



State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES

CALIFORNIA AQUEDUCT SUBSIDENCE PROGRAM LONG-TERM REHABILITATION CAPITAL COST ESTIMATE REPORT



January 2026

*Cover photo by Ken James, Department of Water Resources.
California State Water Project, located near John R. Teerink Pumping Plant
March 28, 2019.*

State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES
Division of Engineering
California Aqueduct Subsidence Program

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*This report is the result of a much larger team of individuals both within the Department and those consulting for the Department. From each of us listed above, thank you to all those that contributed to the success of this project and your assistance in preparing this report.

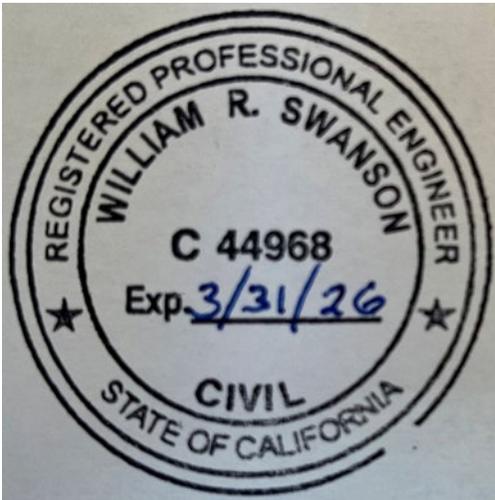
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Division of Engineering

**California Aqueduct Subsidence Program
Long-Term Rehabilitation Capital Cost Estimate Report**

ENGINEERING CERTIFICATION

This report has been prepared under my direction as the professional engineer in direct responsible charge of the work, in accordance with the provisions of the Professional Engineers Act of the State of California.



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Expires: March 31, 2026

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ABBREVIATIONS AND ACRONYMS

AACE	Association for the Advancement of Cost Engineering
Aqueduct	California Aqueduct
CASP	California Aqueduct Subsidence Program
CVP	Central Valley Project
DWR	Department of Water Resources
Long-Term Plan	CASP Long-Term Subsidence Plan
Reclamation	Bureau of Reclamation
SFM	Subsidence Forecast Model
SLC	San Luis Canal
SWP	State Water Project

Executive Summary

The California Department of Water Resources (DWR) California Aqueduct Subsidence Program (CASP) prepared this report to document the estimated total capital cost to rehabilitate or replace those portions of the San Luis Canal (SLC) and California Aqueduct (Aqueduct) facilities in the San Joaquin Valley adversely affected by past and projected future subsidence (Pools 14 through 21 of the SLC and Pools 22 through 40 of the Aqueduct). Subsidence along the SLC and Aqueduct reduces hydraulic conveyance capacity and operational flexibility. Without infrastructure investment, the long-term average water delivery capability of the State Water Project (SWP) could be significantly reduced due to subsidence. Under 2043 climate conditions, projected subsidence would cause reductions in SWP deliveries by 84 percent (DWR 2024a).

This capital cost estimate includes the cost to rehabilitate or replace original facilities in-place that have been or would be affected by subsidence to achieve:

- the original design water surface profile,
- three feet of lined freeboard above the original design water surface and six feet of embankment freeboard above the original design water surface in the SLC,
- two and a half feet of lined freeboard above the original design water surface and five feet of embankment freeboard above the original design water surface in the Aqueduct, and
- structure clearance of two feet for bridges, overchutes, and pipeline crossings, and zero feet for checks.

If different freeboard or structure clearances are required for design, it would change the number of affected facilities and the cost to rehabilitate. The capital cost estimate is based on surveyed 2023 subsidence and projected 2085 subsidence from the CASP Subsidence Forecast Model (DWR 2024b).

Table ES-1 presents the construction cost subtotal; the total escalation; design and construction contingencies; non-contract project implementation costs applied (e.g., land, right-of-way easement negotiation, and purchasing; environmental mitigation; and engineering, permitting, legal, project management, and construction management); and the total capital cost estimate to address past subsidence and projected 2085 subsidence. The total capital cost estimate is \$3.87 billion, of which \$2.25 billion is associated with facilities in the SLC and \$1.62 billion is associated with facilities in the Aqueduct.

Table ES-1 CASP Capital Cost Estimate to Address Past Subsidence and Projected 2085 Subsidence

	SLC^{1,2}	Aqueduct^{1,2}	Total^{1,2}
Construction Cost Subtotal	\$1.16 B	\$0.83 B	\$1.99 B
Design and Construction Contingencies, Non-Contract Costs (Right-of-Way, Environmental Mitigation, Engineering, Permitting, Legal, Project Management, and Construction Management), and Escalation to Mid-Point of Construction	\$1.10 B	\$0.79 B	\$1.89 B
Total Capital Cost³	\$2.25 B	\$1.62 B	\$3.87 B

¹ Values may not add to totals due to rounding.

² Costs presented in billions of 2024 dollars.

³ The CASP capital cost estimate is generally categorized as an AACE Class 4/5 level (reference-Association for the Advancement of Cost Engineering (AACE) 56R-08, According to AACE 56R-08, Class 5 cost estimates are based on very limited information and generally correspond to “rough order of magnitude” or “concept screening level.” Class 4 cost estimates are typically prepared using limited information and are typically used for project screening and preliminary budget approval, corresponding to both “screening” and “authorization.” The accuracy range for this cost estimate is between 30 percent under and 50 percent over (\$2.71B to \$5.81B).

Key: Aqueduct = California Aqueduct; SLC = San Luis Canal.

The SLC is a Bureau of Reclamation (Reclamation) Joint Use Facility, operated and maintained by DWR to convey and deliver Central Valley Project (CVP) and SWP water supplies. DWR is coordinating with Reclamation to develop a set of recommended structural and/or non-structural actions to restore original design hydraulic conveyance capacity and operational flexibility to the SLC and the Aqueduct.

The capital cost estimate presented in this document was prepared to provide preliminary information on the potential scope of required modifications. It is not presented as an initial alternative or recommended solution and is not pre-decisional.

