RECLAMATION

Appendix B
Engineering

North-of-the-Delta Offstream Storage Investigation

July 2017

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B.1 Introduction

This engineering, design, and cost estimate appendix presents information related to the conceptual designs and cost estimates for the Draft Feasibility Report alternatives. This information is largely based on previous studies by the United States Department of the Interior, Bureau of Reclamation (Reclamation) and the California Department of Water Resources (DWR).

Chronology of NODOS Project Engineering Studies

The Sites Reservoir concept has been studied by DWR since 1957, and by Reclamation since 1964. Traditionally, reservoirs have been created by constructing dams on major streams (onstream storage). An offstream storage reservoir is instead constructed on a small, generally seasonal stream that contributes a minor share of the water supply to the reservoir. Offstream storage requires the diversion of water with conveyance into the reservoir.

The earliest published reference to a North-of-the-Delta Offstream Storage (NODOS)/Sites Reservoir Project is found in DWR Bulletin 3, the California Water Plan 1957, which mentions a 48,000 acre-foot (AF) Sites offstream storage reservoir on Stone Corral and Funks Creeks, to be supplied by a then-proposed Tehama-Colusa (T-C) Canal (DWR 1957).

DWR's Bulletin 109, Colusa Basin Investigation 1964, evaluated potential flood control projects, and considered two separate reservoirs of 5,800 and 7,600 AF on Stone Corral and Funks Creeks, respectively (DWR 1964). An update of this report in 1990 found these reservoirs economically unjustified for flood control alone (DWR 1990).

Consideration of larger projects at the Sites location were first documented in December 1964, in Reclamation's West Sacramento Canal Unit Report (Reclamation 1964), which studied the feasibility of extending the T-C Canal, via a new West Sacramento Valley Canal, into Solano County near Fairfield. To develop additional water supply to support this canal extension plan, a 1.2 million acre-feet (MAF) Sites Reservoir was proposed. This study did not evaluate the potential of Sites as a stand-alone project, but only as part of the extended canal system.

In March 1990, CH2M Hill prepared a long-range plan for the Glenn-Colusa Irrigation District (GCID) that included an 870,000 AF Sites Reservoir with a normal water surface elevation (WSE) of 460 feet[1] (CH2M Hill 1990). Based on information contained in Reclamation 1964, GCID determined that an 870,000 AF Sites Reservoir was beyond its financial capability.

In 1993, CH2M Hill published a report, *Meeting California's Water Needs in the 21st Century*, which presented a conceptual Westside Storage and Conveyance System. The report mentioned a Sites/Colusa Reservoir with a feeder pipeline from Lake Oroville (CH2M Hill 1993).

[1] All elevations are per National Geodetic Vertical Datum of 1929.

A July 1995 draft report by the Colusa Basin Drainage District on its proposed Water Management Program recommended a 62-foot-high dam on Funks Creek that would impound 9,500 AF in Golden Gate Reservoir (CBDD 1995). The project benefits listed were flood control and modest springtime irrigation yield.

In late 1995, DWR received numerous requests from water interests, including the Northern California Water Association, for information regarding the potential of an offstream storage reservoir at the Sites location. In response to this renewed interest, DWR reviewed historic documents on the project to assess its potential to augment local and statewide water supplies during drought periods. DWR conducted a brief investigation of environmental literature, studies, and aerial photos; and conducted limited field work in the project area. DWR published its findings in a July 1996 report entitled *Reconnaissance Survey – Sites Offstream Storage Project* (DWR 1996).

DWR's 1996 report briefly summarized Sites project planning information, and updated earlier cost estimates to 1995 levels. No insurmountable problems were identified that would prevent further evaluation of the project. Rather, DWR found that the project had several unique characteristics that made it an attractive candidate for further feasibility-level investigations. The project has a notably lower cost per unit of storage than most other storage locations. Also, the area is sparsely populated and contains relatively few environmentally sensitive species. The geography of the potential reservoir location permits a range of storage options for consideration.

In July 2000, a *NODOS Progress Report* was published to summarize the work conducted since 1997 (CALFED 2000). The document provided CALFED Bay-Delta Program (CALFED) agencies and the public with information about projects under evaluation. Engineering and geologic investigations conducted at the probable locations of the Golden Gate and Sites Dams indicated they were suitable for construction of dams that could impound a 1.8 MAF Sites Reservoir.

