Pumping and Pumping/Generating Equipment

Table B.3-8, Table B.3-9, and Table B.3-10 present a summary of the pumping and pumping/generating equipment to be provided for Alternatives A, B, and C respectively. Pumping and generating power varies between alternative due to reservoir elevation and flow differences. Alternative B requires less units than the other alternatives because the pumping requirement has been reduced by 2,000 cfs without the SRPGP.
Table B.3-11 presents a summary of the pumping and pumping/generating equipment to be provided for Alternative D.

Water from Holthouse Reservoir would be drawn into the plant by the various pumping and pumping/generating units. The number of units operating would be selected to approximately provide the pumping capacity needed to deliver all water stored in the reservoir on a daily basis during the off-peak pumping period. The pumps would be connected to a complex intake/outflow manifold. When water is drawn out of Holthouse Reservoir and pumped up to Sites Reservoir, the pumped water would flow through successive pipe connections until all eleven pipes coming from the pump units are combined into a single, 26-foot-diameter pipe. This pipe then would join the 26-foot-diameter pipe coming from the emergency bypass outlet, and the two pipes would connect to the 30-foot-diameter tunnel discussed earlier.

The pumping/generating plant would be a conventional, indoor-type plant with an in-line arrangement of vertical pumping and pumping/generating units. The SPGP would have a reinforced-concrete substructure and a steel superstructure with the draft tube invert at an elevation of 170 feet. The base of the service bay foundation at the dewatering sump would be at an elevation of 160 feet, and pumping unit bays would be founded at an elevation of 144 feet. The five primary floor levels in the substructure would be:

- Ground Level elevation 215.0 feet
- Electrical Gallery elevation 200.0 feet
- Mechanical elevation 200.0 feet
- Motor Floor elevation 178.0 feet
- Suction Elbow elevation 141.0 feet

Each bay would be a structurally independent monolith, separated from adjacent bays by expansion joints. These joints would be keyed together to prevent transverse and vertical differential movement between bays, while allowing unrestricted movement in the longitudinal direction. Shear keys between all bays would also help prevent differential movements during earthquakes.

Table B.3-8. Sites Pumping/Generating Equipment for Alternative A

Unit Type	Number of Units	Net Head (feet)	Pumping Capacity Per Unit (cfs)	Generating Capacity Per Unit (cfs)	Motor Power Total (MW)	Generating Power Per Unit (MW)	Total Plant Pumping Capacity (cfs)	Total Plant Generating Capacity (cfs)
Pump Francis Vane Dual-Speed	2 (+1 Standby)	290	870	No generation	51.8	No generation	5,926	5,100
		162	870	No generation	28.9	No generation		
Pump Francis Vane Dual-Speed	2	290	435	No generation	25.9	No generation		
		162	435	No generation	14.5	No generation		
Pump/Turbine Reversible Francis, Dual-Speed	4 (+1 Standby)	290/270	663	1,020	78.9	76.9		
		162/142	663	1,020	44.1	40.4		
Pump/Turbine Reversible Francis, Dual-Speed	2	290/270	332	510	19.8	19.2		
		162/142	332	510	11.0	10.1		
Totals	10 (+ 2 Standby)	—	—	—	176.4 (Max)	96.1 (Max)		

Motor power and generation based on 82.5% combined efficiency (unit and transformer), no power factor adjustment, higher efficiencies are likely.
Key:
cfs = cubic feet per second
MW = megawatt(s)

Table B.3-9. Sites Pumping/Generating Equipment for Alternative B

Unit Type	Number of Units	Net Head (feet)	Pumping Capacity Per Unit (cfs)	Generating Capacity Per Unit (cfs)	Motor Power Total (MW)	Generating Power Per Unit (MW)	Total Plant Pumping Capacity (cfs)	Total Plant Generating Capacity (cfs)
Pump Francis Vane Dual-Speed	2 (+1 Standby)	323	300	No generation	19.9	No generation	3,916	5,100
		195	300	No generation	12.0	No generation		
Pump/Turbine Reversible Francis, Dual-Speed	4 (+1 Standby)	323/310	663	1,020	87.9	88.3		
		195/182	663	1,020	53.1	51.8		
Pump/Turbine Reversible Francis, Dual-Speed	2	323/310	332	510	22.0	22.0		
		195/182	332	510	13.3	13.0		
Totals	8 (+ 2 Standby)	-	-	-	129.8 (Max)	110.3 (Max)		

Motor power and generation based on 82.5% combined efficiency (unit and transformer), no power factor adjustment, higher efficiencies are likely.
Key:
cfs = cubic feet per second
MW = megawatt(s)

Table B.3-10. Sites Pumping/Generating Equipment for Alternative C and Alternative D

Unit Type	Number of Units	Net Head (feet)	Pumping Capacity Per Unit (cfs)	Generating Capacity Per Unit (cfs)	Motor Power Total (MW)	Generating Power Total (MW)	Total Plant Pumping Capacity (cfs)	Total Plant Generating Capacity (cfs)
Pump Francis Vane Dual-Speed	2 (+1 Standby)	330	870	No Generation	58.9	No Generation		
		202	870	No Generation	36.0	No Generation		
Pump Francis Vane Dual-Speed	2	330	435	No Generation	29.5	No Generation		
		202	435	No Generation	18.0	No Generation		
Pump/Turbine Reversible Francis, Dual-Speed	4 (+1 Standby)	330/310	663	1,020	89.8	94.0	5,926	5,100
		202/182	663	1,020	55.0	57.5		
Pump/Turbine Reversible Francis, Dual-Speed	2	330/310	332	510	22.5	23.5		
		202/182	332	510	13.8	14.3		
Totals	10 + 2 Standby	-	-	-	200.7 (Max)	117.5 (Max)		

Motor power and generation based on 82.5% combined efficiency (unit and transformer), no power factor adjustment, higher efficiencies are likely.
Key:
cfs = cubic feet per second
MW = megawatt

Table B.3-11. Optional Sites Pumping/Generating Equipment for Alternative D

Type	No of Units	Net Head Range (Feet)	Pump Capacity Per Unit (cfs)	Generating Capacity Per Unit (cfs)	Motor Power Total (MW)	Generating Power Total (MW)	Total Plant Pumping Capacity (cfs)	Total Plant Generating Capacity (cfs)
Variable Speed Francis Pump/ Turbine	2	330	870	750	55.5	36.7	5,926	5,100
		202	870	750	33.9	22.4		
	4	330	663	570	84.7	55.7		
		202	663	570	51.9	34.0		
	2	330	435	375	27.8	18.3		
		202	435	375	17.0	11.2		
	2	330	332	285	21.2	13.9		
		202	332	285	13.0	8.5		
Totals	11				189.2 (Max)	124.6 (Max)		

Motor power and generation based on 87.5% combined efficiency (unit and transformer) for variable speed units, no power factor adjustment, higher efficiencies are likely.
Key:
cfs = cubic feet per second
MW = megawatt

The SPGP would be equipped with cranes to facilitate operation and maintenance of the plant. There would be a 100-ton capacity indoor bridge crane for assembly and maintenance of pumping/generating units and associated equipment. A 50-ton-capacity outdoor traveling gantry crane would be installed for assembly and maintenance of butterfly valves. In addition, a 10-ton capacity outdoor traveling gantry crane would be provided to aid in the installation and removal of inlet gates and trashracks.

Reverse Flow to Sacramento River

For all four NODOS/Sites Reservoir Project alternatives under consideration, water stored in the Sites Reservoir would be released back to the Sacramento River from the Holthouse Reservoir using the Delevan Pipeline. Because of the notable head difference between Holthouse Reservoir and the river, releases through the Delevan Pipeline can be made by gravity without the need for pumping.

The Delevan Pipeline is buried between Holthouse Reservoir and the Sacramento River, and is comprised of two 12-foot-diameter RCC pipes. With a return flow rate of 1,500 cfs, the flow velocity would be approximately 6.6 fps. For Alternatives A, C, and D, release flows would pass through turbine units in the SRPGP to generate hydroelectric power using the available excess head in the system. For Alternative B, there would be no pumping/generating plant at the river, and the excess head would be dissipated through energy dissipating valves in a valve structure at the river. A system for bypassing the reverse flows around the generating units is not included since it is assumed that both generating units would be available whenever reverse flows are occurring.

Holthouse Reservoir

Existing Funks Reservoir and Needed Expansion

Location

The existing Funks Reservoir is on Funks Creek approximately 7 miles northwest of Maxwell. This reservoir, constructed in 1975 by Reclamation, had an approximate active storage capacity of 2,250 AF, and covered a surface area of 232 acres, at an elevation of 205 feet. Funks Reservoir would remain, but be incorporated as part of an expanded reservoir, identified as Holthouse Reservoir, with an active storage capacity of approximately 6,500 AF. The larger storage is required to accommodate operation of the SPGP as a dispatchable pumped-storage facility for up to 6 hours a day during the on-peak period. Water collected in Holthouse from generation, and from inflows from the canals and Sacramento River, would be pumped to Sites Reservoir during off-peak and partial-peak periods as necessary.

The existing Funks Dam is an earthfill dam with a crest elevation of 214.0 feet. The reservoir was constructed on Funks Creek to serve as a regulating reservoir for the T-C Canal. Water enters the reservoir from the T-C Canal on the northern side, and is released to the downstream extension of the T-C Canal by gravity through an outlet control structure on the southern side. In accordance with information received from TCCA, the preferred operating water level range in the reservoir is between elevation 200.0 feet and elevation 205.0 feet. However, releases still could be made by gravity to the downstream canal at reservoir water levels down to an elevation of 198.0 feet.

Flood Flows

The current unregulated flood flows in Funks Creek must pass through existing Funks Reservoir in the winter. To accommodate seasonal flood flows, Funks Reservoir includes a gated, reinforced-concrete spillway with three 25-foot by 20-foot radial gates to pass these flows. The gate sill (bottom) is at an elevation of 186.0 feet. TCCA operates the spillway gates. The spillway discharge capacity is approximately 23,000 cfs with all gates fully open at the maximum design water surface, at an elevation of 206.5 feet (based on spillway rating curve on the design drawings).

