water is withdrawn evenly over the height of the screens.	•

	• Horizontal control of water withdrawals can be varied in 250 cfs increments by closing the conduit gates.	• If greater control is desired on vertical flat plate, the screen module size can be reduced. This would be done by adding divider walls inside the structure and adding more but smaller gated conduits from the structure to the sediment pond.
Flow Control	• Adjustable baffle plates help provide uniform approach velocity through each screen panel.	• These are adjustable from the deck of the screen structure. • Adjustments will likely require multiple iterations of adjustment and measurement for all panels within each 500 cfs bay followed by a set of measurements along the entire screen.
	• Flow control in ~450- to 500-cfs sections, with large control gates and flow meters in box conduit extending behind structure to sediment basins.	• Additional module sections could be added for finer flow control. This makes 12 modules instead of 6. The flow control would be at 250 cfs max increments.
	• Uniform flow performance dependent on adjustable baffles; can vary with river depth and diversion rate.	• Vertical flow control can be achieved with baffling adjustable in 2 or 3 vertical segments. This adds complexity to adjustable baffles. • Accurate flow control highly dependent on downstream sedimentation basin level control to facilitate fine flow control at screens and intake structure sections using baffles and large gates. This is true with tee screens also. I think that adding more modules as described above makes the alternatives about the same.
Operations and Maintenance	• Screen removal frequency relatively high (~ every 3 months).	• At most large flat plate installations screen panel removal is once per year or less. • May be more frequent if mussels, sponges or another organism colonize the screens in the future. Could require monthly removal and cleaning during summer months if mussels or other filter feeders colonize the screen in the future.

	• Screen removal relatively simple.	• Some members feel this is fairly labor-intensive process and could involve divers and underwater work if problems with screens seating properly occur over time. • Other members feel the labor is about equal to removing the screens for either screen configuration.
	• Screen cleaner system more complex.	• From experience, the cleaning arm is subject to significant damage from debris and sediment. Multiple sites have been identified where significant maintenance was required for cleaning arm.
	• Fewer motors, and none submerged.	• Failure of a cleaner arm requires closing 500 cfs screen bay during repairs.
	• Sediment jetting system required to resuspend settled sediment for transport from wet pit intake structure behind screens into the sediment basins.	• Panel suspects that the jetting action will be required quite frequently and continuously at times at a significant cost. • Jetting systems have been used at several screen installations, such as: Paterson, Banta Carbona, RD2035, others.
	• Sediment jetting will also be required in front of the screens to prevent build up which would impede cleaning brush.	• Need to contact other installations, preferably on the Sacramento or San Joaquin Rivers, to see how effective this is.
Other Factors	• Requires wet pit structure to distribute screened flow to sediment basins.	• This also creates a significant sediment trap area that will require jetting pumps
	• Best screen material (Profile Wire by Hendrick Screens) is manufactured by one firm in Kentucky.	•
	• Known regulatory acceptance for proposed large intakes.	•
	• Screen panel can be repositioned to a higher setting in the future, but screen cleaner mechanism	•

	would also need to be modified.	
	• Expected to result in larger and therefore, higher cost intake facilities	•
Potential for sloped screen	• There are challenges with sloped flat screen including increased cleaning difficulty and increased silt intrusion due to more horizontal distance.	• This alternative is not recommended for further study.

Cylindrical Tee Screen Discussion



Comparison Factor	Cylindrical Tee Screens	ITR Commentary
Screen Cleaning	• Cylinders rotate forward and backward on interior and exterior brushes.	• Drive motor and retention of required gap spacing appears to be very reliable based on operational histories
	• Superior cleaning as long as brushes are maintained in good condition. Fewer hot spots.	• This is dependent on the hydraulics of flow approaching the screen structure.
	• Better biofouling performance, and less O&M effort.	• Internal brushes will brush off interior biofouling. Organisms attaching to the non-screen surfaces may remain inside the screen unit.
	• Minor debris collection potential on external	• The brush on each screen cleans a length of about 25 feet (pi

	brushes.	times 8 ft). Whereas, the flat plate brush cleans a length of about 145 feet.
	• Easily removed from service for deep cleaning with minimal impact to operations.	• Some members questioned if it was any easier than flat screen, suggesting that cleaning is done by use of gantry crane to remove blanks above screen, remove screen, lower blank panels over opening, pressure wash screen or maybe remove screen to access inside. • A gate valve directly behind the Tee screen would make this process easier and require no blank plate. Just close the gate and pull the screen out.
	• Superior cleaning of back and front of screens	• Affords greater flexibility to adapt to changing debris and biofouling conditions over time (i. e. zebra mussels, sponges, etc.).
	• The internal and external brush system provides much better cleaning of the slots in the wedgewire fabric.	• Experience at other installations has shown high reliability over years of operation.
Fish Protection	• Space between screen cylinder units (about 1 foot) is a potential predator holding area. Some mitigation may be possible.	• Moving the screens closer together or adding Coned sections on end of screens and/or brush seals and/or flexible fingers could mitigate this issue. • Predators could hold under the screen along the floor looking upward for prey. This behavior has been observed at other locations. This consideration is not screen specific.
	• Area on downstream side of tee connection to structure is a potential predator holding area.	• See above comments • Predator deterrence methods such as electric pulses and methods to obstruct/reduce flow visibility could be deployed in these areas if needed.
	• Substantially shorter structure and related	• Multiple individual screens may provide better opportunities for

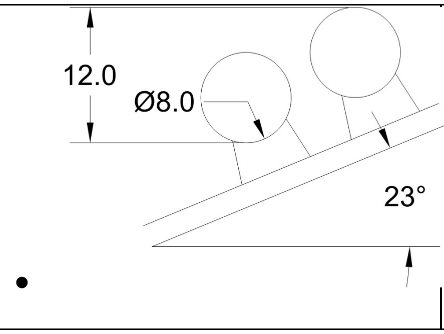
	exposure time than vertical flat plate system.	fish to move away from the screens compared to a continuous flat screen/wall.
	• High refugia opportunity along structure face, but minimal along screens	• Potential for Refugia on non-screened section of Tee screen. Allows for easy removal, inspection and testing of different types.
	• Due to the greater flow control of either the single Tee screen or dual stacked screen, gives better ability to control for either 0.33 ft/s or 0.2 ft/s depending on real time fish population data	• This is accomplished through the smaller conduit and downstream gate valve instead of the 8'x8' slide gate.
	• Either single or Dual stacked screens would allow control bias to pull more from lower portion of the water column or from the higher portion to avoid bed load sediment transport.	•
	• "Cylindrical design expected to occupy less water column and therefore reduce encounter/impingement" from ICF report 7 March 2020.	• The area of fish screen drawing water is the same for Tee screens and flat plate screens. If fish are higher in the water column, this could mean less screen near fish for the Tee screens.
	• Inclined Tee Screen offers additional benefits of providing more low velocity shore area for adult smelt migration.	•
Flow Control	• Flow control for individual screen units better than individual vertical flat plate screen panels.	• This is not necessarily true because: <u>Vertical flat plates</u>: there are newer and better types of baffling arrangements, baffles can be arranged to independently adjust baffling vertically in 2 or 3 sections, baffles can be adjusted relatively easily from the screen deck; however, such adjustments may, or may not, be adjusted correctly over the whole face of the screen. <u>Tee screens</u>:

		Tee screen baffling is fixed based on lab experiments. In the river, flow approaching the structure is probably different than in the lab, especially at different points along 950 feet of screen structure. • To prove the uniformity of approach velocities on the screens, hydraulic measurements will be required at many points along the screens, flat plate or cylindrical. For flat plates this can be done by suspending a vertical boom from the cleaner trolley rail; which can be difficult to perform correctly. On the Tee screens this might have to be done by a diver, which is problematic if sweeping flows are above 2 fps, or it could be done by raising the screen and changing the orientation of an attached sensor, repeatedly. If approach velocities do not meet criteria requirements, the baffles can be adjusted from the structure deck for flat plates. For tee screens each unit has to be raised to the deck and disassembled and the baffle plate replaced with a differently drilled plate and re-installed. • ADV meters could likely be mounted on the screens in their raised position and then lowered into place. This method would provide the best control of meter alignment and data quality.
	• Dual stacked Tee screens could potentially provide even greater resolution for control.	• Each screen having its own gate valve.
	• More difficult to use adjustable baffles for individual units, but screen	• There are variable hydraulic conditions along 950 feet of screen structure. So, I am not

	uniformity easier to laboratory test and adjust.	sure the that the lab baffle settings are going to meet agency approach velocity requirements. • Manufacturer should be asked if adjustable baffles could be designed for the screens. Using two concentric perforated baffle cylinders instead of one may be possible. Adjustment could be made when screens are pulled from center discharge pipe.
	• Flow control for each 100-cfs screen unit using in-line control valve and flow meter; results in a more accurate total intake facility flow control.	•
	• Only minor dependency on downstream sedimentation basin level control because of in-line control valve and meter.	• The culverts in the flat plate layout do the same thing. The valves (tee screens) or gates (flat plate screens) both depend on the sediment basin water level.
	• Tee screens could facilitate a curved intake structure to take advantage of higher sweeping velocities and deeper water in river bends. Potentially reduce river intrusion compared to straight line.	• For either screen type, degree of river intrusion has to do with obtaining desired sweeping velocities while keeping the flood rise to below 0.1 feet.
	• The smaller module approach offered by the Tee screen concept would likely provide greater control of near screen hydraulics thus allowing better compliance with screen criteria. Baffling a large flat plate screen to meet 0.2 ft/s criteria over its full length and height will be difficult at best.	• Meeting approach velocity requirements could be difficult for tee screens because baffling to control flows in each screen is fixed. • The sensitivity of Tee screens to the angle of flow attack should be determined.
	• Cones would likely be needed at upstream and	•

	downstream screens for better flow dynamics and reduce velocity refugia and turbulence that encourage potential predation. •	
Operations and Maintenance	• Screen removal frequency less (~6 months).	• Potentially even longer frequency due to superior cleaning ability.
	• Screen removal is similar to vertical plate screen panels, but involves substantially more weight; therefore, larger crane or hoist equipment is needed.	• While the screens are heavier, the downstream gate valve makes it easier to take one screen out of service at a time and has less risk of sediment intrusion or fish entrapment while screen is out of service. • The agencies will probably require a slide plate/gate immediately behind the Tee that can be closed when the Tee is removed to prevent fish from entering.
	• More motors, all submerged but accessible when screen unit raised; generally low-maintenance motors.	•
	• Possibly more debris collection.	• Since screen cylinders extend out from structure, they could catch large debris. • There is solid evidence from multiple sites that the cleaning is superior for small debris on the screens.
	• Industry experience shows that cylindrical screen systems require less routine maintenance than vertical flat plate systems.	•
	• No sediment jetting system required because intake structure is dry pit.	• However, sediment jetting on the river side below the screens will be critical to ensure sediment does not build up to the screen.
	• Screens directly piped to sediment basins; no wet pit structure required.	• Reduces the buildup of sediment inside screen structure because there is no chamber to trap sediment.

