EBMUD-X6

DWR-212

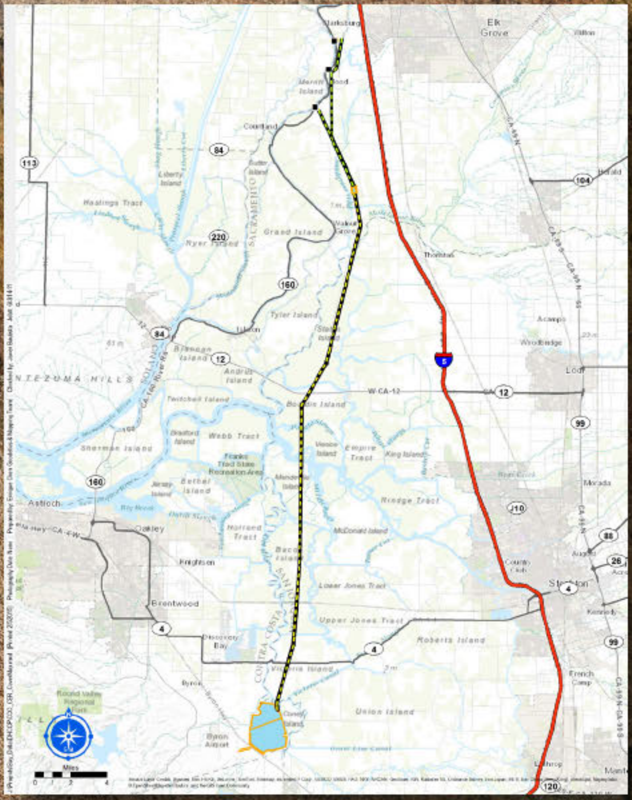
California Department of Water Resources

Advancing the Bay Delta Conservation Plan

Delta Habitat Conservation & Conveyance Program

DHCCP Team

PRELIMINARY
NOT FOR CONSTRUCTION



Delta Habitat Conservation & Conveyance Program (DHCCP)

Final Draft: July 1, 2015

1

Conceptual Engineering Report

Modified Pipeline / Tunnel Option – Clifton Court Forebay Pumping Plant

Volume 1 – Conceptual Engineering Report

901 P Street Suite 411 B, Sacramento, CA 95814

Figures **Page**

Figure 17-2 Head of Old River Gate, Artist's Rendering (Looking Northward) ... 17-6

Figure 19-1: Tunnel Construction Power Requirements ... 19-2

Figure 19-2 Electric Power Grid Connection Plan ... 19-4

Figure 27-1: Photo of island lowlands taken facing east from the gravel levee crest road... 27-1

Figure 27-2: Photo taken on a gravel road overlooking the Old River. ... 27-2

Figure 27-3: Natural screening of island from agriculture on opposite site of Old River toward agriculture screened by shrubs. ... 27-2

Figure 27-4: Vicinity Map including distances from prominent landmarks... 27-3

Figure 27-5: Harvey Banks Pumping Plant. Channel from the Clifton Court Forebay heads to the pumping plant and up to the Bethany Reservoir. ... 27-4

Figure 27-6 Edmonston Pumping Plant. Architectural features, like the arches, align with repetition of the pump heads. ... 27-4

Figure 27-7: Edmonston Pumping Plant. Full height glazing and repetition of order. ... 27-5

Figure 27-8: Site Section. Increase in berm height and plantings buffer view of King's Island residents from tall pump plants. ... 27-5

Figure 27-9: Building Program Matrix ... 27-6

Figure 27-10: Architectural Site Study incorporating the component descriptions from previous sections. ... 27-8

Figure 27-11: Concept Diagrams ... 27-9

Figure 27-12: Rendered perspective of pump plant concepts with rugged landmark and softer human scale. 27-10

Figure 27-13: Material Matrix ... 27-10

Figure 27-14: Graphic Depiction of Design Guidelines for Non-process Buildings ... 27-11

Figure 27-15: Graphic Depiction of Design Guidelines for Process Buildings ... 27-11

Volume 2: Concept Drawings (Bound Separately)

Volume 3: Map Book (Bound Separately)

4.4.6 Clifton Court Forebay Pump Plant (CCFPP) Operations

CCFPP will lift water from the Main Tunnels and discharge into NCCF via two pumping plants. Each pumping plant has an associated gravity flow system that is designed to provide operational flexibility by allowing water to gravity flow when it's available in the system through the use of adjustable weir gates within the pump plant shaft. The weir gates are always set at slightly higher elevation than NCCF water surface elevation whenever any of the pumps are in operation.