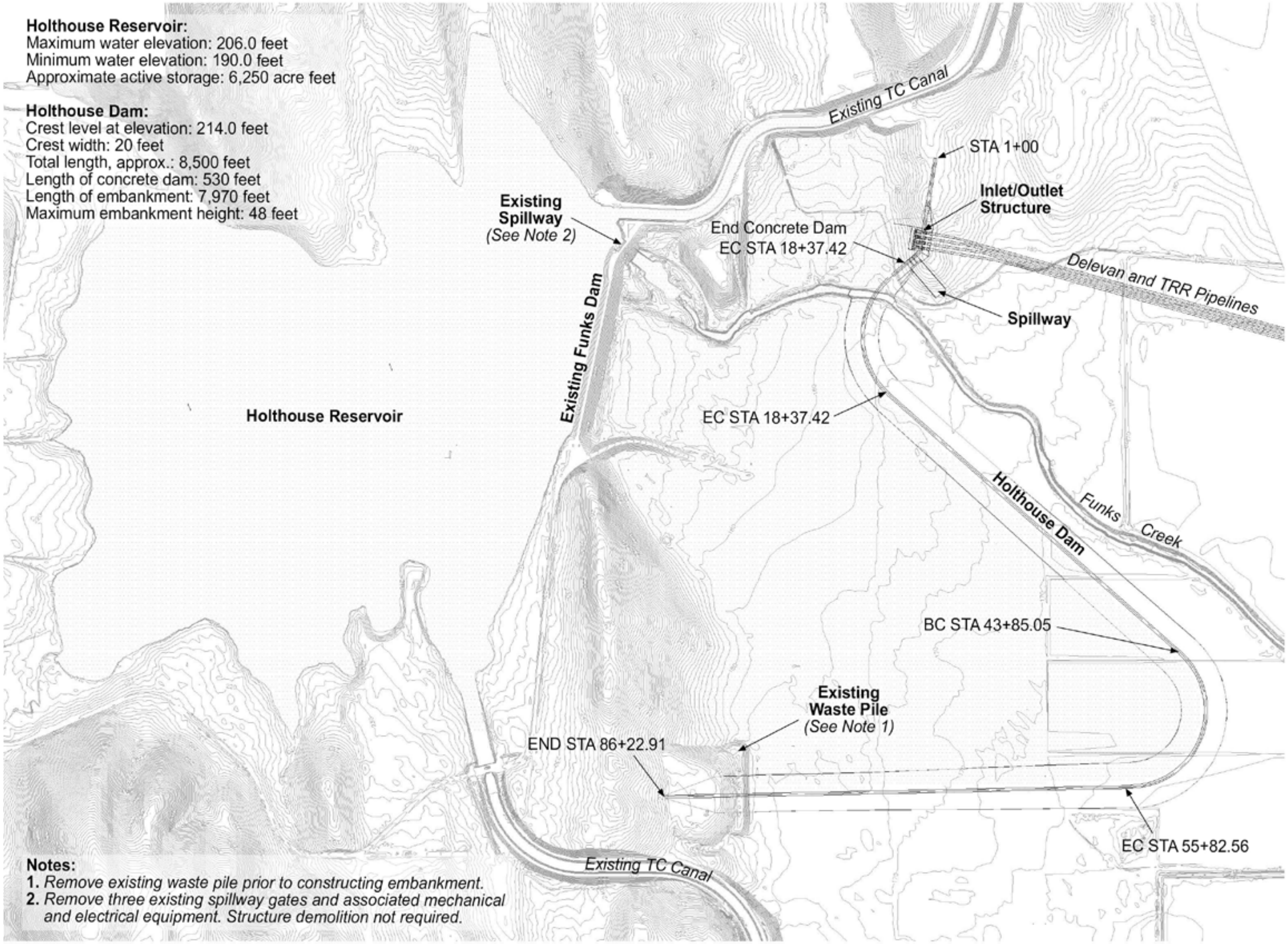
Sediment Accumulation

Because it is an onstream reservoir, a notable portion of the reservoir active storage has been lost to sediment accumulation from Funks Creek. Although topographic data are available for the reservoir from the original construction drawings, there are no current bathymetric data to support an estimate of the amount of sedimentation that has actually accumulated. However, it is believed that the current active capacity could be as low as 1,500 AF. This decreased capacity would mean that approximately 750 AF, or 1.2 million loose cubic yards of sediment have accumulated. A bathymetric survey of the existing reservoir should be performed as part of future design phases of the NODOS/Sites Reservoir Project to establish the volume and physical characteristics of the sediment so the material can be properly managed during design and construction.

A portion of the accumulated sediment may have to be removed and relocated to construct the low-level flow channel connecting the reservoir with the SPGP. A planned construction diversion system would be installed in the Sites Reservoir area to route Funks Creek winter flows south to the Sites Dam diversion tunnel so that Golden Gate Dam can be constructed. After Funks Creek is diverted to the south in the Sites Reservoir area, the sediment can be dewatered over a period of time by ditching and sumping. When dry enough to be excavated and moved, the material can be disposed of in the lower elevations of the new Holthouse Reservoir in a dead storage area, or in backwater areas around the perimeter of the existing reservoir. The construction schedule for the project should allow adequate time to dewater and remove the material without affecting the new dam construction (which is outside the limits of sediment accumulation)

Holthouse Reservoir (Figure B.3-32) is required for the NODOS project to facilitate balancing and regulating Sites Reservoir inflows and outflows through the SPGP, and to provide sufficient supplemental storage to allow simultaneous pump-back power generation on demand for up to 6 hours per day. During fall and winter months, inflows from the conveyance system and water for power generation would be stored during on-peak power periods. The stored water plus ongoing off-peak inflows from the conveyance systems would then be pumped to Sites Reservoir during the partial-peak/off-peak power period on a daily basis.

During the spring and summer months, when releases are being made from Sites Reservoir, released water would be receiving and distributing project flows. This section discusses the preliminary feasibility design of modifications for Holthouse Reservoir to provide increased storage capacity for operation of the conveyance system, and regulation of flows for the proposed SPGP.



PLAN - HOLTHOUSE RESERVOIR

Figure B.3-32. Holthouse Reservoir

Planned Operation

Holthouse Reservoir is the collection point for all water being diverted to Sites Reservoir. Water from the T-C Canal would enter Holthouse Reservoir directly by gravity. Water from the GCID Canal would collect in a new TRR. From the TRR, water would be pumped into Holthouse Reservoir through the new TRR pipeline. Water from the Sacramento River would also be pumped to Holthouse Reservoir through the new Delevan Pipeline. All water collected in Holthouse Reservoir is pumped into Sites Reservoir using the SPGP.

Reservoir Size Required

The current storage capacity of Funks Reservoir is estimated to be approximately 2,250 AF between elevation 190.0 and the normal maximum operating level in the T-C Canal (after sediment removal). Assuming the SPGP operates in a pumped-storage mode, the available active storage should be approximately 6,500 AF. The volume was estimated by AECOM, assuming storage of up to 6 hours of generation water at full SPGP generation flow (on-peak), plus storage of average spring or fall diversion flows to Holthouse Reservoir from the canals and Sacramento River. Diversion flows were estimated from available California Statewide Integrated System Model (CALSIM) modeling. The collected volume of water would then be pumped back into Sites Reservoir during off-peak and partial-peak periods as necessary. This would be a daily cycle. Additional operational studies should be performed in future phases of the NODOS/Sites Reservoir Project to confirm optimal reservoir size for pumped-storage operation.

To provide the required storage for pumped-storage operation, Holthouse Reservoir would be constructed. A new dam would be constructed downstream of the existing Funks Dam to extend the reservoir limits to provide the required 6,500 AF capacity in the anticipated operating water level for pumped-storage operation. Holthouse dam would have the same crest elevation as the existing Funks Dam (crest at elevation 214.0 feet). Holthouse Dam would be constructed as a zoned earthen embankment for most of its required length. However, a concrete gravity section would be provided in a rock cut on the left abutment, to accommodate the inlet/outlet structure for the TRR and Delevan Pipelines and a flood control spillway.

Embankment Dam

Except for the left abutment, Holthouse Dam would be a zoned embankment similar to Funks Dam, with a maximum height of approximately 48 feet. Figure B.3-33 provides typical embankment cross sections. The dam would be approximately 8,500 feet long. Because a deep soil layer could potentially exist along the dam alignment, the central core zone would extend down to suitable foundation in dense soils. To control seepage under the core section, a slurry cutoff wall would be constructed down through the dense, non-liquefiable soils to refusal in weathered rock. A grout curtain line would then be installed adjacent to the cutoff wall on both sides to fresh rock to treat remaining weathered rock below the refusal level for the cutoff wall.

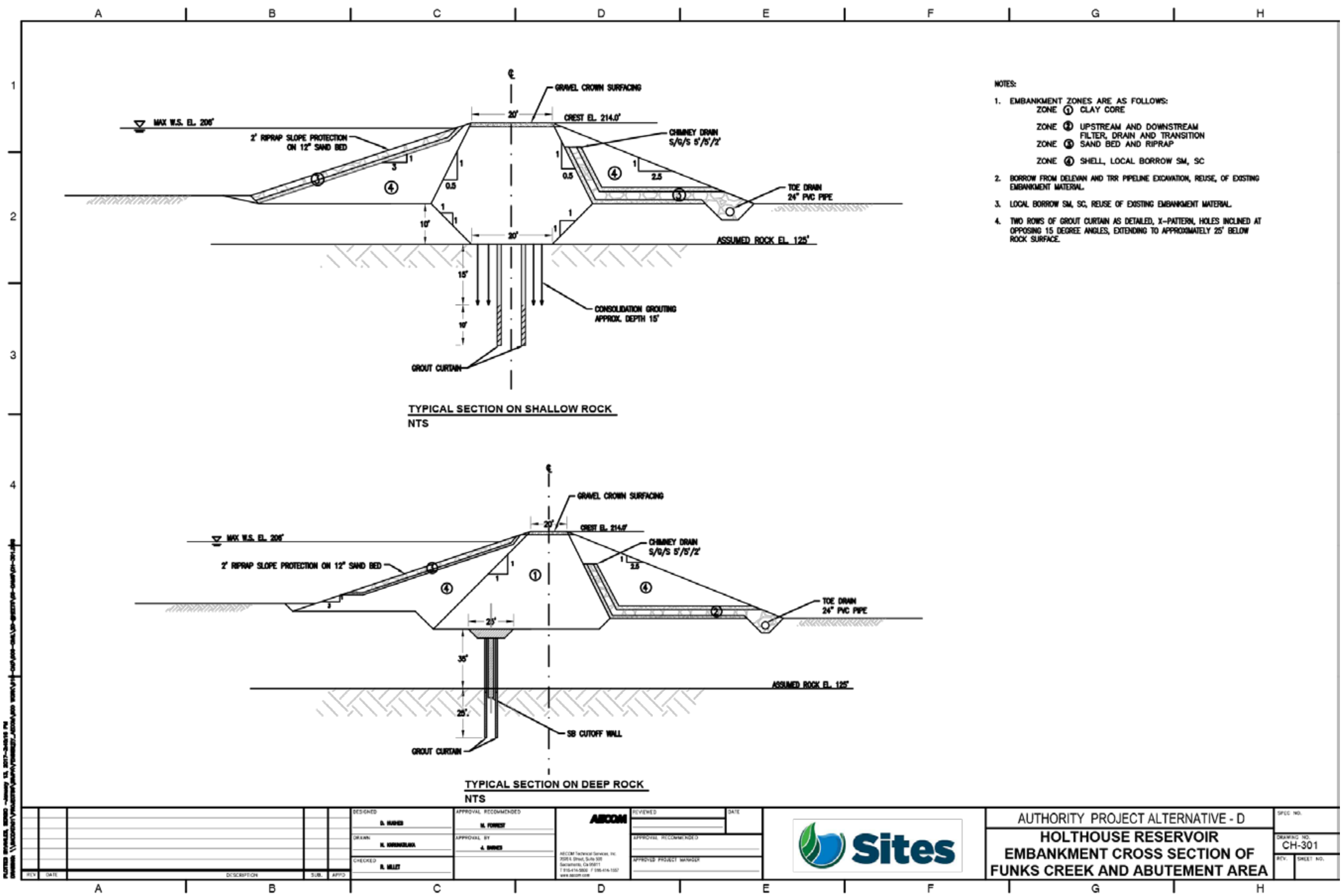


Figure B.3-33. Holthouse Reservoir Cross Sections

Concrete Gravity Dam

On the left abutment, a concrete gravity dam section would be provided that would incorporate the inlet/outlet facilities for the four 12-foot-diameter pipes that comprise the Delevan and TRR Pipelines (two pipes each), and the emergency spillway for Holthouse Reservoir. Figure B.3-34 and Figure B.3-35 provide typical dam and inlet/outlet details. The gravity structure has been located on the abutment to position it far enough into the hillside to reduce the risk of encountering unsuitable foundation conditions for the concrete structure. Foundation conditions should be further investigated in future phases of the NODOS/Sites Reservoir Project.

Pipeline Inlet/Outlet

The inlet/outlet facility for the Delevan and TRR Pipelines (Figure B.3-34 and Figure B.3-35) would incorporate formed concrete transitions for hydraulic efficiency, roller gates to shut off flow in each pipe for dewatering, stop log guides upstream of the roller gates, and a bar rack structure to prevent entry of large debris. The transition entrance for each pipe is sized to limit inlet and outlet flows to approximately 2 fps.

