Subject:	**South Delta Pumping Plant Basis of Conceptual Design Criteria (Final Draft)**
Project feature:	Pumping Plant
Prepared for:	California Department of Water Resources (DWR) / Delta Conveyance Office (DCO)
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1. Introduction

This technical memorandum (TM) provides the basis of conceptual design framework for the Delta Conveyance Project (Project) South Delta Pumping Plant (SDPP). The purpose of this TM is to document design concepts, methodologies, procedures, and expected consistency and quality of work for the SDPP. These design criteria will also assure consistency in documenting permit and code requirements, industry design standards, DCA design criteria requirements and preferences, and general design criteria and engineering work product elements associated with the SDPP. This document will be updated as the SDPP facilities are further advanced through the conceptual, preliminary, and final phases of design.

While the material presented in this TM has been prepared in accordance with recognized engineering principles, this design criteria should not be used by the design engineer without first exercising competent engineering judgment with respect to its suitability for the complexity, criticality, and importance of the facility being designed.

1.1 Facility Description

The SDPP will be located along the northern embankment of the Southern Forebay (SF). The SF has been sited at the northwestern corner of the existing Clifton Court Forebay.

The SDPP will incorporate the following features, which are shown on Figure 1:

- Repurposed tunnel launch shaft to be used as the inlet structure to the SDPP below-ground wet well and as the Project tunnel's gravity flow and surge overflow outlet structure; repurposing the launch shaft will occur once main tunnel section construction is completed.
- Buried pumping plant wet well and above-grade (motor level) structure.
- SDPP complex raised site pad (based on sea-level rise [SLR] and 200-year flood currently being modeled), including required ground improvements. The pumping plant and gravity flow and surge overflow structure site pad has been currently set at elevation 28.0 feet (NAVD88). However, the pad elevation may increase based on future SLR modeling that may be conducted by the California Department of Water Resources (DWR).
- Electrical substation that will initially supply power for the construction of the Project's main tunnel and the SDPP, and then be repurposed as the permanent power supply to the SDPP complex. The electrical substation will be connected to two, high voltage transmission sources.

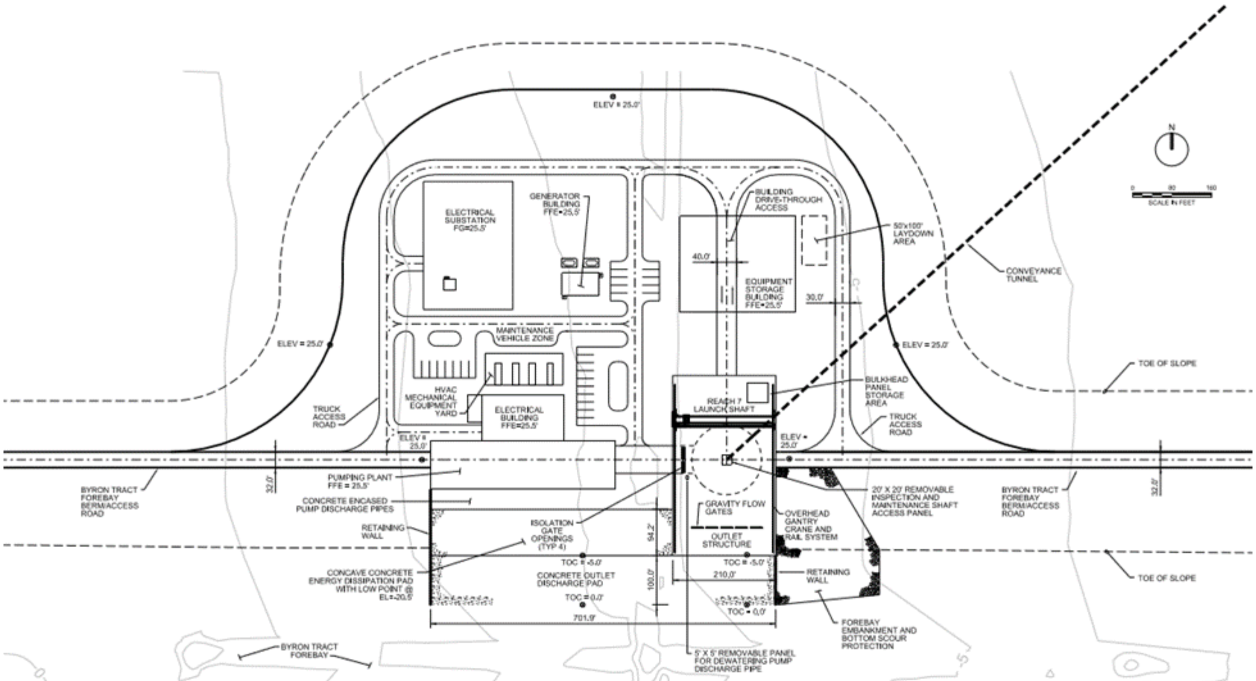

Figure 1. SDPP Facilities Conceptual Configuration and Site Plan

- Adjoining Electrical Building that will house the switchgear and drives for the main raw water pumps and a control room.
- Equipment Storage Building that will contain offices, a welding shop, a machine shop, and a storage area with a drive-through bay.
- Generator Building to supply emergency power to life-safety systems during a main power supply outage.
- Ground-mounted direct expansion (DX) air handler units (AHUs) for Electrical Building heating, ventilation, and air conditioning (HVAC) and roof- or ground-mounted DX AHUs for Mechanical Storage Building HVAC.
- Exterior, rail-mounted gantry crane for the gravity flow and surge overflow outlet structure.
- Interior cranes and hoists for the above-grade structure and the Equipment Storage Building.
- Individual pump discharge piping into SF. Each discharge piping system will include acoustic-type flow meters for flow measurement, and a siphon discharge priming system (each pipe) to reduce the pumping power required by the main raw water pumps.
- Site security and communication systems for the SDPP complex.
- Fire Prevention and Fire Protection system for the entire facility.

The SDPP will pump or provide gravity flow for raw water from the Project's main tunnel into the SF. The SDPP will be connected to the southern end of the Project's main tunnel and will be situated along the SF's embankment, as shown on Figure 1. Water will flow by gravity through the tunnel from the Sacramento River intakes (located on the northern end of the Project) at regulated capacities and will fill the SDPP wet well. The SDPP wet well will be directly connected to the main tunnel via a vertical tunnel shaft that will be located within the SDPP site complex. Figure 1 shows the main tunnel alignment options depicted by a dashed line that terminates at the vertical shaft that will be directly connected to the SDPP's below-grade wet well.

During periods when Sacramento River levels are too low for gravity flow into the SF, the SDPP main raw water pumps will be operated to pump water from the SDPP wet well into the SF inlet facilities located along the eastern side of the SDPP structure. The SDPP will incorporate variable speed main raw water pumps that will be operated to pump the same flow rate being diverted into the tunnel by the northern Sacramento River intakes. Flow meters connected to each pump discharge will be used to control each pump's operating speed so that the total flow output from the SDPP matches the flow rate entering the tunnel through the intakes.

The SDPP will be hydraulically sized to convey a firm design flow capacity between 3,000 and 7,500 cubic feet per second (cfs). The exact Project firm design flow capacity has not yet been established. When confirmed, the firm design flow capacity will be defined as the flow achieved by the SDPP at the defined design head condition, when all pumps within the SDPP are in operation, except the standby pumps. As such, conceptual facility sizing has being conducted for each 3,000, 4,500, 6,000, and 7,500 cfs firm design flow capacities. The SDPP minimum steady-state pumped flow capacity will be 10 percent of the established firm design flow capacity.

When Sacramento River levels are high enough and the SF water level is low enough, the tunnel can flow by gravity into the SF. If the gravity flow capacities match the desired diversion rates at the Sacramento River intakes, no pumping is required at the SDPP. A gravity flow control structure connected to the SDPP wet well influent structure will divert the water directly into the SF using control gates that will be automatically modulated to maintain a set-point water surface level upstream of the gates. When desired intake diversion capacities exceed the achievable gravity flow, the gravity flow control gates will be closed, and the SDPP pumps will be operated.

The SDPP gravity flow control structure will also have emergency overflow weir type openings into the SF to protect PP facilities, the tunnel system, and the area surrounding the pumping plant during a hydraulic transient-surge condition within the main tunnel due to an electrical power failure at the SDPP site (or other emergency that would generate a transient-surge condition) during operation of the conveyance system. The emergency weir type openings within the connecting gravity flow control structure will automatically permit water to flow into the SF and maintain the internal operating pressures in the tunnel to within intended design limits. Suitable storage capacity within the SF will be included to accommodate incoming flow associated with transient-surge events.

The SF stores raw water pumped from the SDPP and supplies this stored water to existing connection channels and the State Water Project (SWP) Harvey O. Banks Pumping Plant (Banks) and possibly the Central Valley Project (CVP) C.W. Bill Jones Pumping Plant (Jones). Separate tunnels and connecting hydraulic control structures associated with the South Delta Conveyance Facilities system will convey regulated flows from the SF to the existing Banks and Jones, either separately or simultaneously.

2. Site Civil

The site civil design criteria for the SDPP and includes the following information:

- Design codes, standards, and references
- Existing site data collection
- Land planning
- Site layout
- Roadways, access drives, and parking
- Storm water management
- Utilities
- Safety and security
- Landscaping
- Site grading

In addition to the criteria provided in this TM, the site civil design will incorporate requirements identified through the environmental impact report (EIR) process and associated documents that are under development by DWR.

2.1 Design Codes, Standards, and References

The latest adopted version of the following codes, standards, and references apply to the SDPP site civil design criteria unless otherwise noted:

- American Association of State Highway and Transportation Officials (AASHTO). *Policy on Geometric Design of Highways and Streets* (AASHTO Green Book).
- California Air Resources Board (CARB). California Code of Regulations (CCR), Title 17, Public Health.
- California Building Standards Commission. 2016. *2016 California Building Code* (CBC). CCR, Title 24, Part 2, Volumes 1 and 2.
- California Department of Social Services (CDSS). CCR, Title 22, Social Security.
- California Department of Transportation (Caltrans). *Highway Design Manual*.
- California Department of Water Resources (DWR) (2012a). "State Water Project - Seismic Loading Criteria Report"; dated September 2012; report prepared under the direction of Jeanne Kuttel.
- California Department of Water Resources (DWR) (2012b). "Delta Seismic Design."
- Caltrans. *California Manual on Uniform Traffic Control Devices* (CA MUTCD).
- Delta Conveyance Design and Construction Authority (DCA). "Seismic Design and Geohazard Evaluation Criteria (Draft)"; April 2020.
- State Water Resources Control Board, Division of Water Quality. National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Construction and Land Disturbance Activities. Order No. 2009-0009-DWQ.
- IEEE Standards Association (IEEE SA). *National Electrical Safety Code* (NESC).
- International Code Council (ICC). *International Zoning Code*.
- National Fire Protection Association (NFPA). *NFPA 1, Fire Code.*

- *NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.*
- Transportation Research Board (TRB). *Highway Capacity Manual*.
- TRB. *Improved Analysis of Two-Lane Highway Capacity and Operational Performance*.
- U.S. Department of Justice, Civil Rights Division. 2010. Americans with Disabilities Act (ADA) *2010 ADA Standards for Accessible Design*
- U.S. Department of Transportation (DOT) Federal Highway Administration (FHA). *Manual on Uniform Traffic Control Devices for Streets and Highways*.

This TM may be updated to add additional relevant standards and specificity as design progresses and details clarify.

2.2 Existing Site Data Collection

2.2.1 Land Surveying

Land surveying will be performed to support the site design prior to performing detailed site layout and design work. The surveying work must be completed under the direction of a professional land surveyor licensed in the State of California. The land surveying must accomplish the following requirements:

- Establish control tied to existing State Water Project (SWP) survey monuments.
- Perform the boundary survey
- Identify existing easements and rights-of-way (ROWs)
- Collect topographic data
- Develop the digital terrain model (DTM)
- Locate existing infrastructure and utilities
- Identify all surface features (constructed and natural)
- Locate wetland delineation and other areas of cultural, environmental, and historical significance

Table 1 summarizes the criteria for land surveying.

Table 1. Land Surveying Criteria

Subject	Criteria	Comments
Access	• Follow all local and state regulations for accessing public and private property, and restore areas to condition existing prior to surveyors' entry or as agreed upon with the property owner • Coordinate permissions for access to properties with DCA	

Table 1. Land Surveying Criteria

Subject	Criteria	Comments
Coordinate system	• State Plane Coordinates based on CCS83 • Coordinates reported in U.S. Survey feet	CCS83 is based on NAD83. Preliminary criteria for the State Plane Coordinate system are based on information contained in the DCE Design Criteria: Volume II. Criteria for the State Plane Coordinate system are preliminary and need to be coordinated with the tunnel team on a programwide basis. State Plane Coordinate systems do not reflect real world distances for long linear projects.
Datums	• Horizontal: The physical reference network for CCS83 is CA-HPGN • Vertical: NAVD88	Per DCE Design Criteria: Volume II.
Accuracy	• Horizontal Control Work: Second-Order, Class II (1:20,000) or better • Vertical Control Work: Second-Order, Class II (0.035 oM) or better • Other Features: Accuracy tolerances of plus or minus 0.10 foot for the horizontal, plus or minus 0.03 foot for the vertical on all other hard surfaces, and plus or minus 0.10 foot for the vertical on soft or natural ground surfaces	Per FGDC Geospatial Positioning Accuracy Standards, Part 4: Standards for A/E/C.

Notes:

A/E/C = Architecture, Engineering, Construction

CA-HPGN = California High Precision Geodetic Network

CCS83 = California Coordinate System of 1983

DCE = Design and Construction Enterprise

FGDC = Federal Geographic Data Committee

NAD83 = North American Datum of 1983

NAV88 = North American Vertical Datum of 1988

oM = square root of distance in miles

U.S. = United States

2.3 Land Planning

The SDPP site will located within the embankment of the Southern Forebay which is generally located in unincorporated Contra Costa County, California. The parcels currently zoned Delta Recreation will require rezoning to a Public/Semi-Public designation. Adjacent parcel zoning designations and land use will need to be determined and documented. Based on the adjacent parcels, land planning for the SDPP project will need to incorporate requirements and ordinances stipulated by Contra Costa County and other local governing bodies regarding setbacks, buffers, easements, and other adjacency requirements.

2.4 Site Layout

Table 2 provides criteria pertaining to the SDPP site layout, facility locations, and other considerations.

Table 2. Site Layout Criteria

Subject	Criteria	Comments
Access	• Provide vehicular access connection with Byron Highway (County Highway J4). • Coordinate site access road with internal SDPP site road network. • Potentially provide a railroad spur to the SDPP site for large material deliveries. • Provide for a material unloading facility within the SDPP site.	Refer to Section 2.5, Roadways, Access Drives, and Parking for additional criteria.
Construction staging	• Provide space accommodations for the tunnel boring machine (TBM) launch pit. • Provide a storage yard to accommodate the supply of stockpiled tunnel lining segments. • Provide a staging area for tunnel lining segments. • Provide a spoils stockpile and processing area for material removed during the tunnel boring process. • Provide an area for construction trailers and parking. • Provide areas for equipment and supplies delivery, staging, and storage. • Provide areas for contractor's maintenance shops.	Land use areas associated with construction staging to be coordinated with the Logistics team.
Temporary facilities	• A concrete batch plant is planned for the site development and facility construction. Site and provide temporary infrastructure for this concrete batch plant. • Fueling stations are planned to be located onsite to facilitate the site development and facility construction. Site and provide temporary infrastructure for temporary fueling station(s).	Land use areas associated with construction staging to be coordinated with the Logistics team. Neither the concrete batch plant nor the fueling stations will be located adjacent to the Byron Highway.

Table 2. Site Layout Criteria

Subject	Criteria	Comments
Permanent facilities	• Locate buildings and other ancillary structures in accordance with 2016 CBC, Title 24, Part 2, Volumes 1 and 2, as adopted by Contra Costa County, considering building architectural wall design and resultant minimum horizontal separation from other buildings, fences, and other structures. • Design electrical substation clearances and transmission line routing within the site in accordance with the latest NESC and utility interconnection requirements as applicable during design and construction.	Requires coordination with architectural building code analysis.
Screening and sound attenuation	• Provide visual screening in areas where visual impairments to adjacent parcels are anticipated based on adjacent land uses. Type of visual screening to be determined during detailed design. • Provide sound attenuation measures to minimize operational noise such that noise levels at nearby residential noise receptors do not exceed 50 dBA Leq during daytime hours (7:00 a.m. to 10:00 p.m.) and 45 dBA Leq during nighttime hours (10:00 p.m. to 7:00 a.m.). • Provide sound attenuating walls to surround noise-producing exterior mechanical and electrical equipment where needed to achieve a noise level less than 50 dB at the SDPP parcel boundary.	
Internal road network	• Provide a site circulation network of roadways that provides access to all buildings, facilities, and needed points of maintenance.	Refer to Section 2.5, Roadways, Access Drives, and Parking for additional criteria.
Sidewalks and paths	• Provide sidewalks and pathways for pedestrian access and small facility maintenance vehicles for connectivity throughout the SDPP site.	Refer to Section 2.5, Sidewalks and Paths section for additional criteria.
Storm water management	• Locate storm water management facilities within the SDPP property to address the criteria described in Section 2.7, Storm Water Management.	

Notes:

dB = decibel(s)

dBA Leq = A-weighted decibel(s) equivalent continuous level

TBM = tunnel boring machine

2.5 Vehicle Access: Roadways, Access Drives, and Parking

The roadways, access drives, and parking areas for the SDPP will be designed to provide safe vehicular and pedestrian travel throughout the site with proper drainage, accessibility, lighting, and other critical elements integrated into the design.

Table 3 provides the design criteria for the roadways and site access drive aisles for the SDPP project. Design criteria pertaining to existing road improvements and new access roads for the SDPP site are not included.

Table 3. Roadway and Access Drives

Subject	Criteria	Comments
Design vehicle	• For primary circulation roads intended to accommodate material deliveries and equipment maintenance vehicles, road design will accommodate an Interstate Semitrailer WB-65 design vehicle per the AASHTO Green Book. • Other secondary internal site roads will be designed to accommodate a Single Unit Truck per the AASHTO Green Book.	
Design speed	• Design speed is 30 mph for site circulation roads within the SDPP parcel (posted speed limit of 25 mph).	
Number of lanes	• The number of lanes required for site circulation roads will be determined during a capacity analysis performed in accordance with the TRB Highway Capacity Manual.	A minimum of two lanes, one in each direction, will be provided.
Widths	• For bidirectional roadways, the minimum lane widths will be 12 feet. • Dedicated turn lanes and two-way left-turn lanes will be provided based on projected traffic volumes and the need for uninterrupted traffic flows. • Access drives will be wide enough to accommodate the design traffic flow and facility roll-up doors.	
Sections	• Transverse slopes for paved roads will be 2%. • Transverse slopes for unpaved roads will be 3%.	
Grades	• 5% or less is typical. • 0.5% minimum for roadways with curb and gutter. • 8% maximum if conditions dictate. • 0.0% acceptable for roads designed without curb and gutter and an appropriately designed roadside ditch to convey storm drainage for the design storm event.	Road grades need to be designed to accommodate large trucks with heavy loads.