1.0 Introduction

1.1 Purpose of this Document

The California Department of Water Resources (DWR) California Aqueduct Subsidence Program (CASP) prepared this report to document the estimated total capital cost to rehabilitate or replace those portions of the San Luis Canal (SLC) and California Aqueduct (Aqueduct) facilities in the San Joaquin Valley adversely affected by past and projected future subsidence (Pools 14 through 21 of the SLC and Pools 22 through 40 of the Aqueduct). CASP was established to develop and implement beneficial and affordable corrective and preventive actions to mitigate the adverse effects of current and future subsidence to the SLC and Aqueduct. In this document, SLC refers to the portion of the San Luis Canal that includes Pools 14 through 21 and Aqueduct refers to the portion of the California Aqueduct that includes Pools 22 through 40.

This capital cost estimate presented in this report is based on the rehabilitation or replacement of facilities in place to achieve:

- the original design water surface profile,
- three feet of lined freeboard above the original design water surface and six feet of embankment freeboard above the original design water surface in the SLC,
- two and a half feet of lined freeboard above the original design water surface and five feet of embankment freeboard above the original design water surface in the Aqueduct¹, and
- structure clearance of two feet for bridges, overchutes, and pipeline crossings, and zero feet for checks.

If different freeboard or structure clearances are required for design, it would change the number of affected facilities and the cost to rehabilitate. This capital cost estimate was prepared to provide preliminary information on the potential magnitude of capital investment for corrective actions to rehabilitate the SLC and Aqueduct in response to historic and projected subsidence. It is not presented as an alternative or recommended solution to address past or projected future subsidence. Multiple alternatives are being developed and will be analyzed as part of a comprehensive planning process that is being conducted in coordination with the Bureau of Reclamation (Reclamation).

1.2 Overview of San Luis Canal and California Aqueduct

The concrete-lined SLC and Aqueduct both consist of a series of connected pools between pumping plants that are operated in coordination to convey water by gravity

¹ Freeboard is the vertical distance between the water surface and the top of the concrete liner or earthen embankment that provides a factor of safety to prevent overtopping.

from one pool to the next. The downstream end of each pool is defined by either a gated check structure that maintains the water surface elevation within the pool and controls the flow into the next pool or a pumping plant that lifts water up to the next pool. The check at the downstream end of each pool is numbered to correspond with the pool it impounds. Figure 1-1 shows the location of the SLC and Aqueduct.

The SLC is owned by Reclamation as a Joint Use Facility and integral feature to both the federal Central Valley Project (CVP) and the California State Water Project (SWP). The Aqueduct is owned by DWR and is the backbone of the SWP. DWR operates and maintains the SLC and Aqueduct. Reclamation water supplies are diverted from pools in the SLC, and Reclamation relies on the available hydraulic conveyance capacity in a portion of the Aqueduct in the San Joaquin Valley to convey water supplies for delivery to wildlife refuges and Cross Valley Canal contractors. DWR relies on hydraulic conveyance capacity in the SLC to convey water supplies downstream to the Aqueduct, where it is conveyed and diverted for delivery.

Water supplies conveyed through the SLC and Aqueduct to CVP and SWP water contractors serve over 1.5 million acres of farmland and approximately 24 million people. The *SWP Delivery Capability Report 2023 Addendum: Impacts of Subsidence* projects that, without additional operational adaptations or infrastructure improvements, the long-term average water delivery capability of the SWP could be significantly reduced due to subsidence. Under 2043 climate conditions, projected subsidence would cause reductions in SWP deliveries by 84 percent could be reduced by up to 84 percent by 2043 (DWR 2024a).