In August 2000, DWR's Division of Engineering (DOE) prepared an *Engineering Progress Report on Feasibility Studies for Sites Reservoir* (DWR DOE 2000). The report documented progress on feasibility-level studies for Sites Reservoir facilities. It summarized the conceptual design for Golden Gate and Sites Dams, spillway, inlet/outlet works, and the pumping/generating plant directly serving the Sites Reservoir. The report deemed detailed geologic mapping and investigation of the faults essential for further studies, because of potential seismic activity at the dam sites.

In June 2002, DOE released another report, *Materials Investigation, Testing, and Evaluation Program for Sites Reservoir* (DWR DOE 2002c). The investigation objectives included identification of the types of available on-site construction materials, examination of their potential uses, and performance of limited testing and evaluation to determine their suitability for use in the dams and appurtenant structures.

In October 2002, a *NODOS Scoping Report* was published by DOE (DWR DOE 2002a), summarizing the public concerns, evaluating the magnitude of concerns, and helping decision makers determine the range of alternatives for the NODOS project.

In April 2003, CH2M Hill (2003a) prepared an *Engineering Feasibility Report on Modifications to GCID Fish Screen and Enlargement of Main Canal*. The study evaluated facility improvements, operating concepts, capital costs, and overall feasibility of expanding GCID's Main Pump Station and Main Canal to convey Sacramento River diversions to the proposed Sites Reservoir.

In May 2003, URS and CH2M Hill prepared a *Final Engineering Feasibility Report for TC Canal Alternatives* for the NODOS project. The study evaluated alternatives for the T-C Canal intake facilities, including enlargement of the canal itself to meet the needs of the Sites Reservoir project.

In May 2003, CH2M Hill prepared the *Stony Creek Alternative for Conveyance to Sites Reservoir NODOS Evaluations* (CH2M Hill 2003b). The purpose was to conduct feasibility-level evaluations of alternative routes and associated conveyance facilities from the Black Butte Dam Afterbay to the T-C Canal near Orland.

In June 2003, DOE released another report, *Sites Reservoir Engineering Feasibility Study – Pumping Plants and Appurtenant Facilities* (DWR DOE 2003b). The purpose of the study was to evaluate the engineering feasibility for the design and construction of a pumping plant, inlet/outlet channel, tunnel, reservoir inlet/outlet structure, emergency release structure, and an ungated spillway. The study found each of these appurtenances to be technically feasible.

In July 2003, DOE released *Geologic Feasibility Report, Sites Reservoir Project* (DWR DOE 2003c). The report summarized all of the geologic information that had been developed to that time. The report found that the proposed project was geologically feasible, and that there were no geological fatal flaws.

In August 2003, DOE released *Sites Project, feasibility Study for Conveyance, Colusa Basin Drain, and Funks Reservoir Modification* (DWR DOE 2003d). The report focused on three tasks for the Sites project: conveyance from the Sacramento River to Funks Reservoir; using the Colusa Basin Drain as a source of supply; and modification of Funks Reservoir to meet the requirements of the Sites Reservoir project.

In September 2005, DOE released a *Feasibility Study for Reverse Flow and Pumping/Generating Plants* (DWR DOE 2005). The report considered the feasibility and benefits of a reverse-flow conveyance system from Funks Reservoir to the Sacramento River.

In May 2006, URS prepared a *North-of-the-Delta Offstream Storage Investigation Initial Alternatives Information Report* (IAIR) for Reclamation (URS 2006). The purpose of the investigation was to identify and screen alternatives for the NODOS project.

In June 2008, CH2M Hill prepared a feasibility study for DWR for the fish screen facility at the proposed diversion location for the NODOS project.

In July 2008, DOE prepared an addendum amending the August 2003 *Feasibility Study Report* (CH2M Hill 2008). The addendum updated the costs of the pumping/generating plants for pumping capacities of 1,500 and 2,000 cubic feet per second (cfs), and a complete site plan of the pumping/generating plant, in concert with CH2M Hill's updated *Fish Screen Facility Study*.

In September 2008, URS prepared the *North-of-the-Delta Offstream Storage Investigation Plan Formulation Report* (PFR) for Reclamation (URS 2008b), describing the formulation, evaluation, and comparison of initial alternatives plans that address NODOS Investigation planning objectives.