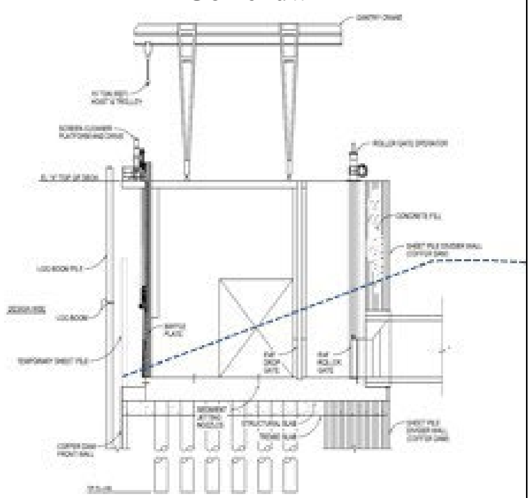
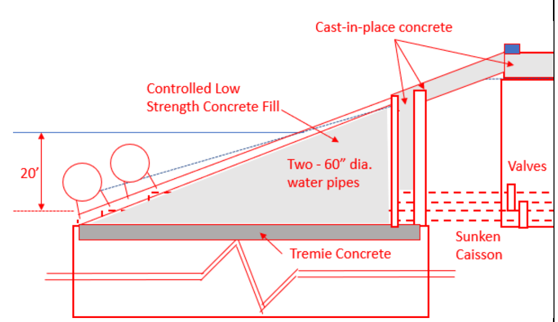
Other Factors	• Currently, single local supplier of the brush cleaned Tee screens (located in Freeport, CA).	• This could require licensing to other contractors to help build tee screens in required time.
	• Regulatory acceptance is good for other installations, but unknown for proposed large intakes.	•
	• Screen unit can be easily repositioned to a higher setting in the future with some modifications.	• Needs new pipe with a tee into the existing pipe in dry well to accomplish this. • Could likely be engineered with a vertical manifold to allow repositioning if this was felt to be important.
	• Expected to result in lower cost intake facilities.	
	• Dual stacked vertical Tee Screen has potential of reducing overall screen length by 10-20%	
Potential for sloped screen	• There is potential for installing either 1 or 2 stacked Tee screens on sloped surface which could result in improved surface water velocity for adult smelt.	• No other significant drawbacks to sloped surface other than increased footprint. I think there are numerous challenges to a sloped design that would need to be worked out, but worth investigating, if passage of adult Delta Smelt is of greater benefit.
	• Tee screens on a slope allow for shallow areas for passage of adult Delta Smelt. Passage has been judged to be difficult at vertical structures where high sweeping velocities over a long-distance limit smelt passage.	• This inclined Tee screen configuration has the potential to decrease the length of the intakes by up to 48%.

	12.0 Ø8.0 23°	

Appendix 4: One Representative Offsite Prefabrication Method Using a Slide-in/Lift-in Construction Technology with a Table Comparing This Offsite Prefabrication Method to Construction Using a Conventional Cofferdam and Examples of Relevant Existing Projects.

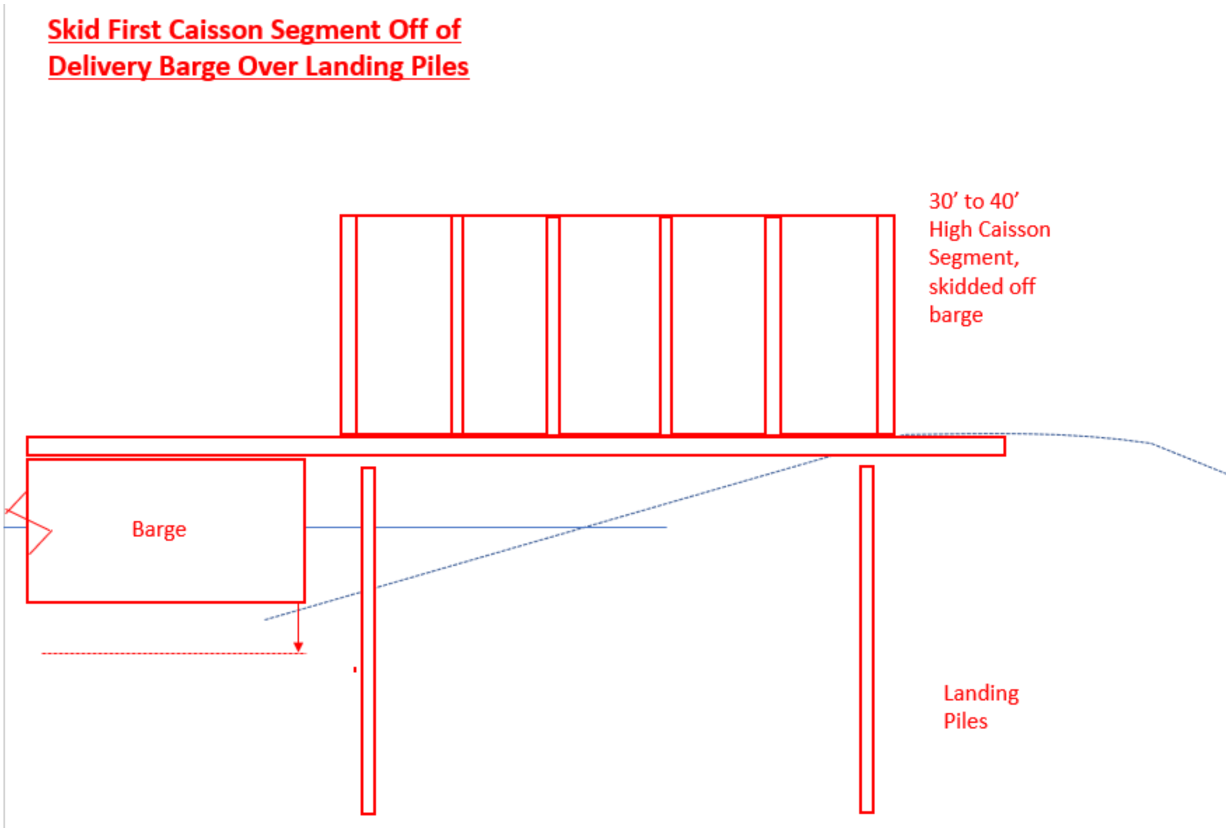
It is noted that the offsite prefabrication method shows an inclined configuration with stacked Tee screens; this construction approach is relevant to both vertical and inclined screen configurations.

Comparison of Conventional Combi-Wall Cofferdam vs Offsite Prefabrication for the Intake Structures
This table was created by the Intake ITR Panel

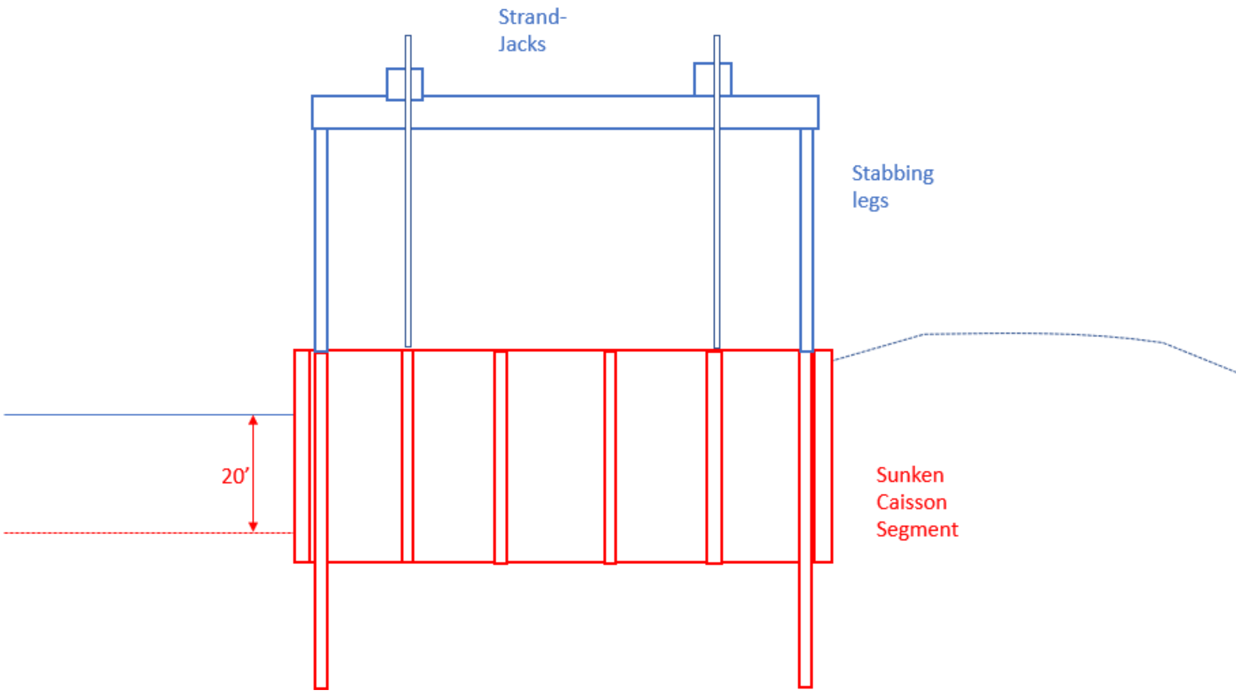
Comparison Factor	Conventional Combi-Wall Cofferdam	Offsite Prefabrication with Slide-in Installation
		