If gravity flow is available in the system, pump operations are halted and the weir gates are lowered to allow water flow from the pump station shaft into NCCF. The amount of water that will gravity flow through the system will depend on the hydraulics differential water surface elevation between the pump plant shaft and NCCF. The weir gates will also serve as system surge protection by allowing water to flow above the weir gates and out into NCCF when the facilities experience a hydraulic surge.

Each pumping plant shaft will house six pumps (total of 12 pumps), capable of delivering the design capacity of 9,000 cfs (4,500 cfs per pumping plant). In order to provide a wider operating range of flows, several of the pumps (or all of the pumps) can be equipped with variable frequency drives (VFD). VFD's will allow adjustment of the pump speed to accommodate a wider range of flows from approximately 500 cfs up to 9,000 cfs. Flow will be measured on each individual pump discharge with calibrated ultrasonic flow meters.

The final number of pumps, the pump speed control systems, and level of automation condition will be finalized during preliminary design. The SCADA system will allow the operator to confirm that the pumping system is working in concert with the Sacramento River intake gates and assure that the intake sites allow delivery of the required pumping capacity to the tunnel conveyance system without violating the intake operating criteria. The pump plant will also incorporate an overflow weir that will be used as surge protection in the event of an operational upset, such as power failure.

4.4.7 North Clifton Court Forebay Operations

The NCCF is designed to provide daily operational storage to equalize and balance differences between inflow from the north Delta intakes and water exported by the Banks and Jones pumping plants. Under normal operating conditions, this leads to situations where inflow to NCCF will exceed the outflow to the export facilities and vice versa. The daily amount of mismatch between inflow and outflow dictates the storage volume at NCCF.

The required daily operating storage is dictated by two operational situations:

- Inflow volume to NCCF exceeds the operating capacity of the export pumping plants: This will happen when the MPTO/CCO is delivering at capacity and the export pumping plants are not pumping or are pumping at some lower rate.
- Export pumping volume from NCCF exceeds the inflow volume: This higher export pumping rate typically occurs when Banks PP is running at a high capacity during the off-peak time of day.

During normal operation, the Banks PP is operated at 10,300 cfs during the off-peak period and the Jones PP is operated at 4,600 cfs continuously. On a daily basis the combined volume of the export from both plants is about 19,500 AF. This volume exceeds the intake conveyance system's maximum delivery capacity of approximately 17,800 AF, assuming that the north Delta intake facilities are diverting 9,000 cfs continuously for 24 hours. Thus, under normal operating conditions, the export pumping plants can pump all of the water the NCCF can supply. However, the timing difference of export pumping and of intake flows requires daily storage to maximize river withdrawals while allowing the Banks PP to operate off-peak. These situations are described below for intermittent and continuous operating modes.

4.4.7.1 Intermittent Mode Daily Storage

To divert all available water during intermittent operations, the north Delta intake facilities must divert water during favorable river flows and tidal cycles. Diversions must be reduced or shut down during certain low river flows and unfavorable tidal conditions (high tides), regardless of the on-peak or off-peak energy situation. If the favorable intake diversion period occurs at the on-peak period at Banks PP, the water needs to be stored until the

SECTION 5.0

Conveyance System Hydraulics

This section describes the conveyance system hydraulics for major system components.

5.1 Facility Capacity

The preliminary concept for the MPTO/CCO has a maximum capacity of 9,000 cfs. The system is supplied by three intakes located on the Sacramento River, each with a capacity of 3,000 cfs, and a 9,000 cfs capacity pumping plant located at Clifton Court Forebay.

5.2 Preliminary Hydraulic Analysis

This section presents a preliminary assessment of the proposed operating and hydraulic conditions throughout the MPTO/CCO system.