In May 2014, DWR released the *Investigation Highlights Report* (DWR 2014), which included a description of the engineering facilities and a cost estimate for the project.

Proposed Alternatives

On January 4, 2011, the Reclamation and DWR Project Team (Team) met to discuss and review 19 storage and conveyance options being evaluated for the NODOS project. Based on the meeting, the Team selected three of the options to be the alternatives carried forward for evaluation in the NODOS Administrative Draft Environmental Impact Report/Environmental Impact Statement (EIR/EIS) (Reclamation and Authority 2017). Table B.1-1 outlines key aspects of these alternatives.

Table B.1-1. Proposed NODOS Project Alternative Projects

	Alternative A	Alternative B	Alternative C
Screening Study Identifier	R12C3	R18C3 (No Pump)	R18C3
Storage Capacity			
Sites Reservoir	1.3 MAF	1.8 MAF	1.8 MAF
Conveyance Capacities To Sites Reservoir			
Tehama-Colusa Canal	2,100 cfs	2,100 cfs	2,100 cfs
Glenn-Colusa Irrigation District Canal	1,800 cfs	1,800 cfs	1,800 cfs
Delevan Pipeline	2,000 cfs	0 cfs	2,000 cfs
Conveyance Capacities from Sites Reservoir			
Tehama-Colusa Canal	800 cfs	800 cfs	800 cfs
Glenn-Colusa Irrigation District Canal	900 cfs	900 cfs	900 cfs
Delevan Pipeline	1,500 cfs	1,500 cfs	1,500 cfs

cfs = cubic feet per second
MAF = million-acre feet
NODOS = North-of-the-Delta Offstream Storage
— = not available

Project Description

Figure B.1-1 is a schematic representation of the principal components of the proposed NODOS/Sites Reservoir Project; it shows the direction of flow and storage volumes. Most of the facilities shown are common to all four project alternatives currently under consideration. The proposed project would include water conveyance from the Sacramento River through existing, expanded, or new facilities and water storage in the Sites Reservoir. Water would be diverted to Sites Reservoir from the Sacramento River, primarily in winter months. The stored water would be released from Sites Reservoir in summer months to deliver water to local water users through existing facilities such as the GCID and T-C Canals or to return water to the Sacramento River

using a new conveyance system. Water would be provided from Sites Reservoir in exchange for water that otherwise would have been released from Shasta Lake. The exchanged water would then remain in Shasta Lake for beneficial use later in the summer. Shasta Lake water could help cool the upper river for fishery maintenance purposes and be used downstream for agricultural, environmental, and urban purposes.