Construction Logistics	• All construction logistical support from land-based operations and equipment. • More contractors qualified resulting in more competition. • Use of land-based equipment results in more emissions	• The majority of construction logistical operations and equipment are marine-based • Larger contractors have existing marine equipment and are better suited for this scale of construction. • Distributed sourcing of prefabricated sub-units or modules could be divided between existing and/or new offsite prefabrication facilities
Construction Schedule	• Risk of adding almost an additional year to the schedule • Land-based construction of both the conventional cofferdams and intakes would add to congestion associated	• Can fabricate precast sub-units at existing precast yards during mobilization, clearing & grubbing and landing shaft installation. • The sunken caisson could be

	with the construction of the back-lands facilities; which would slow construction. • Installation of numerous large diameter drilled shafts could be limited by equipment availability.	fabricated in 20' to 30' high sub-units to facilitate: barge transport, lateral sliding and sinking operations. This would also help to maintain schedule. • Provides more construction float-time by eliminating the time required to build a conventional cofferdam.
Quality Control of Final Product	• Allows for visual inspection of completed intakes • More contractors are familiar with this type of QA/QC. • Quality control within a congested cofferdam is more challenging then for work at the surface.	• Quality of precast concrete elements is typically better than that for concrete cast within a congested cofferdam. • The dry-pit for a Tee screen intake facilities inspection using non-destructive testing.
Cost Considerat ions	• More numerous bidders may limit the cost of the cofferdam; however, a cofferdam is not needed for offsite prefabrication construction. • Unit prices for land-based operations are typically lower than unit prices for marine operations.	• Eliminates the cost of a conventional cofferdam • Reduces the risk of costs associated with potential construction delays. • Marine operations combined with offsite prefabrication can accelerate the construction schedule; which can reduce overhead costs.
Other Factors	• Conventional cofferdams require larger footprints than would offsite prefabrication. • Sheet piles may come out of interlock during construction. • Cofferdam dams are subject to flooding.	• Precast concrete sub-units could be fabricated at the same facility as the precast concrete tunnel liners • Sinking of caissons is less disruptive to the riverine environment. Also, no dredging is required when using the sunken caisson method. • Requires more engineering than conventional construction. • It is practicable to sink several caissons at one time on one site. • A combination of in-the-wet construction techniques could be used including both float-in and lift-in technologies.

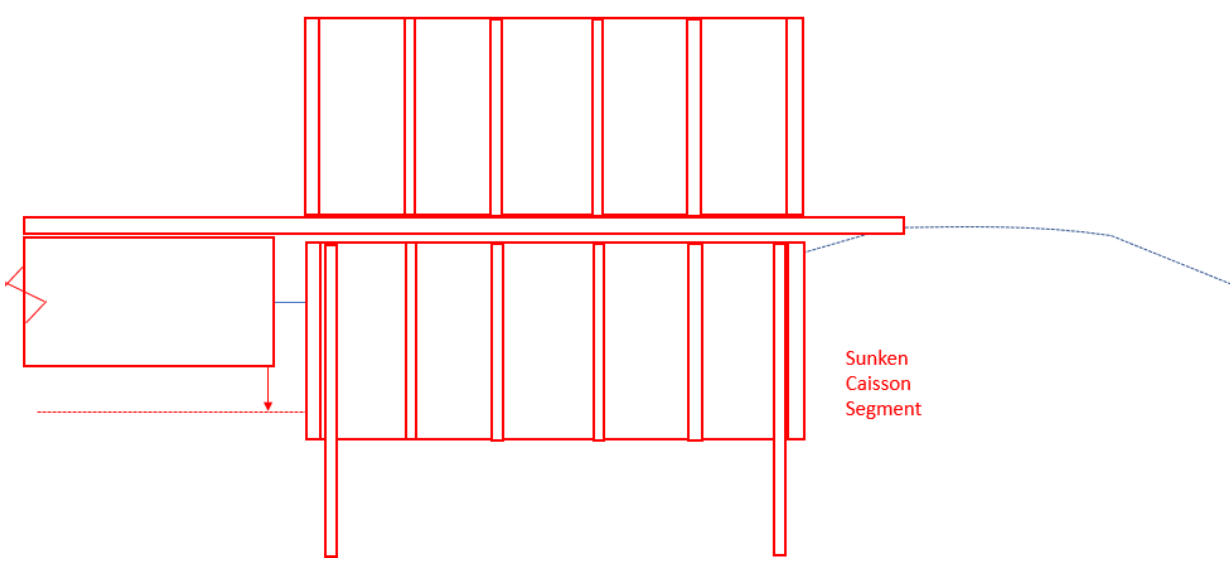
<u>Possible Construction Sequence for Slide-In Offsite Prefabrication of an Inclined Double Tee Screen Intake About 500-ft Long</u>

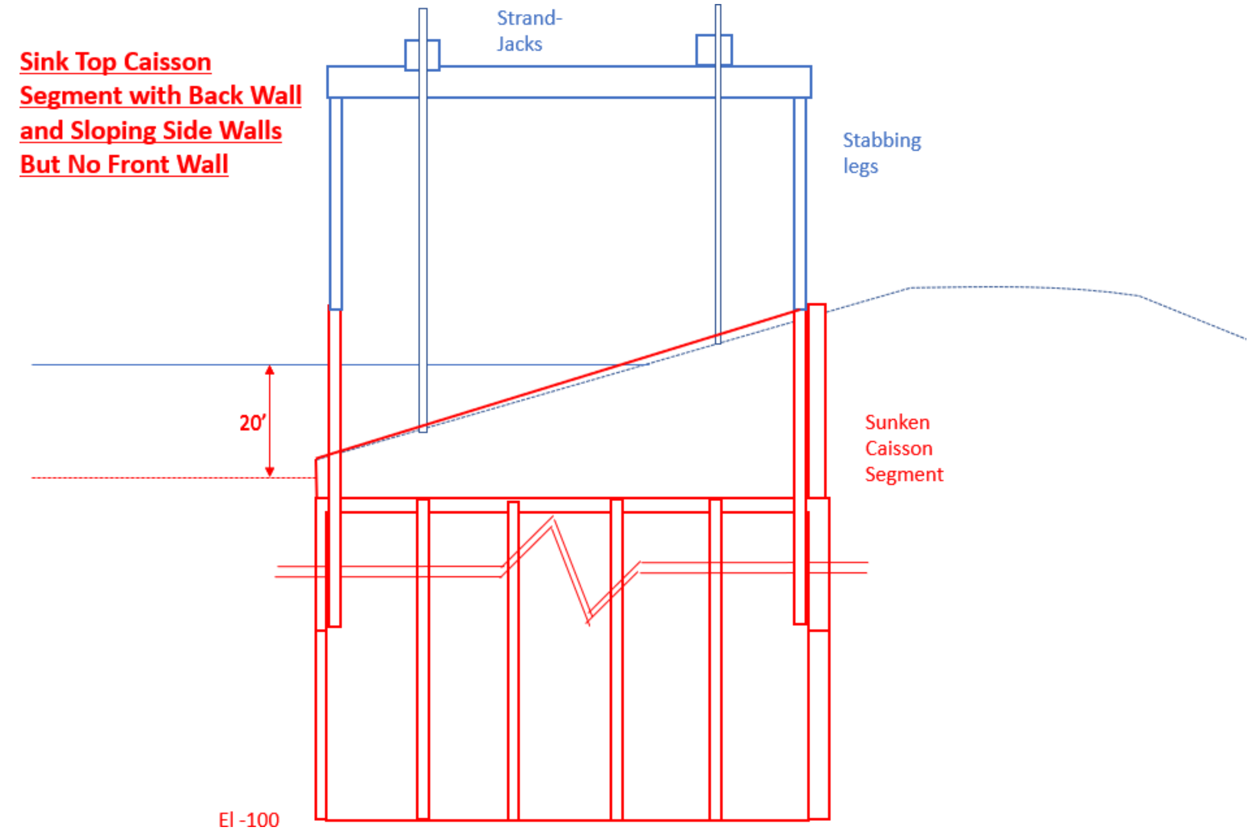


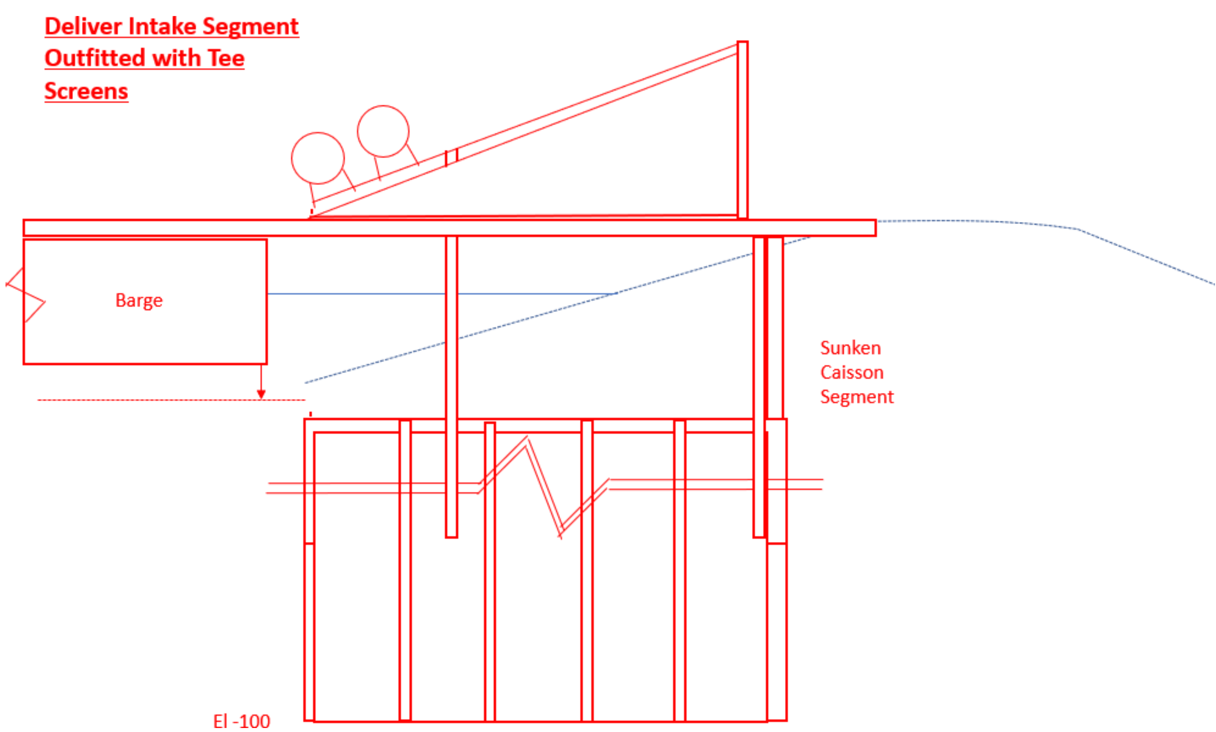
Lower First Caisson Segment Using Strand Jacks and Excavating Interior