Table 3. Roadway and Access Drives

Subject	Criteria	Comments
Vertical curves	• Achieved with parabolic vertical curves. • Designed in accordance with the Caltrans Highway Design Manual. • Stopping sight distance provided based on design speed of road. • Headlight sight distance in sag vertical curves will be addressed. • Minimum vertical curve length will be 100 feet.	
Horizontal curves	• Designed in accordance with the Caltrans Highway Design Manual. • Minimum centerline radius of curvature will be 200 feet. • No superelevation.	
Edge treatment	• Edges of asphalt concrete paved roadways will have one of the following edge treatments, depending on location of the roadway, function, and storm drainage design approach: – 24-inch vertical concrete curb and gutter (18-inch gutter with 6-inch vertical curb) – 24-inch-wide concrete ribbon with 30° sloped outer edge – 3-foot-wide asphalt pavement shoulder with 30° safety edge	
Intersections	• Angle of intersections will be 90°. • Graded to provide smooth, continuous flow of storm water runoff to planned points of collection without runoff flowing through the intersection. • Grade of pavement surface across an intersection will not be more than 5%. • Base intersection configuration on intersection capacity analysis performed in accordance with the TRB Highway Capacity Manual.	

Notes:

% = percent

° = degree(s)

mph = mile(s) per hour

Table 4 provides the design criteria for the parking areas within the SDPP site.

Table 4. Parking Criteria

Subject	Criteria	Comments
General	• Parking areas will be compliant with ADA standards.	
Space count	• The number of parking spaces required will be determined for each facility or assembly area in accordance with the following, whichever is greater: – 1 space per 500 square feet – Greatest number of staff and visitors projected to utilize facility concurrently • The number and type of accessible spaces will be in accordance with ADA standards based on the parking facility total.	
Dimensions	• Perpendicular (90°) passenger vehicle parking will include: – Bidirectional drive aisle width of 24 feet – 10-foot-wide spaces – 16.5-foot-deep spaces where vehicle overhang is provided – 18-foot-deep spaces where there is no vehicle overhang • Angled passenger vehicle parking will include: – 12-foot-wide, one-way drive aisle for 45° angled parking – 15-foot-wide, one-way drive aisle for 60° angled parking • Large vehicle parking will include: – Sized based on planned vehicle type dimensions	
Delineation	• Parking stalls will be striped for paved parking areas. • Parking stalls will be delineated using curb stops or other means in unpaved parking areas.	
Curbs	• Concrete curbs will be provided in paved passenger vehicle parking areas. • Concrete curbs will be considered, but not required, for large vehicle parking areas. • Unpaved parking areas, if applicable, will have perimeter delineation to be determined during detailed design.	
Slope	• Combined longitudinal and transverse slope will not be less than 1%.	

Table 5 provides the design criteria for pavement to be used within the SDPP site.

Table 5. Pavement Criteria

Subject	Criteria	Comments
General	• Pavement design will be in accordance with the Caltrans Highway Design Manual, Chapters 600 through 670.	
Type	• Flexible asphalt pavement will be used for site circulation roadways and passenger vehicle parking areas. • Rigid pavement will be used in areas where heavy vehicles will park, load, and unload, and at facility access aprons.	
Section	• Flexible pavement sections will consist of suitable subgrade, subbase, base course, and the surface course. Tack coats, prime coats, or both may be required based on the application and pavement design. • Rigid pavement sections will consist of suitable subgrade, subbase, base course, and the rigid slab.	
Design	• Pavement design life is as follows: – 40 years for site circulation roads – 20 years for paved parking areas • Minimum pavement section thickness determined based on TI • Minimum TIs in absence of detailed analysis include: – 12.0 for site circulation roads – 14.0 for heavy vehicle access aprons – 5.0 for passenger vehicle parking areas	

Note:

TI = Traffic Index

Traffic control devices, road signage, safety, informational, directional, and other signage types will be required throughout the site. Table 6 provides the design criteria for signage to be used within the SDPP site.

Table 6. Signage Criteria

Subject	Criteria	Comments
Traffic control devices and road signage	• Design in accordance with CA MUTCD.	
Signal warrant analysis	• Perform in accordance with CA MUTCD.	
Other signage	• Determine locations and design requirements based on DCA needs during detailed design.	

2.6 Pedestrian Access: Sidewalks and Paths

The locations and layout of the sidewalks and pathways for foot traffic and smaller facility maintenance vehicles will be determined as part of the site layout and refined during the design development process. All site access routes intended to provide personnel and visitor nonvehicular travel will comply with the ADA Standards for Accessible Design. Table 7 provides design criteria to guide the layout and design of this infrastructure.

Table 7. Sidewalk and Path Criteria

Subject	Criteria	Comments
Location	• At a minimum, provide sidewalks or paths along one side of all interior roads. • Provide sidewalks or paths at the fronts of buildings and facilities. • Provide sidewalks or paths in the spaces between parking areas and building and facility personnel and visitor entrances. • Provide sidewalks or paths in other areas requiring personnel and site maintenance vehicle access based on the facility layout.	
Orientation	• Site sidewalks and paths parallel to roadways. In areas where curbs and gutters are present, provide either a minimum 4-foot-wide planter strip between the back of the curb and the sidewalk or an 8-foot-wide sidewalk located immediately adjacent to the back of the curb. • Site sidewalks and paths parallel to parking area header spaces. • Site sidewalks and paths perpendicular to buildings and facilities. • Site sidewalks and paths to provide direct lines of sight from one building or facility to another. • Site sidewalks and paths at facility element perimeters as needed.	
Material	• Concrete for sidewalks and paths must be ADA compliant. • Gravel, chipped bark, or other similar material for path areas do not require ADA compliance.	
Width	• Sidewalks and paths will be 5-foot minimum; wider where warranted based on access required and access volume.	
Depth	• Sidewalks and paths will have a 4-inch minimum depth for foot traffic only areas. • Thickness based on projected loads for areas designed to accommodate non-foot traffic.	

2.7 Storm Water Management

Storm water discharges in California are regulated through National Pollutant Discharge Elimination System (NPDES) permits. The NPDES storm water program regulates storm water discharges from three potential sources: municipal separate storm sewer systems (MS4s), construction activities, and industrial activities. Storm water management will be provided during construction and postconstruction for the SDPP site. Storm water management consists of overland routing, collection, conveyance, and water quantity and quality mitigation. Table 8 provides the storm water management design criteria for the SDPP site.

Table 8. Storm Water Management Criteria

Subject	Criteria	Comments
Construction general permit	• Obtain coverage for the SDPP project under the General Permit for Discharges of Storm Water Associated with Construction Activity Construction General Permit Order 2009-0009-DWQ. • A certified QSD will develop an SWPPP per the Construction General Permit.	
Storm water control plan	• Prepare a Storm Water Control Plan as required by State Water Resources Control Board, Division of Water Quality.	Refer to California Water Boards State Water Resources Control Board.
Storm water quantity and quality mitigation	• Employ either: – LID Design Guide (Chapter 3) within the Contra Costa Clean Water Program *Stormwater C.3 Guidebook* to meet both treatment and flow-control requirements Or – Continuous simulation hydrologic modeling to demonstrate that post-project storm water rates and durations match preproject discharge rates and durations from 10 of the preproject 2-year peak flows up to the preproject 10-year peak flow. The postproject flow-duration curve will not deviate above the preproject flow duration curve by more than 10% over 10% of the length of the curve corresponding to this range of flows.	Refer to Contra Costa Clean Water Program *Stormwater C.3 Guidebook.*
Storm drainage system	• Design storm drainage to collect and convey the 25-year design storm. • Do not allow flooding of facility structures for the 200-year design storm. • Set the minimum time of concentration to 5 minutes. • Design pipes to flow full without having the energy grade line penetrate the finished surface. Surcharging catch basins and manholes are permissible, providing surcharging is limited to be at least 1 foot below the top of the structure under design flow.	Refer to Caltrans specifications and standard drawings. Final pipe material selection to be coordinated with the corrosion engineer.

Table 8. Storm Water Management Criteria

Subject	Criteria	Comments
	• Design ditches and swales with 1 foot of freeboard for the 25-year design storm. • Provide catch basin or inlet at all planned low points. • For paved roadways with curb and gutter, do not allow gutter spread to exceed 6 feet from the edge of the gutter. Provide catch basins and inlets appropriately to contain gutter spread. • Design manholes a minimum of 48 inches in diameter. Larger-diameter manholes will be required for larger pipes. • Provide manhole steps as required by the local jurisdiction. • Provide manholes at: – All grade changes – All alignment changes – All pipe size changes – Intervals not exceeding 400 feet • Design manhole, junction box, catch basin, and other structures to account for potential buoyancy due to groundwater. • Use the following pipe materials: – RC – Galvanized corrugated metal – HDPE – PVC • Use gasketed pipe joints for storm drain pipe. • Provide minimum velocity of 2 fps for the 2-year design storm. • Provide animal barriers at pipe inlets and outlets. • Provide scour protection at pipe outlets. • Design a minimum pipe diameter of 12 inches, with the exception of the roof downspout conveyance system. Roof drainage systems will have a minimum diameter of 4 inches. • Provide security measures to prevent site access through swales, ditches, pipes, and other storm water discharge locations that allow storm water to discharge offsite.	

Notes:

fps = foot (feet) per second

HDPE = high-density polyethylene

LID = low-impact development

PVC = polyvinyl chloride

QSD = Qualified SWPPP Developer

RC = reinforced concrete

SWPPP = Storm Water Pollution Prevention Plan

2.8 Utilities

2.8.1 Potable Water

The potable water design criteria is based on the premise that connection to a public water system will be available with enough capacity to supply the SDPP. Table 9 provides the design criteria for the onsite potable water distribution system.

Table 9. Potable Water Criteria

Subject	Criteria	Comments
Separation	• Design separation a minimum of 10 feet horizontally and 18 inches vertically over potential sources of contamination, including sanitary sewer pipelines. • Design separation a minimum of 4 feet horizontally and 1 foot vertically above any parallel storm drainage pipeline.	
Backflow prevention	• Use backflow prevention devices at all connections with public potable water sources, separate dedicated fire protection water systems, and other water systems used for special dedicated purposes.	
System sizing	• Size the potable water distribution system to meet the average daily demand plus fire-flow demand. • Base daily demand on all site water requirements from the potable water source, including potable water, service water, seal water, and other service demands. • Design water mains to be no less than 4 inches in nominal diameter.	Coordinate water needs with local provider, including fire demands. Actual demands to be determined during preliminary design.
Minimum pressure	• Design the distribution system to provide a minimum operating pressure of 20 psi at all times.	
Isolation valves	• Provide isolation valves at all connections. • Provide isolation valves no farther than 1,320 LF apart on all mains with a diameter of 12 inches or less.	
High and low points	• Provide air- and vacuum-relief valves at high points. • Provide drains or blowoffs at low points. • Install air- and vacuum-relief valves such that the vent opening is above grade, above the calculated 100-year flood water level.	These criteria apply to pipes 4 inches and larger in diameter.
Flushing	• Provide a flushing valve, blowoff, or hydrant at the end of each dead-end water main. • Do not allow the flushing appurtenance to discharge to sanitary sewer without an air gap separation. • Design the flushing velocity in the main as not less than 2.5 fps.	

Table 9. Potable Water Criteria

Subject	Criteria	Comments
Fire protection systems	• Design outside fire protection systems in accordance with the NFPA 1. • Design hydrant type, spacing, and location in accordance with local requirements.	
Materials	• Design all new water mains to comply with the materials and installation standards of the AWWA, pursuant to Tables 64570-A and 64570-B of the CCR, Titles 17 and 22.	
Water main valve	• Provide a valve box over each buried valve stem. • For valves buried in trenches more than 5 feet below finished grade, provide a valve stem riser.	Valve selection will be determined during preliminary design.
Distribution reservoir	• Provide an onsite distribution reservoir if deemed necessary based on evaluation of water supply and demands.	

Notes:

NFPA = National Fire Protection Association

AWWA = American Water Works Association

LF = linear foot (feet)

psi = pound(s) per square inch

2.8.2 Sanitary Sewer

Sanitary sewer service for the SDPP is anticipated to be connected to a public sewer system for conveyance and treatment. Table 10 provides the design criteria for the sanitary sewer system.

Table 10. Sanitary Sewer Criteria

Subject	Criteria	Comments
Connection to public sewer	• Private side sewer conveyance pipe will connect to the public sewer system at a manhole.	Assumption about connection to public sewer needs to be confirmed.
Gravity line size	• Minimum nominal size for new public gravity sewer will be 8 inches in diameter. • Private side gravity sewers will be 6 inches in diameter and larger based on projected flows.	
Average base wastewater unit flow factor	• 100 gpd / 1,000 sf	
Groundwater infiltration rate	• 170 gpd / acre	

Table 10. Sanitary Sewer Criteria

Subject	Criteria	Comments
Wastewater flow peaking factor	• Per Figure 2.	
Gravity sewer pipe design capacity	• For sewers 8 and 10 inches in diameter, design capacity will be based on pipe flows two-thirds full (d/D < or + 0.67). • For sewers 12 inches and larger in diameter, design capacity will be based on pipes flowing full without surcharging (d/D < or = 1.0).	
Velocity and slope	• Minimum acceptable slope for gravity sewer pipe is based upon a velocity of 3 fps for main sewers and 2 fps for trunk sewers, both when flowing full. • Maximum flow velocity will be 8 fps.	
Separation from potable water lines	• Minimum horizontal separation for parallel installations is 10 feet. • Minimum vertical separation is 18 inches. • Potable water and sewer pipes will cross at 90° whenever possible and no less than 45°. Crossing pipe segments will be centered.	
Pipe material	• Side sewers: – ABS Schedule 40 – PVC SDR 26 – C900 DR 14 • Main sewers: – DI Class 52 – PVC SDR 26 – C900 DR14 • If groundwater is present in the trench area, sewers will be DI. • When the slope of a gravity sewer pipe exceeds 20%, DI pipe is required.	
Pipe cover and clearance	• Pipe cover for side sewers: – ABS Schedule 40 – 5-foot minimum, 24-foot maximum – PVC SDR 26 – 5-foot minimum, 24-foot maximum – C900 DR 14 – 3-foot minimum, 24-foot maximum • Pipe cover for main sewers under roadway: – DI Class 52 – 1-foot minimum, 35-foot maximum – PVC SDR 26 – 5-foot minimum, 24-foot maximum – C900 DR 14 – 3-foot minimum, 24-foot maximum • Pipe cover for mains not under roadway – DI Class 52 – 1-foot minimum, 30-foot maximum – C900 DR 14 – 3-foot minimum, 24-foot maximum	

Table 10. Sanitary Sewer Criteria

Subject	Criteria	Comments
	• Minimum cover for side sewers at the point of connection to the building waste plumbing (within 2 feet of the foundation) will be 18 inches. • Aside from potable water lines, sewer pipes and structures will be separated a minimum of 12 inches vertical and 3 feet horizontal from all other utilities.	
Cleanouts for side sewer	• Cleanouts will be provided in the side sewer system at the following locations: – At the point of connection to the building drain within 2 feet of the building foundation – At any single bend greater than 22.5° – At intervals along the side sewer system where the cumulative total deflection from point of connection to the main sewer or from another cleanout equals or exceeds 90° – At intervals not to exceed 100 feet	
Side sewer overflow protection	• An overflow protection device will be provided on all side sewers.	Verify requirement with Contra Costa during preliminary design.
Warning tape	• Warning tape will be installed a minimum of 12 inches above sewer pipes.	
Sewer manholes	• Minimum interior diameter of 4 feet. • Manholes will be located at all trunk and main sewer intersections, at all points where trunk or main sewer size changes, and at intervals not more than 400 feet. • Drop across the manhole will be a minimum of 0.25 foot and a maximum of 1 foot plus the nominal diameter of the outlet sewer. • The horizontal angle of deflection between incoming and outgoing sewer pipes will be ≤ 90°. • Drop manholes will be avoided. • Manholes will be designed to avoid buoyancy induced by groundwater.	
Trench dams	• Concrete trench dams will be provided at recurring intervals along the pipe to prevent the migration of groundwater through the pipe zone.	
Pipe anchors	• Pipe anchors will be provided at intervals not exceeding 40 feet in sewer trenches where the slope of the pipe exceeds 30%.	

Table 10. Sanitary Sewer Criteria

Subject	Criteria	Comments
Pressure sewer system	• Pipeline velocity minimum of 3 fps and maximum of 8 fps. • Surge tanks, relief valves, or other devices necessary to protect pressure sewer pipelines will be provided. • Thrust restraints will be provided on pressure piping at all bend fittings and dead-ends. • Drains will be provided at low points in the pipe and at air- or vacuum-release valves at high points.	If a pressure sewer system is determined to be needed as part of preliminary design, additional design considerations (e.g., flushing velocities, number of pumps, sump level monitoring and alarms, odor control, backflow prevention, power, wet well sizing) will need to be addressed.

Notes:

< = less than

≤ = less than or equal to

ABS = acrylonitrile butadiene styrene

d/D = depth of flow to the inside diameter of the pipe

DI = ductile iron

DR = dimension ratio

gpd = gallon(s) per day

SDR = standard dimension ratio

sf = square foot (feet)

PCV = polyvinyl chloride

Figure 2 shows the wastewater design flow peaking factor.

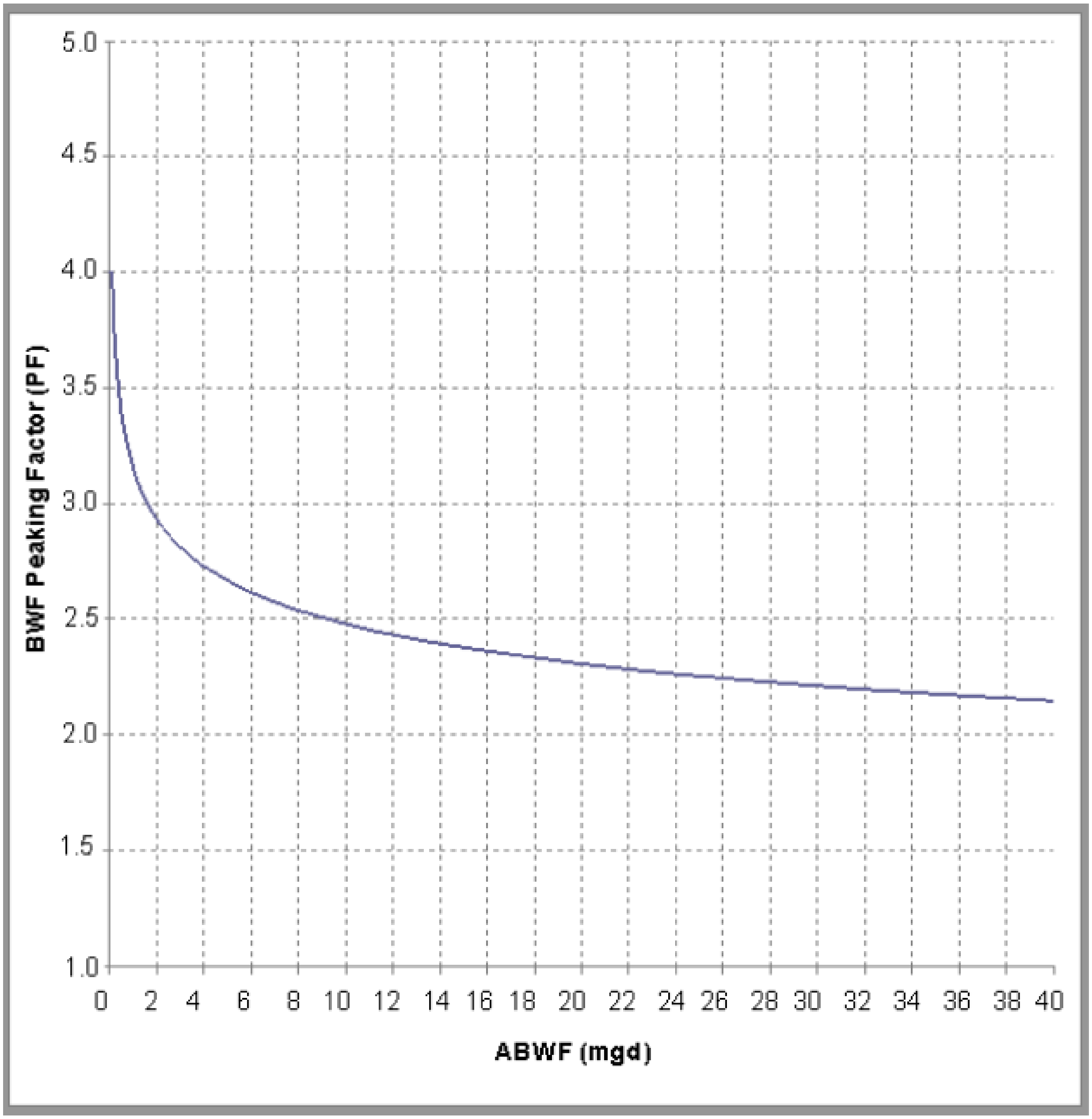

Figure 2. Wastewater Design Flow Peaking Factor

Source: Central Contra Costa Sanitary District Standard Specifications for Design and Construction

2.9 Safety and Security

The design will incorporate site safety and security measures to meet DCA requirements. Table 11 provides criteria pertaining to site safety and security.