Spillway

The spillway in the gravity structure would be similar to the existing Funks Dam spillway, and would incorporate three radial gates with a total bypass capacity of approximately 20,000 cfs. This capacity is dictated by the emergency drawdown requirement for Sites Reservoir, which would pass through the SPGP and into Holthouse Reservoir.

WAPA Transmission Line Relocation

Currently, a tower-supported WAPA transmission line passes through the planned Holthouse Reservoir area. Based on preliminary contacts with WAPA, the current preferred relocation alternative is to move a segment of the line to the west, and cross at a narrow spot in the existing Funks Reservoir. The span is approximately 1,000 feet.

SPGP Canal

An excavated canal is required to connect the Holthouse Reservoir with the SPGP inlet/outlet. Figure B.3-18 shows the location of the canal. The channel width and bottom elevation would be set to limit the flow velocity to 2 fps or less, for a pumping capacity of 5,900 cfs, and a minimum water level in the reservoir at an elevation of 190.0 feet. A similar velocity would also occur under the emergency reservoir release condition with the water in the reservoir at elevation 206.5 feet. Because of the relatively low velocity under normal and emergency conditions, no canal lining is assumed to be required because of excavation into rock, but stability of the excavation considering seepage and erosion requires further investigation and evaluation in future phases of NODOS/Sites Reservoir Project design.

The channel would be excavated in soil and rock. The channel length is approximately 6,200 feet, and the excavated volume is approximately 3.6 million cubic yards. Some of the material may be suitable for the Holthouse Dam and Golden Gate Dam construction, and the remainder would require disposal. Suitability of the excavated material requires further investigation and evaluation in future phases of NODOS/Sites Reservoir Project design.

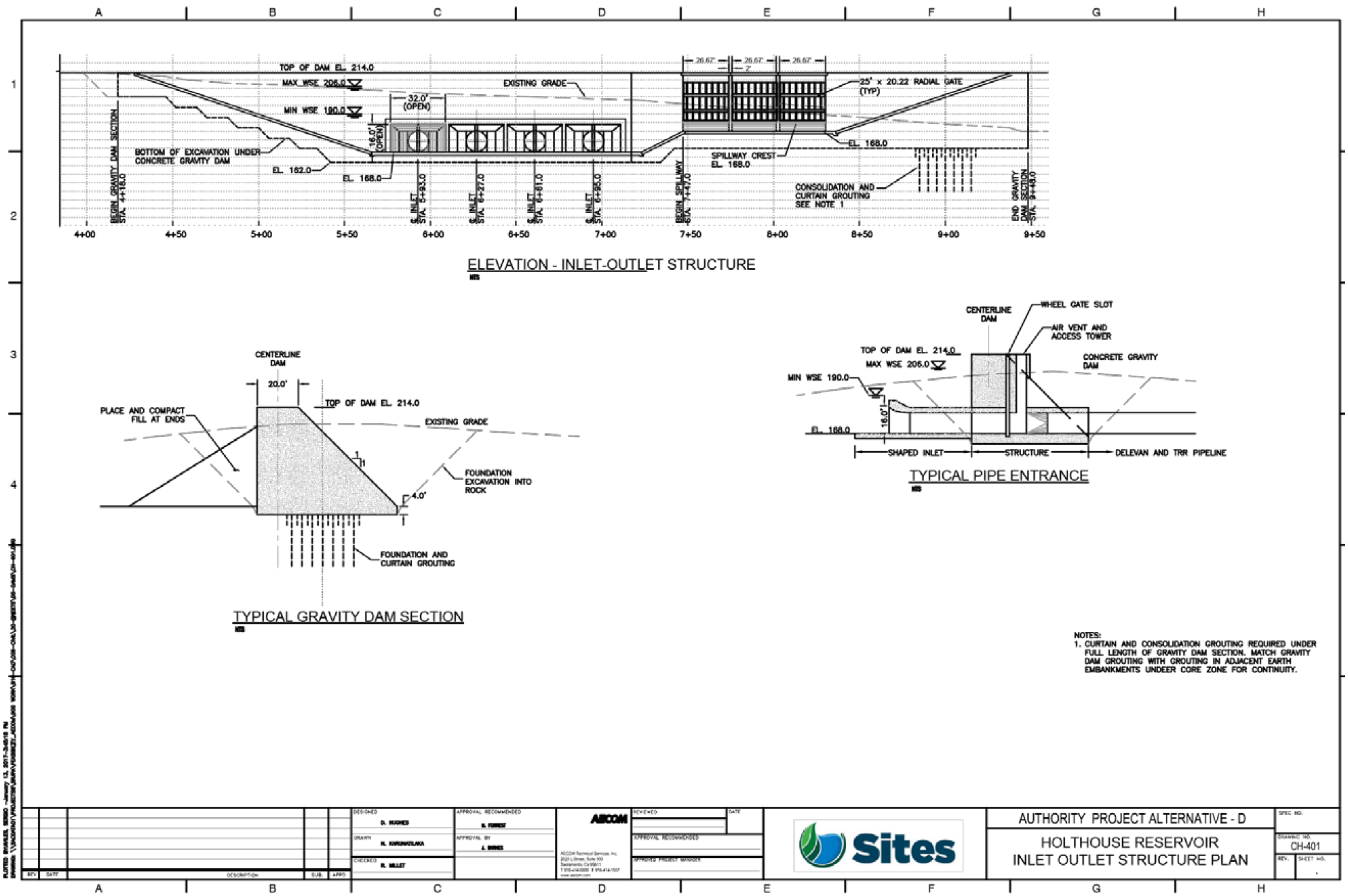


Figure B.3-34. Holthouse Reservoir Concrete Dam

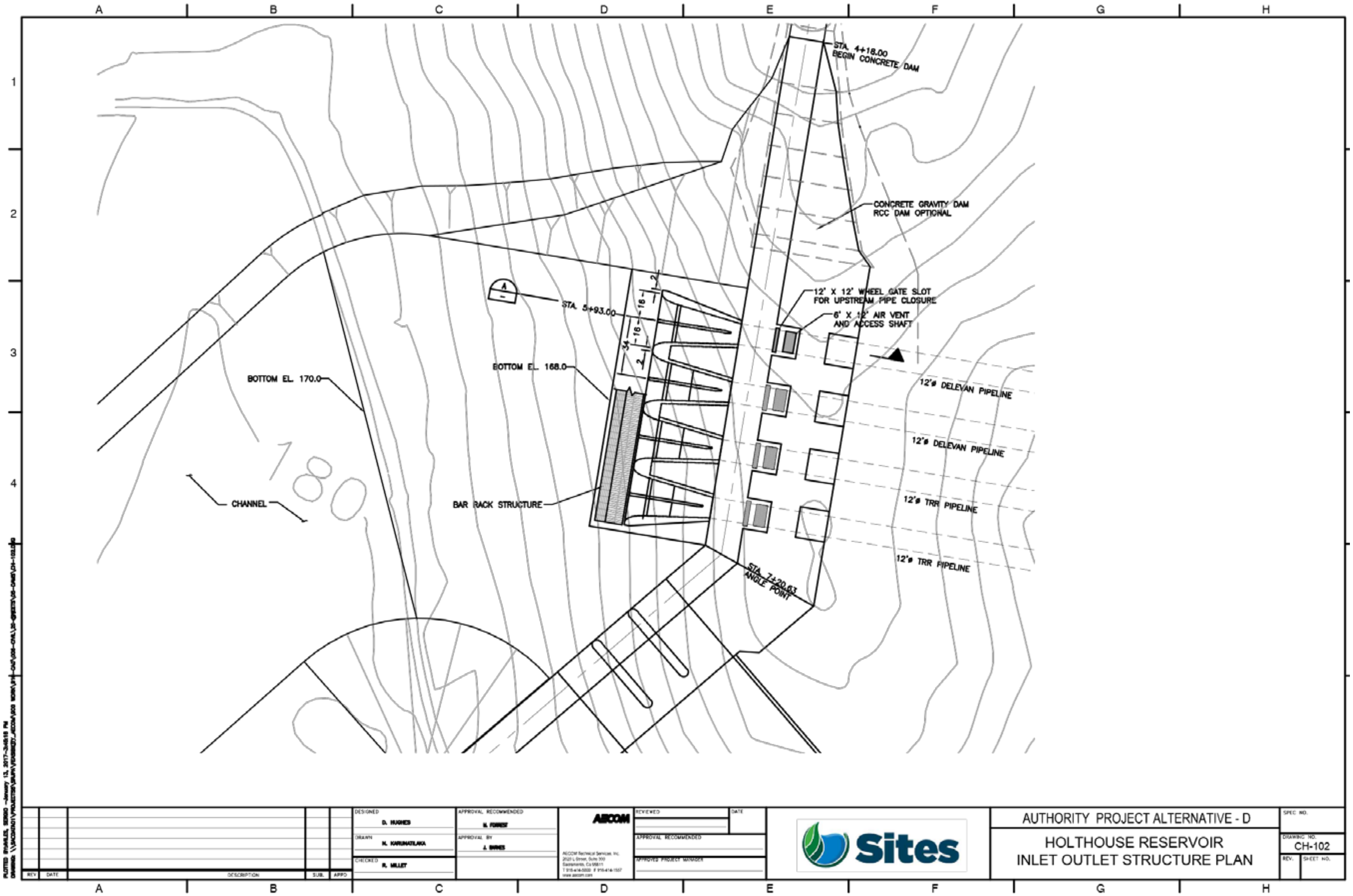


Figure B.3-35. Holthouse Reservoir Inlet/Outlet

Existing T-C Canal Connections

With the proposed configuration for Holthouse Dam, the T-C Canal can continue to discharge into the reservoir at its current location on the northern side.

T-C Canal Construction Bypass

Installation of a 12-foot-diameter bypass siphon pipeline approximately 2,600 feet long is required to divert T-C Canal flow through the Holthouse Reservoir area during construction. The bypass pipeline would be designed for a flow of approximately 1,000 cfs, which is the estimated summer canal demand downstream of Holthouse Reservoir. Winter demands range from 50 cfs to 200 cfs. Figure B.3-36 illustrates typical details for a proposed bypass.

The siphon pipeline would be maintained after construction as a permanent feature of the NODOS/Sites Reservoir Project. This siphon connection between the northern and southern sides of Holthouse Reservoir provides the operational flexibility to pass water to the canal segment downstream of the reservoir without pumping when the reservoir is drawn down, and gravity flow to the canal is not possible. Such drawdown could occur daily at times during the summer, depending on hydroelectric power generation operations at SPGP or during maintenance inspections.

The bypass would consist of installing two cofferdams on the upstream portions of the T-C Canal to isolate the area of embankment cut and pipe installation. The reservoir would be dewatered, and the existing check structure would be dismantled and reconstructed approximately 3,000 feet upstream. The check structure consists of two 18-foot by 15.5-foot gates, electrical control; hoists; and concrete supports and reinforcement. The facility would be relocated slightly downstream of the bypass. The bypass would need to be gated or valve-controlled to regulate releases downstream, as required by the TCCA.

Modification of T-C Canal at Holthouse Reservoir

Evaluation of T-C Canal capacity alternatives resulted in the recommendation that the T-C Canal remain at its current capacity of 2,100 cfs. Because this is the current capacity, no modifications are required or recommended to the T-C Canal from the inlet on the Sacramento River to the NODOS/Sites Reservoir Project.