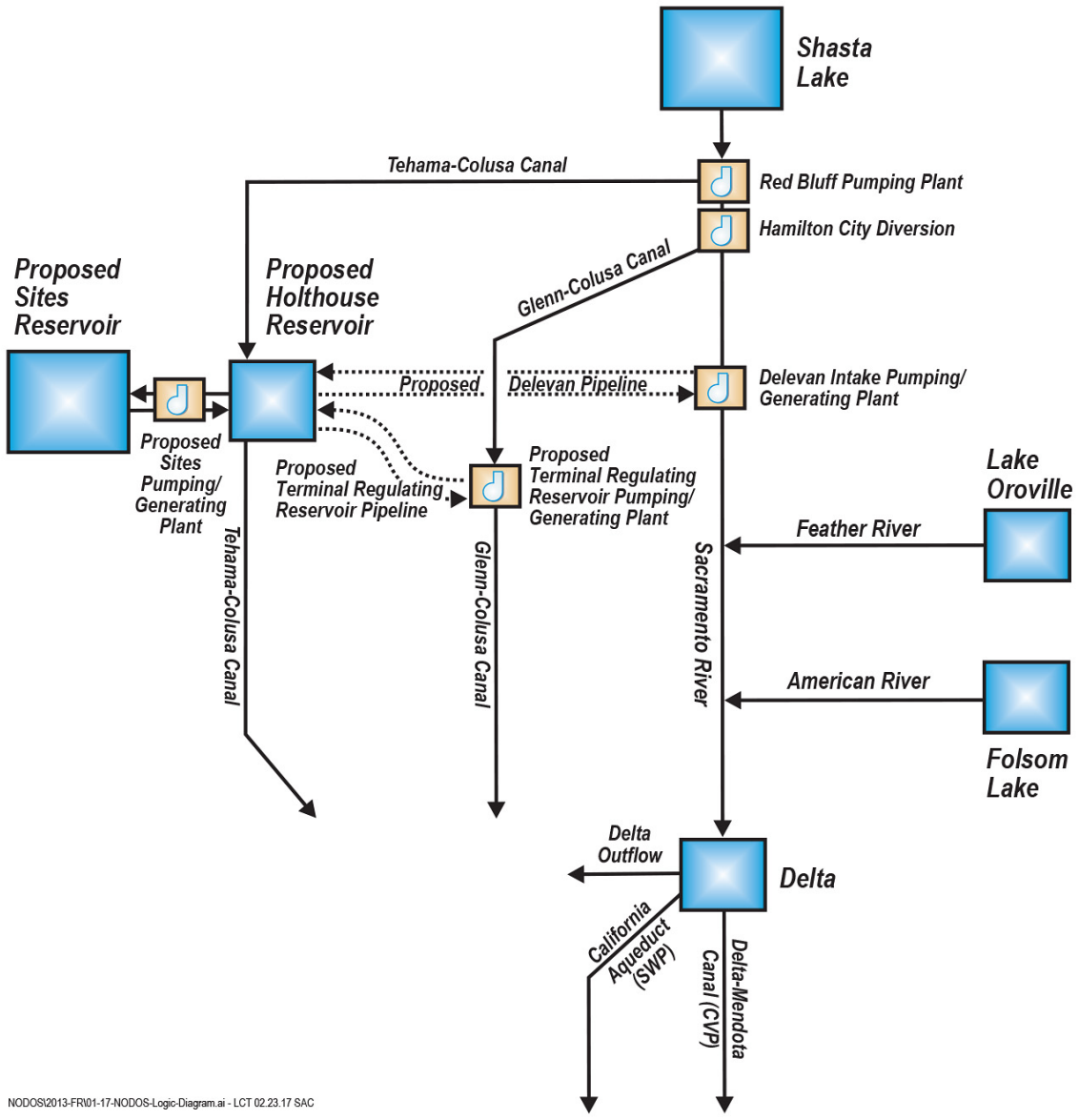

Figure B.1-1. NODOS/Sites Reservoir Project – Schematic Layout

Sites Reservoir would be located approximately 10 miles west of Maxwell, California. The reservoir would be formed by constructing Sites Dam, approximately 290 feet high, on Stone Corral Creek and Golden Gate Dam, approximately 310 feet high, on Funks Creek. Sites Dam would range in height from 290 feet for the 1.8 MAF reservoir to 250 feet for the 1.3 MAF reservoir. Golden Gate Dam would range in height from 310 feet for the 1.8 MAF reservoir to

270 feet for the 1.3 MAF reservoir. Nine saddle dams ranging up to 130 feet high would also be built along the reservoir's northern boundary for the 1.8 MAF reservoir. Six saddle dams would be required for the 1.3 MAF reservoir.

The proposed Sites Reservoir water control features (appurtenances) include water intake and outlet structures, the Sites Pumping/Generating Plant (SPGP) (downstream of the Golden Gate Dam site on Funks Creek), and an emergency signal spillway at Saddle Dam 6. Sites Dam and Golden Gate Dam would have low-level outlet works capable of releasing stream maintenance flows into Stone Corral Creek and Funks Creek after construction is completed. These low-level outlet works would be incorporated as permanent facilities in the creek diversion systems installed at both dam sites to pass winter storm runoff through the construction sites.

Currently, the existing 40-foot-high Funks Dam forms a 2,250 AF reservoir 1 mile downstream of the Golden Gate Dam. This reservoir was constructed by Reclamation and is part of the T-C Canal system. Funks Reservoir serves as a re-regulating reservoir to stabilize flows in the canal below Funks Reservoir as diverters come online and offline. The existing Funks Reservoir would be expanded to form the Holthouse Reservoir by constructing a new dam and reservoir to the east and breaching the existing Funks Dam so that the new and existing reservoirs act as one unit, with an enlarged active storage capacity of approximately 6,500 AF. In addition to facilitating water inflow and outflow water management, the additional capacity provided for pump-back storage would enhance project power generation, particularly during daily on-peak periods. For all the water source options considered, imported water entering Sites Reservoir would pass through Holthouse Reservoir, which would serve as a forebay/afterbay to the SPGP.

