Monterey County Water Resources Agency

Nacimiento Dam and San Antonio Dam Spillway Condition Assessment

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October 16, 2018
Board of Supervisors Meeting

This presentation has been provided to:

- MCWRA Reservoir Operations Committee – July 26, 2018
- MCWRA Board of Directors – August 20, 2018
- Salinas Valley Groundwater Sustainability Plan Development Agricultural Leader Facilitated Process Meeting – October 2, 2018
- San Luis Obispo County Nacimiento Technical Support Group – October 11, 2018
- Grower Shipper Association/Monterey County Farm Bureau Joint Water Committee – October 15, 2018
- MCWRA Board of Supervisors – October 16, 2018

Dam Safety Regulation Authorities

Calif. Dept. of Water Resources, Division of Dam Safety (DSOD)

- Dam Safety Regulation of Nacimiento Dam and San Antonio Dam

Federal Energy Regulatory Commission (FERC)

- Dam Safety Regulation of Nacimiento Dam because of hydroelectric generation

Both DSOD and FERC have authority to restrict water storage at regulated dams for dam safety reasons.

Fines may be levied upon dam owners for non-compliance with dam safety regulations.

Dam Hazard Classification

Relates to downstream hazard potential in event of dam failure (not evaluation of dam condition)

Calif. Dept. of Water Resources, Division of Dam Safety (DSOD)

- Prior to July 1, 2017
  Nacimiento Dam and San Antonio Dam – High Hazard
  Dam failure results in probable loss of 1 or more lives downstream

- As of July 1, 2017
  Nacimiento Dam and San Antonio Dam – Extremely High Hazard
  Dam failure results in considerable loss of life downstream and major impacts to critical infrastructure or property

Federal Energy Regulatory Commission (FERC)

- **Nacimiento Dam – High Hazard**
  Dam failure results in probable loss of 1 or more lives downstream

This Presentation

- Brief Spillway Construction History
- Brief Spillway Operational History
- Condition Assessment Report Conclusions
- Condition Assessment Report Recommendations
- Work Planned for FY 2018-19

Reports

Nacimiento Dam Spillway Condition Assessment Report, June 2018 by GEI Consultants, Inc.

San Antonio Dam Spillway Condition Assessment Report, May 2018 by GEI Consultants, Inc.

