Subject:	**South Delta Pumping Plant Facilities and Site Configuration (Final Draft)**
Project feature:	Pumping Plant
Prepared for:	California Department of Water Resources (DWR) / Delta Conveyance Office (DCO)
Prepared by:	Delta Conveyance Design and Construction Authority (DCA)
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1. Introduction

This Technical Memorandum (TM) describes the purpose and functionality of the main facilities associated with the South Delta Pumping Plant (Pumping Plant) which is a primary element within the Delta Conveyance System (Project). This TM describes the arrangement of the facilities and supporting infrastructure that constitutes the concept level site configuration. The facilities and site configuration have been defined and developed in accordance with the South Delta Pumping Plant Basis of Conceptual Design Criteria (Draft) TM (Jacobs 2020).

The Pumping Plant facilities would be used to pump or convey by gravity, raw water from the Project's main tunnel into the Southern Forebay (SF). The Pumping Plant would be connected to the south end of the tunnel and situated along the northern embankment of the Southern Forebay.

The range of project design flow capacities of 3,000 to 7,500 cubic feet per second (cfs) was established by the DCO. The Pumping Plant concept has been hydraulically sized to convey four specific design flow capacity options of 3,000, 4,500, 6,000 and 7,500 cfs. The Pumping Plant facilities and site configuration have been developed based on the four identified flow capacity options. The size of the overall Pumping Plant site complex remains the same regardless of the selected maximum project design flow capacity. The lengths of the Pumping Plant structure (above grade structure and below grade wet well) and the adjoining electrical building would change based on the number of pumps required to achieve the selected maximum design flow capacity. The overall conceptual level arrangement of the structures and size of the Pumping Plant raised pad remain the same. The concept drawings show required building dimensions as they apply to each project design flow option.

Figure 1 shows the permanent infrastructure layout associated with the Pumping Plant facilities complex. The Pumping Plant complex would be situated along the northern embankment of the Southern Forebay. As can be seen in Figure 1, the following major facilities would be included in the Pumping Plant facilities complex:

- Main conveyance tunnel and the point of connection to a vertical shaft
- Gravity flow/surge overflow facility
- Pumping Plant wet well inlet conduit
- Pumping Plant building and wet well
- Pumped flow energy dissipation and gravity flow outlet structures
- Electrical building
- HVAC equipment yard

- Electrical substation
- Standby electric generator building
- Equipment storage and maintenance building
- Site access and interior roads