Figure 1-1 SLC and Aqueduct Facility Locations

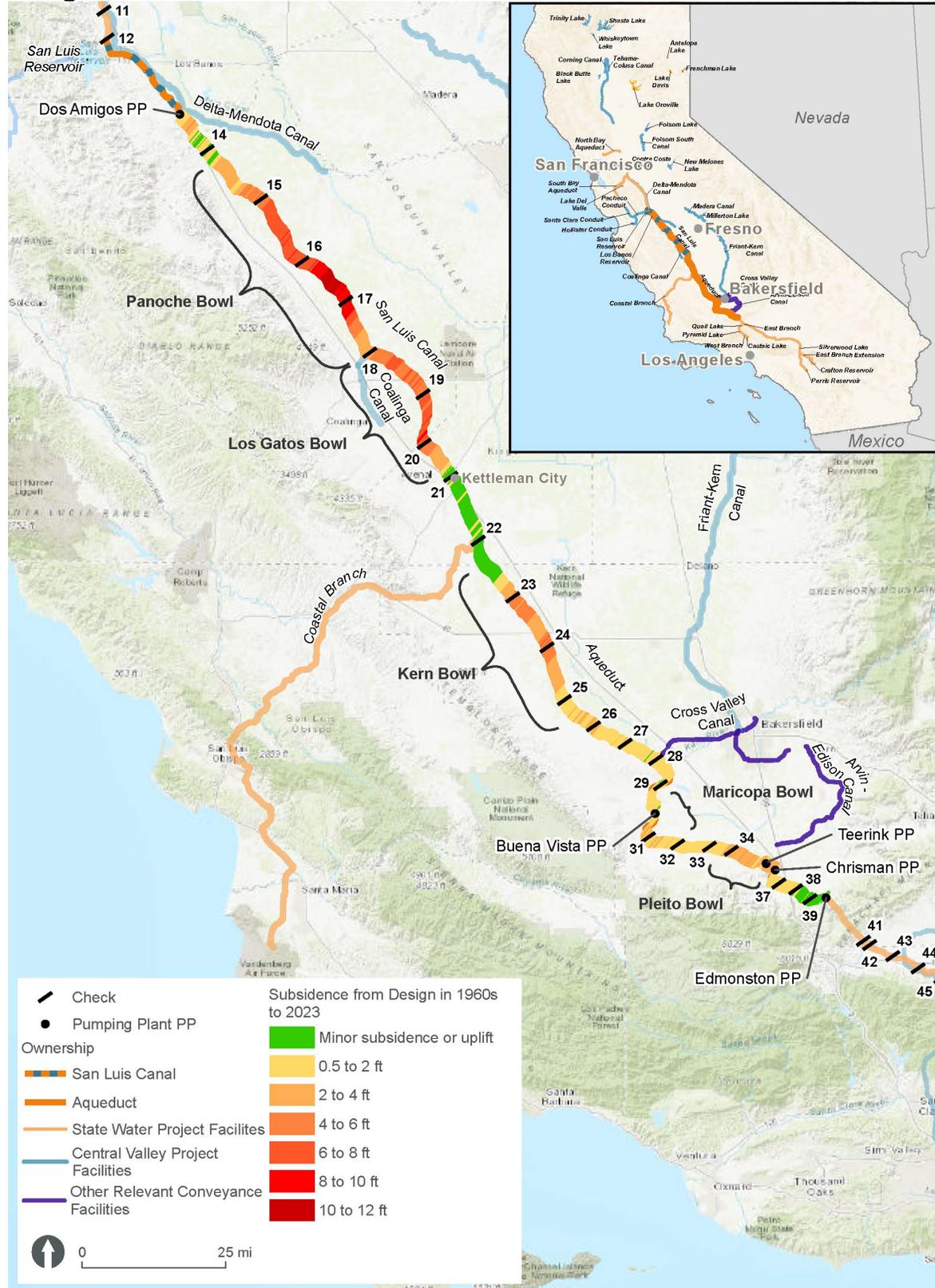


1.3 Subsidence of the San Luis Canal and Aqueduct

Land subsidence is the lowering of the land surface resulting from underground resource extraction. Subsidence in the San Joaquin Valley has been recorded, analyzed, and studied since the 1920s; it is caused predominately by groundwater pumping for agricultural purposes, and may also be impacted by fluid extraction during oil and gas production activities. Before construction of the SLC and Aqueduct began in the mid-1960s, subsidence of 20 to 30 feet had been recorded in portions of the San Joaquin Valley. Subsidence was considered during the design of the facilities by providing additional concrete liner and embankment height that exceeded design freeboard criteria in areas where future subsidence was anticipated. Subsidence continued to occur during construction from the mid-1960s through the early 1970s. Since then, regional land subsidence continued at rates greater than anticipated and has differentially lowered the elevation of portions of the SLC and the Aqueduct at several locations, causing reduced hydraulic conveyance capacity and reduced operational flexibility. Reduced hydraulic conveyance capacity constrains water deliveries.

DWR elevation survey results show that subsidence has lowered the elevation of the SLC and Aqueduct at numerous locations and caused five distinct areas where the profile of the SLC and Aqueduct is significantly depressed. These areas are referred to as subsidence “bowls.” Subsidence bowls along the alignment of the canal cause reduced hydraulic conveyance capacity. Figure 1-2 shows the location and extent of subsidence that has occurred along the SLC and Aqueduct as of 2023 in comparison to the original facility design. As illustrated in Figure 1-2, the SLC has experienced greater subsidence than the Aqueduct.

Figure 1-2 Subsidence of the SLC and Aqueduct as of 2023 Compared to Original Design



CASP developed a probabilistic Subsidence Forecast Model (SFM) to prepare estimates of future subsidence of the SLC and Aqueduct because a physically based model to evaluate subsidence throughout the SLC and Aqueduct does not exist. The SFM quantifies a range of potential future land subsidence in consideration of climate change parameters developed by the DWR Climate Change Program and anticipated future reductions in subsidence rates associated with the implementation of the Sustainable Groundwater Management Act, which requires the high-priority groundwater basins to be in balance by 2040. Additional details about the development of the SFM and projections of future subsidence can be found in the *Probabilistic Subsidence Forecast Model for the California Aqueduct Subsidence Program, San Joaquin Valley, California: Revision 1* (DWR 2024b), located on the [\[DWR website\]](#).

CASP is using a planning horizon to the year 2085 in accordance with DWR's *State Water Project Adaptation Strategy: Reducing Vulnerabilities to Climate Change* (DWR 2025) and standard planning practice. For this capital cost estimate, subsidence projections are based on the 75th Non-Exceedance Subsidence Percentile for 2085, as generated by the SFM. This percentile corresponds to a 25 percent probability that subsidence will exceed the projections at the 75th Non-Exceedance Subsidence Percentile. Figure 1-3 shows the combination of historical and projected 2085 subsidence along the SLC and Aqueduct in comparison to the original facility design.