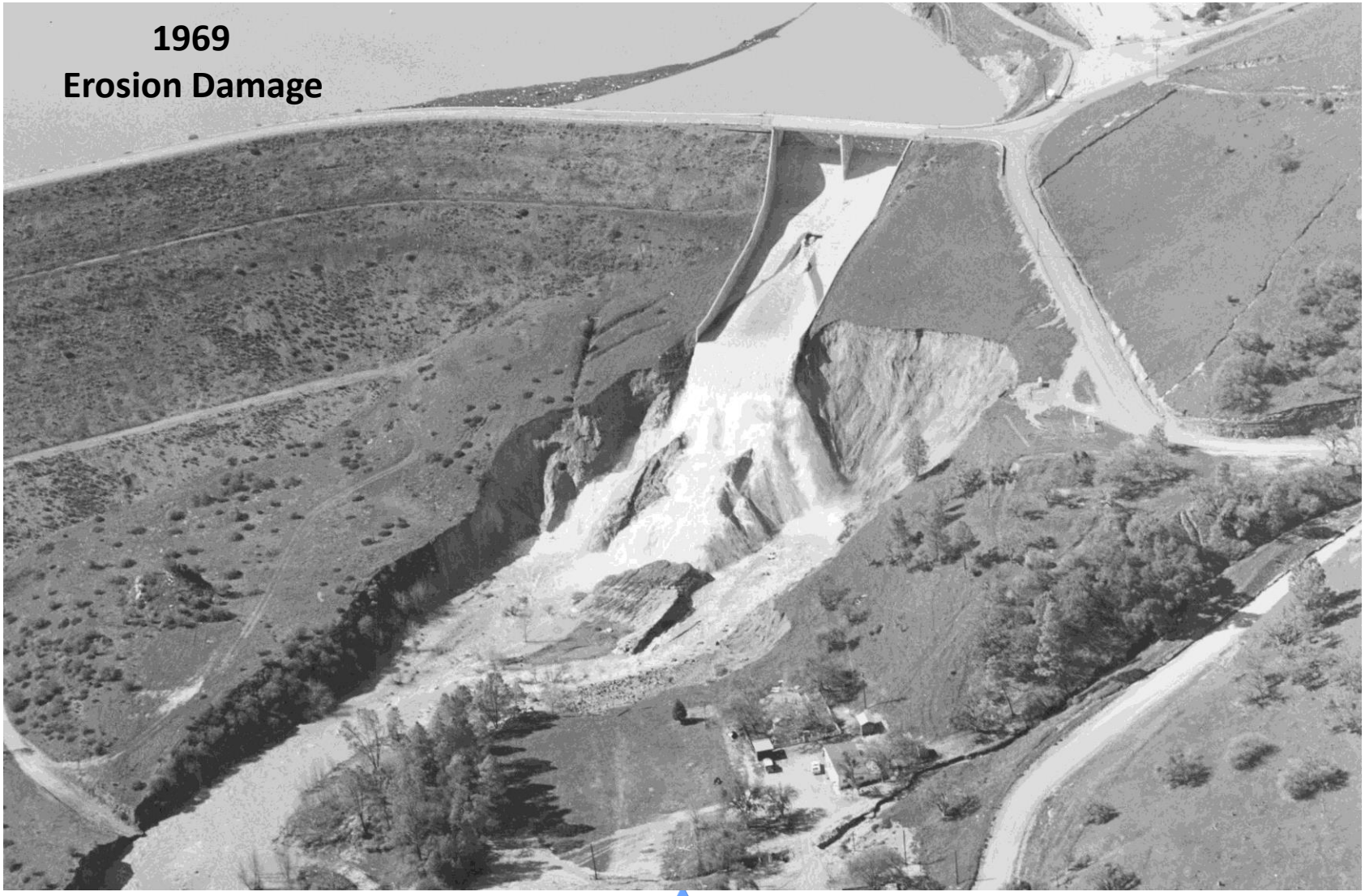
Other Applicable Information

Interlake Tunnel & San Antonio Spillway Modification Project information provided April & July, 2018, by GEI Consultants, Inc.

Nacimiento Dam Spillway
Brief Construction History

- 1957 – Original Spillway Completed
  - 150 ft wide concrete ogee weir – crest Elev. 800.0 ft
  - 100 ft wide x 320 feet long
  - Discharged onto slope to curved exit channel
  - ± 52,000 cfs at Reservoir Elev 820 feet
- 1969 – Significant Spillway Discharge Erosion
- 1970 – Spillway extended 194 feet to base of slope (to 514 ft long) and exit channel straightened
- 2009 – Inflatable crest gates and new chute walls installed to pass updated Probable Maximum Flood flow
  - 131 ft-10 in total width inflatable crest gates
  - Max. crest Elev. 800.0 ft (raised)
  - Min. crest Elev. 787.75 ft (lowered)
  - 101,167 cfs at Reservoir Elev 823.5 feet