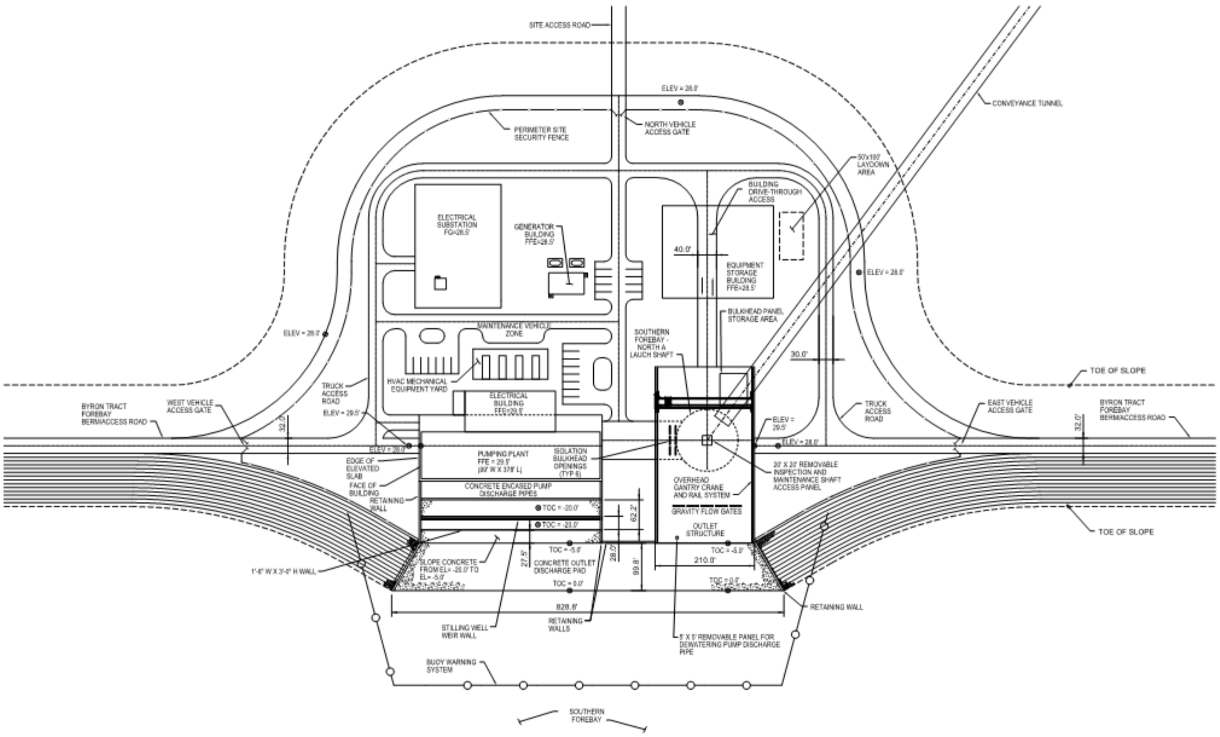

Figure 1. Pumping Plant Facilities Site Plan Configuration

2. Pumping Plant Facilities

The Pumping Plant would be located at the southern end of the tunnel and would be comprised of a vertical shaft, conveyance tunnel, and Pumping Plant facility structures. The following subsections describe the individual facilities that constitute the Pumping Plant facilities and their use, configuration, and functionality.

2.1 Conveyance Tunnel

The main tunnel would terminate at a vertical shaft within the Pumping Plant complex. The tunnel inside diameter (ID) varies within the established range of project design flow capacities. A systemwide hydraulics and capacity analysis of the tunnel diameter options was performed for three specific design flow capacity options of 4,500, 6,000 and 7,500 cfs. The recommended maximum tunnel flow velocity within the design flow range was 6 feet per second (fps) at each maximum design flow considered in the analysis as described in the Systemwide Hydraulic and Capacity Analysis for Tunnel Diameter Selection (Draft) TM, dated March 13, 2020.

Based on the maximum recommended tunnel flow velocity criteria of 6 fps, the following tunnel IDs were recommended at each design flow capacity option for the Project:

- 26-foot ID at the maximum design flow capacity of 3,000 cfs
- 31-foot ID at the maximum design flow capacity of 4,500 cfs
- 36-foot ID at the maximum design flow capacity of 6,000 cfs
- 40-foot ID at the maximum design flow capacity of 7,500 cfs

The main tunnel alignment entering the Pumping Plant site is as shown on the concept drawings.

2.2 Tunnel Launch Shaft

The tunnel launch shaft located within the Pumping Plant raised pad would initially serve as a tunnel launch shaft during construction for the southern section of the tunnel. This launch shaft would be repurposed as the tunnel's gravity flow/surge overflow structure into the Southern Forebay and would also serve as the point of connection to the inlet conduit connecting the main tunnel to the Pumping Plant wet well. Provisions would also be included to install temporary vertical submersible pumps and discharge for dewatered the main tunnel as the bottom of the shaft would be the established low point of the tunnel.

Sacramento River diversion flows from the intakes would flow through the shaft and into either the gravity flow outlet control structure and into the Southern Forebay, or into the Pumping Plant wet well. When Sacramento River levels are high enough and the water level in the Southern Forebay is low enough, gravity flow through the main tunnel between the intakes and the Southern Forebay is achievable. If steady-state gravity flow capacities could be established at or above the desired Sacramento River diversion rate, the Pumping Plant could be bypassed, and the gravity flow is regulated into the Southern Forebay by the gravity flow control structure. When gravity flow conditions are not possible or when the maximum achievable gravity flows are less than the selected Sacramento River diversion rate, water would flow vertically through the shaft and into the inlet wet well conduit, which conveys water to the Pumping Plant wet well. The gravity flow outlet control structure also would incorporate fixed weir-type openings that would automatically permit overflow into the Southern Forebay in the event of a system hydraulic transient-surge condition.