Table 11. Safety and Security Criteria

Subject	Criteria	Comments
Site lighting	• Provide site lighting in parking areas. • Provide site lighting along all pedestrian walkways. • Provide site lighting at all site access points. • Provide site lighting at other key points determined during detailed design. • Provide exterior LED site lighting that does not include blue-rich white light lamps. Determine lighting design using a correlated color temperature that is no higher than 3,000°K, consistent with the International Dark-Sky Associations Fixture Seal of Approval program. • Provide LED lights with shielding to prevent nuisance glare and light spill from affecting materially sensitive residential viewers.	Coordinate with electrical design.
Restricted access	• Provide no fewer than two points of site access. • Control site access points to allow only authorized personnel and permitted entrants. • Provide Knox Box(es) for first responder access. • Provide 011 AVI feature for first responder access through gates.	Specific control measures and means of access to be determined as part of preliminary design efforts.
Fencing	• Provide perimeter site security fencing. • Provide perimeter chain link fences that is plastic or vinyl coated with colors per BLM standard. • Provide security fencing around restricted access areas within the site (e.g., electrical substation).	Fencing details to be determined during preliminary design. Gate design to be coordinated with the owner during preliminary design.
Security cameras	• Provide closed-circuit security cameras at site access points, parking areas, and other areas to be monitored based on DCA requirements.	

Notes:

°K = degree(s) Kelvin

AVI = Automatic Vehicle Identification

BLM = Bureau of Land Management

LED = light-emitting diode

2.10 Landscaping

Site landscaping will be incorporated to achieve an attractive site and to break up the mass of the facilities. Additionally, the landscape design will create a cohesive environment that will promote the physical and psychological well-being of the people who work at the SDPP and who live nearby. Table 12 provides the landscaping criteria.

Table 12. Landscaping Criteria

Subject	Criteria	Comments
Objectives	• Create visual barriers from adjacent properties. • Provide vegetative accents and screening to aid in the perceived reduction of the scale and mass of the built features. • Provide shade. • Reduce noise, glare, and dust. • Control erosion. • Modify temperature, humidity, and wind. • Minimize maintenance.	
Planting type	• Provide native, drought-tolerant species. • Provide variation of size and type of plantings based on planting locations. • Choose plants that display variations in texture and form, with attention to flowering shrubs and seasonal color.	
Sight lines	• Account for sight lines at corners and intersections based on mature sizes of plantings.	
Parking areas	• Screen from streets with low shrubs, walls, and earth berms at a 30-inch maximum height. Choose shrubs that will create a continuous 30-inch-high screen within 2 years of planting. • Provide native oaks or other native trees to provide shading and reduce thermal heating.	
Walls and fences	• Buffer masonry walls and fences with shrubs in areas facing a street.	
Planting setbacks	• Follow these tree planting setbacks: – Fire hydrants – 10 feet – Driveways and access drives – 10 feet – Stop signs or curb returns – 15 feet – Storm drain, sanitary sewer, gas lines – 10 feet – Water, telephone, electrical main – 10 feet – Streetlights – 10 feet • Provide a minimum of 15 feet between overhead power lines and tree plantings. Only trees that will reach less than 20 feet at maturity can be planted within 15 feet of power lines.	

Table 12. Landscaping Criteria

Subject	Criteria	Comments
Grouping	• Group plant materials into appropriate hydrozones per estimated landscape water use.	
Irrigation	• Provide irrigation system as needed to support survival of site vegetation. • Provide a central programmable control. • Provide backflow protection. • Design irrigation so the ELWU will not exceed the LWA.	Determine need for freeze protection during preliminary design.
Mulching and weed control	• Provide weed barriers, mulching, and other measures to prevent the growth of weeds and other undesirable vegetation in landscape planting areas.	

Notes:

ELWU = estimated landscape water use

LWA = landscape water allowance

2.11 Site Grading

This section provides the site grading requirements, and Table 13 provides the site grading criteria.

Table 13. Site Grading Criteria

Subject	Criteria	Comments
Erosion and sediment control	• Provide erosion and sediment control as part of the SWPPP.	
Stripping	• In additional to clearing and grubbing, require topsoil removal and stockpiling for areas that are to be developed for site infrastructure and buildings.	Refer to Geotechnical Design Criteria (being developed under separate cover in future stage of design development).
Overexcavation and soil treatment	• Overexcavate or provide soil conditioning for areas not suitable for fill material placement.	Refer to Geotechnical Design Criteria.
Mass grading	• Design mass site grading to achieve a general site fill elevation above the 200-year flood and wave run-up elevations. • Preload building pads to achieve required density.	Refer to 2019 climate change sea level and 200-year flood study to be performed by others. Refer to Geotechnical Design Criteria.

Table 13. Site Grading Criteria

Subject	Criteria	Comments
Finished grades	• Design site structure finished floor elevations 2 feet above the 200-year flood and wave run-up elevations. • Provide positive drainage away from buildings, structures, slabs, and other site features where the accumulation of storm water is not desirable. Provide 6 inches of fall away from building foundations in the first 10 feet from the foundation. • Set finished grades along perimeter of buildings, slabs, and other structures at 6 inches below floor or slab elevation, except at points of access. • Grade the site to direct storm water runoff to streets, ditches, swales, or catch basins for collection and conveyance. • Provide 1-foot contour intervals for site grading plans. • Provide spot elevations on plans, as follows: – Where needed to provide an appropriate level of detail to achieve the desired grading. – To a 0.01-foot accuracy to precisely define critical elevations of key structural elements, such as top of curbs, drainage structures, pavements, sidewalks, steps, concrete pads, and at doors into buildings and other facilities. – In nonpaved areas, provide at 0.1-foot accuracy. • Show grade break lines on plans.	Refer to 2019 climate change sea level and 200-year flood study being performed by others.
Slopes	• Grade grassed areas requiring mowing at a maximum slope of 5H:1V. • Provide minimum slopes as follows: – 3% for grassed and other nonpaved areas – 0.5% for concrete slabs, gutters, and pavement areas – 1% for asphalt pavement areas (e.g., parking areas)	Final cut and fill slopes to be provided by the geotechnical team. Coordinate requirements accordingly.
Stabilization	• Provide permanent soil stabilization measures to all bare soil areas by seeding, sodding, plantings, mulching, rock, or other means, depending on the location.	Cut and fill slopes to be stabilized using a nonvegetative method to reduce maintenance requirements. Stabilization methods to be determined as part of the preliminary design.

Note:

H:V = horizontal to vertical

2.12 Seismic Ground Motions

DWR's Seismic Loading Criteria Report for State Water Project (DWR, 2012a) presents minimum seismic loadings for SWP and provides different levels of seismic loading criteria based on criticality of a facility. Furthermore, the Delta Seismic Design Report, also published by DWR (DWR, 2012b), presents seismic design criteria and recommendations for the development of fault rupture and ground motions for the SWP facilities in the vicinity of the Sacramento-San Joaquin River Delta Region.

The Conceptual Seismic Design and Geohazard Evaluation Criteria (DCA, 2021a). Builds upon the two aforementioned DWR reports to provide general guidelines regarding the evaluation of seismicity and the development of seismic design ground motions and loading criteria for various facilities, including intakes, pumping plants, levees (excluding existing Delta levees), embankments, appurtenant works, tunnels, shafts, buildings, bridges and other project features planned for the Delta Conveyance project, inclusive of the SDPP. Refer to this DCA report for specific criteria, analyses approach, and modeling requirements.

3. Structural

The SDPP wet well receives gravity flow from the tunnel through the wet well inlet conduit. The wet well inlet conduit connects the SDPP with the tunnel shaft. The SF receives gravity flow from the tunnel shaft outlet structure. Under certain hydraulic conditions, the gravity flow control gates within the tunnel shaft gravity and surge control structure can be opened to allow water to flow directly into the SF by gravity. When hydraulic conditions are not suitable for direct gravity flow into the SF, the SDPP pumps will be operated. During periods where the SDPP wet well requires isolation from the main tunnel and the SF bulkhead gates will be installed at the entrance to the wet well inlet conduit.

Excavation depth and a high groundwater table must be considered in the design and construction of the below ground level wet well and wet well inlet conduit structures. Issues that result include buoyant forces, high lateral earth pressures, and construction dewatering.

The SDPP facilities will be engineered to withstand flood water from the following sources:

- 200-year return flood event in nearby waterways
- The 200-year return flood event with levee breach
- Wind-induced waves
- SLR due to climate change in the next 100 years

3.1 Design Codes, Standards, and References

The latest version of the following codes, standards, and references apply to the SDPP structural design criteria unless otherwise noted:

- *AASHTO LRFD Bridge Design Specifications*.
- Aluminum Association*. Aluminum Design Manual – Specification for Aluminum Structures – Building Load and Resistance Factor Design.*
- American Concrete Institute (ACI). *ACI 207.1R-05 Reapproved 2012 Guide to Mass Concrete*.
- *ACI 318, Building Code Requirements for Structural Concrete*.
- *ACI 350, Code Requirements for Environmental Concrete Structures.*
- *ACI 350.03, Seismic Design of Liquid-Containing Concrete Structures.*

- *ACI 351.3R, Report on Foundations for Dynamic Equipment ()*
- American Institute of Steel Construction (AISC). *Seismic Design Manual*.
- AISC. *Specification for Structural Steel Buildings*.
- *AISC 360, Steel Construction Manual*.
- AISC. *Steel Design Guide No. 7: Industrial Buildings.*
- American National Standards Institute (ANSI). *Rotodynamic Pumps – Guideline for Dynamics of Pumping Machinery, Hydraulic Institute Standard.*
- ANSI. *Rotodynamic Vertical Pumps – Manuals Describing Installation, Operation, and Maintenance, Hydraulic Institute Standard.*
- American Society of Civil Engineers (ASCE). *ASCE 7 - Minimum Design Loads for Buildings and Other Structures.*
- *ASCE 113 - Substation Structure Design Guide.*
- *ASCE 41 - Seismic Evaluation and Retrofit of Existing Buildings.*
- American Society of Mechanical Engineers (ASME). *ASME B30.2, Overhead and Gantry Cranes, Top Running Bridge (Single or Multiple Girder, Top Running Trolley Hoist).*
- American Welding Society (AWS). *AWS D1.1 - Structural Welding Code*.
- *AWS D1.3 - Specification for Underwater Welding*.
- California Division of Occupational Safety and Health (Cal/OSHA). CCR, Title 8, Industrial Relations.
- Crane Manufacturers Association of America (CMAA). *CMAA 70 - Specification for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes*.
- DWR. *Water Resources Engineering Memorandum (WREM) No. 70.*
- DWR. 2018. *Conceptual Engineering Report Byron Tract Forebay Option (WaterFix BTO)* (CER).
- ICC. *International Building Code* (IBC).
- Prestressed Concrete Institute (PCI). *PCI Design Handbook*.
- Research Council On Structural Connections (RCSC). *RCSC Specification for Structural Joints Using High-Strength Bolts.*
- Steel Deck Institute (SDI). *SDI Code of Standard Practice 2017 - No. COSP17.*
- Steel Joist Institute (SJI). *Code of Standard Practice of Steel Joist Institute.*
- United States Department of Agriculture (USDA). *RUS Bulletin 1724E-300 – Design Guide for Rural Substations*

This document may be updated to add additional relevant standards and specificity as design progresses and details clarify.

3.2 Structural Design Basis

Because of the critical nature of these facilities, long delays due to a seismic event could have a significant impact on human life and the California economy. Based on the ASCE 7 description for critical facilities, the following critical design parameters will be determined:

- Design levels
- Load conditions
- Load types
- Loading event performance
- Action after loading event
- Economic consequences
- Seismic recurrence
- Peak ground acceleration

The WREM No. 70 provides guidance for determining the loading criteria based on the criticality of the facility. Lower seismic loads may be used for structures that are deemed not critical to water delivery or that can be repaired in a reasonable time frame.

3.3 Structural Components

The facility can be broken down into the components described in this section:

- Gravity Flow/Surge Overflow Shaft Outlet Structure
- Wet Well Inlet Conduit
- Pumping Plant
- Buildings
- Cranes
- Substation
- Other Structures

All underground structures will be reinforced concrete.

3.3.1 Gravity Flow/Surge Overflow Shaft Outlet Structure

This structure will be constructed on the top of the tunnel outlet shaft to divert gravity flows from the tunnel directly to the SF or to the SDPP wet well, where tunnel flows will be pumped to the SF.

Under gravity flow conditions, a series of mechanical control gates (in parallel) can be opened to allow gravity flow directly into the SF. When operation of the pumping plant is required, the mechanical gates will be closed, and all water will flow directly to the SDPP wet well.

The top of the outlet shaft outlet structure will be constructed to the elevation required to prevent flood flows from entering during construction of the Project tunnel. Therefore, it is anticipated that upper portions of the outlet shaft will be demolished down to the elevations required to release flows to either the SF or the SDPP wet well once tunnel construction has been completed for this reach or the tunnel Contractor's tunnel boring machine (TBM) operation is moved to a separate working shaft.

Large, removable roof hatches will be incorporated over the center of the outlet shaft to allow the installation of deep-set, submersible tunnel dewatering pumps when tunnel access is required. Additional removable roof hatches will be incorporated to allow the installation of dewatering pump discharge piping for conveying pumped flow directly into the SF during the tunnel dewatering process. Under the current concept, the entire tunnel will be dewatered from the outlet shaft located within the SDPP complex.

The structure will be reinforced concrete. A deep foundation, such as piles or drilled piers, is anticipated for portions not supported directly by the outlet shaft.

3.3.2 Wet Well Inlet Conduit

The wet well inlet conduit is a covered box located between the Gravity Flow/Surge Overflow Outlet Shaft structure and the SDPP wet well structure. The upstream portion of the channel will have covered bulkhead gate slots. When pumping plant wet well access is required, double isolation gates will be installed. There will be two rows of gates to provide dewatering redundancy and personnel safety.

The top of the gate access area will match the elevation of the shaft outlet structure. Downstream of the gate area, the top of the box will be buried and located as required by the maximum operating water surface elevation into the wet well. The slide gate panels will be stored either in the Equipment Storage Building or in a separate storage structure when not in use.

The bottom of the conduit will match the bottom of the wet well. Deep excavation shoring, such as Diaphragm-wall (D-wall) construction, is anticipated to support large soil pressures and flood flow groundwater levels that may require a dewatering system and tremie concrete.

3.3.3 Pumping Plant

The SDPP consists of a reinforced concrete rectangular wet well; a pump floor at grade; and a building to protect the pumps, motors, discharge piping and connecting flow meters, and traveling bridge crane. There will be up to ten vertical-style pumps required to accommodate the design flow capacity up to 7,500 cfs (maximum design flow within the current design flow range currently identified).

Like the wet well connection channel, the pumping plant wet well will require deep excavation shoring, such as diaphragm-wall (D-wall) construction, is anticipated to support large soil pressures and flood flow groundwater levels that may require a dewatering system and tremie concrete.

The pumping plant building height will be based on pump and motor removal requirements. It is anticipated that the pumps will be removed in sections. The length of the longest individual section will establish the required crane hook elevation and building height requirements. The design of the pump floor (within the above grade structure) will be based on dead loads, live loads, and vibration and excitation frequencies associated with the operation of the pumps. To prevent the modal natural frequencies of the structure from resonating within the pumps' excitation frequency range, the structure stiffness will be set to avoid resonant conditions. Wet well divider (shear) walls located between pump bays are anticipated to be used to carry lateral earth pressures and to support the pump deck.

The Electrical Building will be an adjoining structure with the pumping plant building. The Electrical Building will house switchgear and variable frequency drives for the for the SDPP complex. The Electrical Building will also house a control room for operation of the pumping plant facilities.

3.3.4 Buildings

There will be four main buildings at the SDPP as follows:

1) Pump Plant Building
2) Equipment Storage Building
3) Electrical Building
4) Generator Building

All buildings will be single story and sized according to the process needs. Building construction will be based on architectural, mechanical, and electrical requirements, and may consist of a combination of cast-in-place concrete, precast concrete, structural steel, and masonry.

The following criteria will be used for the design of the building framing members:

• Building frame lateral drift	H/400
• Live and wind load deflection of framing members	L/360
• Total load deflection of framing members	L/240

L= length of member H=height of building frame

3.3.5 Cranes

The facility will have two cranes as follows:

1) Pumping plant building bridge crane
2) Equipment storage building bridge crane
3) Outlet shaft overhead gantry crane (rail mounted)

The cranes will be designed in accordance with ASCE 7, Chapter 4, and CMMA 70 for a CMMA Class Service C The crane capacities will be specified to be 125 percent of the maximum anticipated load (Tables 20 and 21).

3.3.6 Substation

The substation will be designed in accordance with ASCE 113 and USDA RUS Bulletin 1724E-300

3.3.7 Other Structures

Other structures include a bulkhead slide gate storage structure and miscellaneous site structures.

3.4 Loads

3.4.1 Gravity

Gravity loads include the following:

- Dead Loads: Weight of structure and permanent equipment
- Floor Live Loads: Superimposed uniform or concentrated loads
- Roof Live Load: Conform to ASCE 7, Chapter 4 except as follows:
  - Process Areas: 200 pounds per square foot (psf)
  - Electrical Rooms: 300 psf

Where significant, use the actual weights of equipment.

3.4.2 Crane Impact Loads

For crane impact loads, conform to ASCE 7, Chapter 4.

3.4.3 Wind Loads

For wind loads, conform to ASCE 7, Chapters 26 through 30:

- Ultimate Design Basic Wind Speed (3-second gust): 115 mph
- Exposure Category: C

3.4.4 Earthquake Loads

For earthquake loads, conform to CBC Chapter 16, ASCE 7 Chapters 11 through 16, and the project Geotechnical Report.

For hydrodynamic loads, conform to ACI 350.3, and ASCE 41.

For Immediate Occupancy (S-1) structural performance level, conform to the DWR WREM No. 70.

Seismic design requirements and assumed return periods will be based on the performance objectives for each facility (forthcoming).

3.4.5 Vehicle Loads

Vehicle loads will conform to an AASHTO H-20 Truck.

3.5 Load Combinations

Conform to ASCE 7 Chapter 2 for service and strength level combinations.

3.6 Lateral Earth Pressures

Design backfilled walls using the lateral earth pressure criteria indicated in the final Geotechnical Report. Design nonyielding walls for saturated at-rest, surcharge, and dynamic earth pressures. Yielding retaining walls may be designed for saturated active earth pressures.

3.7 Pump Vibration

The pumping plant structure will be designed to prevent resonance due to pump excitation frequencies using a combination of mass and stiffness.