Nacimiento Dam Spillway
Brief Construction History



Nacimiento Dam Spillway
Brief Construction History

Nacimiento Dam Spillway
Brief Construction History

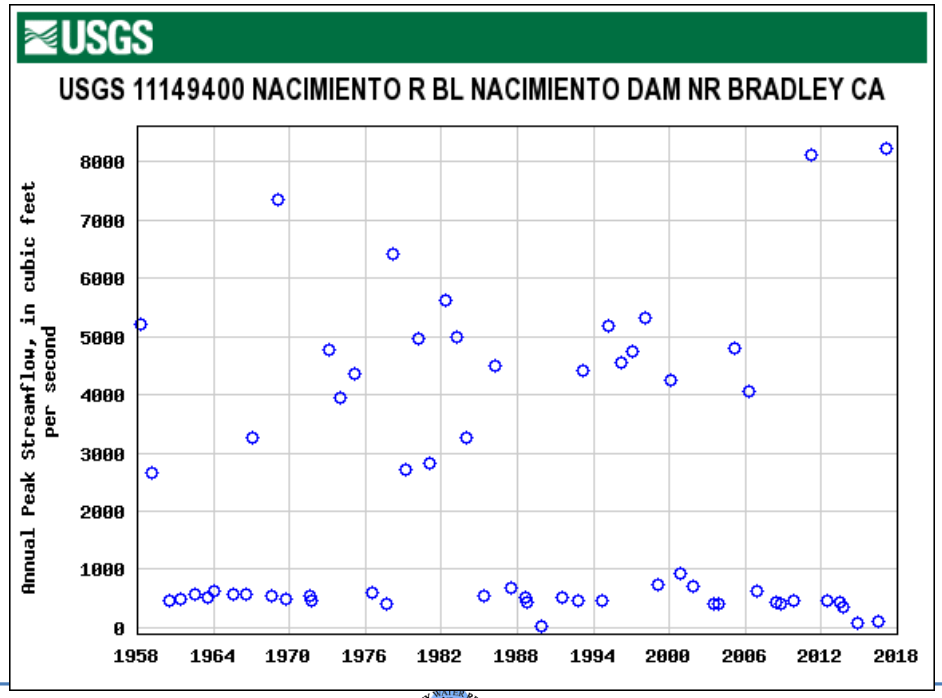
Nacimiento Dam Spillway
Brief Operational History

Spillway crest overtopped (800.0 feet elev.) 1967, 1969, 1983, 2011
(Agency daily reservoir elevation records)

High Level Gates Operated ± 25 years

Peak Spillway Discharge (using Inflatable Crest Gates)

- Feb 22, 2017 – 8,220 cfs (USGS Streamflow gage below dam)



Peak Flows Below Dam (USGS)


02/23/2017 15:35
6,030 cfs (USGS)


Spillway flip-bucket
and discharge apron
02/27/2017 11:06

June 2018 Nacimiento Dam Spillway Condition Assessment Report by GEI Consultants, Inc.

Spillway Condition Assessment included:

- Record review
- Field inspection (July 2017)
- Non-destructive evaluation
  - Ground Penetrating Radar
  - Impact Echo Survey
  - Impulse Response Survey

Conclusions

- Spillway "judged to be in good operable order at the time of inspection (July 2017)"

- Potential failure modes thought to be greatest threat to safe spillway operation:
  - Chute slab failures at joint defects (concrete spalls, delamination, offsets)
  - Clogged or otherwise ineffective underdrains
  - Erosion/head-cutting at plunge pool area threatening spillway flip-bucket

June 2018 Nacimiento Dam Spillway Condition Assessment Report by GEI Consultants, Inc.

Report Recommendations (summarized):

R1 – Repair concrete pop-out at Obermeyer inflatable gate crest (complete)
R2 – Reshape epoxy fill at invert of south high-level gate to allow proper gate seating
R3 – Repair chute spalls, pop-outs, delaminations and offset joints (partially complete)
R4 – Repair wall offset joints (complete)
R5 – Seal all cracks and joints (partially complete)
R6 – Perform borescope exploration at downstream, right side of high-level gate outlet tunnel
R7 – Conduct hydraulic analyses to assess erodibility of exit channel (and solutions)
R8 – Remove bedrock outcrop on right side of exit channel to improve flow characteristics
R9 – Inspect left spillway approach wall (GEI unable to due to water elev.)
R10 – Identify source of seepage through lower right slab joints
R11 – Develop plan to verify function of all subdrains
R12 – Perform borescope exploration throughout chute slab at locations determined by non-destructive evaluation

The Report was sent to FERC and DSOD on July 6, 2018.