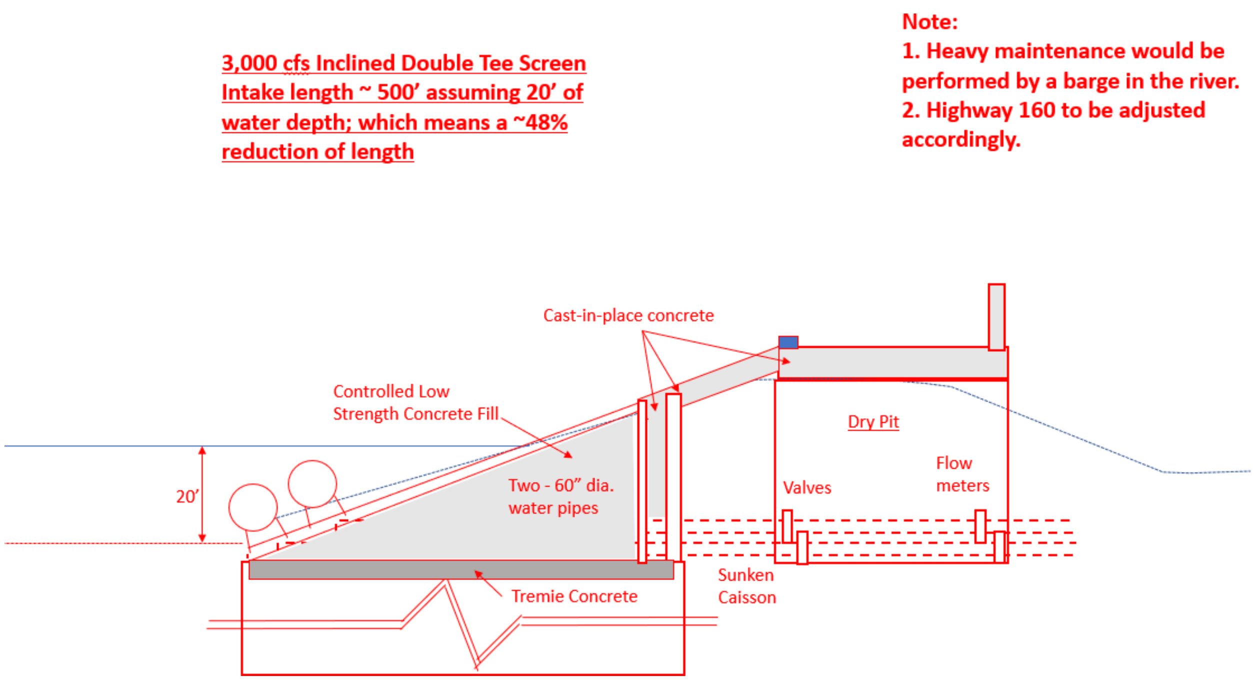


Skid Second Caisson Segment Off of Delivery Barge Over Landing Piles




Sink Top Caisson Segment with Back Wall and Sloping Side Walls But No Front Wall
Strand-Jacks
Stabbing legs
20'
Sunken Caisson Segment
El -100


Deliver Intake Segment Outfitted with Tee Screens
Barge
Sunken Caisson Segment
El -100



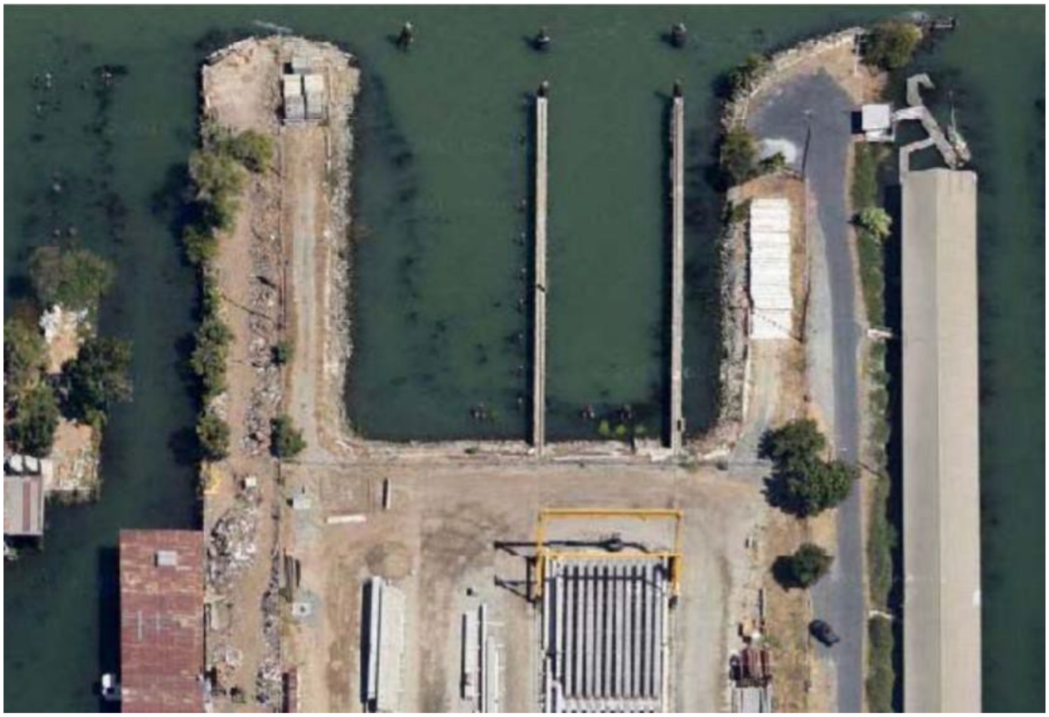
Example of the Slide-in Construction Method for a Replacement Bridge Superstructure

Delivery of Bottomless Concrete Shell by FlexiFloat for the Chickamauga Lock Cofferdam

Support of Bottomless Concrete Shell by Drilled Shafts & Strand Jacks for the Chickamauga Lock Cofferdam

Sequence of Concrete Shell Installation and Outfitting for the Chickamauga Lock Cofferdam

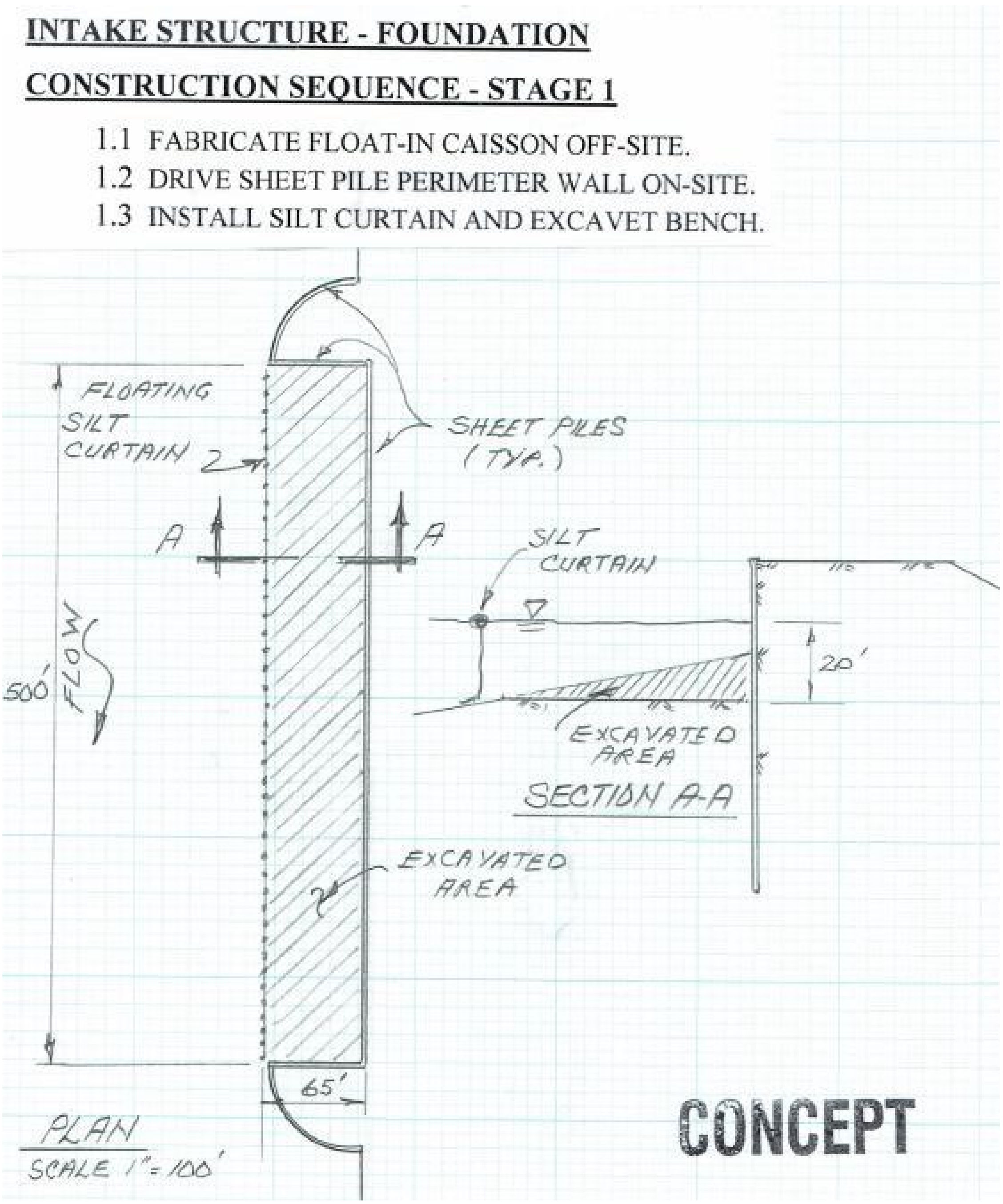
Potential Berthing/Outfitting Facility such as Freeport Area Marina