The bottom of the shaft would be located at elevation -220.00 feet. The shaft would be concrete-lined and have an interior diameter of 115 feet, as shown on the concept drawings.

2.3 Gravity Flow Outlet Structure

The gravity flow outlet structure would be located on top of the vertical shaft and extends south for approximately 1,520 feet to a concrete outlet pad for energy dissipation as water discharges under gravity and surge flow conditions into the Southern Forebay. The gravity flow outlet structure diverts and regulates water directly into the Southern Forebay using control gates that would be 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 would be closed, water would be automatically diverted to the Pumping Plant wet well and the main pumps would be operated.

The Pumping Plant gravity flow control structure would also have emergency overflow weir type openings into the Southern Forebay to protect Pumping Plant facilities, the tunnel system, and the area surrounding the pumping during a hydraulic transient-surge condition within the main tunnel due to an electrical power failure at the Pumping Plant 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 would automatically permit water to flow into the Southern Forebay and maintain the internal operating pressures in the tunnel to within intended design limits. The sizes and elevations of the emergency overflow weirs would be further developed by hydraulic transient-surge analysis. Suitable storage capacity within the Southern Forebay would be included to accommodate incoming flows associated with transient-surge events.

A bulkhead panel storage rack assembly would be located on the top of the gravity flow outlet structure. The bulkhead panels would be used to isolate the Pumping Plant wet well from the main tunnel and the SF. Two sets of bulkhead panels have been included and when installed provide double isolation for life-safety. An overhead rail mounted gantry crane would be located above the concrete decking of the outlet structure. The rail system runs the entire length of the outlet structure in the north-south direction to allow full travel of the gantry crane for transport of materials such as the bulkhead panels, installing dewatering pumps and piping and for use in lowering and raising materials, personnel, and equipment in the vertical shaft when needed. The decking would be sized to provide an additional equipment laydown area around the shaft. A removable panel would be centered over the shaft for the installation of temporary submersible vertical turbine pumps for tunnel dewatering and to permit inspection and maintenance access to the shaft and tunnel. Additionally, removable panels would be located towards the outlet end of the structure to allow routing of the dewatering pump discharge piping into the Southern Forebay.

The invert elevation of the outlet structure is -5.0 feet and the top elevation of the concrete decking would be located at 29.5 feet. The interior width of the outlet is 142-feet and the top concrete deck would be 210-feet wide as shown on the concept drawings.

2.4 Inlet Wet Well Conduit

The inlet wet well conduit conveys water from the vertical shaft to the Pumping Plant wet well during times when gravity flow into the Southern Forebay would not be achievable and pumping would be needed to lift the water from the tunnel into the Southern Forebay. The inlet wet well conduit would be approximately 160-feet long, 60-feet wide, and 77-feet deep. The conduit has an invert elevation of -77.0 feet, as shown in the concept drawings.

A primary and a secondary redundant set of isolation bulkhead openings would be provided in the inlet wet well conduit immediately downstream of the vertical shaft to restrict water flowing through the conduit and entering the Pumping Plant wet well during times of inspection or maintenance within the conduit or wet well. As noted above, the bulkhead panels would be stored on the decking of the gravity flow outlet structure.

2.5 Pumping Plant

The Pumping Plant houses the vertical turbine pump assemblies and consists of a building, rectangular concrete wet well, pump motor level floor at grade, flow meter access gallery, concrete discharge pipe encasement and pump discharge energy dissipation structure (within the Southern Forebay) as shown on the concept drawings. Table 2-1 provides the Pumping Plant building footprint dimensions and corresponding number of main pumps required based on the flow project design flow capacity options.

Table 2-1. Pumping Plant Building Footprint Dimensions by Flow Condition

Flow Rate (cfs)	Width (feet)	Length (feet)	Total No. of Pumps
3,000	99	345	9
4,500	99	345	9
6,000	99	378	10
7,500	99	413	11

The Pumping Plant finished pump floor would be located at elevation 29.5 feet. In addition to personnel access doors, two vertical lift access doors would be provided at the east and west ends of the Pumping Plant building enclosure to allow tractor trailer vehicle access to the interior of the building for material and equipment transport. The vehicles would drive through the building entering one end and exiting through the other end. An overhead bridge crane would be located within the building with travel capabilities throughout the entire building interior for lifting and placing materials and equipment. An adjoining electrical building would be located along the north wall of the Pumping Plant above grade structure.