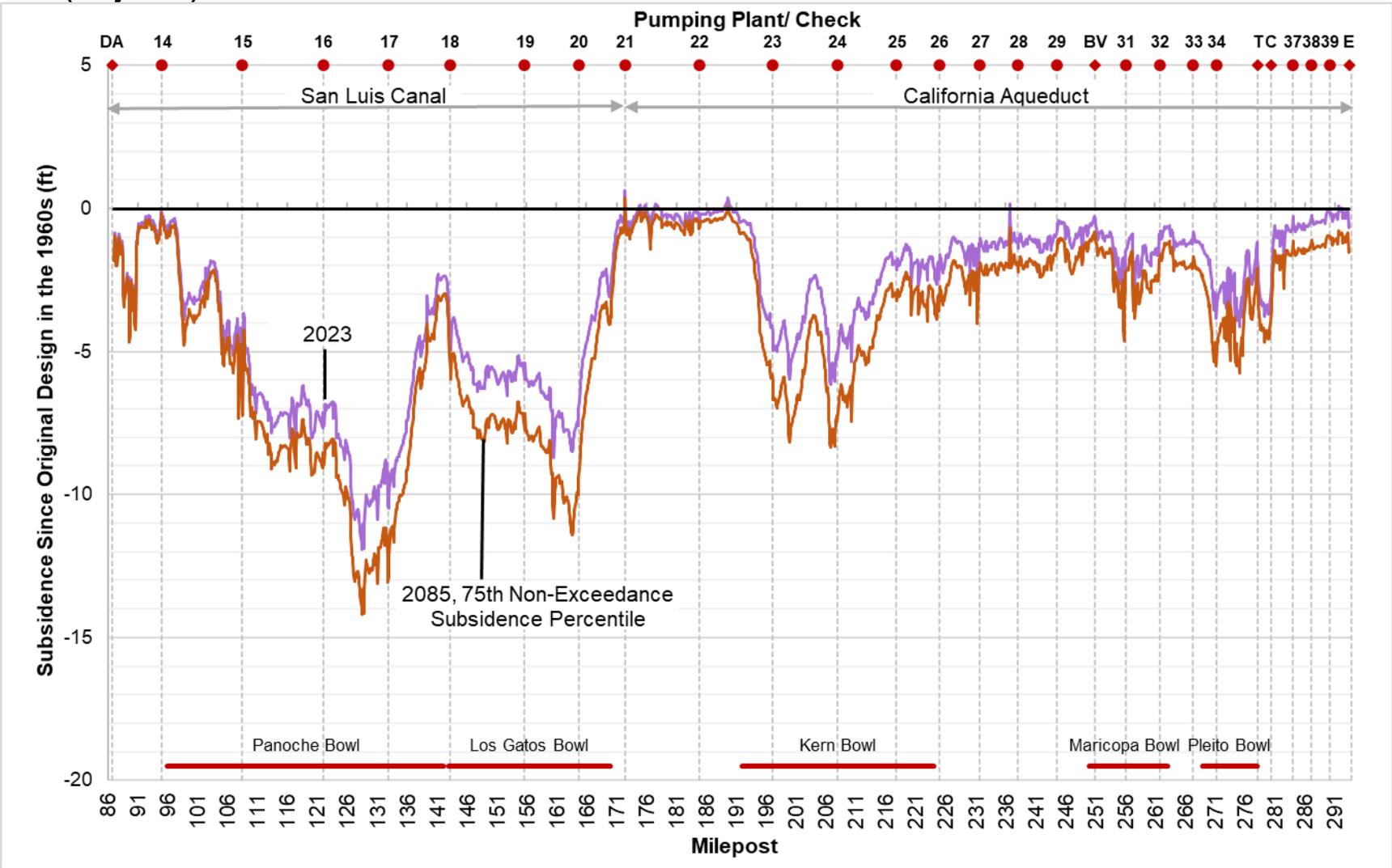
Figure 1-3 Projected 2085 Subsidence of the SLC and Aqueduct Compared to Original Design



Figure 1-4 shows the same historical and projected 2085 subsidence along the SLC and Aqueduct as shown in Figures 1-2 and 1-3, but in profile view. Figure 1-4 shows over 11 feet of subsidence has occurred in Pool 17, and approximately 2.5 feet of additional subsidence is projected to occur from 2023 to 2085. Comparing the magnitude of subsidence that has already occurred (2023 profile) to the magnitude of subsidence that is projected to occur by 2085 (2085 profile) in Figure 1-4 demonstrates that more subsidence has occurred over the last 60 years than is anticipated to occur over the next 60 years.

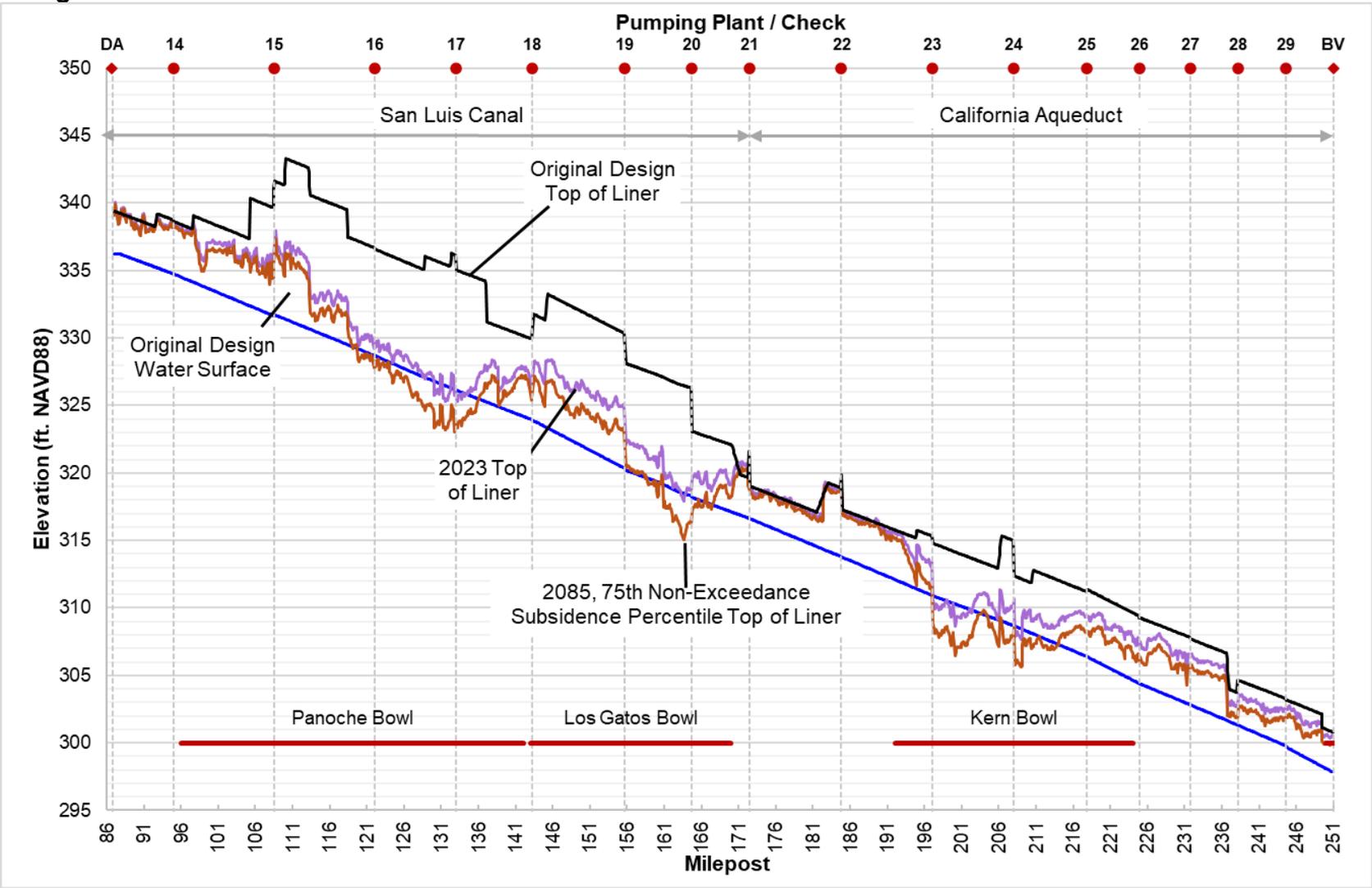
Figure 1-5 shows elevation profiles of the top of concrete liner at the original design, 2023, and projected 2085, along with the original design water surface profile. The distance from the original design top of liner elevation to the 2023 and projected 2085 top of liner elevation represents the subsidence that has occurred or is forecasted to occur. In areas where the top of liner elevation is below the original design water surface elevation, the water would overtop the canal if operated using the original design water surface profile. As illustrated in Figure 1-5, the 2023 and projected 2085 top of liner falls below the original design water surface elevation in Pools 17, 18, 20, 24, and 25. Thus, Figure 1-5 illustrates that the SLC and Aqueduct cannot be operated at the original design water surface profile today, nor into the future. Therefore, rehabilitation or replacement of SLC and Aqueduct facilities will be necessary to restore the original design hydraulic conveyance capacity, freeboard, and operational flexibility.