Development of Sites Reservoir with a diversion capability from the Sacramento River would require at least:

- Minimal modification of the T-C Canal and GCID Canal facilities.
- Construction of a terminal regulating reservoir and pumping/generating plant on the GCID Canal.
- Inter-connection from the GCID Canal to Holthouse Reservoir.
- Construction of the proposed Sacramento River Pumping/Generating Plant for Project Alternatives A, C, and D, which would divert up to 2,000 cfs from the Sacramento River, through a new pipeline. Project Alternative B would not include Sacramento River pumping as a project feature, but seasonal releases would still be made back to the Sacramento River through the Delevan Pipeline.

Winter flows diverted into these canals and pipeline would be conveyed into Holthouse Reservoir and then pumped into Sites Reservoir. These modified or new facilities would allow winter diversions of water from the Sacramento River when downstream criteria are met. Total diversion capacity from the Sacramento River for the currently proposed source and conveyance measures would not exceed 5,900 cfs for Alternatives A and C or 3,900 cfs for Alternative B, with no Sacramento River pumping.

Table B.1-2 summarizes the major features of NODOS project alternatives, as included in the PFR.

When water is released from Sites Reservoir, it would be routed through reversible pump-turbine generators to generate clean hydroelectric power. These releases could help offset the energy costs associated with the pumping and provide firm power to support wind and solar generation. Holthouse Reservoir is sized to provide approximately 6 hours per day of on-demand generation during peak power periods.

As currently envisioned, water would be pumped on a seasonal basis into Sites Reservoir during periods of relatively lower energy cost and released through the hydroelectric generation facilities during times of higher energy value. Volume regulation would occur in Holthouse Reservoir on a daily basis. Pumping and release would occur approximately 5 months per year. During the approximately 2 months per year that water is not stored or released to accomplish major project goals, daily pump-back operations would potentially be performed to enhance the peak power-generating capability to help offset the power usage and provide some ancillary power benefits to enhance the reliability of California's electric grid. These operations would increase the economic return on the project without losing control of the water impounded by Sites Reservoir.

Organization

Section B.2 of this appendix presents the setting of the NODOS/Sites Reservoir Project and summarizes the geotechnical investigation conducted for the project. Section B.3 discusses project design considerations to date. Section B.4 presents a summary of the cost estimates for the four NODOS/Sites Reservoir Project alternatives discussed in the main text of the Draft Feasibility Report. Section B.5 discusses the construction schedule; and Section B.6 discusses the construction equipment utilization and the workforce. Section B.7 lists the reference materials consulted in preparing this appendix.

Table B.1-2. Summary of the Major Features of NODOS Project Alternatives in the Draft Feasibility Report