5.2.1 MPTO/CCO System Description

Table 5-1 lists the physical attributes of the major components of the MPTO/CCO system. For additional details, refer to the Concept Drawings (Volume 2) of each Intake Facility, IF, tunnel alignments, Clifton Court Forebay Pumping Plant; and to Section 3.0, "Overview of Conveyance Option."

Table 5-1: Physical Attributes of MPTO/CCO Components

System Component	Diameter (feet)	Length (feet)	Width (feet)	WSE Maximum	WSE Minimum
North Clifton Court Forebay	N/A	N/A	N/A	14.7	1.1
South Clifton Court Forebay	N/A	N/A	N/A	5.1	1.1
Clifton Court Forebay Pumping Plant	N/A	N/A	N/A	14.7	1.1
Two Parallel Tunnels from IF to NCCF	40	156,620 (each)	N/A	N/A	N/A
Intermediate Forebay	N/A	1,500	800	25	-20
Intake No. 2 Tunnel to Intake 3 Junction Shaft	28	11,150	N/A	N/A	N/A
Intake No. 3 Tunnel to IF	40	36,207	N/A	N/A	N/A
Intake No. 5 Tunnel to IF	28	25,180	N/A	N/A	N/A
Sacramento River at Intake No.2	N/A	N/A	N/A	31.4	1.9
Sacramento River at Intake No.3	N/A	N/A	N/A	30.4	1.6
Sacramento River at Intake No. 5	N/A	N/A	N/A	28.4	0.7

* IF length and width are at maximum WSE
Notes: IF =Intermediate Forebay
N/A=not applicable

The RTM-handling system is likely to consist of continuous conveyor belts and a screw auger to transport the RTM to the ground surface. The RTM handling then consists of stockpiling RTM at the ground surface, with dewatering or drying of the RTM, and subsequent transfer of the solids to disposal areas. Transfer to disposal areas might be handled by conveyor, wheeled haul equipment, barges, or a combination of these methods.

11.2.6 Tunnel Support

Based on early project research and planning, a single-pass tunnel liner system is chosen to balance water conveyance requirements, project schedule, and construction cost. Coupled with modern TBM technologies in the anticipated ground conditions, the tunnel liner system will consist of precast concrete segmental liner with bolted-gasketed joints. The segmental liner will be designed to support external earth pressures; groundwater pressures; internal operating pressures; seismic loads; and construction loads due to handling, erection, and thrusting of the TBM. The segments are bolted together at the circumferential and longitudinal joints. The finished ring formed by the segments is smaller than the excavated tunnel cylinder, so the annular space between the segmental ring and the ground will be backfill-grouted to provide full contact for support. The backfill grout is typically injected through the tail shield of the TBM, which provides full circumferential liner support to ensure successful performance of the tunnel system. This lining system also minimizes impact to groundwater during construction and operation, as all concrete joints are sealed using high performance gaskets.

To minimize ground effects of one tunnel on an adjacent tunnel during parallel tunnels construction, the clear distance between adjacent tunnel bores is assumed to be two tunnel diameters (or 150 feet tunnel center to center). This is a conservative assumption because of insufficient geotechnical data to justify a closer spacing at the current study phase. For the 40-foot ID tunnels, it is anticipated that a 9-piece ring configuration would be used, with segment thickness of 20 inches minimum. The segments (7,000 psi minimum compressive strength) will be cast and steam-cured in concrete segment plants under strict quality control measures and delivered to the tunneling sites. Reinforcement will consist of both high strength steel reinforcement (up to 80,000 psi) and steel fiber for permanent ground loads and construction handling loads. Steel reinforcement will increase segment strength and durability and provide crack control.

Under the single-pass liner design, a typical joint between segments will be composed of gasket material to seal against water seepage and alignment bolts for tunnels subject to compression load only. Given the hydraulic grade line and ground cover of the tunnels, net tension where the internal pressure exceeds the external pressure (soil and water) is expected. If the segment ring is subjected to internal tension, special positive connections across the joint and tension reinforcement are necessary to transfer the tensile force throughout the segments. In general, however, a bolted-gasketed tunnel liner system is designed for compressive ring forces and is seldom subject to net tension. It is important that testing and analysis are conducted during preliminary and final design phases to optimize the tunnel liner system to resist the tension force.