Figure 1-4 Profiles of SLC and Aqueduct Subsidence from Original Design in the 1960s to 2023 (Historical) and 20285 (Projected)



Note: This graphic applies an exaggerated scale to depict a vertical range of 25 feet over a distance exceeding 200 miles.

Figure 1-5 Top of Liner Elevation Profiles – Original Design, 2023, and Projected 2085 in Relation to Original Design Water Surface Profile



Note: The geographic extent is limited to the SLC and Aqueduct reach between the Dos Amigos Pumping Plant and the Buena Vista Pumping Plant because displaying the elevation change at Buena Vista Pumping Plant would limit graphic resolution. This graphic applies an exaggerated scale to depict a vertical range of 55 feet over a distance exceeding 165 miles.

2.0 San Luis Canal and California Aqueduct Facilities Adversely Affected by Subsidence

This capital cost estimate is based on the rehabilitation or replacement of facilities in-place to restore and maintain the original design water surface profile of the SLC and Aqueduct through 2085. General descriptions of facilities assessed for rehabilitation or replacement in-place and how they can be affected by subsidence are summarized below.

- **Bridges:** Bridges spanning the SLC and Aqueduct include one- or two-lane private/access roads; two-lane, undivided local roads; state highways; interstate highways; railroad crossings; and a footbridge. Higher water levels at subsided bridges can reduce hydraulic conveyance capacity, increase safety risks, and preclude regular inspection and maintenance.
- **Overchutes:** An overchute is a concrete channel spanning the Aqueduct that is used to move storm runoff from one side to the other. Overchutes are located over the Aqueduct only; none span the SLC. Higher water levels at subsided overchutes can reduce hydraulic conveyance capacity and increase structural integrity risks.
- **Checks:** A check is an in-line structure with 3 or 4 gates used to control the flow of water by regulating its level. Higher water levels at subsided checks can reduce control of water flow and increase structural integrity risks.
- **Pipeline Overcrossings:** A pipeline overcrossing conveys water, oil, gas, or supports telecommunications in a pipeline suspended above the water surface of the SLC or Aqueduct. Higher water levels at subsided pipeline overcrossings can cause buoyancy and accelerate corrosion. This analysis considers standalone pipeline overcrossings only; pipeline crossings attached to bridges are not considered.
- **Concrete Liner and Earthen Embankments:** The SLC and Aqueduct are concrete-lined prismatic canals built on earthen embankments that extend above the top of the concrete liner to provide stability and additional freeboard that reduces the risk of water overtopping. There are service roads on top of the embankment. Higher water levels in canal sections can reduce available liner and embankment freeboard, increasing the risk of seepage and overtopping. Raising the embankment or liner would require replacement of the service road. The liner and embankment on the east (left) and west (right) are considered separately in this analysis.

- **Turnouts:** A turnout is a structure built into the bank of the SLC or Aqueduct that is used to divert water into a canal, pipeline, ditch, or field for delivery to CVP and/or SWP water contractors. Water levels higher than original design levels at turnouts can cause water to encroach on the turnout structure and may be incompatible with the turnout’s original design. This analysis considered permanent turnouts only; temporary turnouts are not included.

- **Utility Undercrossings:** A utility undercrossing is a pipeline that conveys water, oil, or gas or supports telecommunications beneath the SLC or Aqueduct. Raising an embankment over a utility undercrossing may affect the utility undercrossing and require its replacement.

- **Power line Overcrossings:** Raising and widening an embankment in the vicinity of a power line overcrossing may affect nearby power line poles. A review of power line facilities revealed that wooden power line poles adjacent to the embankment will need to be replaced if the embankment is raised; other steel pole power lines are located far enough from the embankment to not be affected.

The existing 2023 and projected 2085 infrastructure elevations were compared to the original design water surface elevation to identify which facilities would require modification and the height needed to maintain required freeboard or clearance with the original design water surface profile. Table 2-1 includes the clearance and freeboard criteria applied to each type of facility in the SLC and Aqueduct.