Planned 2018 Nacimiento Spillway Construction Work

Recommendations R2, R3, R5, R6, R10, R12:

R6, R10, R12 – Borescope Exploration

- Up to 43 borescope locations
- look at concrete condition, and for voids under concrete chute

R5 – Seal Moving Cracks up to ½-inch Wide (± 900 Lineal Feet)

R5 – Repair Non-Moving Cracks up to ½-inch Wide (± 50 Lineal Feet)

R5 – Seal Fine Concrete Crack Areas (± 1270 Square Feet)

R3 – Repair Delaminated Concrete (± 31 Cubic Yards)

R3 – Concrete Spall Repair

R2 – Reshape epoxy fill at invert of south high-level gate

A detailed Scope of Work was submitted to FERC & DSOD for review and approval on July 31, 2018.

Estimated cost: $150,000

Planned 2018 Nacimiento Spillway Engineering Work

Recommendations R7, R8, R9, R11:

R7 – Conduct hydraulic analyses to assess erodibility of exit channel (and solutions)

- RFP for engineering services to go out Fall 2018
- FY 18-19 Allocated Amount: $50,000

R8 – Remove bedrock outcrop on right side of exit channel to improve flow characteristics

- Permits required, schedule to be determined
- RFP for engineering services to go out Fall 2018
- FY 18-19 Allocated Amount: $0

R9 – Inspect left spillway approach wall

- Inspect in August

R11 – Develop plan to verify function of all subdrains

- Planning underway; submit to FERC & DSOD for approval in August
- Estimated cost: TBD

San Antonio Dam Spillway
Brief Construction History

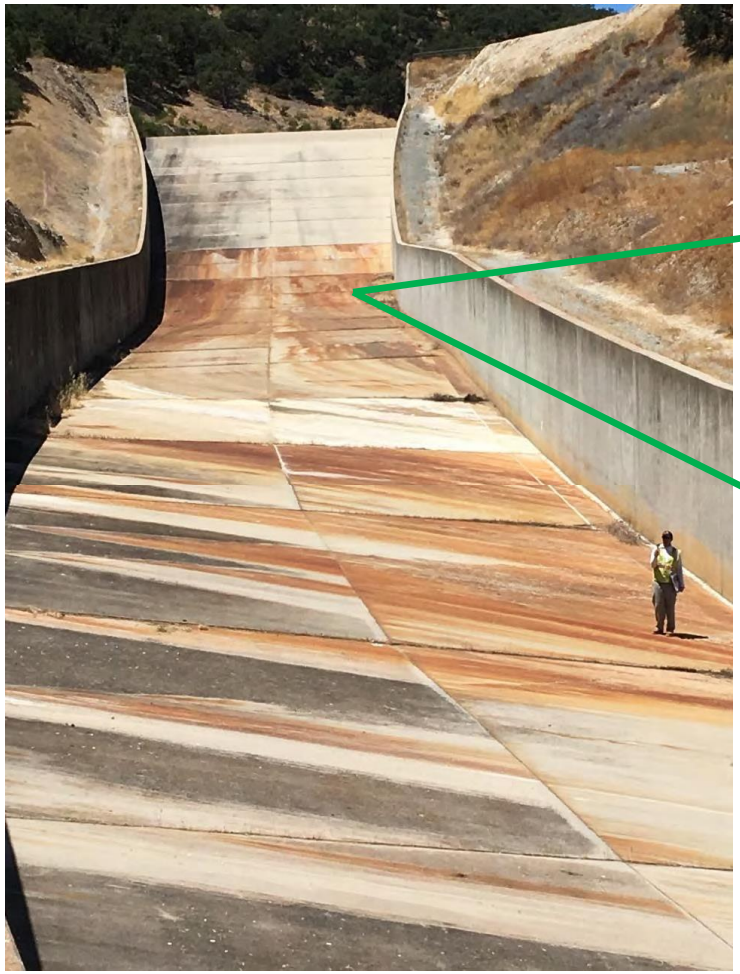
- 1966 – Construction Completed
  - 100 ft wide concrete ogee weir – crest Elev. 780.0 ft
  - 50 ft wide x 1,417 feet long, curved and banked chute
  - Discharges to unlined exit channel
  - ± 35,000 cfs at Reservoir Elev 800 feet flow over-tops spillway chute walls