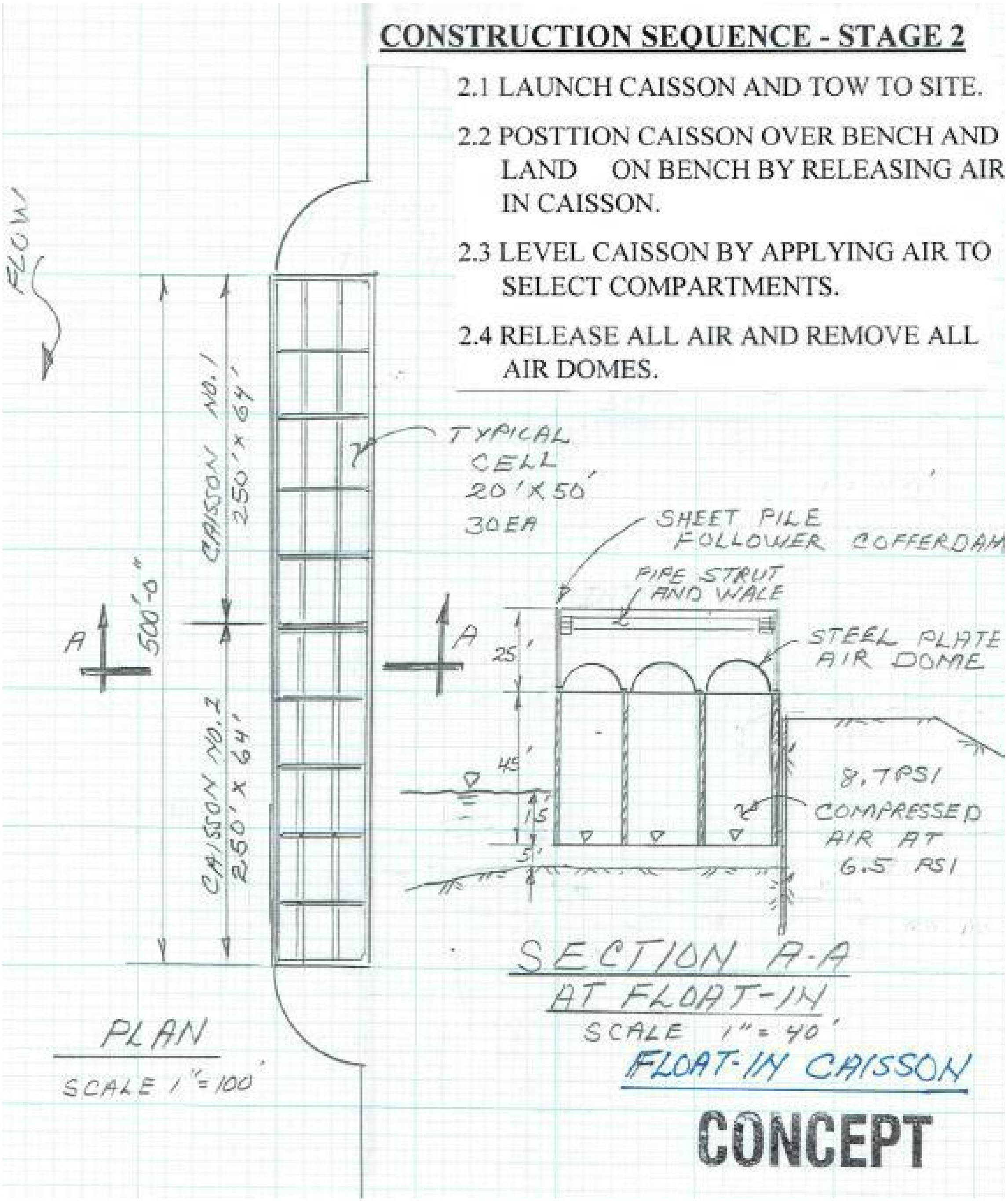
Kiewit Stockton Precast Yard's Loadout Facilities as an Example of Existing Offsite Prefabrication Facility that Could Outload Precast Elements or Concrete Shells

Appendix 5: Presentation of One Possible Offsite Prefabrication Method Using Float-in Construction Means and Methods and Examples of Prior Relevant Float-in Projects

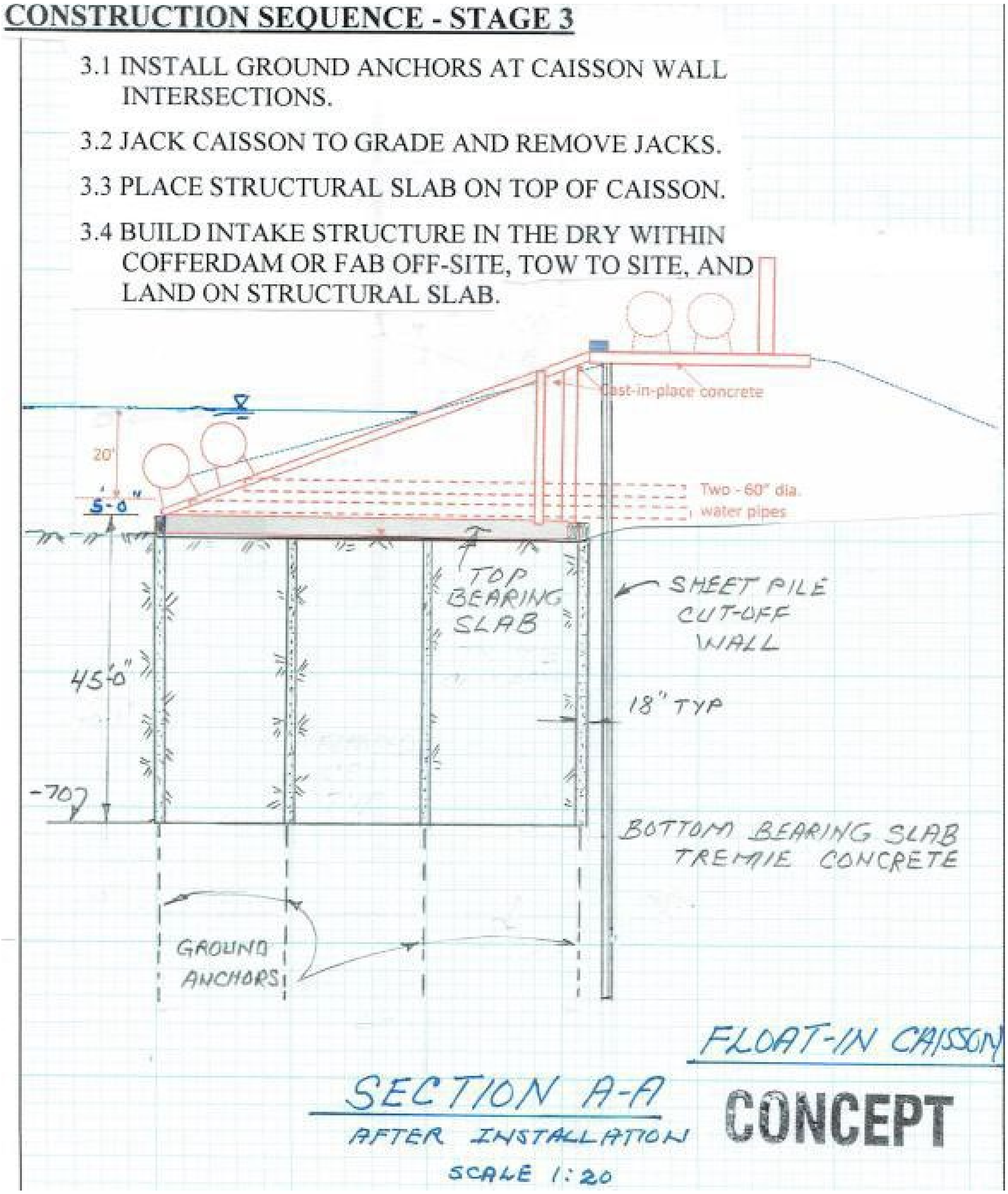
It is noted that the offsite prefabrication method shows an inclined configuration with stacked Tee screens; this construction approach is relevant to both vertical and inclined screen configurations.