3.7.1 Frequency Analysis

Structural design for vibration and frequency response of the pump support structure will be as follows:

- The primary response frequencies of the pump foundations will be more than 1.5 times the value of the operating frequency of the pumps based on the 1.0 time the mechanical operating speed of the pumps and motors. 2.0 times mechanical operating speed and multiples of impeller vane-pass pressure pulsations will also be evaluated.
- The frequency analysis will be based on the cracked concrete section properties.
- The dynamic frequency analysis model will include all masses capable of participating in the pump vibration, including the pump, pump column, supported water, pump support, and motor.
- In accordance with Hydraulic Institute (HI) recommendations, a mass ratio of 5:1 is provided for the mass of the pump support structure relative to the mass of the pumping equipment.

The primary intent of the pump support structure design will be to avoid resonating vibrations of the support structure's natural frequency with the pump and motor operating frequencies. This is achieved by designing the structure so that the frequency of the disturbing force (pump) is significantly different than the frequency of the support structure. To minimize the resonant vibrations, the ratio of the structure's natural frequency to the pump's frequency is typically outside the range by a factor of 0.5 to 1.5. The lower end of the range will not be used because frequencies may resonate when the pump goes through the low-frequency range during startup. A factor of 1.5 will be used for this design.

A preliminary finite element analysis (FEA) model will be created for the pump support structure to determine the natural frequency. The results will be used to provide adequate stiffness to the structure.

3.8 Groundwater and Buoyancy

The facilities will be designed for a long-term groundwater elevation equal to the 200-year flood elevation. It is anticipated that groundwater control during construction will be accomplished with a combination of cutoff walls, tremie seals, and pumping.

3.9 Excavation Shoring

It is anticipated that permanent D-wall shoring will be required because of the excavation depth and high groundwater. The permanent structure will be constructed within and possibly against the D-walls. Portions of the D-wall will be demolished to tie into adjacent structures.

3.10 Materials

Materials will conform to those listed in Table 14.

Table 14. Structural Materials and Properties

Material	Property
New concrete	F’c = 4,500 psi at 28 days, normal weight
Reinforcing steel	ASTM A615, Grade 60, F_y = 60 ksi
Reinforcing steel to be welded	ASTM A706, Grade 60, F_y = 60 ksi
Structural steel:	
Steel plates, shapes except W-shapes and bars	ASTM A572 Grade 50, F_y = 50 ksi or ASTM A36, F_y = 36 ksi
W-shapes and T-shapes	ASTM A992 (Fy = 50 ksi)
Rectangular (and square) HSSs	ASTM A500 Grade B, F_y = 46 ksi
Round HSSs	ASTM A500 Grade B, F_y = 42 ksi
Steel pipe	ASTM A501 or A53, Grade B, Type E or S
Steel pipe for sleeves and piles	API Specification for Pipeline 5L, PSl2; sleeve grade 52; piles grade 65
Stainless steel:	
Bars and shapes	ASTM A276, AISI Type 316LN, F_y = 25 ksi
Plate	ASTM A240, Type 316LN, AISI Type 304L, F_y = 25 ksi
Bolts and rods:	
High-strength steel bolts	ASTM A325, Type 1 bolts with A563 nuts
Steel bolts	ASTM A307, Grade B or A36
Anchor rods	ASTM F1554, Grades 36, 55, and 105 (hooked, headed, or threaded and nutted) as appropriate for application or ASTM A36 (threaded rods either plain or upset ends)
Bolts in contact with water	ASTM A193, GR B8S
Nuts in contact with water	ASTM A194, GR B8S
Bolts Not in contact with water	ASTM A193 GR B16 or B7
Bolts Not in contact with water	ASTM A194 GR 1 or 2H Heavy Series for nuts
Post-tensioning bars	ASTM A722, 150 ksi ultimate stress
Concrete-epoxy anchors	Stainless Steel Hilti or equal
Concrete-grouted anchors	Williams Grout Bonded Rock Anchors by Williams Form Engineering Corp, or equal

Table 14. Structural Materials and Properties

Material	Property
Grating:	
Serrated bar grating	Galvanized steel
Channel grating	Galvanized steel
Fiberglass grating	Molded or pultruded fiberglass
Handrail and guardrail	Galvanized steel

Notes:

AISI = American Iron and Steel Institute
HSS = hollow structural section
API = American Petroleum Institute
ksi = kilopound(s) per square inch

3.11 Design

3.11.1 Reinforced Concrete Hydraulic Structures

Hydraulic structures will be designed in accordance with ACI 350 using the alternate service load method or the strength method with durability factors.

3.11.2 Miscellaneous Concrete Structures

Miscellaneous nonhydraulic concrete structures, including building slabs and foundations, will be designed in accordance with ACI 318.

3.11.3 Mass Concrete

Elements 5 feet thick or more will be considered mass concrete. The design and construction of mass concrete will conform to ACI 207.1R-05.

3.11.4 Structural Steel

Structural steel will be designed in accordance with the latest edition of the *AISC Steel Construction Manual* and the *AISC Specification for Structural Steel Buildings*. Design will use either the Allowable Stress Design (ASD) method or the Load and Resistance Factor Design (LRFD) method.

Seismic design will be in accordance with the *AISC Seismic Design Manual* and the *AISC Seismic Provisions for Structural Steel Buildings*.

3.11.5 Structural Steel Connections

Structural steel bolted connections will be designed in accordance with the RCSC *Specification for Structural Joints Using High-Strength Bolts*.

4. Process Mechanical

This section describes the SDPP process mechanical design standards.

4.1 Design Codes, Standards, and References

The latest version of the following codes, standards, and references apply to the SDPP process mechanical design criteria unless otherwise noted:

- *ANSI/HI Standard 2.4, Rotodynamic Vertical Pumps for Manuals Describing Installation, Operation, and Maintenance.*
- *ANSI/HI Standard 9.6.3, Rotodynamic Pumps – Guideline for Operating Regions.*
- *ANSI/MSS-SP-58, Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation*
- *ANSI/MSS-SP-89, Pipe Hangers and Supports: Fabrication and Installation Practices*
- *ASME Boiler and Pressure Vessel (B&PV) Code*
- *ASME B106.1, Design of Transmission Shafting*
- *ASTM A193/A193M, Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.*
- *ASTM A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and General Applications.*
- *ASTM A276, Standard Specification for Stainless Steel Bars and Shapes.*
- *AWWA C200, Steel Water Pipe, 6 in. (150mm) and Larger.*
- *AWWA C561, Fabricated Stainless Steel Slide Gates.*
- *CMAA 70 - Specification for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes*
- Pipe Fabrication Institute (PFI). *Standard ES-26, Welded Load Bearing Attachments to Pressure Retaining Piping Materials.*

This document may be updated to add additional relevant standards and specificity as design progresses and details clarify.

4.2 Mechanical Equipment and Piping

Equipment will be reviewed for reliability, resiliency, performance, and maintainability.

4.3 General Facility Layout Criteria

Specific equipment makes or models defined in the design criteria may be modeled on the conceptual process mechanical facility layout drawings. However, all equipment included in the final project specifications will be reviewed and verified for overall applicability and connection requirements, such as:

- Connecting piping size and orientation
- Elevation requirements

- Unique appurtenances
- Equipment base support requirements
- Crane access

Equipment and model numbers specified will be verified as still being available in the marketplace.

Ingress and egress routes for ambulances, fire trucks, and emergency personnel must be factored into the facility interior, exterior, and roadway design. Moreover, interior facility pathways and stairways will be carefully located and oriented for appropriate emergency access.

Rotating equipment will be properly mounted on a structural support base. Adequate anchoring and support bracing will be detailed in accordance with the manufacturer’s written recommendations and requirements, and the equipment’s general provisions, which will include consideration of the expected forces generated by the specific equipment’s operation and the specific seismic provisions required by the governing codes.

Required space for equipment removal, replacement, and maintenance will be evaluated and incorporated on the layout drawings. Free-standing equipment control panels and electrical panels will be mounted on concrete equipment pads.

Sufficient headroom will be established and provided for the installation and removal of rotating equipment within structures. Headroom clearance will consider lifting hook height clearance and lifting spreader bar beam assemblies, including cable rigging clearances for accessing pick points. For the deep-set vertical pumps, the maximum shaft and column section lengths for disassembly are within the overhead clearance restraints shown on the drawings. Review disassembly procedures with the equipment manufacturer to verify respective clearances for installation and removal are adequate, including clearance requirements for ancillary lifting components.

Define the layout space requirements for equipment and associated piping and support systems for future equipment installation. Clearly identify on the layout drawings equipment scheduled for future installation.

Provide stairs, platforms, and hatches for accessing and removing equipment for operation and maintenance (O&M). Stair and platform details and requirements will be coordinated with the structural and architectural disciplines for compliance with the governing codes and standards for the intended application.

Coordinate piping joint types used to connect piping, valves, pumps, and other applicable rotating equipment. Verify that piping connections comply the General Drawing Legend. Verify that connecting flanges are compatible and suitable for mating with respect to the following:

- Pressure class
- Outside and inside diameter
- Bolt hole and bolt circle diameter
- Gasket seating surface

Avoid mating flat-face steel flanges with raised-face cast or DI flanges. Verify that enough clearance is maintained between the nearest wall or structural appurtenance, pipe fitting, or pipe support that may interfere with the required clearance of the flange bolts (through bolts and threaded bolts), including the wrench clearance needed for assembly and disassembly.

Provide flexible sleeve-type pipe couplings (such as Dresser or Baker type couplings), or other flexible couplings suitable for the service fluid, to permit minor changes in piping alignment, and to facilitate installation and removal of valves and equipment. Where flexible sleeve-type pipe couplings are used, or for other unrestrained types of flexible couplings, provide tie rods for thrust restraint sized for the maximum possible operating pressure of the conveyance fluid. If referencing a standard detail for thrust tie installation, provide the appropriate straight length of pipe on either side of the harness rings (or flange connections) to allow for thrust tie installation.

Where flanged joints are located immediately after a wall penetration, determine maximum bolt length and tool clearance for bolt installation, and modify the wall penetration detail for suitable clearance between the flange and the wall face.

Where piping systems operate under external ambient temperature changes or internal fluid service temperature changes, provide enough piping system expansion joints at strategic locations to reduce thermal piping stresses and associated piping thrust due to thermal forces on joint penetrations, equipment connections, piping supports, and embedded or other structural connections. Evaluate appropriate piping restraint methodologies associated with thrust loads generated by the conveyance fluid maximum operating pressure.

Provide adequate clearance for O&M of all valve and gate operators. Provide adequate clearance for rising stem valves and gates in all positions.

4.4 Pumping Plant Hydraulics

The Project configuration will incorporate up to three Sacramento River intakes, single main tunnel, pumping plant and connecting forebay, and southern gravity flow conveyance system that deliver raw water to the existing Banks and Jones approach channels. The Project will be sized for a firm design flow capacity ranging between 4,500 to 7,500 cfs.

Preliminary and final hydraulic analysis will be conducted via a systemwide hydraulic model. The Project will be a single main tunnel system that will generally include the following:

- Main raw water tunnel
- Up to three Sacramento River intakes (Intake 2 [C-E-2], Intake 3 [C-E-3] and Intake 5 [C-E-5]), including:
  - Interconnecting tunnels
  - Tunnel shafts
  - SDPP wet well
  - Gravity flow/surge overflow outlet facilities into the SF

For the Project's design flow capacities of up to 3,000 cfs maximum capacity, the single-tunnel conveyance system to be hydraulically evaluated will consist of the following components between the Sacramento River and the SF:

- C-E-5 (up to 3,000 cfs maximum capacity), including:
  - Screens
  - A sedimentation basin
  - A tunnel inlet structure
  - A tunnel to the junction with Intake 5
- A tunnel connecting C-E-5 connecting C-E-5 to the SDPP intake shaft and wet well
- Several shafts along the main tunnel between C-E-5 and the SDPP

For the Project design flow capacities exceeding 3,000 cfs and less than or equal to 6,000 cfs, the single tunnel conveyance system consists of the following components between the Sacramento River and the new SF:

- C-E-3 (up to 3,000 cfs maximum capacity), including:
  - Screens
  - A sedimentation basin
  - A tunnel inlet structure
  - A tunnel to the junction with Intake 3
- C-E-5 (up to 3,000 cfs maximum capacity), including:
  - Screens
  - A sedimentation basin
  - A tunnel inlet structure
- C-E-5 (up to 2,500 cfs maximum capacity), including:
  - Screens
  - A sedimentation basin
  - A tunnel inlet structure
- A tunnel connecting C-E-3 and C-E-5
- A main tunnel connecting C-E-5 to SDPP intake shaft and wet well
- Several shafts along the main tunnel between C-E-5 and the SDPP

For the Project design flow capacities exceeding 6,000 cfs and less than or equal to 7,500 cfs, the single tunnel conveyance system consists of the following components between the Sacramento River and the new SF:

- C-E-2 (up to 1,500 cfs maximum capacity), including:
  - Screens
  - A sedimentation basin
  - A tunnel inlet structure
  - A tunnel to the junction with Intake 3
- C-E-3 (up to 3,000 cfs maximum capacity), including:
  - Screens
  - A sedimentation basin
  - A tunnel inlet structure
- C-E-5 (up to 3,000 cfs maximum capacity), including:
  - Screens
  - A sedimentation basin
  - A tunnel inlet structure
- A tunnel connecting C-E-2, C-E-3 and C-E-5
- A main tunnel connecting C-E-5 to SDPP intake shaft and wet well
- Several shafts along the main tunnel between C-E-5 and the SDPP

The Sacramento River, SDPP wet well, and SF design WSEs are as shown in the Main Raw Water Pump Selection, Adjustable Operating Speed Requirements and Redundancy TM (DCA, 2021b).

The static head pumping requirements developed between the Sacramento River and the SF will require a direct hydraulic connection between the SDPP wet well and the SF. To achieve this hydraulic connection, each individual pump discharge piping system must be primed using a vacuum, since each pump discharge pipe will contain a goose-neck arrangement with an invert elevation above the SF maximum water surface elevation. The SDPP design flow and design head condition will be evaluated under the siphon discharge condition described.

Static head pumping requirements with pumping through an unprimed discharge siphon will also be calculated and incorporated into the pump sizing evaluation for steady-state operation, as this condition will occur each time the pump is started and when the siphon fails to generate or if siphon pressures exceed the recommended limits (based on the final design criteria established for the SF water surface operating range). This condition will assume no hydraulic connection between the SDPP wet well and the SF. That is, no vacuum would be established in the goose-neck piping arrangement. The static head values associated with the unprimed condition will be established using the difference between the free WSEL above the siphon crest invert elevation in the pump discharge piping goose-neck arrangement (that is, nonpressurized pipe flow) and the SDPP wet well free water surface level.

For this analysis, the full total dynamic head (TDH) will be determined for each flow condition as follows:

- Determine the pump suction hydraulic grade line (HGL) elevation in the SDPP wet well by subtracting the intake and tunnel conveyance system headlosses from the range of Sacramento River WSELs.
- Compute the TDH required to lift flow from the HGL elevation to the primed and unprimed discharge head, as described.
- Conduct a hydraulic evaluation of the main tunnel system with Innovyze InfoWorks ICM software (ICM). Roughness values for the main tunnel are currently being evaluated. Until final selection of the roughness value range, use a minimum and maximum Manning's n of 0.014 and 0.016, respectively, to develop the maximum and minimum system head conditions.
- Calculate the friction loss associated with the vertical pump discharge column and connecting discharge piping using the Darcy-Weisbach Formula with the absolute roughness values shown in Table 15 corresponding with the applicable piping system.

Table 15 summarizes the design absolute roughness coefficients for common piping material.

Table 15. Absolute Roughness Coefficients for Common Piping

Pipe	Absolute Roughness (e) (ft)	
Steel (unlined)	0.0003	0.005
Steel (cement mortar lined)	0.0001	0.0015
Ductile Iron (cement mortar lined)	0.0001	0.0015
Copper	0.0001	0.0005
Galvanized	0.0008	0.005
Plastic	0.0001	0.0005

Note:

ft = foot (feet)

During periods when the Sacramento River stage is higher than the SF, gravity flow may be achieved through a weir gate system. The main tunnel launch shaft (adjacent to the SDPP) will be repurposed to incorporate the following components:

- A weir gate system for gravity flow regulation
- Overflow weirs for tunnel hydraulic transient surge protection
- A rectangular channel connecting the SDPP wet well to Project tunnel

The weir gate system and overflow weirs will be sized based on the results of the systemwide hydraulic model and separate hydraulic transient surge analysis.

4.4.1 Computational Fluid Dynamics and Physical Modeling

A computational fluid dynamics (CFD) model analysis of the SDPP wet well and pump intake facilities will be performed during both the preliminary and detailed design phases of the project. This analysis will be performed to assist in the design of the wet well, individual pump intake size, and final configuration relative to the pump suction conditions. Further, the CFD analysis will also identify and recommend key parameters that should be considered in physical model testing of the complete intake and wet well design. Physical model testing will be performed for the pumping plant wet well and open-top pump can intake or formed suction inlet (FSI) facilities as defined during the preliminary and final design phases to verify compliance with ANSI/HI 9.8-2018 recommendations associated with the pump intake hydraulics.

4.4.2 Hydraulic Transient Surge Analysis

A hydraulic transient surge analysis will be performed for the Project main tunnel, pumping plant, Sacramento River intakes, and all connected facilities components that make up the complete system. This analysis will identify, and size required surge control system components, including specific performance and operational requirements.

4.4.3 Discharge Siphon

The SDPP has been configured to operate with a discharge siphon into the SF. A siphon discharge condition will be generated in each individual pump discharge piping assembly. The SDPP outlet structure (within the SF pool) may incorporate a weir structure or other structural features that will limit the maximum subatmospheric pressure at the crown of the siphon to not more than 20 feet of water by maintaining the downstream minimum water surface level relative to the crown of the siphon. A backup siphon priming pump system will be incorporated into the PP system to achieve and stabilize the desired siphon by removing air that could potentially accumulate at the crown of the siphon. The backup siphon priming pumps will be controlled to maintain a pressure set point. Two siphon breaker valves (one plus one standby) will be included in each pump discharge piping system to break the siphon during the shutdown sequence.

4.5 Pump Sizing and Selection

The main raw water pumps (pumps) will be vertical column discharge pumps and will be suspended from fabricated supports at the motor level floor slab. Pumps will either be the same size or combinations of large and small pumps operating in parallel. Small pumps will be sized to have approximately half of the large pumps’ rated capacity. Depending on the final depth of the wet well, pumps may be of the pull-out type design to facilitate removal of the rotating assembly without disconnecting the discharge piping or removing the pump column. The actual pump configuration will be confirmed during the preliminary and final design phases of the project. Preliminary pump selections will be limited to those that maintain the pump's operating conditions to the right of the minimum flow within the pump's preferred operating range (POR), as defined by ANSI/HI Standard 9.6.3.

An analysis will be conducted of the preliminary variable-speed pumps, with the maximum turn-down not to exceed 50 percent of the maximum rated speed, versus the pumps operating at constant speed to verify that the combination of pumps will achieve the desired steady-state flow setpoint within the SDPP design flow range within the envelope of expected system head operating conditions, including necessary redundancy. The following redundancy criteria will be incorporated into the design to provide the reliability necessary of this critical system to meet the peak pumping requirement:

- **Same size pumps:** Total number of duty pumps to meet the peak pumping requirement, plus two standby pumps. For example, if five pumps are required to meet the established design flow pumping requirement, then the total number of pumps will be seven, including two spare pumps.
- **Different size pumps:** Total number of duty pumps to meet the peak pumping requirement, plus three standby pumps. Two standby pumps will be the largest size pumps, and one standby pump will be the smallest size pump. For example, if three large and two small pumps are required to meet the peak pumping requirement, then the total number of pumps will be five large and three small pumps, including the standby pumps.