- No spillway modifications have occurred

San Antonio Dam Spillway
Brief Construction History

Concrete Ogee Weir

San Antonio Dam Spillway
Brief Construction History



Upstream Portion Spillway Chute

Concrete Degradation due to Groundwater Seepage

San Antonio Dam Spillway
Brief Construction History

Flip Bucket and Exit Channel

San Antonio Dam Spillway
Brief Operational History

Summary of spillway operations from construction to date:

Date of Recorded Maximum Reservoir Elevation Above Spillway Crest Elevation	Spillway Crest Elevation (feet)	Maximum Recorded Reservoir Water Surface Elevation on Date Shown (feet)	Estimated Maximum Spillway Flow at Maximum Recorded Reservoir Elevation (cfs)	Number of Days Reservoir Water Elevation Recorded Above Spillway Crest Elevation
2/26/1980	780.00	781.2	**600**	14
4/16/1982	780.00	780.9	**400**	16
3/5/1983	780.00	782.65	**1,750**	37
5/1/2006	780.00	780.9	**400**	61
			Total:	128

Data source: MCWRA daily reservoir elevation records and Bechtel 1967 spillway rating curve.

June 2018 San Antonio Dam Spillway Condition Assessment Report by GEI Consultants, Inc.

Spillway Condition Assessment included:

- Record review
- Field inspection (July 2017)

Conclusions

- Spillway "is generally in poor to fair operable condition."

- Potential failure modes thought to be greatest threat to safe spillway operation:
  - Clogged, non-functioning underdrains – drains cannot be relied upon for uplift resistance; no drain cleanouts
  - Joint construction (no waterstops) – slab uplift
  - Chute wall over-topping – erosion
  - Unlined exit channel – erosion/head cutting into flip-bucket and chute
  - Concrete deterioration from seepage water – chute/wall structural failure

June 2018 San Antonio Dam Spillway Condition Assessment Report by GEI Consultants, Inc.

Report Recommendations (summarized):

R1 – (a) Perform non-destructive evaluation (Ground Penetrating Radar, Impact Echo Survey, Impulse Response Survey) to look for voids, slab thickness
(b) Core sample locations of chute slab to determine concrete condition

R2 – Determine underdrain system functionality

R3 – Conduct spillway hydraulic analyses for potential slab-jacking, cross waves, and wall freeboard under PMF conditions

R4 – Repair chute slab and wall concrete spalls, delamination, deteriorated locations

R5 – (a) Preform water quality testing of seepage water and reservoir water to determine source of seepage water
(b) Determine chemical composition of seepage water for reactivity assessment with concrete

R6 – Apply joint sealant to chute walls

R7 – Perform stability analysis of chute walls assuming full hydrostatic pressure on back sides of walls (due to clogged drains observed in video survey)

R8 – Analyze chute slabs for uplift resistance under full hydrostatic pressure (due to clogged drains observed in video survey)