Representation of Excavation of Local Receiving Area for Float-in Concrete Caisson Foundation



Representation of a Float-in Concrete Caisson Foundation Into Locally Excavated Area



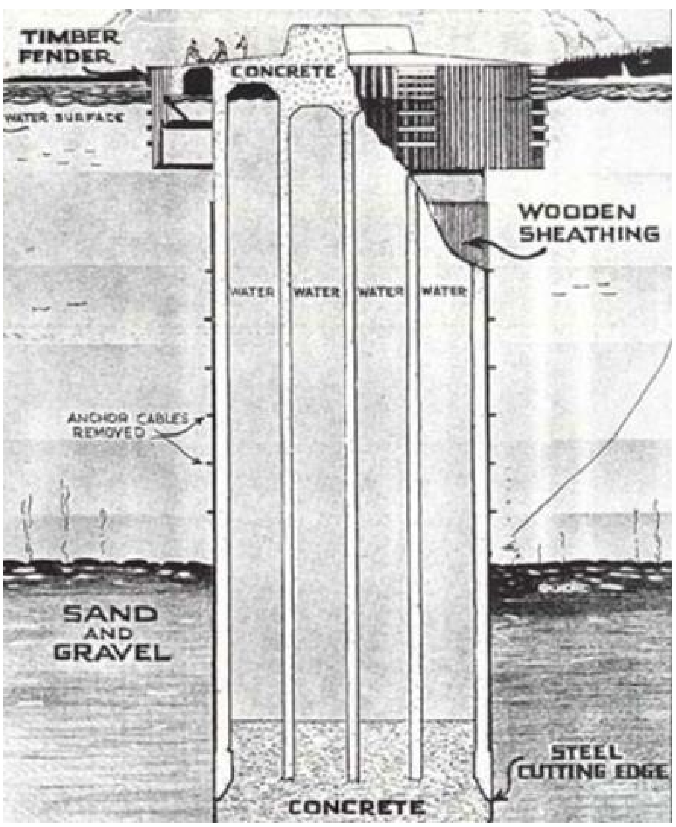
Representation of a Prefabricated, or Cast-In-Place, Inclined Double Tee Screen Module Installed on Top of a Float-in Sunken Concrete Caisson Foundation.

ADVANTAGES TO OFF-SITE FABRICATION AND FLOAT-IN FOUNDATION CONCEPT

1. SHORTER CONSTRUCTION SCHEDULE BY ALLOWING WORK TO BE PERFORMED CONCURRENTLY OFF-SITE AT MULTIPLE LOCATIONS
2. FABRICATION IN A CONTROLLED ENVIROMENT, ALLOWING HIGHER QUALITY OF CONSTRUCTION
3. MINIMIZING EXCAVATION AND DISPOSAL OF MATERIAL OFF-SITE.
4. MINIMIZING ON SITE WORK AND IMPACT TO LOCAL AREA.
5. ELIMINATES THE SUPPLY AND DRIVING OF LARGE FOUNDATION PILES
6. REDUCES THE REQUIRED NUMBER OF SHEET PILES BY APPROXIMATELY 40%

View of the Completed Montezuma Slough Salinity Barrier Construction Using Offsite Prefabrication

View of the Radial Gate Monolith Module for the Montezuma Slough Salinity Barrier During Construction Using Offsite Prefabrication on a Grounded Barge



Example of the Sunken Caisson Construction Method for the Tacoma Narrows Bridge Foundation

Appendix 6: Recommended Action Items

1. The ITR Panel looks forward to the Engineering Design Manager's and DCA's response to the panel's comments (see Appendix 7) and to answer any questions that you might have.
2. The Engineering Design Manager indicated that future input from selected panel members may be needed to further develop offsite prefabrication construction alternates.
3. The dates of the next Intakes ITR Panel meeting need to be determined.
4. The Intakes ITR Panel looks forward to receiving the read ahead documents for the 2nd Intakes ITR Panel meeting when the dates of the meeting have been determined.
5. Gather performance data for both vertical flat plate, and Tee, screens possibly from:
    a. Name and location of relevant existing fish screens that the Design Manager could contact for O&M records;
    b. Existing/published study results of relevant screen performance.
    c. Recommended surveys of manufactures, agencies and/or existing relevant screen facility to gather new data.
    d. Selected photos of performance issues being commented on, such as debris accumulation.
    e. Recommendations for possible physical studies related to screen performance either in test labs or prototype tests in the Sacramento River near one of the three short-listed intake sites.

Appendix 7: Table of Considerations and Requested Responses

Item	Consideration	Response
2.1	Reduce Length of vertical flat fish screen sweeper parking area.	Will consider during future design efforts. Current arrangement considers the pulley system for both landing and launching mechanisms. Reduction in overall length would be nominal.
2.2	The fact that the existing flood control levee will be abandoned, and a new Project levee constructed around the perimeter of the intake facility affords the opportunity to encroach into the existing levee alignment. That is, if deemed worthwhile, the intake facility could be "setback" more into the existing streambank.	Only a small setback would likely result from this concept. If structure set back further, it would require dredging to achieve a "pocket" with upstream and downstream transitions to the face of the intake. This area would likely see additional shoaling of sediment and the setback position may reduce the actual sweeping flow along the screens. This concept does not appear to offer significant cost savings, may reduce the effectiveness of the installation, and will not be implemented.
2.3	Dual stacked Tee Screens could reduce length of screens.	Dual screens will not be pursued further. The screens would occupy a depth zone of about 13 feet (assuming 5-foot diameter units) compared to the 8 foot zone for the larger units. Stacked screens could increase potential for more surface-oriented species (e.g., juvenile salmon) to encounter the screens verses a single Tee screen lower in the water column. Doubling the screen units would also double the velocity shadow areas for potential predator holding. Also, assuming 5-foot diameter units, dual screens would increase the quantity of screen units from 30 single units to about 35 pairs per intake. This arrangement would nominally reduce the concrete structure length by about 200 feet. The dual screen units would increase O&M complexity and introduce about twice as many components (screen units, drive motors, electrical components/connections, etc.).
2.4	Using the Tee screen gives you the option to follow the curve of the bank.	Given the tight spacing of the screen units (1 foot between units), only a slight curvature would be possible without increasing the length of the intake structure. Also, a curved structure would involve more complex cofferdam and concrete structure construction. Preliminary river hydraulics indicate minimal impact on flood flow profiles for the straight structures. There appears to be little advantage to the slight curvature relative to the probable extra cost and possible extra length. This concept will not be pursued further.
2.5	For Tee screen alternative, consider moving screens closer together and using brushes or rubber fingers on the ends of the screens to reduce the potential for predator holding between screens.	Brushes or fingers between screens is being considered as part of the current concept. These would be considered in additional detail during future design efforts.
2.6	Consider Tee screens (either single or double Tee's) installed on the riverbank slope.	This concept will be evaluated in additional detail for single units to determine its applicability to the Project. Substantial operability and constructability issues are evident that will be considered as part of further evaluations.

3.1	Need to build a minimum flow velocity of about 2 to 2.5 fps into conduits behind screens to keep sediment moving in conduits.	Minimum velocity is already included in the current Tee screen concept. Will consider for box conduits (vertical plate option) relative to cost savings, headloss in the system, and discharge jet into sedimentation basins. This concept reduces footprint so is less conservative than current layout and would be considered during future design efforts.
3.2	Work with system modelers to try to reduce the 18 inches of drop at radial gates at one or both intakes (e.g.: via operations).	Reduction of headloss through intake components and considering pump station control schemes for maintaining the level downstream of the radial gates is ongoing and already a key focus of the DCA Engineering effort.
3.3	On flat plate screens use 12 modules instead of 6.	This feature will be considered during future design efforts and as part of planned system hydraulic modeling. Note that this suggestion would not change the overall footprint of the structure.
3.4	Has there been any consideration to training walls or training vanes in front of the screens to force the flows in a parallel sweeping direction and prevent river flow from trying to pass through the screen perpendicularly (for tee screen) or cause too high of an approach velocity for flat screen.	This concept will not be pursued further due to the potential to create eddies and non-uniform flow in front of the screens. Also, such vanes would likely increase the flood flow profile impacts and would be difficult to implement. The current baffle assemblies and control gates allow control of the approach velocity and supplemental in-river features are not considered beneficial.
4.1	The preliminary construction sequencing plan indicates a potential temporary relocation (with associated ground improvement) of State Highway 160 across the project site. In later stages of construction, the roadway would be restored to near the current alignment. Consider temporarily, or permanently, moving State Highway 160 to the existing grade around entire construction site as first step. (see diagram for 4.1 alignment).	Relocation of State Highway 160 traffic out of the work area as suggested may be beneficial. However, the driver for the current plan is the need to maintain a flood control levee at all times. The DCA Engineering Team is continuing to consider options for both the temporary levee and the relocated highway so the suggested concept will continue to be considered as alternatives to the current layout are evaluated.
4.2	A second option would be relocating road to rest on the eastern berm of the sediment basin. This section could be built early in construction with dirt from the excavated basin., with a bridge over what would become the flow control structure. (See diagram in consideration 4.1).	This concept was considered during planning stages for the facilities but was eliminated since the required highway layout would result in greater impacts to properties adjacent to the intakes, would require a longer construction schedule, and is expected to increase cost relative to staging the work.
4.3	It appears that the sediment drying basins are roughly at the current grade of the existing agricultural land. There is the potential to use excess soil from excavating the sediment ponds to raise the elevation of the drying basins instead of having to haul off that material. Some of the material could also be used to make the "levee"/berm around the sediment basin wider/flatter than shown.	This concept is already included in the planning for the intakes.