In addition to strength requirements, leakage control through the liner is essential to ensure liner performance. Excessive leakage through the liner could lead to potential soil erosion, hydraulic fracturing and loss of liner support. Water leakage from the tunnel to the surrounding area also translates to economic loss. The leakage can be mitigated by a properly selected high performance gasket, concrete mix design of long-term durability, supplemental concrete admixtures to increase water tightness, and uniformly-distributed reinforcement and steel fibers for crack control. It is not anticipated that a PVC T-lock liner is required, and the PVC liner could complicate the tunnel construction and long-term operation. Once detailed geotechnical data is available during preliminary design, the segment liner will be designed to limit water leakage by considering surrounding ground-liner interaction and ground permeability.

For the net internal pressure design of the liner during conceptual phase, the external ground water pressure is assumed to be at elevation 0.0 (MSL) along the majority of the alignment. Occasionally, lower ground water elevation may occur due to local conditions. The exact ground water elevations will be determined along the alignment during preliminary design following geotechnical exploration.

The combined pumping plant is located at CCF, with control gates at each river intake. Using results from a preliminary hydraulics study that considers both steady state and surge conditions (see Appendix D), the maximum HGL elevations are summarized below. System hydraulics will be further refined and analyzed during preliminary and final design, and the tunnel liner will be designed for all applicable load cases based on results of accepted hydraulics and geotechnical criteria.

- Static shut-in condition (for all tunnels): HGL = 15 feet of net internal pressure
- Surge condition (North Tunnels @ +0.5 feet): HGL = 15 + 0.5 = 15.5 feet of net internal pressure
- Surge condition (Main Tunnels @ +5 feet): HGL = 15 + 5.0 = 20.0 feet of net internal pressure

Given the net internal pressures, several studies (Jacobs Associates, 2012; CH2M Hill 2014) were conducted to provide alternative tension-resisting elements in the tunnel liner. Such alternatives include effective ground overburden, high strength bolts, shear dowels, post-tensioning system, ferrous push-fit connectors, and proprietary joint connectors. A more detailed evaluation regarding the alternative join anchorage system is included in Appendix I and J.

The preliminary joint design utilizes a high strength bolt connection system as shown in the Concept Drawings (Volume 2), based on past performance in tunneling projects such as the San Diego Bay Outfall Tunnels. Once detailed geotechnical data is available, the following alternatives will be considered (separately or in combination) in the preliminary and final design phases:

- Effective ground overburden to resist internal pressure.
- High strength tension bolting for high tension load case.
- Shear dowels for light to moderate tension load cases.
- Other mechanical lock-fit connections (if applicable).

The tunnel liner system will be designed for all the following load cases to ensure reliable performance during the minimum 100-year design life of the system:

- Full external ground load and external ground water pressure.
- Net internal pressure (difference between internal hydraulic pressure and external ground water pressure). Ground overburden to counteract the internal pressure is ignored at this conceptual phase but will be considered during preliminary and final design once detailed geotechnical data is available.
- Earthquake design – Finite element model on ground-tunnel interaction based on Maximum Considered Earthquake (MCE) events.
- Segment handling loads such as lifting, hosting, TBM pushing.
- Leakage control based on acceptable performance criteria.

11.2.7 Precast Segment Plant and Yard

Multiple precast segment plants will be required to produce tunnel segments for this program. The size of each plant is dependent on the total number of segments required and the schedule for production, but it is likely that plants will require approximately 10 acres for offices, materials storage, concrete batch plant, and casting facilities. Additional segment storage space needs to be added to the plant space requirements and could be several times the space required for the plant. The segments can be transported by barge, rail, or truck where these modes of transport are available.

The current assumption for the segment casting facility is that it will not be located at the tunnel construction site and that tunnel segments will be delivered from off-site facilities. It is also assumed that only limited storage of segments is onsite to reduce the size of the working site required.

11.2.8 Logistics

The TBM consists of a front shield section plus additional trailing gantries carrying support equipment. Although the shield is transported in pieces, the size and weight of the pieces are substantial. It is currently expected that the TBMs complete the final stage of their delivery to the site by road.