Table 2-1 SLC and Aqueduct Facility Clearance and Freeboard Criteria

Facility Type	SLC Clearance or Freeboard (feet) ¹	Aqueduct Clearance or Freeboard (feet) ¹
Bridge	2	2
Overchute	2	2
Check	0	0
Pipeline Overcrossing	2	2
Concrete Liner	3	2.5
Embankment ²	6	5

¹ Lined freeboard is the vertical distance from the water surface to the top of the concrete liner. Embankment or unlined freeboard is the vertical distance from the water surface to the top of the embankment.

² Required modifications to turnouts, power line overcrossings, and utility undercrossings are currently determined based on nearby embankment raises.

Key: Aqueduct = California Aqueduct; SLC = San Luis Canal

Tables 2-2, 2-3, and 2-4 summarize the types and quantities of facilities affected by projected future subsidence for the SLC, Aqueduct, and combined, respectively. Almost 250 miles of liner are affected in total (from the east and west sides of the SLC and Aqueduct combined), with 121 and 127 miles of affected liner in the SLC and Aqueduct, respectively.

Table 2-2 SLC Facilities Requiring Rehabilitation or Replacement Due to Projected 2085 Subsidence

SLC Facility Type	Total Facilities	Affected Facilities	Percent of Facilities Affected
Bridge	37	13	35%
Overchute	0	0	n/a
Check	8	7	88%
Pipeline Overcrossing ¹	16	10	63%
Utility Undercrossing	82	22	27%
Turnout	86	73	85%
Power Line Overcrossing	89	56	63%
Length of Liner Modification ² (miles)	170	121	71%
Length of Embankment Modification ² (miles)	170	129	76%

¹ Only includes the pipeline overcrossings on piers, not pipeline overcrossings attached to bridges or overchutes.

² Length includes the left/east and west/right liner and embankment. The lengths are slightly shorter than double the length of the SLC due to the length of checks, siphons, and pumping plants being excluded from potential liner and embankment raises.

Key: SLC = San Luis Canal

Table 2-3 Aqueduct Facilities Requiring Rehabilitation or Replacement Due to Projected 2085 Subsidence

Aqueduct Facility Type	Total Facilities	Affected Facilities	Percent of Facilities Affected
Bridge	39	4	10%
Overchute ¹	74	51	69%
Check	15	5	33%
Pipeline Overcrossing ²	51	10	20%
Utility Undercrossing	14	1	7%
Turnout	57	36	63%
Power Line Overcrossing	71	20	28%
Length of Liner Modification ³ (miles)	237	127	54%
Length of Embankment Modification ³ (miles)	237	89	38%

¹ Only concrete overchutes are included in this count. Six much smaller steel overchutes are included as pipeline crossings, as the replacement cost would be more similar to a pipeline crossing than a large concrete overchute.

² Only includes pipeline overcrossings on piers, not pipeline overcrossings attached to bridges or overchutes.

³ Lengths include the left/east and west/right liner and embankment. The lengths are slightly shorter than double the length of the Aqueduct due to the length of checks, siphons, and pumping plants being excluded from potential liner and embankment raises.

Key: Aqueduct = California Aqueduct

Table 2-4 Total SLC and Aqueduct Facilities Requiring Rehabilitation or Replacement Due to Projected Subsidence

SLC and Aqueduct Facility Type	Total Facilities	Affected Facilities	Percent of Facilities Affected
Bridge	76	17	22%
Overchute ¹	74	51	69%
Check	23	12	52%
Pipeline Overcrossing ²	67	20	30%
Utility Undercrossing	96	23	24%
Turnout	143	109	76%
Power Line Overcrossing	160	76	48%
Length of Liner Modification ³ (miles)	407	249	61%
Length of Embankment Modification ³ (miles)	407	218	54%

¹ Only concrete overchutes are included in this count. Six much smaller steel overchutes are included as pipeline crossings, as the replacement cost would be more similar to a pipeline crossing than a large concrete overchute.

² Only includes pipeline overcrossings on piers, not pipeline overcrossings attached to bridges or overchutes.

³ Lengths include the left/east and west/right liner and embankment. The lengths are slightly shorter than double the length of the SLC and Aqueduct due to the length of checks, siphons, and pumping plants being excluded from potential liner and embankment raises.

Key: Aqueduct = California Aqueduct; SLC = San Luis Canal

3.0 Capital Cost Estimate Methodology and Classification

This capital cost estimate was prepared by applying unit costs to rehabilitate or replace each facility type to the quantities of affected facilities and applying project contingencies to account for uncertain items, conditions, or events that are likely to result in additional project costs. The level of detail used to develop unit costs varies by facility type, in accordance with the level of engineering design that has been completed to date. While engineering design has been initiated for select facilities in the SLC, no systemwide (occurring throughout Pools 14–40) preliminary engineering, geotechnical, or environmental work has yet occurred.

The CASP capital cost estimate is generally categorized as an AACE Class 4/5 level (reference-Association for the Advancement of Cost Engineering (AACE) 56R-08, *Cost Estimate Classification System—As Applied in Engineering, Procurement, and Construction for the Building and General Construction Industries*). According to AACE 56R-08, Class 5 cost estimates are based on very limited information and generally correspond to “rough order of magnitude” or “concept screening level.” Class 4 cost estimates are typically prepared using limited information and are typically used for project screening and preliminary budget approval, corresponding to both “screening” and “authorization.” Table 3-1 describes the assumed replacement or rehabilitation activity, unit cost source, and AACE Classification by facility type.

This capital cost estimate represents DWR’s opinion on the probable cost based on currently available information and is presented with an accuracy range between 30 percent under and 50 percent over (\$2.71 B to \$5.81 B) applied to the estimated capital cost (\$3.87 B) that includes non-contract costs and contingencies. This accuracy range is in alignment with AACE 56R-08 guidance and is expected to narrow as the maturity level of the project design increases. The capital cost estimate is preliminary and subject to refinement as additional information becomes available, alternatives are developed, and additional engineering details are developed.