The pumps will be sized for their majority of operation within each pump's POR for the flow and TDH conditions defined within the design operating range.

4.5.1 Pump Characteristic Curves

The pump manufacturer's characteristic performance curves used for preliminary and final pump selection will include the following parameters as defined by ANSI/HI-9.8:

- Specific speed of the pump
- Flow capacity versus total head
- The pump's preferred operating range (POR)
- The pump's maximum allowable operating range (AOR)
- Pump efficiency
- Required net positive suction head required to result in a 3 percent loss of total head at the first stage impeller due to cavitation (NPSH3)
- Pump brake horsepower (BHP) throughout the entire operating range of the pump, from shutoff to maximum specified operating capacity

The pump manufacturer's pump performance curves will be overlain on the calculated system head curves over the entire range of design flow and TDH conditions. Minimum and maximum flow affinity curves associated with the POR of each pump will be plotted on the combined pump performance curves and calculated system head curves for all speeds, from 50 to 100 percent of the rated pump speed. The maximum and minimum flow POR curves should have complete overlap between a single pump in operation and all pumps in parallel operation within the minimum to maximum operating speed range, demonstrating complete POR coverage from the minimum flow POR of one pump to the maximum flow POR of all pumps in operation within the system head curve range and throughout the required operating speed range. Where operation occurs outside of the POR, the performance point must be well within the pump manufacturer's recommended AOR.

Operation outside of the POR but within the pump manufacture's maximum flow AOR affinity curve will be permitted to achieve design flow capacities associated with nonsiphon discharge conditions. This operating condition must be reviewed with the pump manufacturer to confirm flow recirculation within the pump is at acceptable levels such that stable pump operation at steady-state is confirmed.

Except as noted below, the head on the head-capacity curve shall always be decreasing with increasing capacity of the flow over the entire flow range. The maximum head shall occur at zero flow.

1) A reversal of slope of the curve will be allowed provided that the locally occurring maximum:
    a) Does not exceed the head at zero flow, and
    b) Does not exceed the locally occurring minimum at a lesser flow by more than 3 percent of the rated head, and
    c) The slope reversal does not occur at a flow rate exceeding 80 percent of the rated flow.

The pump speed will be selected by the candidate pump manufacturer and will be based on the following considerations

- Available speeds of the driver
- Critical speeds that may generate structural resonance frequencies
- The limit imposed by the suction head conditions and the suction capability of the subject pump

4.5.2 Submergence

Two suction configurations will be examined. One is a formed suction intake (FSI) and the other is an open-top can. Two criteria will need to be examined for each configuration when considering the submergence of the pumps. The first criterion is to calculate the required submergence to suppress vortexing, as outlined in the ANSI/HI Standard 9.8. The second criterion is to examine the manufacturers' required net-positive suction head (NPSH) for their particular pump design. The more stringent value (highest submergence) between these two criteria will be selected as the final submergence value.

For the FSI configuration, the vortex calculation shall be applied to the horizontal inlet portion of the intake in accordance with ANSI/HI Standard 9.8.

For the open-top can configuration submergence calculations for vortexing will be performed both at the pump inlet and at the top of the can (invert of the pumping plant forebay). Calculations at the pump bell will use the previously identified equation from ANSI/HI Standard 9.8.

Vortex submergence calculations at the top of the can require the adaption of the standard vortex equation to account for the flow area between the can and the pump column. This is done by computing an equivalent circular diameter, based on the calculated cross-sectional area of the annular space between the pump column assembly and the inside diameter of the pump intake can. The velocity in the annular space between the pump column assembly and the inside diameter of the pump intake can must not exceed 5 fps, using the pump's maximum allowable region flow value. The adapted submergence equation is provided here:

$$S = 1.0*D + 2.3*[(12*0.409Q/D^2)/(12gD)^{0.5}]*D$$

Where:

S = submergence (inches)

D = resultant diameter between the annular space of the pump column and pump can (inches)

Q = flow (gallons per minute [gpm] at the pump's maximum allowable region flow value)

4.5.3 NPSHa to NPSH3 Ratio

The NPSH evaluation compares the available NSPH ($NPSH_a$) of the system to the required NPSH ($NPSH_r$) as provided by the pump manufacturer. The minimum $NPSH_a$ to the main raw water pumps will be based on the calculated submergence depth between the free-water surface within the wet well and the vertical centerline of the first-stage impeller eye elevation. The ratio of the $NPSH_a$ to pump's $NPSH_r$ must, as a minimum, comply with recommendations of ANSI/HI 9.6.1, the pump manufacturer's recommendation, or 1.35, whichever is higher, throughout the entire operating region of the pumps.

4.5.4 Pump Foundation Requirements

Section 3, Structural, provides the pump foundation requirements.

4.5.5 Rotor Dynamic Analysis

The pump specifications will require a complete rotor dynamic lateral and torsional critical speed analysis of the pump-coupling-motor rotating assembly to be performed by the pump manufacturer or qualified third party (accepted by the DCA). For pumps equipped with AFDs, the pumps will not be operated at less than 50 percent of their motor's maximum rated speed or at more than 100 percent of the motor's maximum rated speed during normal steady-state operation. Pumps may operate in parallel at identical or different speeds simultaneously.

The purpose of the lateral analysis is to identify the lateral critical speeds and corresponding mode shapes for the pump-coupling-motor rotating assembly. Critical speed maps will be generated as part of this analysis and must demonstrate that a lateral critical speed does not occur at less than 1.20 times the maximum rated speed of the pump and motor. The damped vibration response will be calculated for the shafts and verified for acceptable vibration amplitudes that will be defined in the final specifications.

The purpose of the torsional analysis of the pump-coupling-motor rotating assembly is to calculate the system torsional frequencies and corresponding mode shapes, as well as the steady-state and transient responses. Critical speeds will not be permitted between 0.80 times the pump's minimum specified operating speed and 1.20 times the maximum specified operating speed. In no case will a critical operating speed associated with the mechanical running speed (1 times the shaft speed) excitation frequency occur at less than 1.20 times the maximum rated operating speed.

A forced response analysis will be required for all critical speeds determined to occur at less than 0.80 times the minimum specified operating speed. Excitation frequencies for steady-state pump operation will include:

- Electrical line frequency
- Two times the electrical line frequency
- Current modulating frequencies produced by the AFDs
- Mechanical running speed (1 times the shaft speed)
- Two times the mechanical running speed (2 times the shaft speed)
- Blade pass frequency

The calculated steady-state and transient dynamic torsional shaft stresses and coupling torques will be shown in the analysis to be less than allowable levels, such that the motor shaft, pump shaft, and associated drive train components are capable of an unlimited number of startup and shutdown cycles associated with 0 revolutions per minute (rpm) up to the maximum rated pump speed. The allowable stresses (endurance limits) for the pump and motor shafts will be determined in accordance with ASME B106.1 or MIL STD 167, whichever is less. A factor of safety of at least 2 will be included in the allowable stress levels. The allowable dynamic torque in the couplings will be in accordance with the coupling manufacturer's requirements.

The pump specifications will also require a structural response frequency analysis to be performed by the pump manufacturer for the pump and motor assembly. At a minimum, the finite element model must include the following components:

- Motor
- Pump
- A portion of the connected piping
- The fabricated support stand
- Other critical components based upon the mounting detail shown on the drawings

The minimum structural natural frequency of the complete pump and motor assembly, including the fabricated pump and motor support stand system, will be a minimum of 1.50 times the maximum rated pump and motor speed. The calculated natural frequencies of the pump and motor assembly and fabricated pump and motor support stand will be verified by the pump manufacturer when the unit is installed at the project site.

4.5.6 Motor Sizing

Pump motor sizing will be in accordance with Section 6.2.6, Raw Water Pump Motors.

4.6 Pumps

Table 16 summarizes the preliminary design criteria for the raw water (main) pumps. The pumps will discharge below the motor level floor. Each pump will discharge directly to the SF via an individual pump discharge piping system. Each pump will be started and stopped against an unprimed siphon discharge pipe Pumps will operate with a siphon discharge during normal design head conditions. No pump control valve or nonreturn valve is intended to be installed in the discharge piping of each main raw water pump. Reverse flow through the pump will be prevented using two, automated vent valves of equal size installed on the crown of inverted elbows of each pump discharge piping system to break the siphon. The invert elevation of the inverted elbows in each discharge piping assembly will be set above the SF maximum normal working WSEL.

Pumps will be line shaft type, single stage, vertical column discharge, product water lubricated open line shaft, or utility water lubricated with enclosed line shaft if required based on product water quality. Depending on the minimum operating water surface depth of the wet well, pumps may be of the pull-out type design to facilitate removal of the rotating assembly without disconnecting the discharge piping or removing the pump column. The motor pedestal for each pump will support the motor above and permit access to the shaft seal, lubrication connections, and shaft coupling.

Table 16. Raw Water (Main) Pumps Design Criteria

Subject	Criteria	Comments
Pumping unit type	Vertical column discharge	Propeller type or mixed-flow type
Minimum pump motor efficiency	• Synchronous: 97% • Induction: 95%	
Pump motor speed	As required by the pump without the use of the gear reducer	
Pump motor enclosure	TEWAC	Motor cooling alternatives will be evaluated in a separate TM
Motor thrust bearing	Pressure-lubricated, water-cooled, pad type	
Line shaft	Open or enclosed, as required	Flushed with product water
Shaft seal	Split-type mechanical seal	Flushed with utility water
Number of stages	One	
Pump materials of construction: • Impeller • Bowl casing • Shaft • Coupling • Discharge head • Motor base stand • Column pipe • Shaft seal • Vibration monitoring system	• Type 316LN stainless steel • Cast steel, ASTM A27, Class 65-35 • A564, Type 630, Condition 1150 type A193, Gr B7 type • Carbon steel • Carbon steel • ASTM A53, ASTM A36, or A283 • Type 316 stainless steel • TBD	Five vibration points will be monitored on the motor: X- and Y-axes at the lower motor bearing; X-, Y-, and Z-axes at the upper motor bearing
Intake design	Open-top can or formed suction inlet (FSI)	Pump to be mounted with fabricated motor support stand to upper (motor level) floor
Pump intake	Designed in accordance with pump manufacturer's requirements and per the recommendations of the ANSI/HI Standards	CFD and physical model testing to be used to verify design
Reverse rotation	TBD	

Table 16. Raw Water (Main) Pumps Design Criteria

Subject	Criteria	Comments
Noise	TBD	• In accordance with the Delta Conveyance EIR/EIS Noise Abatement Plan that is in development. • The entire pump rotating assembly will meet decibel and octave requirements

Notes:
- = not applicable
EIS = environmental impact statement
ODP = open drip-proof
TBD = to be determined
TEWAC = totally enclosed water and air cooled

4.7 Tunnel Dewatering Pump

Submersible vertical turbine pumps will be used to dewater the Project's main tunnel. The dewatering pumps will be installed in the SDPP wet well inlet shaft. The following dewatering pump components will be stored within the SDPP Equipment Storage Building (located within the SDPP site complex):

- Column piping
- Discharge elbow
- Check valve
- Above-grade discharge piping
- Cable reels

The check valve will be nozzle style attached to the pump. Pump storage and the periodic rotation of the pump and motor assemblies will be in accordance with the manufacturers' recommendations. When tunnel dewatering is required, the pump, motor, discharge elbow, column piping, check valve, discharge piping, and cable reels will be picked up by the Equipment Storage Building bridge crane; transported via truck; and installed in the repurposed tunnel launch shaft using the outdoor gantry crane. Dewatering pumps will discharge flow into the SDPP. Table 17 summarizes the dewatering pump preliminary design criteria.

Table 17. Dewatering Pump Design Criteria

Subject	Criteria	Comments
Pumping unit type	Vertical, deep well submersible motor	
Pump capacity	26,000 gpm minimum at rated capacity	
Pump motor enclosure	Water filled	
Shaft seal	Mechanical seal	

Table 17. Dewatering Pump Design Criteria

Subject	Criteria	Comments
Pump materials of construction: • Impeller • Bowl casing • Shaft and couplings • Discharge head • Column pipe • Shaft seal	 • Type 316 stainless steel • Cast steel, ASTM A27, Class 65-35 • Stainless Steel, ASTM A479 • Carbon steel • ASTM A53, ASTM A36, or A283 • Type 316 stainless steel	Final material selections will be based on the water quality analysis

Note:

gpm = gallon(s) per minute

4.8 Pumping Plant Piping

4.8.1 Materials

Materials are as shown in the tables in this section.

4.8.2 Suction Pipe Geometry

Suction pipe geometry will be in accordance with ANSI/HI 9.6.6.

4.8.3 Pipeline Velocities

SDPP pipeline velocities will be as follows:

- Gravity pipeline velocities:
  - Normal: 4 to 5 fps
  - Maximum: 9 fps
  - Minimum: 2 fps
- Pressure pipeline velocities:
  - Normal: 5 to 9 fps
  - Maximum: 12 fps
  - Minimum: 2 fps

4.8.4 Operating Pressures

All pump discharge piping, couplings, thrust harness assemblies, and flanged connections will be pressure rated (at the maximum fluid service temperature) for the maximum surge pressure, operating pressure, shut off head, or field hydrostatic test pressure, whichever is greatest.

4.8.5 Thermal Expansion, Flexibility, and Hydraulic Thrust

Piping systems will be designed to accommodate thermal expansion, flexibility, and hydraulic thrust.

4.8.6 Raw Water Pump Discharge Piping Design Criteria

The Table 18 provides the pump discharge piping design criteria.

Table 18. Raw Water Pump Discharge Piping Design Criteria

Subject	Criteria	Comments
Piping material	AWWA C200 - Welded steel pipe	• Liquid epoxy-lined and coated (TBD) • Polyurethane finish on exposed piping
Siphon piping crest invert elevation	16.00 ft (to be confirmed)	2 ft above the maximum BTF WSEL
Siphon piping invert elevation in BTF	8.00 ft (to be confirmed)	
Siphon valve	TBD	
Flowmeter type: • Upstream pipe diameters • Downstream pipe diameters • Path capability	Ultrasonic and acoustic in accordance with PTC 18: • TBD • TBD • (8 x 8) 16 acoustical path	• Per manufacturer recommendations • Per manufacturer recommendations • Per manufacturer recommendations

4.8.7 Portable Dewatering Pump Discharge Piping Design Criteria

The portable dewatering pump will have temporary discharge piping connected to the above-grade pump discharge head. The temporary piping will discharge to SF. Table 19 provides the portable dewatering pump discharge piping design criteria. The design will consider structural framing to support the pump baseplate and well head. A sump configuration for the dewatering pumps will be incorporated into the bottom of the shaft.

Table 19. Portable Dewatering Pump Discharge Piping Design Criteria

Subject	Criteria	Comments
Piping material	AWWA C200 - Welded steel pipe	• Liquid epoxy lined and coated. • Polyurethane finish on exposed piping
Vent valve	Stainless steel	

4.8.8 Pipe Supports

The design, fabrication, and installation of pipe hangers and supports, where required for process piping, will be in accordance with the following documents and specifications:

- ANSI/MSS-SP-58
- ANSI/MSS-SP-69, Pipe Hangers and Supports: Selection and Application
- ANSI/MSS-SP-89, Pipe Hangers and Supports: Fabrication and Installation Practices
- ANSI/MSS-SP-90, Guidelines on Terminology for Pipe Hangers and Supports
- PFI Standard ES-26

4.9 Facility Bridge Cranes

There will be two facility bridge cranes, one in the SDPP) and the other in the Equipment Storage Building. The bridge crane will primarily be used for lifting raw water pumps, pump motors, and flow meters. The bridge crane will primarily be used to lift pumps, motors, cables, and other equipment. The bridge crane will also be used for maintenance. Table 20 provides design criteria for the bridge cranes.

Table 20. Facility Bridges Crane Design Criteria

Subject	Criteria	Comments
Bridge crane design	Design in accordance with applicable provisions of CMAA 70, (Section 3, Structural, provides details)	Designed for a minimum of 125% of the heaviest anticipated load (TBD)
Main hoist capacity	Designed for a minimum of 125% of the heaviest anticipated load (pump assembly and motor stand), based on loads provided from candidate pump manufacturers	
Small hoist capacity	TBD	Faster hoist travel to save time in handling smaller loads
Operation	Operate with a wireless pendant (TBC) Load cell with scoreboard readout	
Access	Use a ladder and cage inside the building	Required for access to crane platform for maintenance
Platform and railing	Provide access to all crane maintenance points and to maintain building high-bay lighting fixtures	

Note:

TBC = to be confirmed

4.10 Outdoor Gantry Crane

The outdoor gantry crane will be primarily used for lifting gravity flow slide gates and isolation gates between the Reach 7 outlet shaft and the pump station wet well. Table 21 provides design criteria for the gantry crane.

Table 21. Outdoor Gantry Crane Design Criteria

Subject	Criteria	Comments
Outdoor gantry crane design	Design in accordance with applicable provisions of CMMA 70, Class C (moderate service)	Designed for a minimum of 125% of the heaviest anticipated load (TBD)
Main hoist capacity	Designed for a minimum of 125% of the heaviest anticipated load (gravity flow slide gates or isolation gates), based on loads provided from candidate gate manufacturers	Designed for heaviest load (TBD)
Operation	Operate with a wireless pendant (TBC) Load cell with scoreboard readout	
Access	Use a ladder and cage outside of the building	Required for access to crane platform for maintenance
Platform and railing	Provide access to all crane maintenance points and to maintain building high-bay lighting fixtures	
Lighting	Provide LED task lighting on bridge to light work areas below and immediate travel area	To be further coordinated during final design

Note:

TBD = to be determined

4.11 Gravity Flow Slide Gate

Table 22 provides design criteria for the gravity flow side gates.

Table 22. Gravity Flow Slide Gates Design Criteria

Subject	Criteria	Comments
Design	AWWA C561	Upward acting type for mounting in channels with concrete embedded frame and invert.
Materials of construction	• Plate, sheet, and strip: ASTM A240/ A240M, Type 316L or 304L • Bars and shapes: ASTM A276, Type 316L or 304L. • Guide frames: Type 304L or Type 316L • Disc: Type 304L or Type 316L • Stem: ASTM A276, Type 316L or 304L • Anchor bolts and hardware: Type 316 stainless steel	Final material selections will be based on the water quality analysis
Quantity	Five (TBD)	Quantity to be confirmed by system-wide hydraulic analysis

Table 22. Gravity Flow Slide Gates Design Criteria

Subject	Criteria	Comments
Size	22 feet W x 15 feet H (TBD)	Size to be confirmed by system-wide hydraulic analysis
Operation	Modulating	
Actuator	Hydraulic or electric	

Notes:
H = high
W = wide

4.12 Double Isolation Gate

Table 23 provides design criteria for the isolation gates.

Table 23. Isolation Gates Design Criteria

Subject	Criteria	Comments
Design	AWWA C561	Stop Logs
Material of construction	• Plate, sheet, and strip: ASTM A240/ A240M, Type 316L or 304L • Seals: Neoprene bulb • Anchor bolts and hardware: Type 316 stainless steel	Final material selection will be based on the water quality analysis
Service condition	Guide frame invert and side mounting	Guide frames and invert will be Type 304L or Type 316L stainless steel
Quantity	32 or 16 (to be confirmed)	Total quantity based on selected panel size.
Size	18 feet W x 10 feet H or 18 feet W x 20 feet H (to be confirmed)	
Operation	Manual	Gate panels installed and removed by overhead gantry crane

4.13 Centralized Hydraulic Fluid Power System

A centralized hydraulic fluid power system or individual self-contained hydraulic fluid power systems with nitrogen/hydraulic oil accumulators may be provided to operate gravity flow slide gates. Table 24 provides the general design criteria for the major components associated with the hydraulic fluid power system.