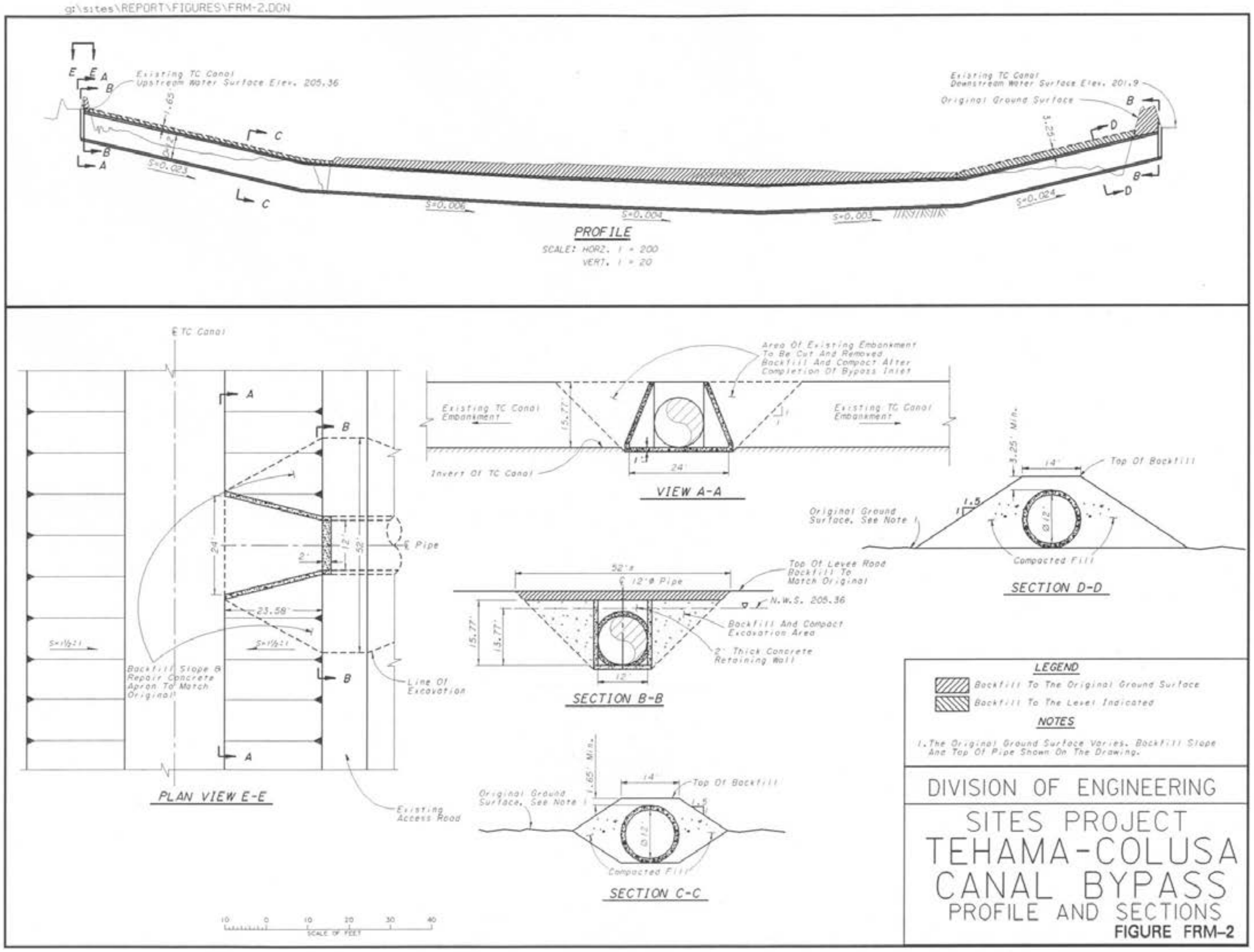


Figure B.3-36. Tehama-Colusa Canal Bypass – Profile and Sections

Terminal Regulating Reservoir and TRR Pumping/Generating Plant

Water conveyed down the GCID Canal would be conveyed into a future TRR. A new pump station, the TRR Pumping/Generating Plant, would then convey the water from the TRR to Holthouse Reservoir via the new TRR Pipeline when water is being diverted from the canal for ultimate delivery to Sites Reservoir. Water can also be released back to the TRR from Holthouse Reservoir via the TRR Pipeline to meet irrigation needs in the GCID Canal. The returning water can be used to generate hydroelectric power using two turbine generating units in the TRR Pumping/Generating Plant. The TRR would provide routine operational storage for the pumping/generating plant, and an afterbay for the turbine generating units. It would also provide regulatory storage to balance out normal and emergency flow variations in the 40 miles of GCID Canal between the headworks pump station on the Sacramento River and TRR. A pipeline would also be provided for the TRR to Funks Creek to facilitate reservoir drainage.

Terminal Regulating Reservoir Alternatives

The TRR would be constructed on the valley floor close to the GCID Canal by excavating below grade, and constructing a low perimeter embankment around the excavated area. The general location and arrangement of the TRR would be selected to facilitate gravity flow to and from the GCID Canal.

Alternatives A, B, and C

Under Alternatives A, B, and C, the TRR would have a maximum storage capacity of 2,000 AF and a footprint covering approximately 200 acres. The bottom dimensions would be roughly 2,900 feet by 2,900 feet. The pond location or embankment alignment would be adjusted locally to avoid impacting several existing structures in the pond vicinity. The depth would be approximately 15 feet, comprised of 2 feet of dead storage, 5 feet of operational storage, 5 feet for emergency storage, and 3 feet of freeboard. The embankment height above existing grade would vary around the pond perimeter approximately 6 feet.

Alternative D

To evaluate if the 2,000 AF pond size could be reduced to address local concerns about the size of the facility, the original sizing approach was reviewed and discussed with GCID. GCID indicated that approximately 200 to 300 AF of storage would be required for flow regulation, compared with the 1,000 AF assumed in the previous studies. GCID also indicated that leaks and other issues that disrupted canal flows in the past have historically been addressed in 6 to 8 hours without long-term outages. Based on this information, it is assumed that the TRR storage could be reduced to approximately 1,200 AF. This would provide for operational storage, and for up to approximately 8 hours of pumping at TRR Pump Station to Holthouse Reservoir in the event of a flow interruption in the canal. Under this assumption, pumping would be curtailed in the event of a canal outage lasting more than approximately 8 hours.

Terminal Regulating Reservoir Design

The pond should be non-jurisdictional with respect to Division of Safety of Dams, but this should be verified in future phases of NODOS/Sites Reservoir Project design. The TRR normal operational storage capacity would be based on the need to provide normal transient operating storage for the TRR Pump Station. The emergency storage would permit continued TRR Pump Station operation for up to 8 hours without inflow from GCID Canal. Major appurtenance features would include a GCID Canal transition bay, a connecting channel from the GCID Canal to the TRR, and a flow control inlet structure.

The TRR Complex would be comprised of four hydraulic structural systems. These systems include a GCID Canal energy dissipation bay with check structure, a reservoir inlet channel and control structure, a reservoir, and pump station. The GCID canal energy dissipation bay with check structure would function to reduce the flow into a stable pool, just before the turnout to the TRR connecting channel. The TRR inlet channel and control structure connects the GCID canal to the TRR, and controls flows into the reservoir. The reservoir would function to provide operational and emergency storage, as well as a forebay for the TRR Pump Station. In this latter capacity, it would provide operational storage to smooth out the normal transient mismatches in flow rates between the inflow rate of the existing GCID, and the outflow rate of the TRR Pump Station. The final size of the TRR would be determined by the requirements of the dead, normal operational, and emergency storages.

TRR Pumping/Generating Plant

The structural building for the TRR Pumping/Generating Plant would be similar to that described for the Sacramento River Pumping/Generating Plant. The basic TRR Pumping/Generating Plant elevations at the plant inlet are listed below:

- Maximum water elevation 123.00 feet
- Minimum water elevation 104.00 feet
- Intake elevation 94.00 feet
- Pump station finished floor elevation 130.00 feet

- The number of pump and turbine generating units is listed below:
- Three large pumping units, each rated at 620 cfs (two operational and one standby), with 7.5-foot-diameter inlet valves.
- Two small pumping units each rated at 325 cfs, with 5-foot-diameter inlet valves
- One turbine generating unit rated at 800 cfs, with 8.5-foot-diameter inlet valves
- One 32-foot-diameter spherical air chamber on each pump station discharge line to reduce the surge pressures in the pipeline.

Access to the construction site would be from Interstate 5, and approximately 2.5 miles west on Delevan Road; then approximately 0.5 mile south on McDermott Road. All temporary construction utilities would be provided by the contractor.

Power Supply

Power would be generated during operation of the NODOS/Sites Reservoir Project. A comprehensive power study is being performed to assess power supply versus demand, and to assess the costs for connecting the new site facilities to existing power circuits. Completion of the ongoing operational study would also be essential in determining power needs.

Excavation

Excavation would be conducted using temporary slopes of 1.5H:1V for the 25-foot-deep trench along the proposed pipelines, and a temporary slope of 2H:1V for the 40-foot-deep foundation of the pumping/generating plant. The foundations would be excavated in in-situ materials, and no major improvements to the foundations are anticipated. The proposed cut slopes are based on drill hole information and on-site inspection conducted by DWR geologists. Preliminary stability analysis has been performed for this study. During construction, the topsoil material would be excavated, stockpiled separately, and replaced so that native grasses and plants grow.

Groundwater was encountered in most of the auger holes (based on drill-hole logs provided by DWR), and dewatering would be required during construction.

Staging areas for the NODOS/Sites Reservoir Project would be at each pump station site and at designated locations along the pipeline alignment. Excess suitable material from conveyance excavation can be hauled to either of the proposed dam sites, west of Holthouse Reservoir. Excavation depths for the project would range between 25 and 40 feet.

Refilling Pump Units

The pump discharge lines and TRR Pipeline may need to be dewatered periodically for inspection and maintenance. These lines need to be filled at a slow rate to allow the release of air through air and vacuum valves. Primary means for refilling would be from Holthouse Reservoir at the upstream end of the pump discharge lines at a slow rate. It may also be possible to fill the pump discharge piping near the plant using small refilling pumps at the pump station. This will be further investigation and evaluation in future phases of NODOS/Sites Reservoir Project.

Operation

Monitoring and Control

As noted above, GCID indicates that upgrades are being made to their SCADA system prior to the proposed NODOS/Sites Reservoir Project implementation, and that the scope and functionality of the new SCADA systems for the proposed project must be coordinated with GCID’s system.

Extensive remote monitoring and combinations of local and remote controls would be required to operate the modified GCID Canal using an integrated SCADA system. The SCADA system would need to provide information on operating parameters such as Main Pump Station flows, canal water levels, check structure gate positions, major lateral turnout flows, canal spills, and TRR inflows and water levels. Communication and coordination between the GCID system and other components of the Sites Reservoir supply system, such as the TRR Pump Station, would require integration of the local GCID SCADA with the regional NODOS project SCADA system.

Canal Capacity Allocation

The canal would have a total capacity of 1,800 cfs. The total conveyance capacity would have to be used to meet both GCID’s internal water supply needs and the NODOS project conveyance requirements. Therefore, the balance of available capacity between these two uses would vary by month based on factors such as weather, irrigation demands in GCID, Sacramento River flows, and overall NODOS project system operating conditions. Figure B.3-37 shows the approximate monthly conveyance capacity allocation for the 1,800 cfs GCID Canal, based on average monthly GCID service area demands.

Delevan and Terminal Regulating Reservoir Pipelines

Two new pipelines would be constructed to convey water between NODOS/Sites Reservoir Project facilities. The approximately 13.5-mile-long Delevan Pipeline would convey water from the Sacramento River to Holthouse Reservoir to fill Sites Reservoir; and would also convey water from Holthouse Reservoir to the Sacramento River for releases. The 3.5-mile-long TRR Pipeline would convey water from the TRR to Holthouse Reservoir. Figure B.3-38 and Figure B.3-39 show plan and profile and typical trench details for the pipelines. Located to the west of the TRR, the TRR Pipeline would parallel the Delevan Pipeline and would share a common trench and outlet structure into Holthouse Reservoir. The Delevan and TRR Pipelines, as described in this section, would be the same for all four project alternatives.