Facility	Feature	Alternative A	Alternative B	Alternative C	Alternative D
Sites Reservoir	Gross Storage Capacity	1.3 MAF	1.8 MAF	1.8 MAF	1.8 MAF
	Water Surface Elevation	480 feet msl	520 feet msl	520 feet msl	520 feet msl
	Dam Crest Elevation	500 feet msl	540 feet msl	540 feet msl	540 feet msl
	Minimum Operating Pool	320 feet msl	320 feet msl	320 feet msl	320 feet msl
	Inundation Area (approximate)	12,500 acres	14,000 acres	14,000 acres	14,000 acres
	Inlet/Outlet Type	Multi-level inlet/outlet tower A low-level inlet/outlet structure	Multi-level inlet/outlet tower A low-level inlet/outlet structure	Multi-level inlet/outlet tower A low-level inlet/outlet structure	Multi-level inlet/outlet tower A low-level inlet/outlet structure
Golden Gate Dam (Sites Reservoir)	Location	Funks Creek	Funks Creek	Funks Creek	Funks Creek
	Type	Earth/rockfill embankment	Earth/rockfill embankment	Earth/rockfill embankment	Earth/rockfill embankment
	Crest Length	1,450 feet	2,120 feet	2,120 feet	2,120 feet
	Maximum Height	260 feet	310 feet	310 feet	310 feet
	Embankment Volume	5,987,000 cubic yards	10,590,000 cubic yards	10,590,000 cubic yards	10,590,000 cubic yards
Sites Dam (Sites Reservoir)	Location	Stone Corral Creek	Stone Corral Creek	Stone Corral Creek	Stone Corral Creek
	Type	Earth/rockfill embankment	Earth/rockfill embankment	Earth/rockfill embankment	Earth/rockfill embankment
	Crest Length	725 feet	850 feet	850 feet	850 feet
	Maximum Height	250 feet	290 feet	290 feet	290 feet
	Embankment Volume	2,853,000 cubic yards	3,836,000 cubic yards	3,836,000 cubic yards	3,836,000 cubic yards
Saddle Dams for Sites Reservoir	Location	North end of reservoir from Funks Creek to Hunter Creek	North end of reservoir from Funks Creek to Hunter Creek	North end of reservoir from Funks Creek to Hunter Creek	North end of reservoir from Funks Creek to Hunter Creek
	Type	Earth/rockfill embankments	Earth/rockfill embankments	Earth/rockfill embankments	Earth/rockfill embankments
	Saddle Dam Numbers	1, 6, 8b – <5 feet to 25 feet high 3, 5, 8a – 50 feet to 85 feet high	1, 4, 9 – 40 to 50 feet high 2, 3, 5, 6, 7, 8 – 70 to 130 feet high	1, 4, 9 – 40 to 50 feet high 2, 3, 5, 6, 7, 8 – 70 to 130 feet high	1, 4, 9 – 40 to 50 feet high 2, 3, 5, 6, 7, 8 – 70 to 130 feet high
Emergency Spillway (Sites Reservoir)	Location	Saddle Dam 6	Saddle Dam 6	Saddle Dam 6	Saddle Dam 6
	Diameter	7-foot RCP	7-foot RCP	7-foot RCP	7-foot RCP
	Inlet Elevation	487.0 feet (above PMF storage)	526.0 feet (above PMF storage)	526.0 feet (above PMF storage)	526.0 feet (above PMF storage)
Sites Reservoir Inlet/Outlet	Type	Multi-level Inlet Tower and Low-Level Outlet	Multi-level Inlet Tower and Low-Level Outlet	Multi-level Inlet Tower and Low-Level Outlet	Multi-level Inlet Tower and Low-Level Outlet

Facility	Feature	Alternative A	Alternative B	Alternative C	Alternative D
Works	Capacity	15,300 cfs (emergency release)	15,300 cfs (emergency release)	15,300 cfs (emergency release)	15,300 cfs (emergency release)
	Size	30-foot-diameter concrete and concrete/steel-lined pressure tunnel	30-foot-diameter concrete and concrete/steel-lined pressure tunnel	30-foot-diameter concrete and concrete/steel-lined pressure tunnel	30-foot-diameter concrete and concrete/steel-lined pressure tunnel
Sites Pumping/ Generating Plant	Location	Downstream from Golden Gate Dam	Downstream from Golden Gate Dam	Downstream from Golden Gate Dam	Downstream from Golden Gate Dam
	Flow Capacity (Max)	5,926 cfs pumping 5,100 cfs generating	3,916 cfs pumping 5,100 cfs generating	5,926 cfs pumping 5,100 cfs generating	5,926 cfs pumping 5,100 cfs generating
	Pumping Head (Max)	290 feet	323 feet	323 feet	323 feet
	Generating Capacity (Max)	96 MW at 5,100 cfs	110.3 MW at 5,100 cfs	117.5 MW at 5,100 cfs	117.5 MW at 5,100 cfs
Holthouse Reservoir	Maximum Height	45 feet	45 feet	45 feet	45 feet
	Normal Operating WSE	205 feet msl	205 feet msl	205 feet msl	205 feet msl
	Surface Area	445 acres (including Funks)	445 acres (including Funks)	445 acres (including Funks)	445 acres (including Funks)
	Total Active Capacity	6,500 AF	6,500 AF	6,500 AF	6,500 AF
Delevan Pipeline from Sacramento River to Holthouse Reservoir	Flow Capacities	2,000 cfs pumping 1,500 cfs releasing	No pumping 1,500 cfs releasing	2,000 cfs pumping 1,500 cfs releasing	2,000 cfs pumping 1,500 cfs releasing
	Length	13.5 miles	13.5 miles	13.5 miles	13.5 miles
	Size	Two 12-foot-diameter RCPs (steel cylinder)	Two 12-foot-diameter RCPs (steel cylinder)	Two 12-foot-diameter RCPs (steel cylinder)	Two 12-foot-diameter RCPs (steel cylinder)
	From/To	Sacramento River to Holthouse Reservoir	Sacramento River to Holthouse Reservoir	Sacramento River to Holthouse Reservoir	Sacramento River to Holthouse Reservoir
Delevan Intake Pumping/ Generating Plant	Location	West side of Sacramento River, near Highway 45	No pumping/generating plant, release only; Sacramento River, near Highway 45	West side of Sacramento River, near Highway 45	West side of Sacramento River, near Highway 45
	Flow Capacities	2,000 cfs pumping 1,500 cfs releasing	No pumping 1,500 cfs releasing	2,000 cfs pumping 1,500 cfs releasing	2,000 cfs pumping 1,500 cfs releasing
	Pumping Head (Max)	282 feet	No pumping	282 feet	282 feet
	Generation	9.8 MW (94 feet head)	No generation	9.8 MW (94 feet head)	9.8 MW (94 feet head)
	Fish Screens Required	Yes	No	Yes	Yes
TRR	Capacity	2,000 AF	2,000 AF	2,000 AF	1,200 AF
	Footprint	191 acres	191 acres	191 acres	125 acres
	Depth	17 feet	17 feet	17 feet	17 feet