R9 – Repair 10” spillway underdrain pipe near downstream right access manhole

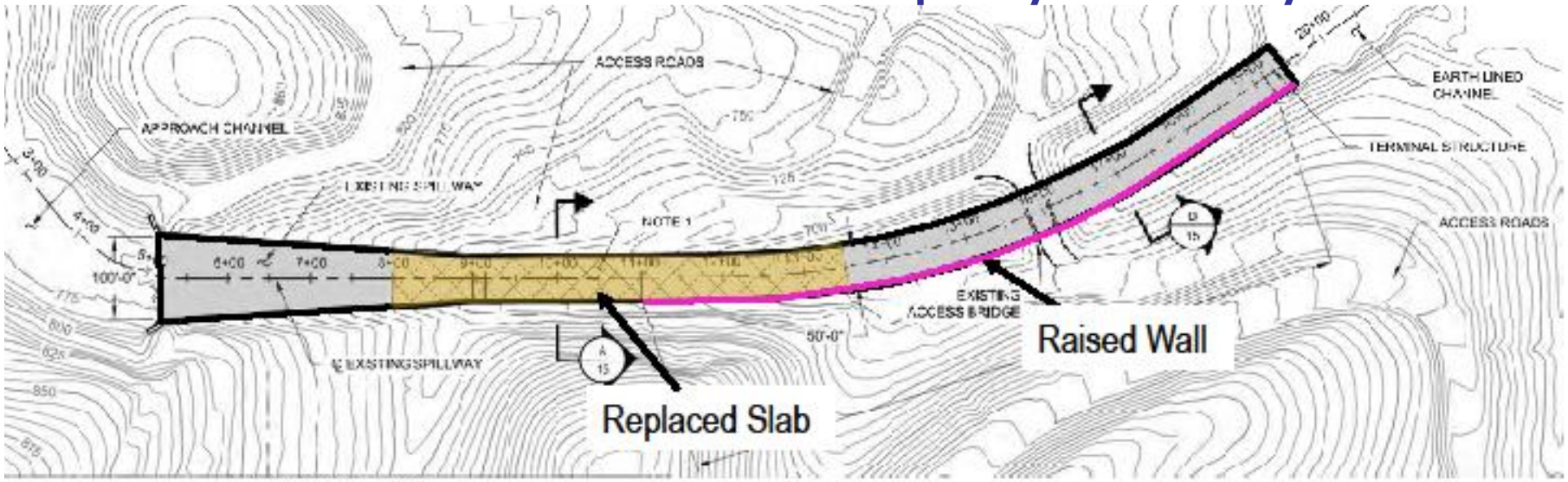
R10 – Conduct Potential Failure Mode Analysis for the spillway

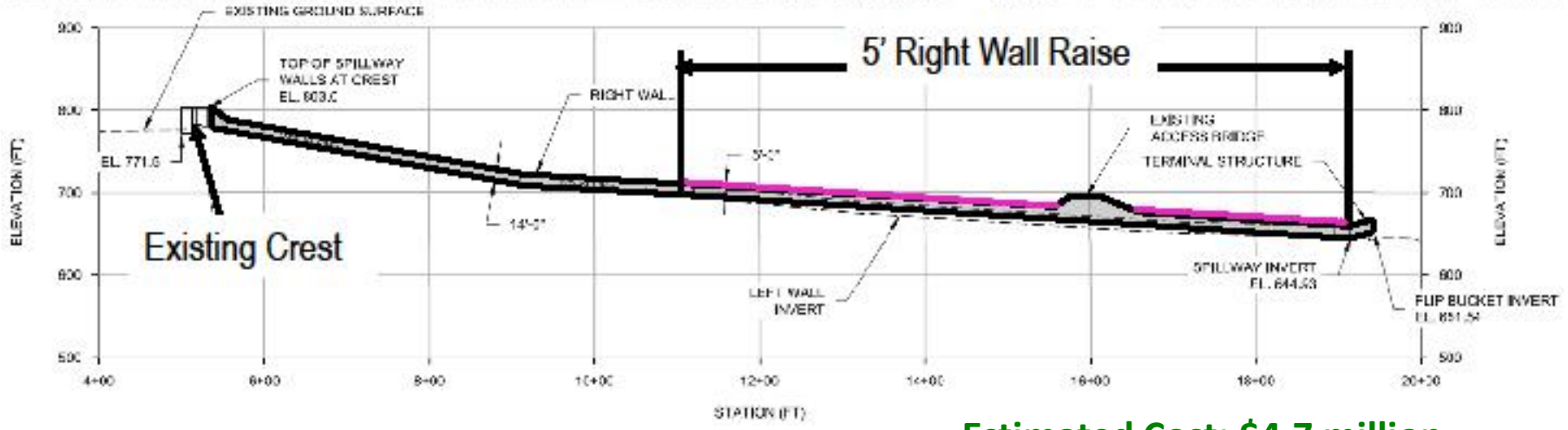
The Report was sent to DSOD on May 23, 2018.