Table 24. Centralized Hydraulic Power Unit Criteria

Subject	Criteria	Comments
Centralized air and hydraulic fluid power system	Pressure TBD	Nitrogen gas/hydraulic fluid Accumulators sized to provide two complete valve strokes (fully closed to fully open) for each gravity flow slide gate simultaneously under a power failure condition. Open and closure rates will be determined during final design.
Control panel enclosures	NEMA 4X, stainless steel construction	
Hydraulic supply and return piping system	Stainless steel sized such that the maximum hydraulic fluid velocity does not exceed 5 fps	Stainless steel braided flexible hydraulic hose will be used between the control panel and the gates.
Hydraulic fluid pumps	Hydraulic fluid fixed displacement gear-type pumps	Transfers hydraulic fluid from the hydraulic fluid reservoir to the accumulator to maintain a predetermined operating volume level within the accumulator. Two pumps required (one duty with one standby). Manual hand pumps will be included within each control panel for emergency operation.
Accumulator tank	ASME welded steel pressure vessel	Sized to provide one complete valve stroke (fully open to fully closed) for each gravity flow slide gate simultaneously under a power failure condition at the minimum hydraulic power unit operating pressure.
Hydraulic fluid reservoir	Welded steel tank	Provides total oil volume storage with additional freeboard. Tanks will be double walled and located above the 200-year flood level with sea level rise predicted for this facility.
Hydraulic fluid	Either mineral- or bio-based hydraulic oil	

Note:

NEMA = National Electrical Manufacturers Association

4.14 Individual (Self-contained) Hydraulic Fluid Power System Alternative

As an alternative to the centralized system, self-contained hydraulic fluid power units can be used. The individual self-contained power systems will be packaged units located next to each individual gravity flow slide gate's hydraulic cylinder operators. The type of actuators and hydraulic systems will be further analyzed during final design.

4.15 Noise Control

Equipment and systems will be designed to control noise emissions and protect Operations personnel against the effects of noise exposure. Noise control strategies and exposure levels will be coordinated with the future Delta Conveyance Noise Abatement Plan being developed by DWR as part of the EIR. The project will implement a site-specific noise abatement plan to avoid or reduce potential construction and O&M related noise impacts. The noise abatement plan will include measures, such as the following:

- Restrictions on use of construction equipment outside of daytime hours
- Required use of noise-reducing technologies for construction equipment
- Installation of temporary barriers or enclosures to reduce construction noise at sensitive receptors
- Local coordination efforts to reduce noise effects on sensitive uses, including schools, parks, places of worship, and residential uses

In addition to the decibel limits, the operating octaves of the emitted noise needs to be evaluated and addressed.

5. Heating, Ventilation, and Air Conditioning

This section discusses the HVAC design criteria, approaches, and concepts to be used for the numerous facilities and buildings associated with the project. Final criteria, approaches, and concepts will be further developed and reviewed with DCA and DWR before finalizing. Options for equipment selection will be reviewed and evaluated with DCA and DWR.

This section includes design criteria and discussion for the following:

- Design codes, standards, and references
- Climate zones
- Outdoor design temperatures
- Interior design temperatures and relative humidity
- Ventilation and exhaust rates
- Ductwork materials of construction
- Ductwork sizing and pressure drop calculations
- Air filtration
- Heating and cooling design software
- Mechanical equipment and electrical gear heat generation calculations
- Louvers
- Cooling and heating coils
- Calculation safety factors
- Equipment safety factors
- Equipment redundancy
- HVAC equipment and component noise
- HVAC equipment installation locations
- HVAC equipment types for cooling
- HVAC equipment types for heating
- HVAC system energy recovery equipment
- HVAC control systems
- HVAC equipment construction and corrosion protection
- Seismic requirements
- Sustainable facilities

5.1 Design Codes, Standards, and References

The latest adopted version of the following codes, standards, and references apply to HVAC design criteria unless otherwise noted. Some titles in this section have dates in published titles, like from ASHRAE, so those listed here are the latest versions while writing this TM. This document may be updated to add additional relevant standards and specificity as design progresses and details clarify. The following codes, standards, and references are relevant to the SDPP design.

- Air Conditioning, Heating, and Refrigeration Institute (AHRI).
- Air Movement and Control Association International (AMCA).
- *AMCA Standard 511, Certified Ratings Program Product Rating Manual for Air Control Devices*.
- American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). *2016 ASHRAE Handbook—HVAC Systems and Equipment*.
- *2017 ASHRAE Handbook—Fundamentals*.
- *2019 ASHRAE Handbook—HVAC Applications*.
- *ASHRAE Standard 55, Thermal Environmental Conditions for Human Occupancy*.
- *ASHRAE Standard 62.1, Ventilation for Acceptable Indoor Air Quality*.
- *ASHRAE Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings*.
- California Building Standards Commission (CABSC). *California Green Building Standards Code* (CalGreen).
- California Energy Commission (CEC). *Reference Appendices Joint Appendix JA2*.
- CEC. *California Building Energy Efficiency Standards for Residential and Nonresidential Buildings*.
- DCA design standards.
- ICC. *International Energy Conservation Code* (IECC).
- National Environmental Balancing Bureau (NEBB).
- Sheet Metal and Air Conditioning Contractors National Association (SMACNA). *HVAC Duct Construction Standards - Metal and Flexible.*
- State of California. *Mechanical Code*.
- Testing, Adjusting and Balancing Bureau (TABB).

5.2 Climate Zones

Per the 2019 *California Building Energy Efficiency Standards for Residential and Nonresidential Buildings*, the climate zone for the Byron and Stockton areas is Zone 12.

Per the 2016 ASHRAE 90.1 and 2018 IECC, the climate zone for Contra Costa County or San Joaquin County is 3B.

5.3 Outdoor Design Temperatures

Per 2016 California 2016 Reference Appendices Joint Appendix JA2, which is based on data from the ASHRAE Climatic Data for Region X, the heating design temperatures will be no lower than the Heating Winter Median of Extremes values. The cooling design temperatures will be no greater than the 0.5 percent cooling dry bulb (DB) and mean coincident wet bulb (MCWB) values. Table 25 lists the outdoor design temperatures.

Table 25. Outdoor Design Temperatures

Location	Temperature	
	Winter Heating DB (°F)	Summer Cooling DB and MCWB (°F)
Brentwood and Discovery Bay	27	97/68

Source: 2016 California Reference Appendices Joint Appendix JA2
Note:
°F = degree(s) Fahrenheit

5.4 Indoor Design Temperatures and Relative Humidity

Indoor design temperature and humidity conditions for occupied comfort spaces and for unoccupied spaces are noted in Table 26.

Table 26. Indoor Design Temperatures and Relative Humidity

Facility	Space Type	Occupied	Temperature	
			Heating DB[a] (°F)	Cooling DB[a] (°F)
Electrical Building	Electrical Room	No	50	85
	Battery Room	No	50	85
Generator Building	Generator Room	No	50	107[b]
Maintenance Building	Maintenance Room	No	50	107[b]
SDPP	Pump Room	No	50	107[b]
Administration	Conference	Yes	70	75
	Control	Yes	70	75
	IT Server	No	70	75
	Janitor	No	70	75
	Kitchenette	Yes	70	75
	Locker	Yes	70	75
	Meeting	Yes	70	75
	Mud	No	70	75
	Office – Closed	Yes	70	75
	Office – Open	Yes	70	75
	Restroom	Yes	70	75
	SCADA	No	70	75
	Shop	No	60	107[b]
	Shower Room	Yes	70	75
	Storage	No	60	75
Miscellaneous	Electrical Room	No	50	85

[a] Humidity not controlled.
[b] Summer ambient design temperature +10°F. Short-term excursions exceeding 107°F are to be expected.
Notes:
IT = information technology
SCADA = supervisory control and design acquisition

Winter humidification and summer dehumidification will not be required for occupied or unoccupied spaces.

5.5 Ventilation and Exhaust Rates

Outdoor air ventilation loads for occupied spaces will be based on the 2019 *California Building Energy Efficiency Standards for Residential and Nonresidential Buildings*, Section 120.1(c)3 and Table 120.1-A – Minimum Ventilation Rates.

Exhaust rates for occupied spaces will be based on Table 120.1-B – Minimum Exhaust Rates.

Ventilation rates for unoccupied and process spaces will be based on the outdoor and indoor space temperature criteria and heat generation calculations or the applicable Building Code requirements.

5.6 Ductwork Materials of Construction

Table 27 lists the ductwork materials of construction.

Table 27. Ductwork Materials of Construction

Space	Material
Occupied spaces, unless noted otherwise	Galvanized, G90 coating designation
Process spaces, electrical rooms	Galvanized, G90 coating designation
Restroom, locker room, shower room, mud rom	Aluminum, Alloy H5052-H32

Ductwork will be constructed based on the SMACNA *HVAC Duct Construction Standards - Metal and Flexible*. The ductwork pressure classification will be based on a pressure no less than the HVAC equipment manufacturer's calculated total static pressure (TSP) of the fan system pressurizing the ductwork.

5.7 Ductwork Sizing and Pressure Drop Calculations

Table 28 lists the ductwork sizing criteria.

Table 28. Ductwork Sizing Criteria

Service	Maximum Velocity (fpm)	Maximum Pressure Drop (in. wc per 100 ft)
Supply air, medium pressure, upstream of TCU	2,000	0.20
Supply air, low pressure, downstream of TCU	1,200	0.08
Supply air, low pressure, no TCU	1,500	0.08
Return air	1,000	0.05
Exhaust air	1,500	0.08
Transfer air	500	0.03
Flex duct, supply side	600	0.05
Flex duct, return or exhaust side	500	0.05

Notes:
Ductwork pressure drop calculations for duct and fittings will be based on ASHRAE or SMACNA methods or software.
fpm = foot (feet) per minute
in. wc = inch(es) of water column
TCU = terminal control unit

5.8 Air Filtration

Filters for occupiable spaces will meet the requirements of the *California Building Energy Efficiency Standards for Residential and Nonresidential Buildings*, Section 120.1.(a) and (c). At a minimum, unoccupied spaces will be provided with Minimum Efficiency Reporting Value (MERV) 10 filters. Filters will be disposable, pleated with a 2-inch minimum thickness.

The maximum filter face velocity is 450 fpm.

5.9 Heating and Cooling Design Software

Heating and cooling loads will be determined using commercial heating and air conditioning modeling software. Examples include:

- Carrier's Hourly Analysis Program (HAP)
- Trane's TRACE
- U.S. Department of Energy's (DOE's) eQUEST®
- Elite Software's Chvac

Software will be used to calculate the building envelope heating and cooling requirements based on building construction and outdoor and indoor design temperatures.

5.10 Mechanical Equipment and Electrical Gear Heat Generation Calculations

Detailed calculations will be required to determine the mechanical equipment and electrical gear contributions to space heat generation and will be used in the heating and cooling design software. Mechanical equipment includes:

- Pumps
- Motors
- Compressors
- Boilers

Electrical gear includes:

- Switchgear
- Motor control centers (MCCs)
- Transformers
- AFDs
- Control panels

Calculations will use typical heat generation data available from vendors or other published sources, and will include the electrical gear percent run time (diversity) and percent loading. The mechanical equipment will include diversity in the calculations.

5.11 Louvers

Louvers will be selected based on a minimum free area requirement determined by calculations using the required air flow in cubic feet per minute (cfm), maximum free area velocity, and vendor literature. Table 29 lists the design velocity and pressure drop criteria.

Table 29. Design Velocity and Pressure Drop Criteria

Service	Maximum Velocity (fpm)	Maximum Pressure Drop (in. wc)
Supply air, ducted or open connection	600	0.05
Exhaust air, ducted connection	1,000	0.10
Exhaust air, open connection	600	0.05

Note:
wc = water column

5.12 Cooling and Heating Coils

Where required, cooling and hearing coils will be selected based on a maximum airside coil face velocity of 450 fpm and a maximum airside pressure drop of 0.3 in. wc.

5.13 Calculation Safety Factors

All calculations related to HVAC design will include a minimum safety factor of 10 percent. Care must be taken so that safety factors are not added upon with each calculation.

5.14 Equipment Safety Factors

Equipment sizing safety factors will not be required or included, as safety contingency will be based on the calculation safety factor. Some safety factors will be indirectly provided by equipment when selected. Where provided, equipment will be a manufacturer's common sizes and not custom equipment.

5.15 Equipment Redundancy

HVAC equipment serving critical nonprocess spaces, like electrical, server, control, and IT rooms, will be sized based on an N+1 scheme, where N equals the number of units providing the total capacity. HVAC equipment serving noncritical, non-process spaces, like HVAC, mechanical, and battery rooms, will be sized based on multiple units providing the required capacity. A spare unit will not be provided. HVAC equipment serving occupied, administrative spaces, like offices and conference and rest rooms, will be sized based on a single unit providing the required capacity.

5.16 HVAC Equipment and Component Noise

HVAC equipment will be commercial grade and selected from a manufacturer's standard product lines. Selection of custom-fabricated equipment will be minimized to decrease costs and provide better maintainable equipment.

Indoor and outdoor equipment will be selected with standard manufacturer's options where available to reduce the sound generated during operation. This includes the following equipment specifications:

- Lined fan boxes
- Double wall construction for AHU cabinets
- Lined ductwork
- Equipment with low noise generation

Noise at the property line will be reviewed, and construction and design steps will be taken to limit the noise to a maximum 55 dBA at the property line. It may also be necessary to conduct preconstruction and postconstruction ambient background noise testing to determine whether noise reduction is needed. Table 30 lists the sound criteria for grilles and diffusers.

Table 30. Sound Criteria for Grilles and Diffusers

Space	Maximum NC Level
Office	30
Open offices	35
Conference room	30
Public circulation	40
Process areas	35
Electrical rooms	35
Nonprocess areas	35

Note:

NC = noise criterion

5.17 HVAC Equipment Installation Locations

Installation locations for equipment depend on the HVAC concept. Possible locations include:

- Rooftop
- Exterior wall
- Interior wall
- Ground
- Interior floor

Wherever the equipment is located, access will be required for maintenance and electrical requirements. For equipment with cooling or heating coils, space will be provided to remove and replace a coil. Where equipment is located above a floor or working platform, an access platform will be considered to provide necessary equipment maintenance.

The location of outdoor equipment will need to consider whether people who live near the SDPP can see the HVAC equipment. If viewing the equipment is not acceptable to DCA, screening may be necessary. Screening includes equipment installed on the ground as well as on a rooftop.

5.18 HVAC Equipment Types for Cooling

Selected cooling methods include DX cooling and ventilation cooling. DX cooling is intended for occupied administrative and nonprocess electrical and computer spaces. These nonprocess spaces include IT, server, and control rooms. DX equipment will need to meet the energy efficiency requirements of the applicable codes, including use of AFDs and energy efficiency ratios.

Ventilation cooling is intended for process spaces and support nonprocess spaces. Process spaces include the SDPP, while non-process spaces include the battery room, HVAC rooms, and mechanical rooms. SDPP space ventilation will use supply and exhaust fans for improved air movement and system redundancy. Other process space ventilation will use supply fans only.

The use of supply fans rather than exhaust fans provides a positive pressure in the process space; therefore, minimizes intrusion of dust and dirt. Process spaces using supply fans and occupied spaces will be positively pressurized to a minimum of 0.05 in. wc.

Outdoor air-cooled condensing units will be designed to operate at a minimum temperature of 26°F and a maximum temperature of 107°F based on ASHRAE climatic data for the extreme annual temperature. Equipment heating and cooling capacity will need to be met at these temperature conditions.

Destratification fans will be considered for non-process spaces, including the SDPP and Maintenance Building. Motorized and manual balancing dampers will be low leakage, meeting the requirements of AMCA Standard 511.

During the preliminary design phase, other methods of cooling may be investigated. Possible cooling methods include:

- Direct evaporative cooling
- Indirect evaporative cooling
- Indirect, water-cooled systems
- Ground source cooling

Evaluation should include the advantages and disadvantages of each system, including equipment, installation, operation, and energy usage criteria.

Selected HVAC cooling equipment is also dependent on the type of cooling required by electrical gear or mechanical equipment. For example, SDPP pump motors and pump AFDs can be air- or water-cooled. For air-cooled AFDs, the heated air can be discharged outside the room or into the room. The differing heat load generated and whether the heated air is discharged to the space can impact the selected cooling system.

Water-cooled systems do not add heat to the space. Water-cooled systems can be closed-loop and circulated or once-through designs.

5.19 HVAC Equipment Types for Heating

Selected heating systems include heat pumps and electric coils. Heat pumps will be used for occupied administrative and nonprocess electrical and computer spaces. Electric coil heating devices will be used for process and nonprocess spaces.

5.20 HVAC System Energy Recovery Equipment

Depending on the design conditions and equipment size, the IECC and the CEC Building Energy Efficiency Standards may require energy recovery systems. The type of energy recovery device may not be defined, but the use would be required. Further review of this requirement will be needed as the design progresses.

5.21 HVAC Control Systems

Simple electronic control and direct digital control (DDC) systems are intended. Each building will have a stand-alone DDC to control the major HVAC equipment. A common alarm is intended to be sent to the plantwide SCADA system to indicate an alarm in a building. The local DDC system will control and indicate the specific equipment alarm or failure. It is not intended to network the HVAC DDCs together.

Redundant equipment will operate in a LEAD/LAG/STANDBY fashion. Unit 2 operates when unit 1 is unable to maintain the temperature set point. Where installed, the third, fourth, and successive units will operate in a similar fashion. If any unit fails, the STANDBY unit operates.

5.22 HVAC Equipment Construction and Corrosion Protection

HVAC cabinet construction is intended to be of galvanized or painted sheet metal. Condensing unit cooling coils will be provided with corrosion-inhibiting coatings. AHU cabinets will be insulated with solid, double panels. Coil drain pans will be 316 stainless steel. Cabinets will have the manufacturer's standard paint system. Equipment cabinets will be provided with cabinet access doors. Where possible, doors on both sides of the equipment are preferred.

5.23 Seismic Requirements

HVAC equipment, components, piping, and ductwork will be provided with code-required seismic restraint based on the structural design criteria. Further investigation will be needed to determine what California codes or DCA requirements are applicable to the design. Future questions concerning the applicability of meeting California Office of Statewide Health Planning and Development (OSHPD) requirements will be needed.

5.24 Sustainable Facilities

One goal of the design will be to construct sustainable facilities. To that end, the design will follow, at a minimum, the requirements of the *California Building Energy Efficiency Standards for Residential and Nonresidential Buildings*, CalGreen, and the IECC. Energy efficiency and energy recovery will be two concepts reviewed and discussed during the preliminary design phase. The added cost for design, equipment, and construction will be weighed against the energy savings.

Possible sustainability features include:

- Destratification fans
- Energy recovery equipment
- Alternative methods of cooling and heating
- Process equipment and electrical gear heat recovery for building heating

The design will not follow Leadership in Energy and Environmental Design (LEED) requirements.

6. Fire Prevention and Fire protection System

The plant shall be designed and built with fire prevention and fire protection systems for the safety of construction and operating personnel, the physical integrity of plant components, and the continuity of plant operations in accordance to National Fire Protection Association Standard No. 851 – Recommended Practice for Fire Protection For Hydroelectric Generating Plants (NFPA 851). The fire prevention and fire protection shall be incorporated into the plant design such as life safety, smoke alarms, fire detections, emergency lighting, etc., fire protection systems and equipment such as water supply, fire detections, fire suppression systems, fire fighter communication, etc., identification of the protection of hazards such as hydraulic control oil systems, motor windings, transformers, switchgear and relays, etc., and fire protection for the construction site such as temporary construction materials, construction site laydown area, site clearing, excavation and tunneling, etc.