4.4	Working In-the-Dry Results in: a) risk of up to one-year delay due to cofferdam installation; and b) a congested work site that could delay construction by many months. Thus, it is recommended that either the construction schedule be revisited with this risk considered and/or that a construction risk matrix be developed for the baseline/assumed construction method. Potential offsite prefabricated construction alternatives are discussed in Appendices 4 and 5; and it is understood that the Construction Logistics ITR Panel will evaluate the logistics of material handling vs river transport.	Working in the wet is expected to only be allowed for about 4 months per year due to fisheries impacts. Therefore, some sort of cofferdam would be required to construct a foundation and maintain the construction schedule regardless of the prefabrication concepts for the intake structure. Prefabrication in the vicinity of the intakes would be subject to the same in-river work windows and the same logistical constraints in the area and would increase the number and overall acreage of impact areas. The use of existing marinas near the intakes is not considered feasible. The DCA Engineering Team will only consider alternative construction concepts provided they are logistically feasible and do not increase impacts.
4.5	The design proposes the soils excavated for the settling basin be used for construction of the new perimeter Project levee. Based on the preliminary waterside borings completed to date, if similar conditions are present landside, it is likely these soils will be sandy and not meet either CVFPB Title 23 or USACE levee embankment material requirements. Will need to consider either select fill materials will need to be imported or the excavated materials will need to be blended/modified to meet embankment fill requirements.	Acknowledged. The project description currently includes importing core material for a zoned embankment. Additionally, a slurry cutoff wall would be provided beneath and into the embankment. The upper soil layers on the land side of the levee are expected to be predominantly fine grained and should be useable for levee construction with the core material considered. In any case, additional site-specific geotechnical information would be collected during future design efforts to more definitively verify the materials availability at the sites. Acquisition of this information is a high priority for the DCA.
5.1	Evaluate constructing the deep foundations using a slide-in sunken caisson system (200' to 300' long), see Appendix 4.	Consideration of alternative construction, foundation, and cofferdam concepts is currently planned. The suggested concept is not considered feasible because it involves off-site fabrication and river delivery. It is not feasible to transport the foundation structure to the site from down-river and local offsite construction would increase footprint and impacts in the vicinity of the intakes. Refer also to response for Item 4.4.
5.2	Evaluate a stay-in-place prefabricated slide-in concrete cofferdam (200' to 300'), see Appendix 4.	See response to Item 5.1.
5.3	The option for off-site fabrication and float-in of a precast screening structure should be maintained as a potential construction option, see Appendix 5.	See response to Items 4.4 and 5.1.
5.4	Consider use of a Construction Manager at Risk, CMAR, contracting mechanism for offsite prefabrication.	Contracting mechanisms are planned to be evaluated as part of program development activities later in the project sequence. The suggested mechanisms would be considered as part of that effort.

5.5	The preliminary geotechnical information presented for the vicinity of the intake structures indicates problematic soil conditions. These include potentially liquefiable soil deposits and compressible organic materials. Ground improvement to mitigate these conditions as indicated will likely be required. Typical ground improvement measures may include jet grouting, deep soil mixing, deep dynamic compaction, and/or other methods such as stone (or sand) columns.	Acknowledged. Ground improvement using a cement deep mechanical soil mixing (DMM) shear wall grid is currently included in the project description. Once more site-specific geotechnical information is available, a more detailed evaluation of effective ground improvement methods and physical locations of such improvements would be conducted.
5.6	In some locations there are dense sands/gravels and stiff clays present. This will present difficult sheet and pipe pile driving conditions. Similar hard driving conditions at other intake cofferdam locations along the Sacramento River has resulted in split sheet pile containment walls that required special additional sheet piles and grouting options. This should be anticipated in the design concept. Predrilling, as proposed, may be required.	Pile driving effort has been evaluated as part of the current project description. Preliminary analysis suggests that sheet pile installation is feasible in the soils represented by the existing borings. Note that consideration of alternative foundation and cofferdam construction concepts is currently planned.
5.7	Seepage cutoff walls are favorable features to reduce seepage beneath the new levee embankments. Suggest optimization of various methods be considered including both Soil-Bentonite (SB) and Slag Cement-Cement-Bentonite (SCCB) for open trench construction methods and Soil-Cement-Bentonite (SCB) for deep soil mixing methods.	Acknowledged. This suggestion would be evaluated in greater detail during future design efforts. The current concept leverages the need for ground improvement using DMM methods to create a grid and avoids the need for a second construction method to complete the cutoff walls.
5.8	BMPs such as attenuation of pile driving using an impact hammer, predrilling to reduce pile installation sound pressure, etc. should apply to all in-water construction activity.	Acknowledged. A test pile program is planned to help develop BMPs for pile driving. Also, consideration of alternative foundation and cofferdam construction concepts is currently planned which may affect this situation.
6.1	Evaluate disposal of treated sediment by river barge from July to October 1.	This concept would require daily conveyance of dried, or partially dried, sediment across the state highway to reach a barge. Barge traffic limitations are in effect that would also limit barge movements. We acknowledge that guidance on sediment disposal and/or its potential reintroduction back into the Delta is needed and needs to be developed as part of this Project. However, we do not believe barging of sediment is a practical offsite disposal option given the logistical constraints at the site.
6.2	Allow more scour at base of screens by lowering the elevation of the rock scour protection design.	Scour at the interface of the structure is generally not allowed as part of CVFPB and USACE permitting. Additionally, the rock scour protection is provided to help protect disturbed areas that are dredged in front of the screens to smooth out the riverbank at the structures. No change planned.

6.3	The concept of a gravel lined sediment settling basin is of concern to the Panel - especially along the waterside of the new Project levee. Suggest consideration of revetment (6” to 8” cobbles), soil cement lining/facing, or other hard features (e.g. articulated concrete mats).	Concur. The suggestion would be considered during future design efforts.
6.4	Sediment must be managed below screens (river side) regardless of which screen is used. Jets below screens may be effective but will require frequent operation. Traveling “toothbrush” type screen is extremely sensitive to this sediment, and it could result in major maintenance issues. At PG&E’s Philadelphia diversion the oscillating brush mechanism frequently lodged in sediment bar resulting in significant damage and high maintenance. Sweep arm will need to be very robust, have good access for repair and have plenty of spare parts.	Agreed. Robust structural design and sediment-related features (such as the "snow plow" used at FRWA) would be considered for this mechanism during future design efforts.
6.5	Consider baffles or “S” walls in sediment pond to force the water/sediment to travel further increasing settling time before entering tunnel.	This has been considered and does not achieve the results suggested since the velocity on the flow channel increases and proportionally increases the required settling length.
6.6	Consider permanent boom for suction dredge.	The details of the sediment dredging system would be considered during future design efforts. Permanent or semi-permanent features would be considered.
6.7	The CER describes the system as “The sediment jetting pump will pressurize water from the pipe manifold located behind the back wall of the intake structure and deliver it to the spray nozzles, which will spray the bay floor”.	Acknowledged. The quoted statement is generally the current plan except there is no longer a pipe manifold. Water would be drawn from within the intake structure.
6.8	Sediment removed from the intakes should, to the extent possible, be used beneficially in the Delta to reverse effects of island subsidence, in combination with carbon sequestration, as well as support shallow water aquatic habitat restoration in the Delta.	Agreed. All sediment disposal must be in accordance with applicable off-site discharge permits which are not currently defined. As noted above on 6.1, more final disposal sediment management guidance is needed and will be developed as part of the Project.
6.9	With regards to sediment disposal it would be important to anticipate whether the solids may likely contain contaminants (mercury, ag chemicals, etc.) that may impact the ability to dispose of the materials. Additionally, local groundwater conditions should be investigated for adverse chemical conditions. The construction of the Northwest Interceptor in West Sacramento encountered naturally occurring boron which complicated the disposal of dewatering fluids. This consideration merits testing for contaminants in the sediment and groundwater.	Acknowledged. Limited data currently exists for sediment chemical constituents and would be further investigated during future design efforts. Geotechnical testing would include groundwater quality testing.

7.1	Evaluate allowing the tops of the vertical flat plate screens to extend above design water level.	The DCA does not intend to further evaluate higher screens. In all cases, the screen facility will be designed for a 3000 cfs capacity at an approach velocity of 0.2 fps (with some screen area redundancy allowances). Additional screen height would not result in additional capacity due to overall hydraulic design of the facility.
7.2	The Panel believes that it would be difficult to clean a 20-ft high vertical flat plate screen located 25 to 30 feet below the deck of the structure due to cleaner arm and brush length required. The panel suggests evaluating panel height, screen length and cleaner arm size (diameter and length) together. Evaluate whether the trolley rail can be located lower on the structure to reduce the length of the brush arm.	Trolley is currently located below deck and configuration and strength would be considered during future cleaner design efforts. Panel heights are currently limited to 17.5 feet maximum height to facilitate effective cleaning and limit brush length. More specific ITR Panel input on this subject would be helpful.
7.3	Determination of the design screen sill elevation would be impacted by both intermittent mobilized sediment sand dune height and frequency. More data will be required to know the impacts of dune migration and its impact on sill elevation.	Agreed. To date, bathymetric data from 2008 to 2019 suggest a stable river cross section and generally consistent sediment accumulation in the vicinity of intakes. This information would be supplemented with sediment modeling and additional bathymetry during future design efforts.
8.1	Evaluate developing two intake sites, at Sites 2 and 3, with a maximum diversion capacity of 3,000 cfs each. Isolate diversion within each intake to 100 to 500 cfs increments. Preferentially operate (December1-May 31) the most upstream diversion first before initiating operations downstream. Preferentially operate the upstream diversion to the lowest diversion rate needed to meet existing demands).	**DWR RESPONSE:** This option exists and is being evaluated as part of operational modeling and impacts analysis being conducted.
8.2	Site Location/selection – Sites 2, 3, and 5 appear to be the locations under consideration. Sites 3 and 5 are the likely favorites based on the screen and constructability. However, the selection of the two sites may be driven more by local input than based on preferred screen/river hydraulics. Screens could be constructed and operated successfully at each of the sites. Screen design should account for the river hydraulics at the chosen sites. This may result in some differences in the screen design for the different sites. Tee screens are likely less impacted by site conditions compared to the longer and taller vertical screen options. Hydraulic 2-D and CFD modeling might show that some sites are better than others among the three final site choices. This could also inform the choice of vertical or tee screen structures.	Acknowledged. 2-D and CFD modeling are planned for the selected alternative. 2-D modeling may be conducted before alternative selection and would be used to support intake site and type selection, as applicable.