Both pipelines would be bi-directional, allowing water to be pumped from the Sacramento River (Delevan Pipeline) or the TRR (Pipeline) to Holthouse Reservoir for storage, and allowing water to flow by gravity from Holthouse Reservoir for release to the Sacramento River or the TRR/GCID Canal. As water released from Holthouse Reservoir flows through the pump stations at the end of the pipelines, it would pass through turbines to generate electricity.

The Delevan Pipeline would begin at the SRPGP near the Sacramento River. The pipeline would be aligned due west until reaching the GCID Canal. At the GCID Canal, the Delevan Pipeline would turn southwesterly, and would parallel the TRR Pipeline in a shared trench until it reaches the Holthouse Reservoir. The pipeline would consist of two 12-foot-diameter reinforced concrete steel cylinder pipes. During pumping, the Delevan Pipeline would convey 2,000 cfs from the SRPGP to Holthouse Reservoir. During release periods, the pipeline would convey 1,500 cfs of water by gravity from Holthouse Reservoir back to the Sacramento River. The pipeline would be buried a minimum depth of 10 feet (to top of pipe) below the ground surface.

The TRR Pipeline would convey 1,800 cfs from the TRR PGP to Holthouse Reservoir. The capacity of the pipeline to convey water from Holthouse Reservoir to the TRR by gravity would be 1,500 cfs, but only 800 cfs to 900 cfs would be utilized to meet GCID Canal and other water supply demands from the TRR Reservoir. The pipeline would consist of two 12-foot-diameter reinforced-concrete steel cylinder pipes. The pipeline would be buried a minimum depth of 10 feet (to top of pipe) below the ground surface. As mentioned above, the TRR and Delevan pipelines will be collocated in a common trench between TRR and Holthouse Reservoir.