San Antonio Dam Spillway

Additional Information from Inter-Lake Tunnel Project Work – GEI, April/July 2018

Additional Needs to Obtain Basic Spillway Functionality



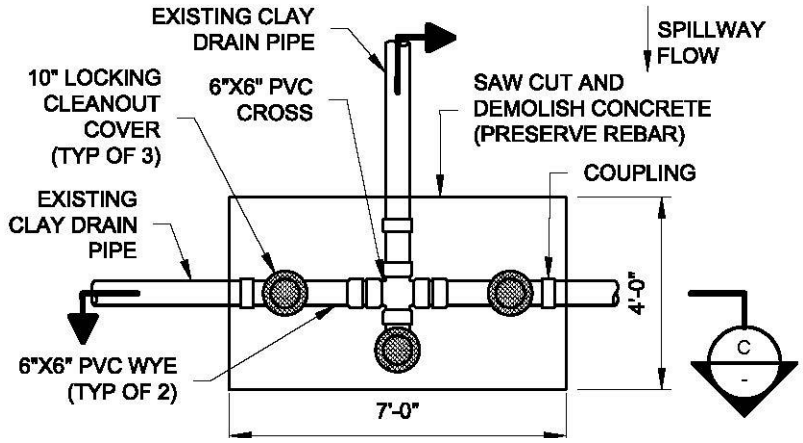


Estimated Cost: $4.7 million

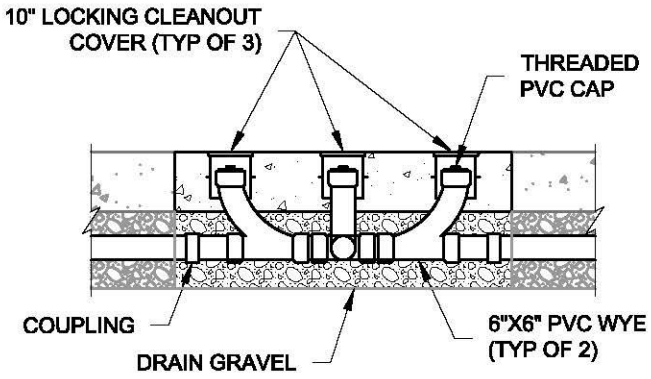
San Antonio Dam Spillway

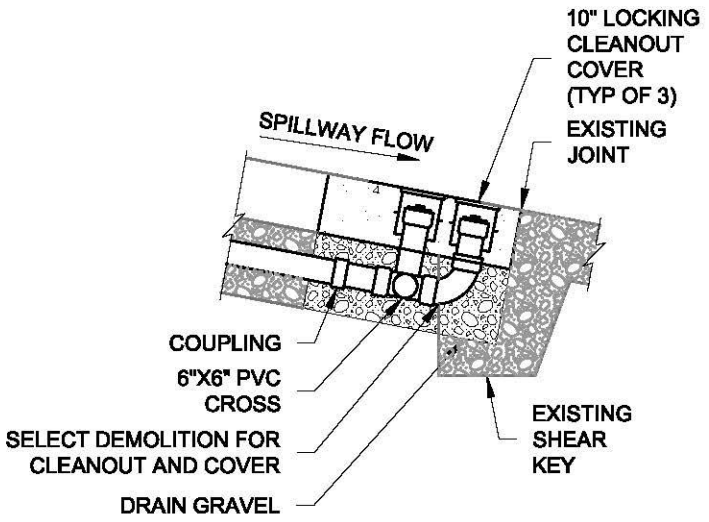
Additional Information from Inter-Lake Tunnel Project Work – GEI, April/July 2018

Additional Needs to Obtain Basic Spillway Functionality



Underdrain System Access Needed to Determine Functionality





Planned 2018 San Antonio Spillway Construction Work

Recommendations R2, R9:

R2 – Determine underdrain system functionality – cut through chute floor to access underdrains (Plan to be submitted to DSOD for approval)

R9 – Repair 10” spillway underdrain pipe near downstream right access manhole

Estimated cost: $50,000 +

Planned 2018 San Antonio Spillway Engineering Work

Further consideration is needed to provide comprehensive approach to San Antonio spillway needs.

Thank you

Questions?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