Facility	Feature	Alternative A	Alternative B	Alternative C	Alternative D
	Maximum Embankment Height	21 feet	21 feet	21 feet	21 feet
TRR Pumping/ Generating Plant	Location	TRR Reservoir	TRR Reservoir	TRR Reservoir	TRR Reservoir
	Capacity	1,890 cfs pumping 800 cfs generating	1,890 cfs pumping 800 cfs generating	1,890 cfs pumping 800 cfs generating	1,890 cfs pumping 800 cfs generating
	Pumping Head (Max)	114 feet	114 feet	114 feet	114 feet
	Generation	4.7 MW	4.7 MW	4.7 MW	4.7 MW
TRR Pipeline	Location	TRR Reservoir	TRR Reservoir	TRR Reservoir	TRR Reservoir
	Flow Capacities	1,890 cfs pumping 800 cfs releasing	1,890 cfs pumping 800 cfs releasing	1,890 cfs pumping 800 cfs releasing	1,890 cfs pumping 800 cfs releasing
	Length	3.5 miles	3.5 miles	3.5 miles	3.5 miles
	Size	Two 12-foot-diameter RCPs (steel cylinder)	Two 12-foot-diameter RCPs (steel cylinder)	Two 12-foot-diameter RCPs (steel cylinder)	Two 12-foot-diameter RCPs (steel cylinder)
	From/To	TRR to Holthouse Reservoir	TRR to Holthouse Reservoir	TRR to Holthouse Reservoir	TRR to Holthouse Reservoir
Power Transmission	Westside	WAPA or PG&E connection for Sites PGP and TRR	WAPA or PG&E connection for Sites PGP and TRR	WAPA or PG&E connection for Sites PGP and TRR	WAPA or PG&E connection for Sites PGP and TRR
	Delevan Intake Source	East/West Transmission to Delevan Intake	No new transmission to Delevan Intake	East/West Transmission to Delevan Intake	North/South Transmission to Delevan Intake
Recreation	Facilities	Stone Corral, Lurline Headwaters, Antelope Island	Stone Corral, Lurline Headwaters, Antelope Island	Stone Corral, Lurline Headwaters, Antelope Island	Stone Corral, Peninsula Hills

AF = acre-feet
cfs = cubic feet per second
MAF = million acre-feet
msl = mean sea level
MW = megawatt(s)
NODOS = North-of-the-Delta Offstream Storage
PG&E = Pacific Gas and Electric Company
PGP = Pumping/Generating Plant
PMF = Probable Maximum Flood
RCP = reinforced-concrete pipe
T-C = Tehama-Colusa
TRR = Terminal Regulating Reservoir
WAPA = Western Area Power Administration
WSE = water surface elevation