Ultrasonic flow meters would be installed on each pump discharge piping system. Access hatches would be provided from the motor level floor to the flow meter gallery for periodic inspection, calibration, maintenance, and replacement.

The pump discharge piping would be encased in concrete immediately adjacent to the Pumping Plant building prior to the point of water discharge into the energy dissipator structure within the Southern Forebay.

The main raw water pumps (pumps) would be vertical column type and would be suspended over the below grade wet well from the floor of the above grade Pumping Plant structure. The Pumping Plant wet well would be configured for parallel operation of the pumps. The wet well features would include either individual formed suction intakes (FSI) or open top vertical intake cans for each pump and either would provide suitable pump suction hydraulics throughout the required flow and head operation range of each pump. The wet well minimum operating depth was established to provide sufficient submergence over each pump intake at its minimum water surface elevation at each pump’s maximum design flow capacity. The traveling bridge crane in the Pumping Plant’s above grade structure would be used to hoist the pumps during installation and removal.

2.6 Pumped Flow Energy Dissipation and Gravity Flow Outlet Structures

The energy dissipation structure for pump discharge would consist of a cast in place concrete submerged trench structure with a weir wall. The height of the weir wall would maintain a minimum free-water surface to maintain the internal operating pressure within each pump’s siphon discharge to within acceptable limits. The bottom of the energy dissipation structure was set at an elevation of – 20.0 feet with the top of the weir wall set at an elevation of 10.0 feet. This structure would surround the row of pump discharge piping outlets as shown on the concept drawings.

A concrete discharge pad would be located downstream of the gravity flow outlet structure and prevents scour within the Southern Forebay as shown on the concept drawings. The pad would be set to an elevation of – 5.0 feet along the outer wall of the gravity flow structure. From an elevation of -5.0 feet, the outlet discharge pad slopes upward to elevation 0.0 feet at the point of transition from the concrete outlet pad to the earthen bottom of the Southern Forebay.

Retaining walls are provided on either side of the Pumping Plant discharge and gravity flow out dissipation structures to account for the elevation differences between Southern Forebay embankment and the outlet pad elevations.

2.7 Electrical Building

The electrical building would be located immediately adjacent to the Pumping Plant building and with a finished floor elevation of 29.5 feet. The electrical building would house the Pumping Plant switchgear and variable frequency drives for the main raw water pumps in the Pumping Plant and tunnel dewatering pumps (installed within the tunnel shaft when required). Additionally, a control room will be located within this building for operation of the Pumping Plant facilities.

2.8 HVAC Mechanical Equipment Yard

A heating, ventilation, and air conditioning (HVAC) equipment yard would be provided adjacent to the electrical building for the purpose of providing the HVAC service for the electrical building. There would be up to four pad-mounted, direct expansion (DX) air handler units (AHUs) installed within this HVAC mechanical equipment yard. The sizes of the DX AHUs would vary based on the final selected water conveyance system flow capacity and corresponding electrical gear and pump sizes. Currently, all main pumps are assumed to operate with air cooled variable frequency drives (VFDs).

The AHUs would be placed on a concrete equipment pad. A wall would be constructed around three sides of the HVAC mechanical equipment yard for visual screening and noise abatement. Adequate space would be provided around the around and within the screening wall and the HVAC equipment yard to allow for periodic access to perform maintenance on the AHUs.

The finished grade elevation of the equipment yard would be approximately 28.5 feet.

2.9 Electrical Interconnect Site

As shown in the concept drawings, an electrical interconnection would be provided near the high voltage overhead power transmission system located west of the Pumping Plant elevated pad. Two electrical feeder lines would be routed from the electrical interconnect site to the electrical substation located within the elevated Pumping Plant site pad.

2.10 Electrical Substation

The two high voltage electrical feeders from the electrical interconnect site would terminate at an electrical substation constructed to provide electrical service to the facilities associated with the Pumping Plant. Initially, the substation would supply power for the construction of the tunnel and the Pumping Plant infrastructure. Following construction, the substation would be repurposed to supply power to the permanent Pumping Plant facilities.