The major goals for the fire systems are:

1) Life Safety
2) Property protection
3) Business interruption
4) Environmental impact

6.1 Life safety and property protection

Although they are not distinct goals, life safety and property protection are not entirely independent, with improvements in one potentially benefitting the other. Life safety involves protecting persons and providing suitable means of egress during a fire. DWR has ranked life safety as the most important goal. Protecting persons and providing suitable means of egress are critical to plant's fire protection systems. Protecting property, though not as critical, is also extremely important because the plant's failure to operate would affect Department's ability to deliver water.

6.2 Business Interruption

Business interruption is the period necessary to restore DWR's capacity to deliver water after a fire in a SWP facility. The extent of damage incurred by the fire is quantified in terms of probable maximum loss (PML) and maximum foreseeable loss (MFL). DWR's goal is to restore a minimum of 25 percent of the plant's capacity within 30 days and 50 percent capacity within 60 days following a PML occurrence. However, It should be noted that investment costs related to business interruption may preclude this goal. Therefore, this issue needs to be analyzed independently, using operational practice to determine appropriate risk tolerance.

6.3 Environmental Impact

The potential environment treats resulting from the discharge of water-based fire suppression systems into the waterways and shall be considered to reduce the impact of an oil-and-water spill threat to waterways.

7. Electrical

The electrical design section for the SDPP is divided into two major systems:

- Pumping Plant Systems
- Substation Systems

7.1 Design Codes, Standards, and References

The latest adopted version of the following codes, standards, and references apply to SDPP electrical design criteria unless otherwise noted:

- 29 *Code of Federal Regulations* (CFR) 1910.1200-2012, *OSHA Hazard Communication Standard.*
- CFR Part 431-2018, *Energy Conservation for Commercial Equipment Distribution Transformers Energy Conservation Standards.*
- *ANSI C84. 1-2016 - American National Standard for Electric Power Systems and Equipment—Voltage Ratings (60 Hz).*
- *ANSI/ASME B1.20.1-2013 - Pipe Threads, General Purpose, Inch.*
- *ANSI/NEMA CC 1-2018 - Electric Power Connection for Substations.*
- *ANSI/NEMA MG 1-2016 - Motors and Generators.*
- API 541-2014-2008 - Form-wound Squirrel-Cage Induction Motors - 500 Horsepower and Larger
- API 546 - Brushless Synchronous Machines - 500 kVA and Larger
- API 670-2014 - Machinery Protection Systems
- *ASCE 7-2016 - Minimum Design Loads for Buildings and Other Structures.*
- ASME - B&PV Code.
- ASME - *American National Taper Threads.*
- *ASTM A123/A123M-2017, Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.*
- *ASTM A153/A153M-2006, Zinc Coating (Hot-Dip) on Iron and Steel Hardware.*
- *ASTM B117-2019, Standard Practice for Operating Salt Spray (Fog) Apparatus.*
- *ASTM D92-2018, Flash and Fire Points by Cleveland Open Point Tester.*
- *ASTM D877-2019, Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.*
- *ASTM D924-2015, Standard Test Method of Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids.*
- *ASTM D971-2020, Standard Test Method for Interfacial Tension Against Water by the Ring Method.*
- *ASTM D974-2014, Standard Test Method for Acid and Base Number by Color-Indicator Titration.*
- *ASTM D1275-2015, Standard Test Method for Corrosive Sulfur in Electrical Insulating Oils.*
- *ASTM D1533-2012, Standard Test Method for Water in Insulating Liquids by Coulo metric Karl Fischer Titration.*
- *ASTM D1654-2016, Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.*
- *ASTM D2472-2015, Standards Specification for Sulphur Hexafluoride.*
- *ASTM D3487-2016, Mineral Insulating Oil Used in Electrical Apparatus.*
- *ASTM D5222-2016, High Fire-Point Mineral Electrical Insulating Oils.*

- ICC, *International Fire Code®* (IFC)-2018.
- Insulated Cable Engineers Association (ICEA*). ICEA S-95-658-2009 - Power Cables Rated 2000Volts or Less for the Distribution of Electrical Energy.*
- IEEE 80-2013 – Guide for Safety in AC Substation Grounding
- IEEE 81-2012 – Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System
- IEEE 141-1999 – Recommended Practice for Electric Power Distribution for Industrial Plants - IEEE Red Book
- IEEE 142-2007 – Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book
- IEEE 242-2001 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems - IEEE Buff Book
- IEEE 315-1993 – Graphic Symbols for Electrical and Electronics Diagrams
- IEEE 399-1997 – Recommended Practice for Industrial and Commercial Power Systems Analysis - IEEE Brown Book
- IEEE 421.x Series (2007-2017) - Standard Criteria and Definitions for Excitation Systems for Synchronous Machines
- IEEE 446-2000 – Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications - IEEE Orange Book
- IEEE 450-2010 – Recommended Practice for Maintenance Testing and Replacement of Vented Lead-Acid Batteries for Stationary Applications
- IEEE 493-2007 – Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems - IEEE Gold Book
- IEEE 519-2014 – Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems
- IEEE 551-2006 – Recommended Practice for Calculating Short- Circuit Currents in Industrial and Commercial Power Systems - IEEE Violet Book
- IEEE 605-2008 – Guide for Bus Design in Air Insulated Substations
- IEEE 691-2001 – Guide for TL Structure Foundation Design and Testing
- IEEE 693-2018 – Recommended Practice for Seismic Design of Substations
- IEEE 979-2012 – Guide for Substation Fire Protection
- IEEE 998-2012 – Guide for Direct Lightning Stroke Shielding of Substations
- IEEE 1188-2010 – IEEE Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications
- IEEE 1246-2011 – Guide for Temporary Protective Grounding Systems Used in Substations
- IEEE 1375-2003 – Protection of Stationary Battery Systems
- IEEE 1584-2018 – Guide for Performing Arc-Flash Hazard Calculations

- IEEE C2-2017 – National Electrical Safety Code
- IEEE C62.22-2009 – Guide for the Appl of Metal-Oxide Surge Arresters for AC Sys's
- IEEE C62.92.x SERIES (2012-2017) – Guide for the Application of Neutral Grounding in Electrical Utility Systems
- Institute of Electrical and Electronics Engineers (IEEE). *IEEE 693-2018 - Recommended Practices for Seismic Design of Substations.*
- *IEEE 979-2012 - Guide for Substation Fire Protection.*
- *IEEE C37.04-2018 - Rating Structure for AC High-Voltage Circuit Breakers.*
- *IEEE C37.06-2017 - AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis – Preferred Ratings and Related Required Capabilities for Voltages Above 1000 V.*
- *IEEE C37.09-2018 - IEEE Standard Test Procedures for AC High-Voltage Circuit Breakers with Rated Maximum Voltage Above 1000 V*
- *IEEE C37.010-2016 - Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.*
- *IEEE C37.011-2019 - Guide for the Application of Transient Recovery Voltage for AC High-Voltage Circuit Breakers.*
- *IEEE C37.012-2014 - Guide for the Application of Capacitive Current Switching for AC High-Voltage Circuit Breakers Above 1000 V.*
- *IEEE C37.017-2010 - IEEE Draft Standard for Bushings for High Voltage (over 1000 Volts ac) Circuit Breakers and Gas Insulated Switchgear.*
- *IEEE C37.082-1982 - Standard Methods for the Measurement of Sound Pressure Levels of AC Power Circuit Breakers.*
- *IEEE C37.11-2014 - Standard Requirements for Electrical Control for AC High-Voltage (>1000 V) Circuit Breakers.*
- *IEEE C37.90-2005 - IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus.*
- *IEEE C37.100-1992 - Standard Definitions for Power Switchgear.*
- *IEEE C57.12.00-2015 - General Requirements for Liquid-Immersed Distribution, Power and Regulating Transformers.*
- *IEEE C57.12.10-2010 - Standard Requirements for Liquid-Immersed Power Transformers.*
- *IEEE C57.12.28-2014 - Standard for Pad-Mounted Equipment—Enclosure Integrity.*
- *IEEE C57.12.30-2010 - Requirements for Load Tap Changing Transformers 230,000 Volts and below.*
- *IEEE C57.12.70-2011 - Terminal Markings and Connections for Distribution and Power Transformers.*
- *IEEE C57.12.80-2010 - Transformer Terminology for Power Distribution Transformers.*
- *IEEE C57.12.90-2015 - Standard Test Code for Liquid-Immersed Distribution, Power and Regulating Transformers and IEEE Guide for Short-Circuit Testing of Distribution and Power Transformers.*
- *IEEE C57.13-2016 - Standard Requirements for Instrument Transformers.*

- *IEEE C57.19.01-2017 - Performance Characteristics and Dimensions for Outdoor Apparatus Bushings c57.*
- *IEEE C57.19.100-2012 – IEEE Guide for Application of Power Apparatus Bushings.*
- *IEEE C57.98-2011 - Guide for Transformer Impulse Tests.*
- *IEEE C57.109-2018 - Guide for Liquid-Immersed Transformer Through-Fault Current Duration.*
- *IEEE C57.110-2018 - Guide for Partial Discharge Measurement is Liquid-Filled Power.*
- *IEEE C57.113-2010 - Recommended Practice for Partial Discharge Measurement in Liquid Filled Transformers and Shunt Reactors.*
- *IEEE C57.119-2018 - Performing Temperature Rise Tests on Oil-Immersed Power Transformers.*
- *IEEE C57.120-2017 - Loss Evaluation Guide for Power Transformers and Reactors.*
- *IEEE C57.123-2019 - Guide for Transformer Loss Measurements.*
- *IEEE C57.127-2018 - Trial Use Guide for the Detection of Acoustic Emissions from Partial.*
- *IEEE C57.131-2012 - Standard Requirements for Load Tap Changers.*
- *IEEE C62.11-2012 - IEEE Standard for Metal-Oxide Surge Arresters for AC Power Circuits (> 1 kV)*
- *IEEE C63.2-2016 - Electromagnetic Noise and Field Strength Instrumentation.*
- *IEEE C84.1-1993 - Voltage Ratings for Electrical Power Systems and Equipment.*
- *IEEE C227.4-2006 - Three-Phase, Pad-Mounted Distribution Transformers with Separable Insulated High-Voltage Connectors.*
- *IEEE PC37.12.1-2007 - Guide for High Voltage (>1000V) Circuit Breaker Instruction Manual Content.*
- Illuminating Engineering Society (IES)
- Instrument Society of America (ISA)
- NEMA ICS - Industrial Control and Systems Control
- NEMA WC -Cable Standards
- NEMA WD – Wiring Devices
- *NEMA C29.1-2018 - Test Methods for Electrical Power Insulators.*
- *NEMA FU-1-2012 - Low-Voltage Cartridge Fuses.*
- *NEMA SG 4-2009 - Alternating Current High-Voltage Circuit Breakers.*
- *NEMA TR1-2019 - Transformers, Regulators and Reactors.*
- *NFPA 70 - National Electrical Code (NEC).*
- *NFPA 70E – Standard for Electrical Safety in the Workplace*
- *NFPA 79-2018 – Electrical Standard for Industrial Machinery*
- *NFPA 850-2020 - Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations.*
- *NFPA 101®-2018 - Life Safety Code®.*
- Occupational Safety and Health Administration (OHSA).

- Service rules and regulations of the local electric utility company.
- State of California. CBC.
- The design of the equipment must conform to current OSHA and NESC regulations and requirements
- UL 347-2016 – Medium-Voltage AC Contactors, Controllers, and Control Centers
- UL 845-2005 – Motor Control Centers
- UL 1059-2019 – Standard for Terminal Blocks

This document may be updated to add additional relevant standards and specificity as design progresses and details clarify.

7.2 Pumping Plant Systems

The electrical design for the pump plant systems include the following:

- Power distribution
- Medium-voltage adjustable frequency drives (MVAFDs) – Raw Water Pumps
- Medium-voltage reduced-voltage solid-state starters (MVRVSSs) – Dewatering Pumps
- Low-voltage systems
- Standby Electric Generator (SEG)
- Raw water pump motors

7.2.1 Power Distribution

Table 31 summarizes the preliminary design criteria for the permanent phase of the Pumping Plant.

Table 31. 15-kV Switchgear Design Criteria

Subject	Criteria	Comments
Operating voltage	5, 12.47, 13.2, or 13.8 kV, TBD	Operating voltage to be determined on matching the MVAFD operating voltage. If 13.8 kV is used, then a large step-down transformer would be needed for each AFD. These transformers would take up a large amount of space and have a large heat contribution if installed inside. A 6.9-kV operating voltage is preferred and is a standard operating voltage. The MVAFD voltage will be determined based on the motor HP size and motor type. This will be determined as part of preliminary design.
Ampacity	TBD	Size will be rated to allow for 100% operation from either the main breaker closed or with the other main open and tie breaker closed.
Bus type	Silver-plated copper	Per department standard.

Table 31. 15-kV Switchgear Design Criteria

Subject	Criteria	Comments
Incoming feeders	15 kV, XLPE insulation with PVC jacket, MV-105 133% insulation level, copper top or bottom feed TBD	
Switchgear entry mains	Top or bottom -TBD	Top or bottom feed will be determined if a vault is selected. Bottom would be better with a vault.
Switchgear entry feeders	Top or bottom - TBD	Top or bottom feed will be determined if a vault is selected. Bottom would be better with a vault.
Switchgear configuration Load transfer	• Main-Tie-Main Electronically interlocked • 125 VDC automatic transfer • Semi-automatic closed transition retransfer	Semi-automatic closed transition retransfer will be provided. This will allow retransfer back to normal power without shutting down the pumps.
Enclosure	• NEMA 1G • Arc resistant, Type 2B • ANSI/NEMA C37.20.2 metal clad • Seismic rated	Gasketed. An arc event will not cause holes in the enclosure where the arc event occurs.
Short-circuit rating BIL	>=63kA TBD	
Main and feeder circuit breaker type	• ABB AMVAC – Magnetic Actuation preferred • Drawout • Electrically operated – 125 VDC • Stored energy trip and close mechanism • Local and remote open and close operation	Single breaker per cubicle, bottom mounted, with the instruments and relays in the top. AC capacitor trip with battery backup.
• Main and feeder protective relays • Relay wiring • Arc flash protection	• SEL (no substitutions) • Westinghouse Method specified in the CER • To be provided with the relays	Redundant relaying is Department Standard, with the exception of Arc Flash relaying.
Power monitoring	SEL power monitoring systems.	Need input from DCA on what types they prefer.
Arc detection system	SEL 751A w/Fiber-optic loops, backed up by point sensors.	

Table 31. 15-kV Switchgear Design Criteria

Subject	Criteria	Comments
Surge protection	IEEE C62.11	Surge Arrestors installed for protection of switchgear.
Space heaters	240/120 V; TBD if required	The Electrical Building is conditioned, so heaters would not be needed but maybe desired.

Notes:

AC = alternating current

AFD = adjustable frequency drive

BIL = basic insulation level

EPR = ethylene propylene rubber

kV = kilovolt(s)

SEL = Schweitzer Engineering Laboratories

V = volt(s)

VDC = volt(s) direct current

7.2.2 Medium-Voltage Adjustable Frequency Drives - Raw Water Pumps

Many of these features will depend on the exact motor type (induction or synchronous) and the actual HP size selected. The AFD selected will impact the operating voltage of the 15-kV switchgear, as discussed. Most pump manufacturers can provide a 6.6-kV motor, and most AFD manufacturers can provide a 6.9-kV-rated AFD for the 6.6-kV-rated motor; however, this can vary greatly by AFD manufacturer and motor type and size. It would be favorable to have the switchgear and AFDs at the same operating voltage, or step-down transformers (13.8 to 4.16 kV, for example) would be required. These step-down transformers would require significant space (either inside or outside) and would give off a lot of heat, which would affect air cooling size if installed inside. Table 32 summarizes the preliminary design criteria for raw water pump MVAFDs.

Table 32. Medium-Voltage Adjustable Frequency Drives

Subject	Criteria	Comments
Operating voltage	4.16, 12.47, 13.2, 13.8kV	Input voltage to these drives will be determined as motor horsepowers are finalized.
HP and amps Overload capacity	TBD 110% variable torque and normal duty	
Rectifier	Active front end or 36 pulse minimum - Meets IEEE 519-1992 - TBD	This varies greatly with motor type, HP, and with each AFD manufacturer. This will be determined after the motor HP and type is selected.
Cooling	Fan air or liquid - TBD	
Isolation transformer	TBD	This varies greatly depending on the rectifier and manufacturer, along with HP size and motor type.
Input power factor	> 0.95	
Enclosure	NEMA 1G (UL/CSA) Seismic Rated	
Noise level	TBD	This varies greatly depending on the rectifier and manufacturer, along with HP size and motor type.
Network and communications	TBD	This varies greatly depending on the rectifier and manufacturer, along with HP size and motor type.
Efficiency	TBD	This varies greatly depending on the rectifier and manufacturer, along with HP size and motor type.
Output frequency and speed	1-75 Hz	
Arc resistant	TBD	Many manufacturers are providing this feature but varies greatly.
Output contactor	TBD	An output contactor needs to be evaluated if the motor can spin backwards and send current back to the AFD. Non-reverse ratchet on the motor will help prevent this. Contactor will add to AFD footprint and costs.
Input contactor	TBD	This varies by manufacturer and the rectifier they provide.

Notes:
> = greater than
CSA = CSA Group
Hz = hertz

7.2.3 Medium-Voltage Reduced-Voltage Solid-State Starters - Dewatering Pumps

Table 33 summarizes the preliminary design criteria for MVRVSSs.

Table 33. Medium-Voltage Reduced-Voltage Solid-State Starters

Subject	Criteria	Comments
Operating voltage	4.16, 12.27, 13.2, 13.8kV	
HP and amps	TBD	
Cooling	Fan air	
Enclosure	NEMA 1G (UL/CSA) Seismic rated	
Noise level	TBD	This varies greatly depending on the rectifier and manufacturer, along with HP size and motor type.
Network and communications	TBD	This varies greatly depending on the rectifier and manufacturer, along with HP size and motor type.
Efficiency	TBD	This varies greatly depending on the rectifier and manufacturer, along with HP size and motor type.
Arc resistant	TBD	Many manufacturers are providing this feature but varies greatly.
Output contactor	TBD	An output contactor needs to be evaluated if the motor can spin backwards and send current back to the MVRVSS. Non-reverse ratchet on the motor will help prevent this. Contactor will add to MVRVSS footprint and costs.
Input contactor	Vacuum contactor - TBD	

7.2.4 Low-Voltage Systems

Currently, there are two MCCs (SDPP MCC and outlet shaft MCC) shown in the CER (DWR, 2018). If it is determined that two MCCs will be needed, switchgear may be needed to distribute the 480-V loads to the multiple MCCs and other 480-V loads. This will need to be determined during preliminary design. Table 34 summarizes the preliminary design criteria for the 480-V switchgear.

Table 34. 480-V Switchgear

Subject	Criteria	Comments
Operating voltage	480 V	
Ampacity Bus type	TBD Silver-plated copper	Size will be rated to allow for 100% operation from either main breaker with other main open and tie breaker closed. Per DWR standard.
Incoming feeders	600-V rated, copper, XHHW-2 insulation, wire sizes - TBD 600-Vrated, copper, XHHW-2 insulation, wire sizes -TBD	Main and feeder wire sizes will be determined by the actual load of each equipment and sized per the NEC.
Entry mains	Top or bottom - TBD	Top or bottom feed will be determined if a vault is selected. Bottom would be better with a vault.
Entry feeder	Top or bottom - TBD	Top or bottom feed will be determined if a vault is selected. Bottom would be better with a vault.
Configuration	Main-Tie-Main, electrically interlocked	
Current and Potential Transformers	• CTs: Window Type, C200, min. (Protection), C20, min (Protection, Zero Sequence), 0.3, B1.8 (Metering), bus mounted if PCB stabs are insufficient • PTs: dual secondary fused, 120V Secondary voltage	Per DWR standard
Enclosure	• NEMA 1G • Arc Resistant Type 2B • ANSI/NEMA C37.20.7 metal clad • UL 1588 • Seismic rated	
Short-circuit rating	TBD	Short circuit will be determined after total loads of all equipment are known and preliminary calculations are done.
Circuit breaker type	• Draw-out power circuit breaker • Electrically operated • Removable solid-state trip units • ANSI C37.16 • Local and remote open and close operation	
Power monitoring	TBD	Need input from DCA on what types they prefer.