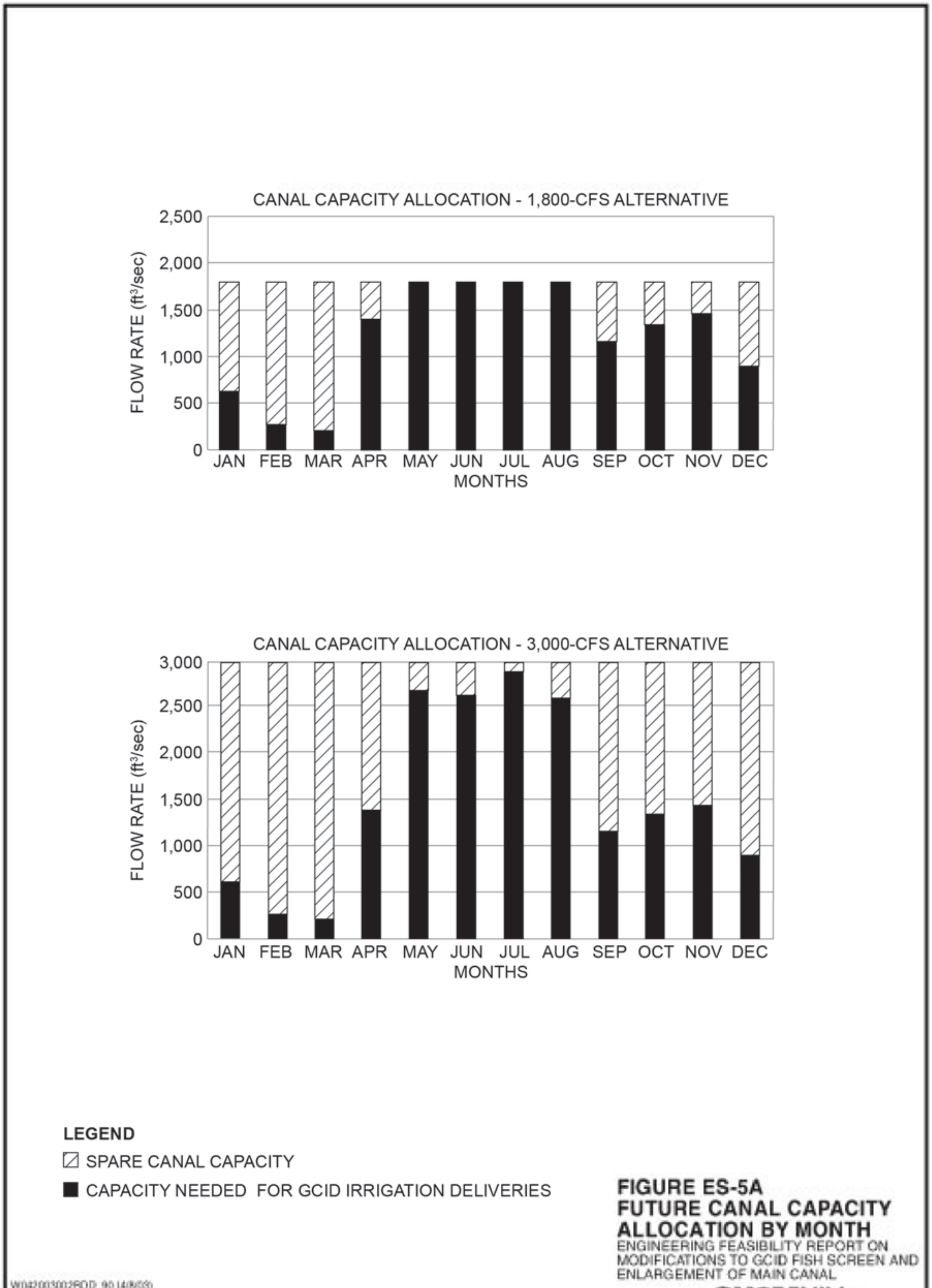


Figure B.3-37. Monthly Conveyance Capacity Allocation for GCID Canal

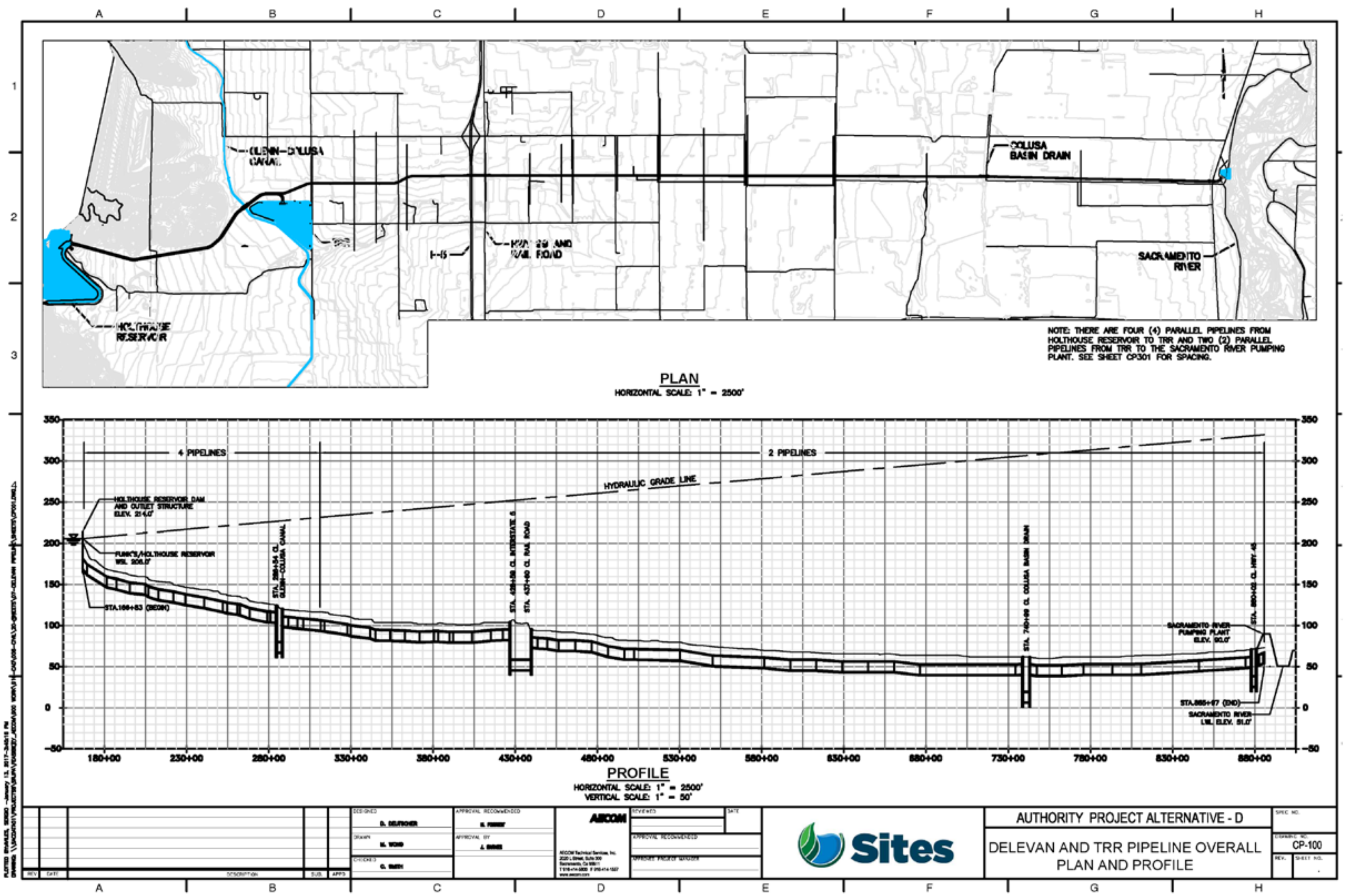


Figure B.3-38. Delevan TRR Typical Pipeline Air Valve and Blow-off Details

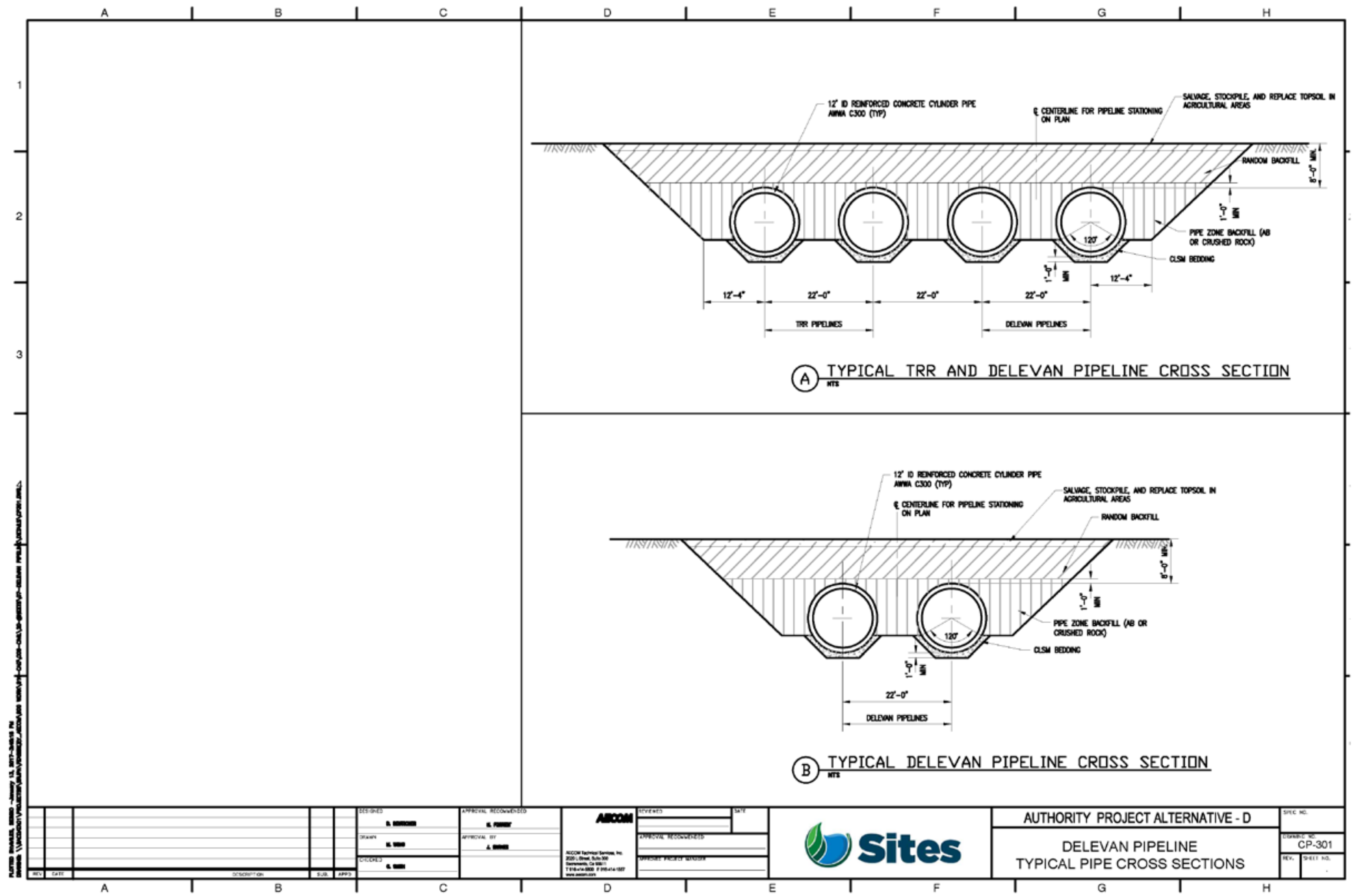


Figure B.3-39. Delevan TRR Typical Trench Details

The proposed pipeline would be underground and would have two types of aboveground features. All other appurtenant structures would be below ground. Table B.3-12 lists the proposed aboveground features and their physical characteristics.

Table B.3-12. Aboveground Features Associated with the Proposed Delevan Pipeline

Aboveground Feature	Height Above Ground/Diameter	Color	Appearance	Feature Locations
Manhole and Air Valve	4 feet maximum, 108 inches in diameter	Gray	Concrete Box	At high points, and at average of every 2,000 feet along the pipeline
Manhole and Blow-off Valve	1 foot maximum, 108 inches in diameter	Gray	Concrete Box	At low points: Sacramento River/Highway 45 Colusa Basin Drain Highway 99/Interstate 5 GCID Canal

Key:
GCID = Glenn-Colusa Irrigation District

Facilities associated with the Delevan and/or TRR Pipelines are:

- Blow-off structures
- Air valve structures
- Crossings
- Relocation of existing transmission power lines, natural gas pipelines, water lines, and other utilities

These facilities are described below.

Blow-off Structures

Blow-off structures would be provided to clean low points in the pipeline, and allow dewatering at the Sacramento River and at the GCID Canal, at a minimum. Structures would be 108 inches in diameter, and would have a 30-inch manway and 16-inch blow-off valve. Blow-off valves release water from the pipeline. These valves are generally at major water conveyances so that water can be drained directly into the river or canal, and carried downstream. Figure B.3-40 shows typical blow-off details.

Air Valve Structures

Air and vacuum valves are required to evacuate air in the pipeline during filling, and supply air during normal dewatering, as well as to release accumulated air. Air and vacuum valves would be located at high points and grade changes in the pipelines. The distance between valves would generally not exceed the manufacturer’s recommended spacing of 2,500 feet. The structures are 108 inches in diameter, and would house a 30-inch manway and a 16-inch nozzle for the air and vacuum valve assembly. The manway would be used to access the pipeline for future maintenance or inspections. Figure B.3-40 shows typical air valve structure details.

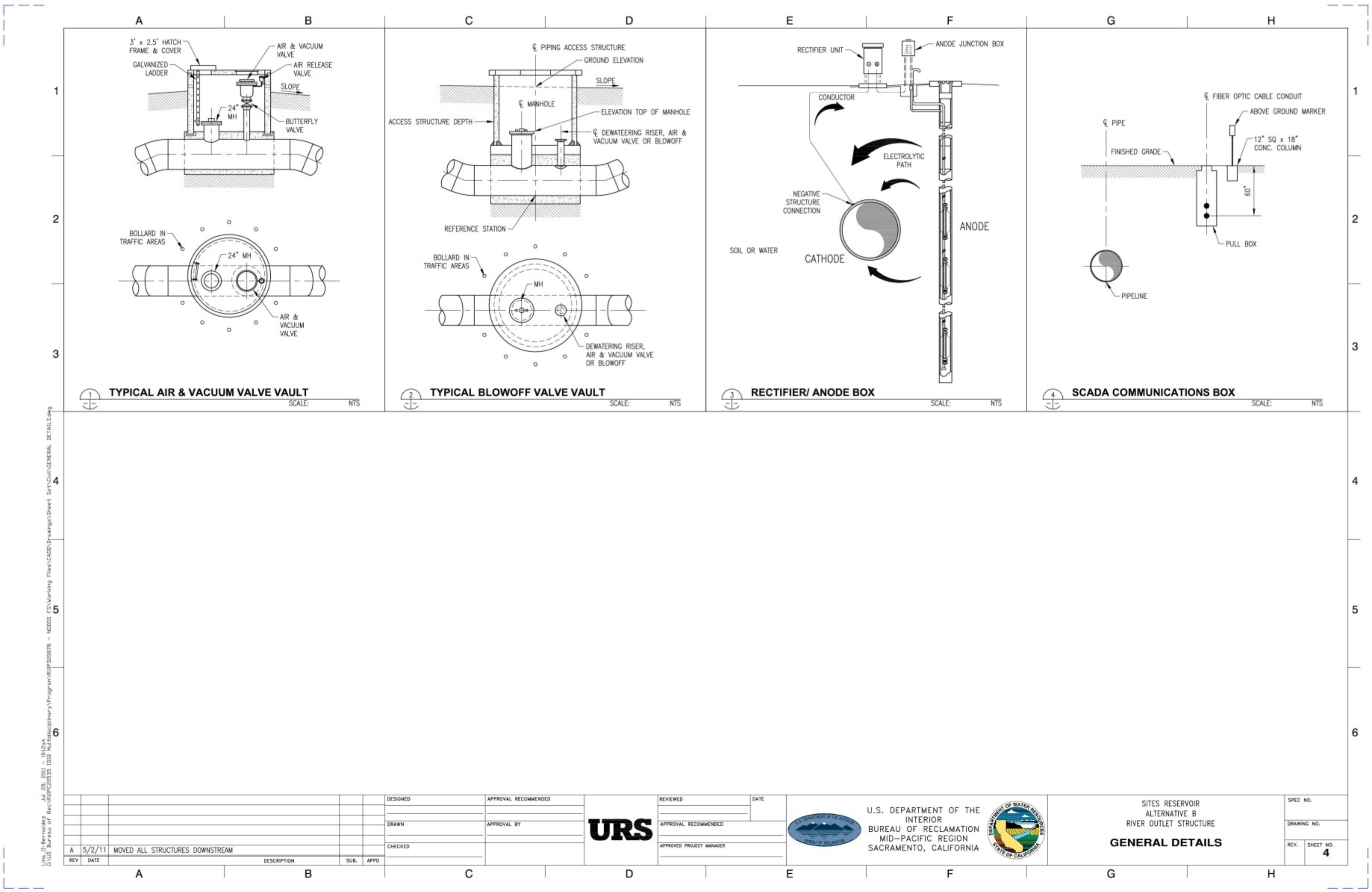


Figure B.3-40. Typical Pipeline Air Valve and Blow-off Details

Crossings of Existing Infrastructure

The proposed alignment of the Delevan and TRR Pipelines would require crossings of major existing infrastructure. At these crossings, the pipelines would be tunneled through the ground below the existing infrastructure so that services would not be interrupted. The anticipated crossings are:

- Highway 45 (Delevan Pipeline)
- Colusa Basin Drain (Delevan Pipeline)
- Highway 99, Interstate 5, and Union Pacific Railroad (Delevan Pipeline)
- Gas transmission line (Delevan Pipeline)
- GCID Canal (Delevan and TRR Pipelines)

At these locations, the bore-and-jack construction method would likely be used. Bore-and-jack construction entails excavating a large pit on each side of the existing infrastructure (highway, railroad, or canal) and then tunneling horizontally under the structure without disturbing it. All additional work required for bore-and-jack construction would be conducted in the construction staging areas, and would not require the disturbance of additional land.

The proposed pipeline routes would also require crossing the easements of a high-voltage electrical transmission line: the PG&E 230-kilovolt (kV) line. No permanent aboveground structures, other than a gravel maintenance road, would be constructed where the electric utility easements and the pipeline easements would intersect. No special construction methods or construction limitations are anticipated where the pipeline trench passes under the transmission lines.

Other existing infrastructure that the pipelines likely would cross include: gas lines, communications lines, and other infrastructure. The gas transmission pipeline could be relocated using horizontal directional drilling prior to construction of the water conveyance pipeline as an alternative to boring and jacking the transmission pipelines under the gas transmission line. The proposed pipelines likely would be installed beneath most existing utilities. Disruptions to these utilities would be minimized to the extent possible, and the ground surface would be restored to pre-construction conditions after pipeline installation. Construction activities for the proposed pipelines and modifications to existing utilities would occur within the identified construction easement, and would require only slightly more excavation than that required for the pipeline.

Project Construction

Pipeline construction likely would be done in three independent and concurrent sections. Two of the sections likely would begin from the same point and move in opposite directions. As pipelines are installed and tested, the trench would be backfilled to minimize the amount of open trenching.

The construction easement for the pipeline would be a linear area 13.5 miles long and approximately 300 feet wide, from the Sacramento River to the TRR (10 miles); and approximately 335 feet wide from the TRR to Holthouse Reservoir (3.5 miles). The additional width of the easement is needed to accommodate the additional pipelines from the TRR to Holthouse Reservoir. Approximately 20 acres would be required for a concrete batch plant.

Easement boundaries would typically be marked with tape or flagging, at a minimum. Silt fencing and exclusionary fencing would also be provided for environmental protection of adjacent areas, and to protect remaining trees and other vegetation. All active work areas would be fenced for public safety and security along the entire pipeline construction route, including staging and fabrication areas. Fencing would be 6-foot-high chain-link fence; and would be either permanent or moveable, depending on the site and level of protection needed. Moveable fencing would be used to protect the perimeter of the pipeline excavation. This fencing would be moved forward as needed to follow pipeline excavation and backfilling operations. Moveable fencing would also be used around open excavation. Permanent fencing would be used around trailer complexes, fabrication yards, and equipment storage and maintenance areas.

Trenching/Excavation of Pipeline Route

Approximately 4.3 million cubic yards of material would be excavated for the pipeline trench. Topsoil would be stockpiled separately from other excavated materials. Trench excavation would be approximately 23 feet deep. For the Delevan-only section (Sacramento River to TRR), the trench would be approximately 120 feet wide. Trench excavation for the 3.5 miles from the TRR to Holthouse Reservoir would be approximately 165 feet wide to accommodate both the Delevan and TRR Pipelines, which will include a total of four 12-foot-diameter pipes that would be installed. Trench side slopes would be approximately 1H:1.5V with dewatering. No shoring would be installed under normal excavation conditions. Special conditions at some locations (unknown at this time) may require additional depth or width, or steeper or flatter side slopes, or shoring to accommodate localized soil conditions.