The electrical substation would have an area of approximately 47,300 square feet and the finished grade elevation would be approximately 28.5 feet. Security fencing would be provided around the perimeter of the substation to restrict access.

2.11 Generator Building

A standby emergency generator (SEG) would be located within a building adjacent to the electrical substation to supply emergency power to life-safety systems. Fuel for the SEG would be provided immediately adjacent to the generator building.

SEG noise abatement would be provided within the building. The finished floor elevation for the building would approximately 28.5 feet as shown on the concept drawings.

2.12 Equipment Storage Building

An equipment storage and operations maintenance building would be in close proximity to the Pumping Plant and gravity outlet flow structure. The building would be equipped with large vertical opening doors capable of allowing large transport trucks to drive through for material / equipment drop off and pickup. The vehicle openings and drive aisles would be wide enough to accommodate two-way travel through the building.

Within the building, there would be offices, a welding shop and a machine shop to support the operations maintenance requirements. Both shops would be fully outfitted to perform a wide array of activities and permit multiple personnel to utilize the spaces simultaneously.

There would be two material storage bays provided located on either side of the vehicle drive aisle. There would be space accommodations for storage of the following:

- Two spare motors for main pumps (one higher capacity pump and one lower capacity pump)
- Two spare pump impellers (one higher capacity pump and one lower capacity pump)
- Pump accessories
- Two submersible vertical turbine pumps for tunnel dewatering
- Submersible pump column sections including connecting discharge piping
- One complete set of shaft sections for one higher capacity pump and one lower capacity pump
- Submersible pump cable reels for each submersible vertical turbine pump
- Lubricating oil storage

The building height would accommodate delivery and offloading of pump motors, pump column sections, and other long equipment and materials. The finished floor elevation for the building would be approximately 28.5 feet as shown on the concept drawings.

2.13 Reusable Tunnel Material Storage

A portion of the reusable tunnel material (RTM) extracted during construction of the tunnel and shaft excavations would be stockpiled north of the Pumping Plant's raised site pad as shown on the concept drawings. Excess and/or unsuitable RTM not used for construction of the Southern Forebay embankments would be permanently stabilized and remain in place. A space with approximate dimensions of 5,450-feet long and 1,865-feet wide would be allocated to be used for permanent storage of RTM.

3. Pumping Plant Site Plan Configuration

The Pumping Plant site layout was developed to provide adequate space for the facilities required for operating the Pumping Plant following construction of the tunnel and the other large facilities associated with the South Delta Complex, as shown on the concept drawings. The site was configured to locate structures near other structures that have functional dependencies to create a site with intentional distribution and circulation. The site layout accounts for setbacks required by codes with the goal of limiting the facility footprint permanent areas of impact. The following sections provide detailed information regarding the specific site elements.

3.1 Site Location

The Pumping Plant site would be located at the southern terminus of the tunnel along the northern embankment of the Southern Forebay at approximately the mid-point of the northern embankment. The site would be located approximately 10,400 linear feet northeast of Byron Highway and approximately 7,450 linear feet south of State Route 4.

3.2 Pad Characteristics

The raised site pad dimensions for the Pumping Plant would be approximately 1,115 feet in the east-west direction and 945 feet in the north-south direction. The pad would encompass a total area of 40.6 acres inclusive of the pad side slopes. The pad would be elevated above existing grade to establish a top of pad elevation 28.0 feet, which matches the top of embankment for the Southern Forebay, and would place the pad above emergency overflow levels within the Southern Forebay and the 200-year flood level with sea level rise, wave run up and required freeboard requirements. The Pumping Plant pad would be integrated with the Southern Forebay embankment. To provide adequate space for energy dissipation and elevation transition from either the Pumping Plant pump discharge pipes or the gravity flow outlet structure, the Pumping Plant finished grade would extend into the Southern Forebay approximately 290 feet. From the top of pad, the grade would slope at 4:1 run-to-rise to match existing grades along the exterior perimeter and to achieve pond bottom within the Southern Forebay.