Table 34. 480-V Switchgear

Subject	Criteria	Comments
Arc detection system	Department standard is SEL 751A, with fiber loops backed up by point sensors	
Surge protection	IEEE C62.11	
Space heaters	120 V; TBD - if desired.	Need DCA input if they would want these and the Electrical Building is conditioned so heaters would not be needed but maybe desired.

Note:

XHHW-2 = cross-linked polyethylene high heat-resistant water-resistant

Table 35 summarizes the preliminary design criteria for the 480-V MCC.

Table 35. 480-V Motor Control Center

Subject	Criteria	Comments
Operating voltage	480 V	
Ampacity Bus type	TBD Silver-plated copper	Size will be rated to allow for 100% operation from either main breaker with the other main open and tie breaker closed. Per DWR standard.
Incoming feeders	600V rated, copper, XHHW-2 insulation, wire sizes -TBD 600V rated, copper, XHHW-2 insulation, wire sizes - TBD	Main and feeder wire sizes will be determined by the actual load of each equipment and sized per the NEC.
Entry mains	TBD - Top or bottom	Top or bottom feed will be determined if a vault is selected. Bottom would be better with a vault.
Entry feeders	TBD - Top or bottom	Top or bottom feed will be determined if a vault is selected. Bottom would be better with a vault.
Configuration	TBD	
Enclosure	• NEMA 12 • Arc Resistant Type 2B • UL 845 • Seismic rated	
Short-circuit rating	TBD	Short circuit will be determined after total loads of all equipment are known and preliminary calculations are done.

Table 35. 480-V Motor Control Center

Subject	Criteria	Comments
Circuit breaker type	• Fixed circuit breakers with removable solid-state trip units (for 225 A and larger) • Auxiliary contact for breaker position monitoring	
Starters and feeders	• Plug-in type and removable • Solid-state overloads	
Power monitoring	TBD	Need input from DCA on what types they prefer.
Arc detection system	Fiber-optic type installed in the breaker and bus compartments	Can be provided by some manufacturers.
Surge protection	IEEE C62.11	

Note:
A = ampere(s)

Table 36 summarizes the preliminary design criteria for the 15-kV to 480-V transformer.

Table 36. 15-kV to 480-V Transformer

Subject	Criteria	Comments
Type	• Oil filled (Type FR-3 fluid) • OA/FA • Outdoor rated	
Primary voltage	• TBD • Three phase, three wire	Voltage will match 15-kV switchgear operating voltage.
Secondary voltage	• 480Y/277 V three phase, four wire	
kVA	Maximum of 1,000 kVA per DWR standards	
Impedance	TBD	
Efficiency	Meet or exceed DOE 2016	
Taps	• Full capacity, two 2.5% below and two 2.5% above rated voltage • Externally operated, no load tap changer	
Windings	Copper	
Spill containment	TBD	For prevention of an oil spill.
Transformer blast wall	TBD	To prevent a transformer oil fire from effecting the other transformer.

Note:
kVA = kilovolt(s)-ampere

7.2.5 Standby Electric Generator (SEG)

Table 37 summarizes the preliminary design criteria for the generator.

Table 37. Standby Emergency Generator

Subject	Criteria	Comments
Engine type	Natural gas or diesel - TBD	Engine type will be determined by fuel availability as well as reliability of fuel supply and refuel. TBD during preliminary design. Mostly likely diesel depending on final size required.
kW/kVA at 0.8 pF	TBD	The current load shown on the generator from the CER was only for the Electrical Building HVAC and life safety systems—not for any pumps or gravity flow control gates. During preliminary design, it will be determined what loads will be required to be powered from the generator, as this will greatly affect the generator size and generator building if powering some of the pumps is required.
Voltage	480Y/277V	
Emissions	TBD	
Fuel tank and capacity	TBD	
Exhaust system	TBD	
Automatic transfer switch	Size TBD	
Enclosure	TBD Seismic rated	It is proposed that the generator be installed in a building in lieu of it being installed outside in a weather-protective enclosure.
Load bank	TBD	

Notes:

kW = kilowatt(s)

pF = power factor

7.2.6 Pump Motors

Table 38 summarizes the preliminary design criteria for the pump motors.

Table 38. Raw Water Pump Medium-Voltage Motor

Subject	Criteria	Comments
Operating voltage and HP	• 6.9 or 11 kV - TBD • HP - TBD	Operating voltage, HP, and FLA to be coordinated with AFD manufacturers and availability. Section 6.2.2 provides details regarding AFD selection.
Type	• Continuous duty • Premium efficiency • Induction or synchronous motor (size dependent) on AFD • Synchronous motors for constant speed, if applicable • RPM – TBD • API 546 • TEWAC	• Motor cooling alternatives will be evaluated in a separate TM.
Service factor	1.15 for constant speed and 1.0 for AFD	
Frequency and speed turndown	10:1 variable torque	This is a standard motor turndown and is acceptable for most pump applications; however, this will need to be verified during preliminary design with the pump flow turndown requirements.
Bearing life	100,000 hours L-10	
Insulation	Class F minimum meeting NEMA MG1, API 546	
Winding heaters	240/120-VAC motor space heaters	
Motor protection	• Differential ground protection current transformers	Motors shall have 3 phase and 3 neutral CTs
Temperature sensing - RTDs	• T1, t2, t3 windings - 3 rtds ea • Upper bearing - de axial pad • Upper bearing - radial shell • Upper bearing - oil reservoir • Upper bearing - de axial pad • Upper bearing - radial shell • Lower bearing - radial shell • Lower bearing - radial shell • Lower bearing - oil reservoir • Bearings - water inlet (manifold) • Bearings - water outlet (manifold) • Upper bearing - oil reservoir • Lower bearing - oil reservoir	

Table 38. Raw Water Pump Medium-Voltage Motor

Subject	Criteria	Comments
Vibration sensing	• Velocity transductor - Bently Nevada 330500 - lower bearing - axis x • Velocity transductor - Bently Nevada 330500 - lower bearing - axis y • Velocity transductor - Bently Nevada 330500 - upper bearing - axis x • Velocity transductor - Bently Nevada 330500 - upper bearing - axis y	
Non-reverse protection to prevent motor and pump from spinning backwards	Department standard is reverse over-spin controlled by valve operation. Non-reverse ratchet not preferred.	
Bearing protection	• Low-resistance path from shaft to frame • Ground to motor terminal box • Inpro seals	Prevents induced electrical bearing damage when using an AFD on vertical motors.

Notes:

FLA = full load ampere(s)

RTD = resistance temperature detector

VAC = volt(s) alternating current

7.3 Substation Systems

Multiple high-voltage (HV) substations will be required to feed the construction and permanent electrical loads at the pumping plant, intake facilities, forebays, and other facilities along the tunneling route. Substations have to be built along the tunneling route depending on the shaft location and reach distances of the tunnels. This section establishes the design criteria for the substation to be built along the SDPP site to feed temporary loads for the tunneling and pumping plant construction, and to feed the permanent pumping plant loads upon completion of construction of the SDPP complex.

7.3.1 Project Site – Substation Location

Table 39 summarizes the design criteria for the substation location.

Table 39. Substation Location

Subject	Criteria	Comments
Geographical location	• Located at a suitable location to feed the permanent pumping station loads at the SF • Will consider feeding the TBM loads for the Reach 7 section of the tunnel from the SF to Bacon Island, and Reach 8 section between the SF outlet structure and southern tunnel outlet structure • Located closer or in the direction of existing transmission ROW to facilitate easy interconnection from the nearby transmission lines or utility substation sources. • Will meet federal and state noise limits	

7.3.2 Electrical Design Parameters

7.3.2.1 High-Voltage System for Customer Load Substation

The load substation at the SDPP has the option to be served by different transmission voltages. Depending on the service voltage to the load substation from the utility, voltage, current, and short-circuit details have to be updated. Table 40 summarizes the design criteria for the customer load substation HV system.

Table 40. High-Voltage System for Customer Load Substation

Subject	Criteria	Comments
Substation type	Air insulated	
Busbar HV bus arrangement	Two; each line should be rated to carry the entire substation load	Substation will be served by two incoming feeders from the utility. During the outage or failure of one of the lines, the other healthy line should serve the entire substation load. Lines shall be radial feeds and looping of utility power through customer buses or equipment is not acceptable. Note: DCE Design Criteria Volume II - Chapter VIII: Electrical Design Criteria, Section 2 (2013), specifies a single HV line from the utility. However, considering the critical nature of the load, a second utility source is recommended.
Number of step-down transformers (HV to MV)	Two; each transformer should be rated to carry the entire substation load	When one transformer is on outage or failed, the other healthy transformer should serve the entire substation load.
Nominal system frequency	60 Hz	
Nominal HV system voltage	69/115/230 kV	Indicated are customer standard interconnection voltages. Actual interconnection voltage is dependent on the available utility voltages at the point of interconnection.

Table 40. High-Voltage System for Customer Load Substation

Subject	Criteria	Comments
Maximum HV system voltage	72.5/121/242 kV	Dependent on the utility interconnection.
Rated HV lightning impulse withstand voltage (BIL)	TBD kV	Dependent on the utility interconnection.
Rated power frequency withstand level	TBD kV	Dependent on the utility interconnection.
Rated HV busbar continuous current	TBD A	Dependent on load and utility interconnection requirement.
Nominal MV system voltage	TBD kV	Dependent on pumping plant and TBM loads.
Maximum MV system voltage	TBD kV	Dependent on pumping plant and TBM loads.
Rated MV lightning impulse withstand voltage (BIL)	TBD kV	In accordance with IEEE 1427 and per insulation coordination.
Rated power frequency withstand level	TBD kV	In accordance with IEEE 1427 and per insulation coordination.
Rated HV busbar continuous current	TBD A	Dependent on load and utility interconnection requirement.
Rated short-circuit current	TBD kA	Dependent on utility interconnection requirement.
Short-circuit current withstand capacity	3 seconds	

Note:

MV = medium voltage

7.3.2.2 Spacing and Clearances

Table 41 summarizes the design criteria for spacing and clearances. Spacing and clearances will be determined based on service voltage, codes, insulation coordination, and utility interconnection requirements.

Table 41. Spacing and Clearances

Subject	Criteria	Comments
Rigid bus: • Phase-to-phase minimum spacing (centerline to centerline) • Phase-to-phase minimum (metal to metal) • Phase-to-ground minimum (metal to metal)	TBD	In accordance with voltage class, IEEE 1427, NESC, insulation coordination, and utility interconnection requirements
Strain bus: • Phase-to-phase minimum spacing (centerline to centerline)	TBD	In accordance with voltage class, IEEE 1427, NESC, insulation coordination, and utility interconnection requirements
Minimum clearance - rigid parts (metal to metal)	TBD	In accordance with voltage class, IEEE 1427, NESC, insulation coordination, and utility interconnection requirements
Minimum clearance to grade inside substation ground for personal safety	TBD	In accordance with voltage class, IEEE 1427, NESC, insulation coordination, and utility interconnection requirements
Minimum vertical distance between live parts and roadway inside the substation	TBD	In accordance with voltage class, IEEE 1427, NESC, insulation coordination, and utility interconnection requirements
Minimum horizontal clearance from live parts to the fence	TBD	In accordance with voltage class, IEEE 1427, NESC, insulation coordination, and utility interconnection requirements

7.3.2.3 Alternating Current Low-Voltage System

Table 42 summarizes the design criteria for the AC low-voltage (LV) system.

Table 42. Alternating Current Low-Voltage System

Description	Criteria	Comments
Nominal system frequency	60 Hz	
Nominal AC system voltage	TBD	
Maximum voltage deviation	±10% nominal	
AC system	3 phase, solid grounded system	
Minimum short-circuit current	10 kA (symmetrical)	
Maximum continuous conductor temperature	194°F /90°C	

Table 42. Alternating Current Low-Voltage System

Description	Criteria	Comments
Voltage for HVAC equipment	TBD	
Voltage for battery chargers	TBD	
Voltage for lighting	120 V/277V	Outdoor lighting will be 277V AC with LED fixtures
Voltage for convenience receptacles	120 V	
Voltage for equipment space Heaters	120 V	
Voltage for transformer cooling fans and tap changer	TBD	

Notes:

°C = degree(s) Celsius

kA = kiloampere(s)

rms = root mean square

7.3.3 Substation Direct Current Auxiliary Supply

Table 43 summarizes the design criteria for the substation direct current (DC) auxiliary supply.

Table 43. Substation Direct Current Auxiliary Supply

Description	Criteria	Comments
Battery type	Valve Regulated Lead Acid	To be confirmed at the later phases of projects.
Number of battery systems	2	Two independent battery systems for main and backup
Battery rack type (seismic rating)	TBD	In accordance with the Geotechnical Report being developed. Shall be in accordance with Owner's Seismic Criteria
Aging factor	1.25	IEEE 485
Design temperature (correction factor)	77°F /25°C	IEEE 485
Design margin	1.1	IEEE 485
Grounding	Center point grounded	
Battery duty cycle and backup	8 hours	
Recharge time	8 hours	
Nominal DC system voltage	125 V	
Operating voltage	90-140 V	
Control and signal voltage level	90-140 V	
Telecommunication voltage level	90-140 V	

Table 43. Substation Direct Current Auxiliary Supply

Description	Criteria	Comments
Emergency lighting voltage level	90-140 V	
Equipment motor drive voltage level	90-140 V	
Trip circuit voltage level	70-140 V	

Note:

USGS = U.S. Geological Survey

7.3.4 Grounding System

7.3.4.1 Grounding Design

Table 44 summarizes the design criteria for the grounding system.

Table 44. Grounding System

Description	Criteria	Comments
Grounding connection	Solid	
Dissipation of 3-phase ground fault to grid (split method)	IEEE 80	
Grid resistance target value	≤ 0.5 ohm	Per DCE (2013) IEEE 80
Typical soil resistivity	TBD	In accordance with the Geotechnical Report being developed.
Crushed rock resistivity	≥ 5,000 ohm-m	Crushed rock shall be ¾" with no fines
Body weight used to determine safety criteria	50 kg	IEEE 80
Tripping time	0.5 second	Indicative; will be finalized in the next design phases

Notes:

≤ = less than or equal to

≥ = greater than or equal to

kg = kilogram(s)

7.3.4.2 Ground Grid

Table 45 summarizes the design criteria for the ground grid.

Table 45. Ground Grid

Description	Criteria	Comments
Type of ground grid conductor and pigtails	BTN copper cable	
Minimum ground grid conductor size	500 kcmil	Per DCE (2013)
Minimum pigtail size	4/0 AWG	Per DCE Design Criteria: Volume II.
Ground rods – copper clad steel	TBD	
Type of ground grid connections	Exothermic Weld/Mechanical	Exothermic welded connection for below grade and mechanical connectors for below ground applications.
Minimum ground grid depth	TBD	

Notes:

AWG = American wire gauge

BTN = bare tinned copper

kcmil = thousands of circular mils

7.3.5 Illumination Parameters

Table 46 summarizes the conceptual design criteria for illumination.

Table 46. Illumination

Description	Criteria	Comments
Indoor – inside building enclosures	15 ft-c	Per NESC
Outdoor – minimum security	> 0.2 ft-c	Per NESC

Note:

ft-c = foot-candle(s)

7.3.6 Major Electrical Equipment

Major electrical equipment for the SDPP is described in the following subsections.

7.3.6.1 High-Voltage to Medium-Voltage Transformers

Table 47 summarizes the design criteria for HV and MV transformers.

Table 47. High-Voltage to Medium-Voltage Transformers

Description	Criteria	Reference
Type	Outdoor oil-immersed winding	
Power rating (ONAN/ONAF1/ONAF2)	TBD MVA	During normal operation, two transformers will share the load and operate at an ONAN rating. In case of failure of one transformer, the other transformer will be capable of carrying the entire load at a fan-cooled rating. During continuous operation, the load will not exceed a 90% rating of the transformer.
Primary (HV) winding voltage	TBD kV	
Secondary (MV) winding voltage	TBD kV	
Primary (HV) winding vector	Delta	
Secondary (MV) winding vector	Wye	Low side lagging high side by 30°.
Primary bushing BIL (kV)	TBD kV	
Secondary bushing BIL (kV)	TBD kV	
Secondary winding neutral BIL (kV)	TBD kV	Neutral low impedance grounded.
Frequency and phase	60 Hz, 3 phase	
Bushing current transformers - primary	TBD	
Quantity per bushing	3	
Accuracy class	C800	
Ratio	TBD #:5 (multi-ratio)	
Thermal rating factor	2.0	
Bushing current transformers - primary	TBD	
Quantity per bushing	TBD	
Accuracy class	C800	
Ratio	TBD #:5 (multi-ratio)	
Thermal rating factor	2.0	
Bushing current transformers - neutral	TBD	
Quantity per bushing	TBD	
Accuracy class	TBD	
Ratio	TBD #:5 (multi-ratio)	
Thermal rating factor	2.0	
Onload tap changer	± 10%	

Note:
MVA = megavolt-ampere(s)

7.3.6.2 High-Voltage Circuit Breakers

Table 48 summarizes the design criteria for HV circuit breakers.

Table 48. High-Voltage Circuit Breakers

Description	Criteria	Comments
Type of circuit breaker	Dead tank	
Insulating medium	SF_6 gas	
Nominal voltage rating	TBD kV	
Maximum voltage rating	TBD kV	
Frequency and phase	60 Hz, 3 phase	
Rated continuous current	TBD A (rms)	
Short time capability (3 seconds)	TBD kA	
Basic impulse withstand voltage	TBD kV	
Rated power frequency withstand (1 minute dry)	TBD kV	
Rated interrupting time	3 cycles	
Operating duty cycle	TBD	
Seismic zone	TBD	Shall be in accordance with Owner's Seismic Criteria
Bushing current transformers	TBD	
Quantity per bushing	Minimum 2	
Accuracy class	C800	
Ratio	TBD #:5 (multi-ratio)	
Thermal rating factor	2.0	
Trip coil	TBD	
Number of trip coils	Two	
Nominal operating voltage	125 VDC	
Nominal close coil voltage	125 VDC	

Note:

SF_6 = sulfur hexafluoride

8. References

California Department of Water Resources (DWR). 2018. *Conceptual Engineering Report Byron Tract Forebay Option (WaterFix BTO)*.

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9. Document History and Quality Assurance

Reviewers listed have completed an internal quality review check and approval process for deliverable documents that is consistent with procedures and directives identified by the Engineering Design Manager (EDM) and the DCA.

Approval Names and Roles			
Tony Naimey / EDM Pumping Plant Lead	Ted Davis / EDM QC Reviewer	Gwen Buchholz / DCA Environmental Consultant	Terry Krause / EDM Project Manager

This interim document is considered preliminary and was prepared under the responsible charge of Anthony M. Naimey, California Professional Engineering License M28450.

Note to Reader

This is an early foundational technical document. Contents therefore reflect the timeframe associated with submission of the initial and final drafts. Only minor editorial and document date revisions have been made to the current Conformed Final Draft for Administrative Draft Engineering Project Report version.