The pipeline trench would be excavated using trenchers, and tracked and/or wheeled excavators and backhoes; or pushed up using bulldozers. The type of soils encountered would determine the type of equipment used for trenching. Harder soils, such as caliche, would require larger trenchers. In specific areas, vacuum excavation, “pot-holing” with a backhoe, or hand digging may be necessary to locate buried utilities.

Excavation activities similar to the pipeline excavation would also be done for electrical transmission pole footings that would be installed in the pipeline right-of-way (ROW). These activities would occur simultaneously with the pipeline excavation.

Dewatering

Dewatering of the trench would be necessary in many locations, and could be permitted to discharge into local irrigation ditches and drainage canals, and/or the CBD after settling of silts. Silts would be disposed of with excavated material. Dewatering would be in accordance with Central Valley Regional Water Quality Control Board requirements and California Storm Water Quality Association Best Management Practices for dewatering.

Bedding Preparation

Bedding material would be installed in the trench under each pipeline before installation of the pipe. Bedding material would likely be controlled low strength material for safety and to help expedite the construction schedule.

On-Site Fabrication of Pipe

Pipe could be fabricated on site at the concrete batch plant. A fabrication and curing area for the pipe could be located within the 20-acre batch plant footprint. Pipe would be fabricated from straight lengths of sheet steel. This activity would require the use of a hydraulic reinforcing steel bender. Formed reinforced-steel pieces would be tied/welded together on site to complete the reinforced-steel structures. The structures would then be installed in pipe forms, and the forms would then be filled with poured concrete.

Each section of pipe would be allowed to cure (dry and harden) for a minimum of 28 days before being moved into place along the pipeline. Movement of pipe sections in the concrete batch plant site would be done using a 50-ton-capacity forklift or wheeled crane. Fabrication of pipe would proceed year-round, and installation of pipe through the area that is considered giant garter snake habitat would occur from May 1 through October 1 of each year of construction. In the western 3.5 miles of the pipeline that are not considered giant garter snake habitat, this construction timing restriction would not apply. During spring and early summer, there would be pipe sections stockpiled on the site.

It is possible that several of the West Coast concrete pipe manufacturers could fabricate pipe in their existing plants in the Sacramento and Tracy, California areas. Pipe could be shipped by road or rail. If by rail, a temporary siding for delivery and unloading may be required. It is recommended that plant fabrication and shipping of pipe be further evaluated in future phases of the NODOS/Sites Reservoir Project.

Installation of Pipe and Valves

The finished sections of pipe would be transported from the concrete batch plant to the installation location, primarily along the pipeline route on flatbed trucks traveling along the construction access roadway (within the construction easements). These trucks would cross public roadways. Pipe sections would be offloaded from flatbed trucks and placed in the excavated pipeline trench by a 50-ton-capacity crane. Once in place, the metal joining plates cast into the end of each pipe would be welded together, and the joint would be covered with a cement-based sealing compound. At valve locations, pre-fabricated valves would be delivered to the site on flatbed trucks, and installed into pre-built structures in the trench using the same crane.

Backfill of Trench

Approximately 3.2 million cubic yards of material would be needed to backfill the trench after the pipes are installed. Excavated material would be reused to backfill the trench, or moved to other NODOS/Sites Reservoir Project locations for use, to the extent possible, after placement of pipes. Excess spoils from the excavation (estimated at approximately 1.0 million cubic yards) could be spread on adjacent agricultural lands of willing landowners; used as backfill at the SRPGP, Holthouse Reservoir, or other facilities requiring backfill; or placed in the dead storage areas of Sites Reservoir or Holthouse Reservoir. A portion of the excess spoils may also be suitable borrow to reinforce existing flood control levees in the area, under a separate program. Reuse of excavated material may be limited by water content of excavated material and soil compaction requirements.

New Sacramento River Pumping/Generating Plant and Conveyance for Alternative A, Alternative C, and Alternative D

This section describes Alternative A, Alternative C, and Alternative D, which include pumping/generating capability on the Sacramento River. Alternative B does not include pumping or generating capability on the Sacramento River, but still includes the Delevan Pipeline conveyance from Holthouse Reservoir to convey water from Sites Reservoir back to the Sacramento River. Alternative C is discussed in a following section.

The SRPGP would be constructed with a pumping capacity of 2,000 cfs, an intake and fish screen structure at the Sacramento River, and the Delevan Pipeline from the SRPGP to the Holthouse Reservoir. The conveyance system would also be capable of releasing up to 1,500 cfs from Holthouse Reservoir to the Sacramento River. Total length of the conveyance is approximately 13.5 miles, with a difference in elevation of approximately 150 feet. The return flow can be used to generate hydroelectric energy with the residual head in the conveyance system. Figure B.3-1 and Figure B.3-41 show the new Sacramento River Conveyance configuration.

River Diversion and Pumping/Generating Plant

The proposed pumping/generating plant would involve the construction of (1) a pumping/generating plant with manifolds to connect with the Delevan Pipeline; (2) a forebay/afterbay pond with sheet piling wall; (3) two surge suppression air chambers; (4) a control building; (5) an electrical switchyard; and (6) an intersection with Highway 45 and access and maintenance roads.

- Preliminary design of the proposed new facilities was performed considering the following criteria:
- Divert up to 2,000 cfs from the Sacramento River during high flows and convey it to Holthouse Reservoir.
- Sacramento River diversion would be below River Mile (RM) 158.5, with a mechanically cleaned fish screen facility and pumping/generating plant to raise water to Holthouse Reservoir.
- Finished grades would be a minimum of 2 feet above the 100-year flood elevation at the Sacramento River (flood elevation of 82.0 feet).
- Site fill would be tied to the existing flood control levees along the Sacramento River for uninterrupted flood protection, including underseepage mitigation if necessary.
- Deter fish from entering intake bays, using a proven fish screening method conforming to Federal and State standards.
- Install conveyance pipelines to maximize ground usage for rice and row crops after installation.
- Use an on-bank design parallel to the river for the fish screen facility.

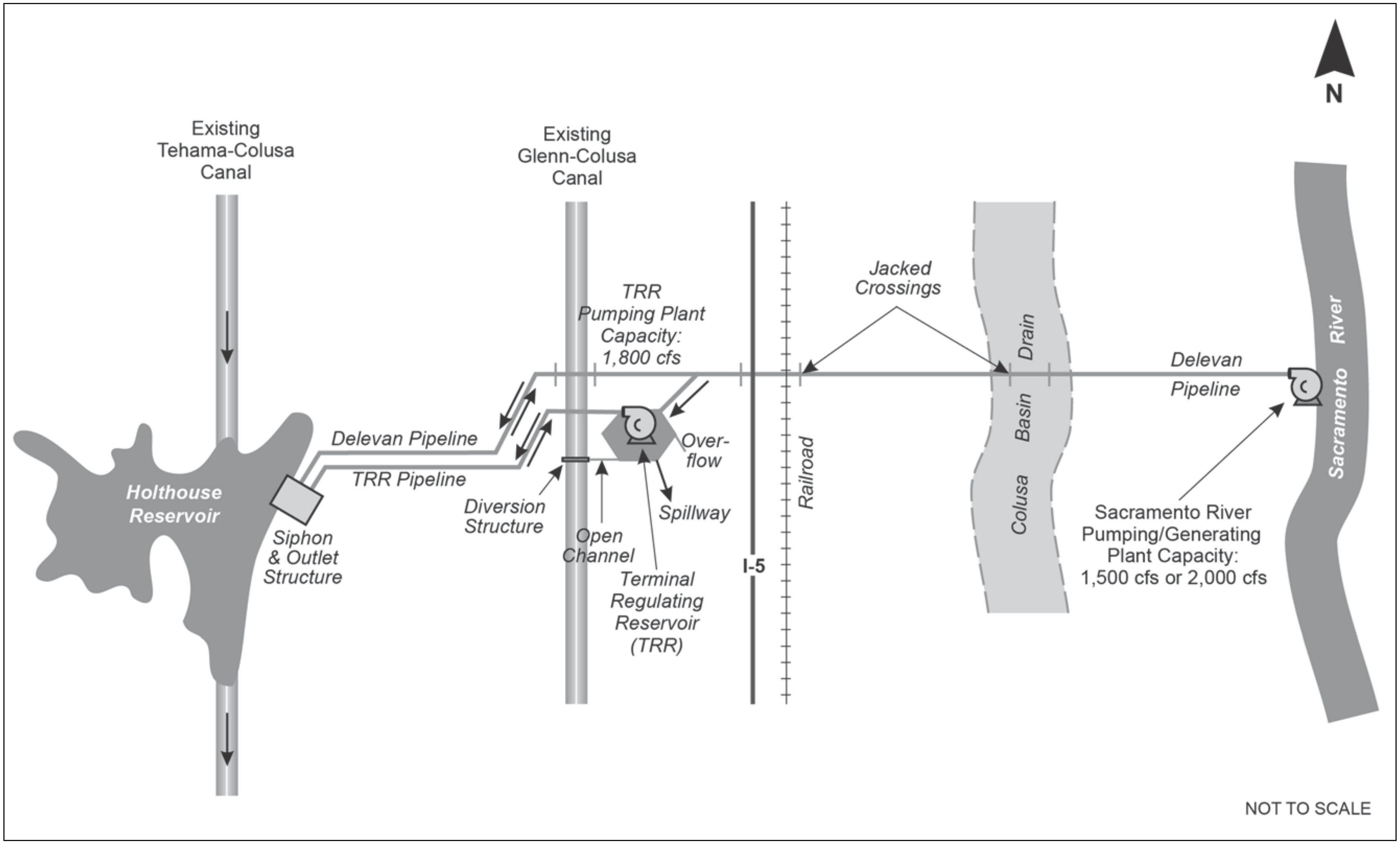


Figure B.3-41. Schematic Layout of New Sacramento River Conveyance Delevan Pipeline

The SRPGP and fish screen facilities (Figure B.3-42) are on the western side of the Sacramento River, slightly downstream of RM 158.5 and on the eastern side of Highway 45. Based on the fish screen design and construction studies of June 2008, the proposed location of the plant is considered the best for the hydraulics of the fish screen facilities.

For each 12-foot-diameter pipeline, the system has the capacity to transport 1,000 cfs of water to Holthouse Reservoir, and 750 cfs for reverse flow and power generation. The pumping/generating plant would consist of four pumping units, each with a design pumping capacity of 600 cfs; one spare pumping unit with a design pumping capacity 600 cfs; two generating units, each with a generating capacity of 750 cfs; pipelines; mechanical and electrical equipment; and aboveground control and OM&R buildings, and related equipment.

The overall dimension of the plant building is approximately 300 feet long by 80 feet wide, with a multiple-story structure to provide spaces for mechanical and electrical equipment. A gantry crane with crane rails approximately 60 feet apart would be installed on the finish floor of the plant for moving pumps, motors, pumping/generating units, valves, and electrical/mechanical equipment. The maximum height of the crane would be approximately 25 feet, with a capacity of 100 tons. Figure B.3-43 and Figure B.3-44 show a floor plan of the motor floor and pump floor, respectively. Figure B.3-45 and Figure B.3-46 show traverse and longitudinal sections of the plant, respectively. Plans and sections would vary between NODOS/Sites Reservoir Project alternatives due to differences in number of units and unit sizes. These figures are intended to present general concepts only.

The pumping/generating plant would allow for dewatering of the pipelines, and for reverse flow into the Sacramento River through the generating units. No additional bypass system for dewatering is required at the plant, provided there is at least one unit that is operational.