3.3 Access

The Pumping Plant would be accessed from State Route 4 to the north and from Byron Highway to the southwest. There would be three points of access to the Pumping Plant pad: one from the west, one from the east, and one from the north. The pad site access from the west and east would utilize the roads located on the top of the Southern Forebay embankment. The pad access from the north would utilize a portion of the road network that would be constructed as part of the construction site access as shown on the concept drawings.

The permanent RTM storage area and tunnel maintenance working shaft (located approximately 5,500 feet to the northeast of the Pumping Plant) would be accessed using portions of the roads that would be constructed as part of the construction site access road network.

The site access roads would be two-lane roads with 12-foot travel lanes and 3-foot paved shoulders or 24-inch wide concrete curb and gutter. Generally, the 3-foot paved shoulders would be provided for the roads beyond the Pumping Plant pad and the concrete curb and gutter would be provided within the Pumping Plant top of pad area. Paved access would be provided to each of the Pumping Plant facilities.

Vehicles that drive through the Pumping Plant building and the equipment storage building would be permitted to travel across the concrete pads for the inlet wet well conduit and gravity flow outlet structure.

3.4 Perimeter Site Security Fencing

Perimeter site security fence would be provided around the Pumping Plant and tunnel maintenance working shaft. The perimeter security fence for the Pumping Plant would be located at the top of the pad and approximately 30-feet from the top of slope. The security fence would be provided along the top of the Southern Forebay embankment and ties to the retaining walls for the Pumping Plant concrete outlet discharge pad.

The three points of access to the Pumping Plant and one access to the tunnel maintenance working shaft would be restricted by controlled vehicle access gates. There would not be any additional vehicle or personnel access gates.

A buoy system would be provided within the Southern Forebay for watercraft warning by the Pumping Plant concrete outlet discharge pad.

3.5 Facility Layout

The tunnel vertical shaft, gravity flow outlet structure, inlet wet well conduit, and Pumping Plant would be located immediately adjacent to the Southern Forebay in close proximity for discharging into the forebay. The Pumping Plant wet well would be located approximately 165 feet west from the outer edge of the vertical shaft.

The electrical building would be located immediately adjacent to the north of the Pumping Plant with a shared wall. The electrical building would be centered along the Pumping Plant’s norther wall. The HVAC mechanical equipment yard for the electrical building would be setback from the electrical building by 25 feet to the north. This 25-foot setback would be provided to allow for equipment access and HVAC duct routing.

The electrical substation and generator building would be collocated in the northwestern quadrant of the Pumping Plant pad. The electrical substation would have a footprint of 182 feet by 260 feet available for electrical gear. The electrical substation would be located 350 feet from the northwest corner of the gravity flow outlet control structure and the overhead gantry crane.

The equipment storage building would be located directly north of the gravity flow outlet structure to allow vehicles to drive directly to-from the vertical shaft and to the Pumping Plant. Approximately 145 feet would separate the edge of the gravity flow outlet structure pad and the equipment storage building to provide a clear-zone between the overhead gantry crane and the building.

3.6 Vehicle Circulation

The roads would be configured to allow vehicles to circulate throughout the site and minimizing dead-ends. The three Pumping Plant pad points of access would be interconnected with the road network. Furthermore, the west access gate would be located to permit vehicles to drive in a straight line to the Pumping Plant, through the Pumping Plant, across the gravity flow outlet structure, and exit through the east gate if desired. Large radii would be provided for horizontal curves and at site access road intersections to accommodate large truck turning movements.

3.7 Pedestrian Circulation

Pedestrian travel routes are provided throughout the Pumping Plant pad to allow for movement amongst the various facilities and vehicle parking areas.

3.8 Parking

Passenger vehicle parking areas would be provided in several locations in close proximity to the various buildings. A total of 25 dedicated spaces would be provided based on the anticipated number of personnel and visitors. The passenger vehicle parking would be configured using perpendicular (90-degree) orientation. A long parallel parking area would be provided for maintenance vehicles to service the HVAC equipment located in the mechanical equipment yard north of the electrical building.

4. 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 and the DCA.

Approval Names and Roles			
Prepared by	**Internal Quality Control review by**	**Consistency review by**	**Approved for submission by**
Tony Naimey / EDM Pumping Plant Lead	Ted Davis / EDM QC Reviewer	G. 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.