Table 3-1 Unit Cost Source and AACE Classification by Facility Type

Facility Type	Assumed Rehabilitation/ Replacement Activity ¹	Unit Cost Source	AACE Classification
Bridge	Bridges are replaced adjacent to the existing bridge.	Unit costs for bridge structure and approach are derived from 95 percent bridge design and cost estimates prepared for several bridges that cross the SLC.	Class 4/5 ²
Overchute	Overchutes are replaced adjacent to the existing overchute.	Unit costs are derived from 95 percent structure design and cost estimates for several bridges that cross the SLC.	Class 5

Facility Type	Assumed Rehabilitation/ Replacement Activity ¹	Unit Cost Source	AACE Classification
Check Structure	Check structures are replaced at the location of existing check structures.	Unit costs are derived from design and cost estimates for replacement of a check in the SLC.	Class 5
Pipeline Crossing	Pipeline crossings are replaced at their existing locations.	Lump sum construction cost for a typical pipeline crossing.	Class 5
Concrete Liner	Existing concrete liner would be extended by placing concrete on the existing and raised embankment.	Unit cost based on recent, similar construction in the San Joaquin Valley, applied to the estimated quantity of concrete and appurtenant structures.	Class 4
Embankment	Additional embankment material is added to the existing embankments at the original design slope, with the service road replaced on the embankment crest where necessary.	Unit cost based on recent, similar construction in the San Joaquin Valley, applied to the estimated quantity of earthen fill, roadway, and appurtenant structures.	Class 4
Utility Undercrossing	Utility undercrossings are replaced at their existing locations.	Lump sum construction cost for typical utility undercrossing.	Class 5
Turnout	Turnouts are either waterproofed or raised where technically possible or replaced.	Costs to waterproof turnouts or to raise or modify turnout decks are lump sum construction costs for typical facilities. Turnout replacement costs are based on 35 percent designs and cost estimates for turnouts in the SLC.	Class 4/5 ³
Power Line	Affected wooden poles are replaced along the alignment of existing power lines.	Typical cost based on recent similar modification.	Class 4

¹ All structure replacements are assumed to be in accordance with current design criteria, which in many cases have changed since original construction to account for seismic risk, additional safety requirements, and other considerations.

² 95 percent bridge replacement designs and cost estimates were prepared for private access road bridges, local road bridges, and a state highway bridge in the SLC. Unit costs for these three bridge types are considered Class 4. Unit costs for interstate highway bridges, railroad bridges, and a footbridge are considered Class 5.

³ 35 percent turnout replacement designs and cost estimates were prepared for turnouts in the SLC. Turnout replacement unit costs are considered Class 4. Turnout waterproof, deck modification, or desk raise costs are considered Class 5.

Key: AACE = Association for the Advancement of Cost Engineering; SLC = San Luis Canal.

The capital cost estimate includes the buildup of allowances to determine the total project cost. The capital cost estimate includes owner’s costs, also known as non-contract costs or implementation expenses, to provide an estimate that encompasses the entire project life cycle. The cost estimate buildup is described below:

- Contract Cost: Subtotal of construction items plus:

- Escalation to the mid-point of construction using a 5.5 percent federal discount rate (December 2023) and a 2-year construction duration.
- A 20-percent contingency for design and unlisted items is applied to the sum of construction items escalated to the mid-point of construction to account for scope variations and unknown site conditions.
- Field Cost: Contract Cost plus:
 - A 10-percent construction contingency is applied to the Contract Cost to account for potential construction-related issues or changed field conditions.
- Capital Cost: Field Cost plus the following non-contract project implementation costs:
 - A 5-percent cost for land, right-of-way easement negotiation, and purchasing,
 - A 10-percent cost for environmental mitigation, and
 - A 25-percent cost for engineering, permitting, legal, project management, and construction management.
- Uncertainty in capital cost is represented by an accuracy range of 30 percent under and 50 percent over applied to the capital cost.

4.0 Capital Cost Estimate Summary

The capital cost estimate includes the cost to rehabilitate or replace facilities in-kind within the SLC and Aqueduct between Pools 14 and 40 that have been or would be affected by subsidence to restore the original design water surface profile based on projected 2085 subsidence. Additional costs, such as groundwater monitoring, public outreach, and other program activities, are not included herein. The capital cost estimate is presented in 2024 dollars and is “undiscounted,” an economic term meaning the value does not account for the time value of money.

Table 4-1 presents the capital cost estimate to address past subsidence and projected 2085 subsidence, including the construction costs by facility type, escalation to the mid-point of construction, design contingency, construction contingency, and non-contract costs. Review of Table 4-1 reveals the following insights:

- The total capital cost estimate is \$3.87 billion, which is subject to an uncertainty range of 30 percent under to 50 percent over (\$2.71B to \$5.81B).
- Approximately 58 percent (\$2.25B) of the cost in this estimate is associated with facilities in the SLC, and about 42 percent (\$1.62B) of the cost is associated with facilities in the Aqueduct.
- About 74 percent (\$1.67B) of the cost to rehabilitate or replace facilities in the SLC for projected 2085 subsidence can be attributed to subsidence that occurred before 2023.
- About 65 percent (\$1.05B) of the cost to rehabilitate or replace facilities in the Aqueduct for projected 2085 subsidence can be attributed to subsidence that occurred before 2023.

Table 4-2 presents the capital cost estimate to address past subsidence and projected 2085 subsidence for Repayment Reaches along the SLC and Aqueduct.