Some basic elevations are listed below:

- Maximum operating water elevation: 70.00 feet
- Minimum water elevation: 51.00 feet
- Intake elevation: 35.00 feet
- Plant finished floor elevation: 84.00 feet

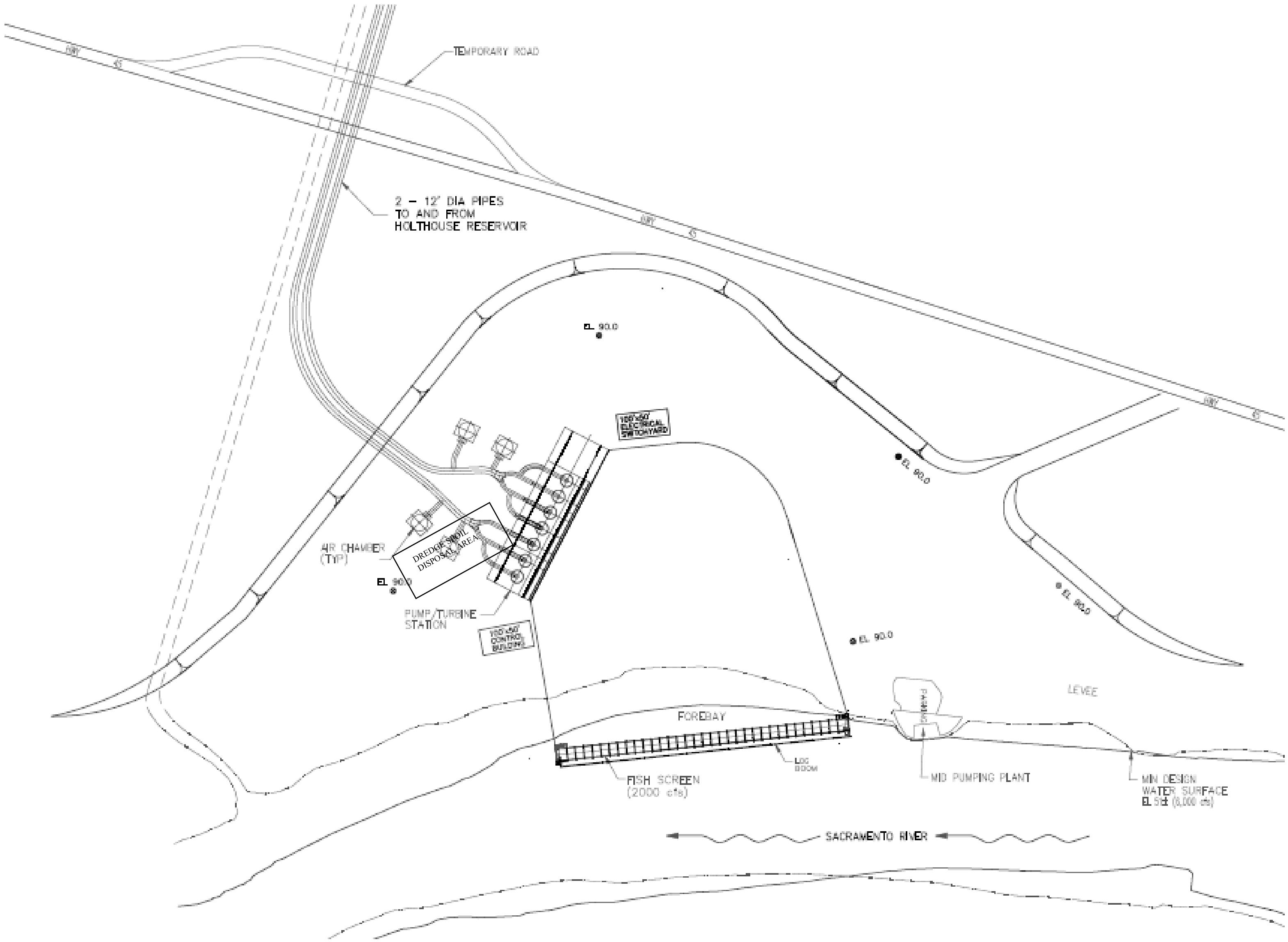


Figure B.3-42. Sacramento River Pumping/Generating Plant Site Layout

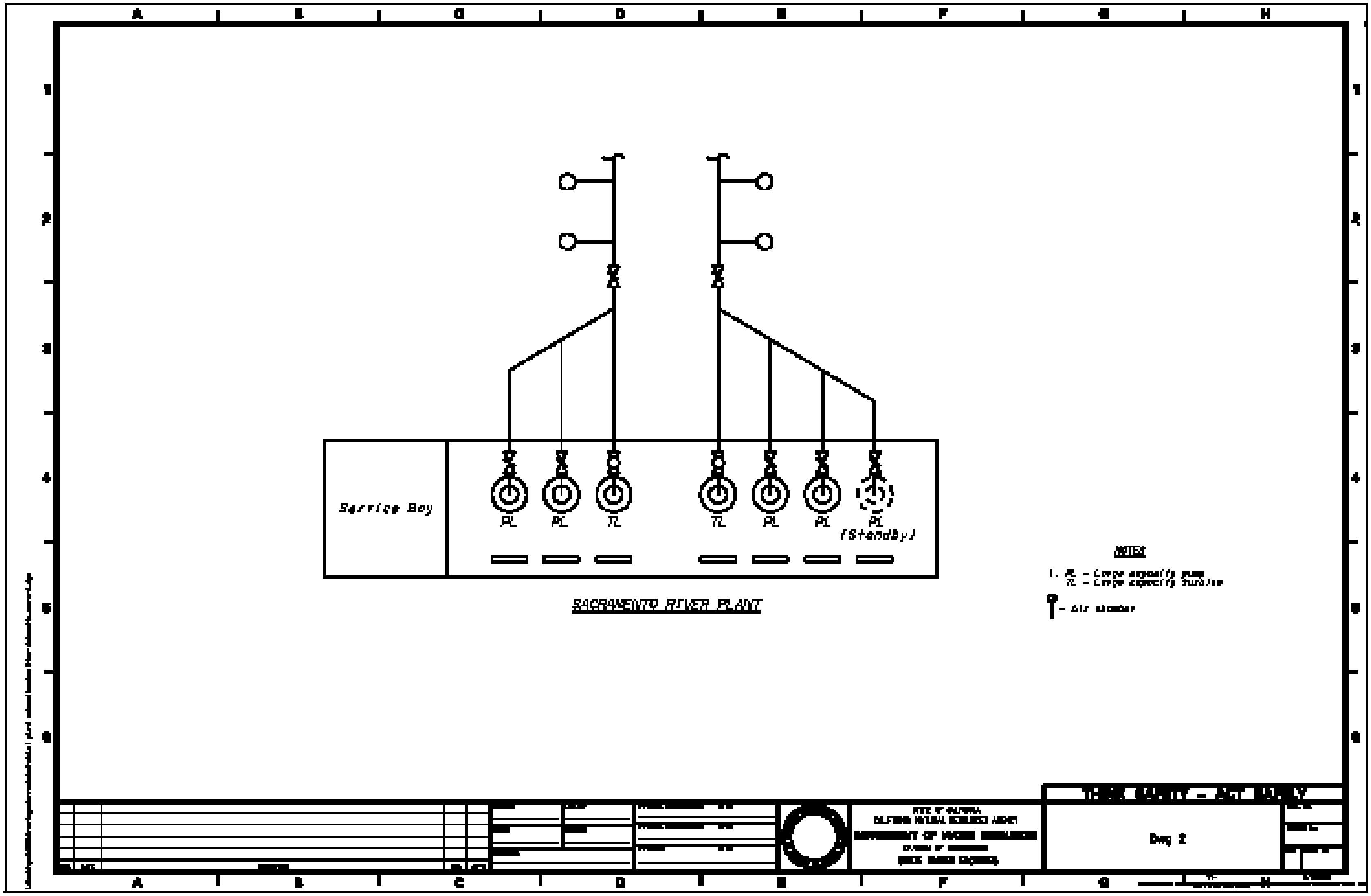


Figure B.3-43. Sacramento River Pumping/Generating Plant Motor Floor Plan

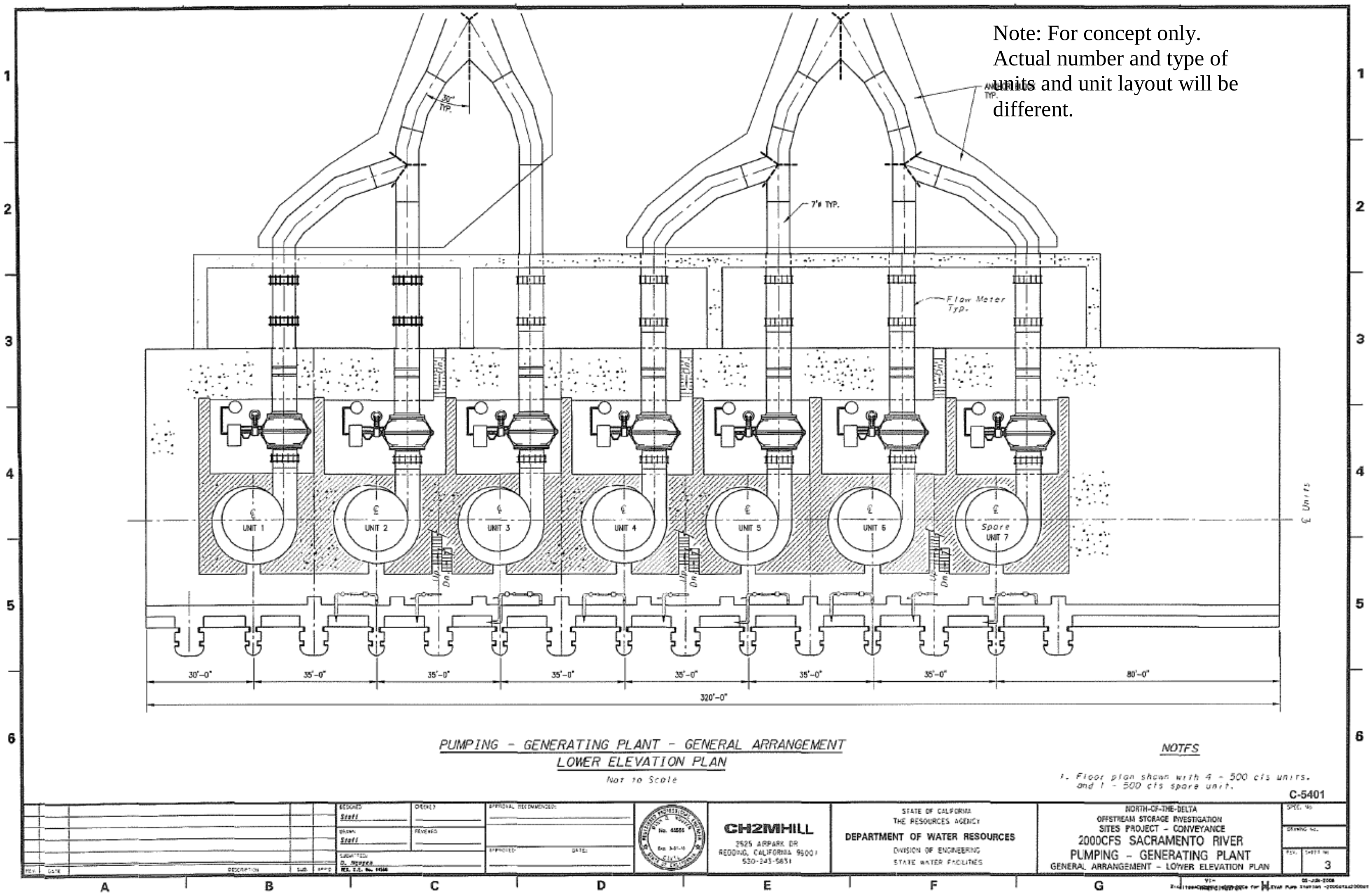


Figure B.3-44. Sacramento River Pumping/Generating Plant Lower Elevation Plan