8.3	Limit diversion rates to 0.2 ft/sec approach velocity between December 1 and May 31 to protect adult delta smelt, juvenile salmonids, and other fish. Diversion operations during October 1-November 30 and June 1-15 would be 0.33 ft/sec or less unless a pulse of juvenile salmonids is detected moving toward the intake site when diversion rates should be reduced to 0.2 ft/sec (see near real-time operations below). Between June 15 and October 1 diversion rates should be limited to 0.33 ft/sec for juvenile salmonids and other fish.	**DWR RESPONSE:** The proposed intakes will be designed for the 0.2 fps criteria. Operational concept will be assessed further through the environmental planning and permitting process in coordination with the fisheries agencies.
8.4	Unless tied to reductions in export rates or curtailment, real-time biological monitoring offers potential benefits only during the October 1-November 30 and June 1-15 periods. If real time data (e.g., Knights Landing, Sacramento trawl, acoustic tagging) shows a pulse of juvenile salmonids approaching the intake sites when diversion rates would be reduced to 0.2 ft/sec or curtailed there could be biological benefit from reduced diversion exposure. Diversion operations during the periods October 1-November 30 and June 1-15 can be coordinated with Delta Cross Channel (DCC) gate closures for fishery protection based on near real-time monitoring so that diversion rates are reduced to 0.2 ft/sec when the DCC gates are closed for fishery protection.	**DWR RESPONSE:** The proposed intakes will be designed for the 0.2 fps criteria. Operational concept will be assessed further through the environmental planning and permitting process in coordination with the fisheries agencies.
8.5	Acoustic tag survival studies should be conducted using juvenile Chinook salmon and steelhead (and white sturgeon surrogates) released upstream of the intake reach and immediately upstream and downstream of each intake site to assess baseline predation losses before and after intake construction over a range of river hydrologic conditions.	**DWR RESPONSE:** Acknowledged. DWR is currently evaluating baseline biological studies.
8.6	Restoration of shoreline juvenile rearing habitat should occur a minimum or five miles upstream of the most upstream intake site to improve habitat conditions and growth of juvenile salmonids before migrating downstream and encountering the intakes as well as to avoid an attractive nuisance in the immediate area of the intakes.	**DWR RESPONSE:** This concept will be assessed further through the environmental planning and permitting process. Impacts associated with habitat removal at the intake sites will be evaluated, and opportunities to offset and mitigate impacts will be identified and analyzed. Location and design of potential compensatory habitat restoration will be evaluated in coordination with fish and wildlife agencies.

8.7	Control of Aquatic Weed Impingement: Assume increased occurrence of and concentration of aquatic weeds in the future as river flow may warm and new exotic species show up. This a critical issue to maintaining screen performance for both delivery and fish protection. The cleaners must be capable of removing debris from the screen along its length during heavy aquatic debris loads. Possible ways to minimize impact – • Maximizing Sweeping/Approach velocity ratio. • Frequent screen cleaning. Provide flexibility to increase cleaning cycles. • Minimize screen length. • Reduce diversion during high concentrations of aquatic weeds. • Avoid exceptionally tall screens that may require long cleaner sweep arms.	Acknowledged. Screen-type evaluation currently being conducted takes cleaning and debris accumulation into account. Screen height is currently limited to 17.5 feet maximum height.
8.8	Control of Biofouling: Control of aquatic organisms that will attach to the front or back of the screen. Mussels, freshwater sponges and snails are known to impact screen operation when they occur in abundance. Filter feeders are particularly problematic as the back side of screens with low approach velocity are ideal habitat for these organisms. Possible ways to minimize impact – i. Use Tee screens with internal brushes. ii. Close one module of the vertical screen to remove and clean all screens sequentially. Installation of blank panels should maintain a smooth screen face to prevent introduction of excessive near screen turbulence.	Acknowledged. Current concepts are consistent with comment. Screen type evaluation currently being conducted takes cleaning into account, both in place and on the top deck for interior or panel back areas.
8.9	Mechanical Equipment: Minimizing the impact to diversion of mechanical failures on large screens will be needed. Major components that directly impact operating the screen within design criteria should be identified and ranked as to potential impact on diversion. Possible ways to minimize impact – i. Compartmentalize screen operation to the degree possible. ii. Stock key components on site. iii. Maximize diversion flexibility between diversion sites. iv. Plan for access to perform O&M of screen cleaners during high flows.	Acknowledged. Comments are already included in current concepts or are planned for during future design efforts.
9.1	Minimizing the screen footprint is important for reducing environmental impacts and improving operation of the screen. The Tee screens offer a major advantage on this issue and should be given strong consideration.	Acknowledged.

9.2	Predation is a major concern no matter what type of screen is selected. Flat Plate screens could harbor predators behind the 6 sweeper masts, along the log boom, and downstream of the structure. The Tee screen could harbor predators behind the base of the tees projecting from the structure, downstream of or under the cylinders, along the log boom, downstream of the structure.	**DWR RESPONSE:** Acknowledged. This is being considered as part the screen-type biological effects evaluation.
9.3	The smaller module approach offered by the Tee screen concept would likely provide greater control of near screen hydraulics thus allowing better compliance with screen criteria.	Acknowledged. Comment is consistent with current concept.
9.4	Measuring approach velocities at vertical flat plate, and Tee, screens could be difficult especially in areas of high sweeping velocities. The flat plate screen approach velocities would be measured from meters on a boom hung from a dolly on the sweeper trolley rail. Adjustments to the baffling would be mad from the deck of the structure. The Tee screens would likely require divers to position the velocity meters on all sides of the screen. Baffling would be determined from large scale laboratory tests. Field adjustment of Tee screen baffles would be difficult.	Acknowledged. Comment is consistent with current concept. Tee screen baffle adjustment would be considered during future design efforts.
9.5	Avoid screen designs that could require intermediate bypass collection and conveyance systems in the intake design. V screens should be avoided to eliminate the need for fish bypass pipes and fish handling and exposure to concentration and turbulence and the discharge location.	Concur. Current concepts are consistent with this comment.
9.6	A key element of intake design will be regulatory acceptance of the design configuration. Unless there is a strong rationale for an alternative design the preferred intake configuration supported by CDFW, USFWS, and NMFS should be the preferred design concept. Either the flat plate or Tee screen intake configurations appear to be functional at the selected sites so that the preferred intake design would be the design approved by the regulatory agencies.	Screen facility design details will be developed in coordination with the fisheries agencies for their acceptance.
9.8	Screen Brush on Vertical Flat Plates – add more pivot points to more evenly distribute forces on the brushes. See Appendix 3 for additional details.	Agree. This would be considered as part of future design efforts.
10.1	Evaluate fully designing a continuous horizontal refugia with continuous horizontal bars mount on the bankside of the piles for the floating boom. Also, design a shroud that could be installed underwater to cover the refugia if it does not prove beneficial.	**DWR RESPONSE:** Acknowledged. Incorporating refugia design features into the facility will be informed by best available science.

10.2	Refugia mechanisms could be incorporated on non-screen sections of Tee screen which would not add to overall length.	**DWR RESPONSE:** Acknowledged.
10.3	Refugia should include horizontal bar configuration and extend, to the extent practical giving screen modules and cleaning, across the entire length of each intake. The refugia bars should be spaced to allow fish less than 3 inches in length to enter and exclude all Tee screen intake modules should be located as low in the water column as possible while avoiding bed load sediment transport.	**DWR RESPONSE:** Acknowledged.
10.4	For the Tee screen option, cones should be placed on the upstream and downstream screens to provide smoother hydraulic conditions and reduce velocity refugia and turbulence that encourage potential predation.	Agree. This is included in the current concept and will be defined in greater detail as part of future design efforts.
10.5	Design refugia to exclude fish greater than 16 inches in length. If debris loading, excessive eddies or turbulence, predation, etc. are observed the refugia should be covered and no further consideration of application of refugia given to intake design or operation (adaptive decision).	**DWR RESPONSE:** Acknowledged.
10.6	There is no definitive data as to the benefit or dis-benefit of refugia. Are refugia safe locations for prey or small predators?	**DWR RESPONSE:** Acknowledged. Incorporating refugia design features into the facility will be informed by best available science.
10.7	For design look at wider horizontal refugia built into fish screens or at bottom of blank panels above screens. Consider designing in removable camera locations inside refugia to assist in adaptive management decisions.	**DWR RESPONSE:** Acknowledged. Incorporating refugia design features into the facility will be informed by best available science.
11.1	Do 2-D river modelling early enough to inform decision of final screen placement.	Agree. 2-D river modeling is currently planned to verify placement of intake structures.
11.2	Potentially, screens could be moved slightly closer to outer bend to increase sweeping velocities.	Will consider slight facility adjustments; however, screens are currently placed at locations with suitable depth and as close to outer bend locations as possible without excessive protrusion into the flow channel to minimize impact on flood levels.
11.3	More information is needed for screen contact and predation.	**DWR RESPONSE:** Acknowledged.
11.4	Screen contact – the data on salmonids is pretty good. Data on Delta Smelt needs some more work. Consider fish lab work for fish behavior (especially smelt) at cylindrical screens, possibly as an adaptive measure.	**DWR RESPONSE:** DWR to consider as part of fisheries analyses. Extensive studies were conducted by UC Davis researchers on delta smelt screen contact, as cited in the California WaterFix BA, for example. These, as well as the juvenile salmonid studies, inform the potential effects of fish contacts with screens.
11.5	Need studies of fish presence and distribution at the screen sites. Needed for baseline studies anyway.	**DWR RESPONSE:** DWR to consider baseline fisheries studies in the intake vicinity areas.

11.6	Study predator use of piles and log booms at existing screens.	**DWR RESPONSE:** Log booms and piles are a necessary part of fish facility protection systems and will need to be included. DWR to consider specific baseline fisheries studies such as these.
11.7	Non-physical fish deterrents/guidance can be considered.	**DWR RESPONSE:** Acknowledged. Enhancement projects near the intake sites, or potentially elsewhere, may improve passage efficiency; however, these projects should be considered separately. The intake facility should be designed based on use of best available technology.
11.8	On a sustainability basis, you may want to consider installing solar panels to augment power usage.	Acknowledged. This will be considered as part of future design efforts.
11.9	If Tee screens are used, consider using electric motor in lieu of hydraulics.	Electric motors are the current concept.
11.10	Suggest confirmation of project hydraulics in light of the recent adoption of the Folsom Dam operating manual. Additionally, the widening of the Sacramento Weir will affect the frequency and flow characteristics of the Sacramento River downstream of the American River confluence. Potential changes in hydraulic grade lines as well as sediment transport conditions may affect project operations.	**DWR RESPONSE:** Acknowledged. These changes would not be expected to effect low water depth and would be considered as appropriate with flood agencies for flood impact modeling.