Table 4-1 CASP Capital Cost Estimate to Address Past Subsidence and Projected 2085 Subsidence

	SLC ^{1, 2}	Aqueduct ^{1, 2}	Total ^{1, 2}	Percent of Subtotal of Construction Items ¹
Bridge	\$116.7 M	\$34.5 M	\$151.2 M	7.6%
Overchute	\$0.0 M	\$89.0 M	\$89.0 M	4.5%
Check	\$350.0 M	\$250.0 M	\$600.0 M	30.2%
Pipeline Crossing	\$3.7 M	\$3.7 M	\$7.4 M	0.4%
Utility Undercrossing	\$16.2 M	\$0.7 M	\$17.0 M	0.9%
Turnout	\$190.1 M	\$27.6 M	\$217.7 M	11.0%
Power Line	\$3.6 M	\$1.3 M	\$4.9 M	0.2%
Concrete Liner	\$164.8 M	\$159.5 M	\$324.3 M	16.3%
Embankment Material ³	\$218.5 M	\$174.5 M	\$393.1 M	19.8%
Service Roads	\$91.7 M	\$88.9 M	\$180.6 M	9.1%
Subtotal of Construction Items	\$1,155 M	\$830 M	\$1,985 M	100.0%
Subtotal of Construction Items with 5.5% Escalation to Mid-Point of Construction	\$1,219 M	\$875 M	\$2,094 M	
Design Contingency (20%)	\$244 M	\$175 M	\$419 M	
Contract Cost	\$1,463 M	\$1,050 M	\$2,513 M	
Construction Contingency (10%)	\$146 M	\$105 M	\$251 M	
Field Cost	\$1,609 M	\$1,156 M	\$2,764 M	
Land/Right-of-Way Easement Negotiation/Purchase (5%)	\$80 M	\$58 M	\$138 M	
Environmental Mitigation (10%)	\$161 M	\$116 M	\$276 M	
Engineering, Permitting, Legal, Project Management, and Construction Management (25%)	\$402 M	\$289 M	\$691 M	
Total Capital Cost	\$2.25 B	\$1.62 B	\$3.87 B	
AACE Class 4/5 Capital Cost Low Estimate (-30%)	\$1.58 B	\$1.132 B	\$2.71 B	
AACE Class 4/5 Capital Cost (+50%)	\$3.38 B	\$2.427 B	\$5.81 B	

¹ Values may not add to totals due to rounding.

² Costs presented in 2024 dollars.

³ Embankment haul costs are dependent upon the assumed distance to haul embankment materials, inclusive of handling costs. Right-of-way embankment material is assumed to be within 2,000 feet one way; short-haul embankment materials are assumed to be available within 5 miles one way, and long-haul embankment material is assumed to be available within 35 miles one way. Embankment material in the SLC is assumed to be 20% right-of-way, 70% short haul, and 10% long haul. Embankment material in the Aqueduct is assumed to be 10% right-of-way, 10% short haul, and 80% long haul.

Key: AACE = Association for the Advancement of Cost Engineering; Aqueduct = California Aqueduct; SLC = San Luis Canal.

Table 4-2 Capital Cost Estimate to Address Past Subsidence and Projected 2085 Subsidence, by Repayment Reach

Repayment Reach	Facility	Start MP	End MP	Estimated Total Capital Cost (\$M, 2024) to Address Historic Subsidence + Projected Future Subsidence To 2085 ^{1, 2}
4	SLC	86.73	108.56	\$232 M
5	SLC	108.56	143.29	\$1,174 M
6	SLC	143.29	155.70	\$177 M
7	SLC	155.70	172.44	\$668 M
8C	Aqueduct	172.44	172.66	\$2 M
8D	Aqueduct	172.66	184.84	\$84 M
9	Aqueduct	184.84	197.07	\$173 M
10A	Aqueduct	197.07	210.31	\$579 M
11B	Aqueduct	210.31	217.81	\$113 M
12D	Aqueduct	217.81	229.71	\$85 M
12E	Aqueduct	229.71	238.13	\$146 M
13B	Aqueduct	238.13	249.46	\$104 M
14A	Aqueduct	249.46	261.77	\$56 M
14B	Aqueduct	261.77	271.33	\$1 M
Total ³	SLC & Aqueduct	86.73	271.33	\$3.87 B

¹ Values may not add to totals due to rounding.

² Costs presented in 2024 dollars.

³ This AACE Class 4/5 Capital Cost Estimate is subject to -30% and +50% accuracy.

Key: \$M = million dollars; Aqueduct = California Aqueduct; MP = Milepost; SLC = San Luis Canal

5.0 Capital Cost Estimate Uncertainty

This capital cost estimate is based on the rehabilitation and replacement of facilities to restore the original design water surface profile in the SLC and Aqueduct under projected 2085 subsided conditions. This capital cost estimate is not based on systemwide engineering, geotechnical, or environmental evaluations and therefore does not represent a cost to implement a formulated alternative. Sources of cost uncertainty that apply to the capital cost estimate, include, but are not limited to, the following:

- The SFM provides a range of possible future subsidence magnitudes at locations where subsidence has historically occurred (DWR 2024b). For this capital cost estimate, subsidence projections are based on the 75th Non-Exceedance Subsidence Percentile for 2085. At any location along the SLC or Aqueduct, actual subsidence could be less or greater than projected.
- If freeboard or structure clearances required for design are different than those used to prepare this capital cost estimate, it would change the number of affected facilities and the cost to rehabilitate.
- This capital cost estimate is based on varying levels of design detail used to develop facility unit costs.
- With limited exception, sources of earthen material for embankments have not yet been identified or located, nor has the geotechnical or environmental suitability of available earthen material been evaluated.
- Neither project phasing, project timeline, construction duration, nor construction bid packages have been defined for the project.

6.0 References

- Association for the Advancement of Cost Engineering (AACE) International. 2020. *AACE International Recommended Practice No. 56R-08: Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Building and General Construction Industries*. August 7, 2020.
- California Department of Water Resources (DWR). 2024a. *The State Water Project Delivery Capability Report 2023 Addendum: Impacts of Subsidence*. Sacramento (CA). November 2024.
- California Department of Water Resources (DWR). 2024b. *Probabilistic Subsidence Forecast Model for the California Aqueduct Subsidence Program, San Joaquin Valley, California: Revision 1*. Sacramento (CA). October 4, 2024.
- California Department of Water Resources (DWR). 2025. *State Water Project Adaptation Strategy: Reducing Vulnerabilities to Climate Change*. Sacramento (CA). August 2025.