



MARK PESTRELLA, Director

# COUNTY OF LOS ANGELES

## DEPARTMENT OF PUBLIC WORKS

*"To Enrich Lives Through Effective and Caring Service"*

900 SOUTH FREMONT AVENUE  
ALHAMBRA, CALIFORNIA 91803-1331  
Telephone: (626) 458-5100  
<http://dpw.lacounty.gov>


ADDRESS ALL CORRESPONDENCE TO:  
P.O. BOX 1460  
ALHAMBRA, CALIFORNIA 91802-1460

IN REPLY PLEASE

REFER TO FILE:

WR-1  
779549

March 16, 2017

TO: Each Supervisor  
FROM: Mark Pestrella   
Director of Public Works

### **BOARD MOTION OF FEBRUARY 14, 2017, AGENDA ITEM 42-A DAM SAFETY PROGRAM**

On February 14, 2017, the Board instructed the Director of Public Works to report back to the Board within 30 days on the status of the Dam Safety Program and all its efforts undertaken to assure the proper and safe operation of its 14 dams and identify high-priority flood control projects that must be completed to ensure maximum safety and efficiency and report back to the Board with a timeline on completing these projects.

The attached report entitled Dam Safety Program Report to the Board includes detailed information in response to the Board motion stated above. The report contains an overview of the dam safety program Public Works manages along with the current conditions of the Los Angeles County Flood Control Dams.

If you have any questions, please contact me or your staff may contact Chris Stone at (626) 458-6100 or [cstone@dpw.lacounty.gov](mailto:cstone@dpw.lacounty.gov).

SEK:sv

P:\wrd\ADMINVA-MEMOS\Board Report Each Sup memo.docx

Attach.

cc: Chief Executive Office (Rochelle Goff)  
Executive Office

**COUNTY OF LOS ANGELES  
DEPARTMENT OF PUBLIC WORKS  
DAM SAFETY PROGRAM  
REPORT TO THE BOARD  
MARCH 15, 2017**



## Contents

Executive Summary.....	2
Introduction.....	4
Status of Dams and Rehabilitation Programs .....	5
Seismic and Spillway Rehabilitation Program .....	5
Inlet/Outlet Works Rehabilitation Program .....	6
Sediment Removal Program .....	7
Security Improvement Program.....	7
Debris Dam Rehabilitation Program.....	8
Status of Dams.....	10
Dam Safety Inspection and Monitoring Program .....	25
Dam Safety Inspections .....	25
Dam Performance Monitoring and Instrumentation.....	25
Dams Automated Data Acquisition System .....	26
Monitoring Reports .....	26
Emergency Response Preparedness.....	27

## Executive Summary

The Los Angeles County Flood Control District, is a special district overseen by the Board of Supervisors and managed by the County of Los Angeles Department of Public Works. It operates a regional system for flood protection that encompasses 6 major watersheds, covering more than 2,700 square miles and 86 cities. Its major facilities include 14 major dams and reservoirs, 19 debris dams, 483 miles of open channel, and 3,330 miles of underground storm drains. This system has been designed to manage flood risk from what is known as a Capital Flood Event, which is a storm with a 2% chance of happening any year on a burned and saturated watershed. Furthermore, the dams are required to withstand the Probable Maximum Flood Event, which is the largest flood theoretically possible for a particular area.

The California Department of Water Resources, Division of Safety of Dams (DSOD) has jurisdiction over the 14 major dams and 19 debris dams. The DSOD has established standards for the design and operations of dams. It reviews and approves design plans for structural modifications and upgrades to dams and inspects each dam on a yearly schedule to ensure they are performing according to the established standards and being maintained in a safe manner.

### ***Findings***

In summary, all major dams were found to be in acceptable condition by the DSOD annual inspections in 2016. All of the major dams meet current standards for seismic, spillway, monitoring, and outlet works, with two exceptions at Santa Anita Dam and Puddingstone Dam. For Santa Anita Dam, a project is scheduled to begin construction in summer 2017 to increase its spillway capacity. Puddingstone Dam is currently being evaluated to address potential dam safety issues. As directed by the State, Puddingstone Dam is operated at a reservoir level well below its maximum capacity, which is considered seismically safe. Other dam rehabilitation projects may be planned upon further evaluations.

All debris dams are currently operational and have been found to be in acceptable condition by the DSOD in 2016. A series of rehabilitation projects have been completed at the debris dams and additional projects are planned.

Public Works, on behalf of the County, has four improvement/maintenance programs for the major dams and debris dams to ensure safe and resilient dam operations. These programs are summarized as follows with additional information and status included within this report:

- The Dams Seismic and Spillway Rehabilitation Program implements improvements to meet current State standards for both seismic performance and adequate spillway capacity. This program includes enlarging spillways, seismic strengthening, erosion protection measures, and foundation and abutment improvements.

- The Dams Inlet/Outlet Works Rehabilitation Program is a plan to modify, rehabilitate, or replace all deficient gates, valves, piping, and control systems. This program aims to maintain reliability of critical equipment for flood control and stormwater capture operations. The program also includes access roads, bridges, electrical systems, lighting, waterlines, buildings, cranes, hoists, generators, and other appurtenances that are essential for the safe and effective operation of the dams.
- The Dams Security Improvement Program implements measures to improve security at the dams.
- The Debris Dams Rehabilitation Program identifies structural deficiencies and develops improvement projects for these dams.
- The Reservoir Sediment Management Program develops and implements sediment removal projects to maintain adequate reservoir capacity for flood management and stormwater capture.

Public Works also manages a dam safety monitoring and inspection program comprised of staff with various technical expertise. The dams are equipped with instrumentation to monitor the performance of the dam structures. Public Works places emphasis on emergency response preparedness with protocols, communications systems, and emergency action plans.

A review of high-priority projects flood control projects needed to ensure the maximum safety and efficiency resulted in the following projects:

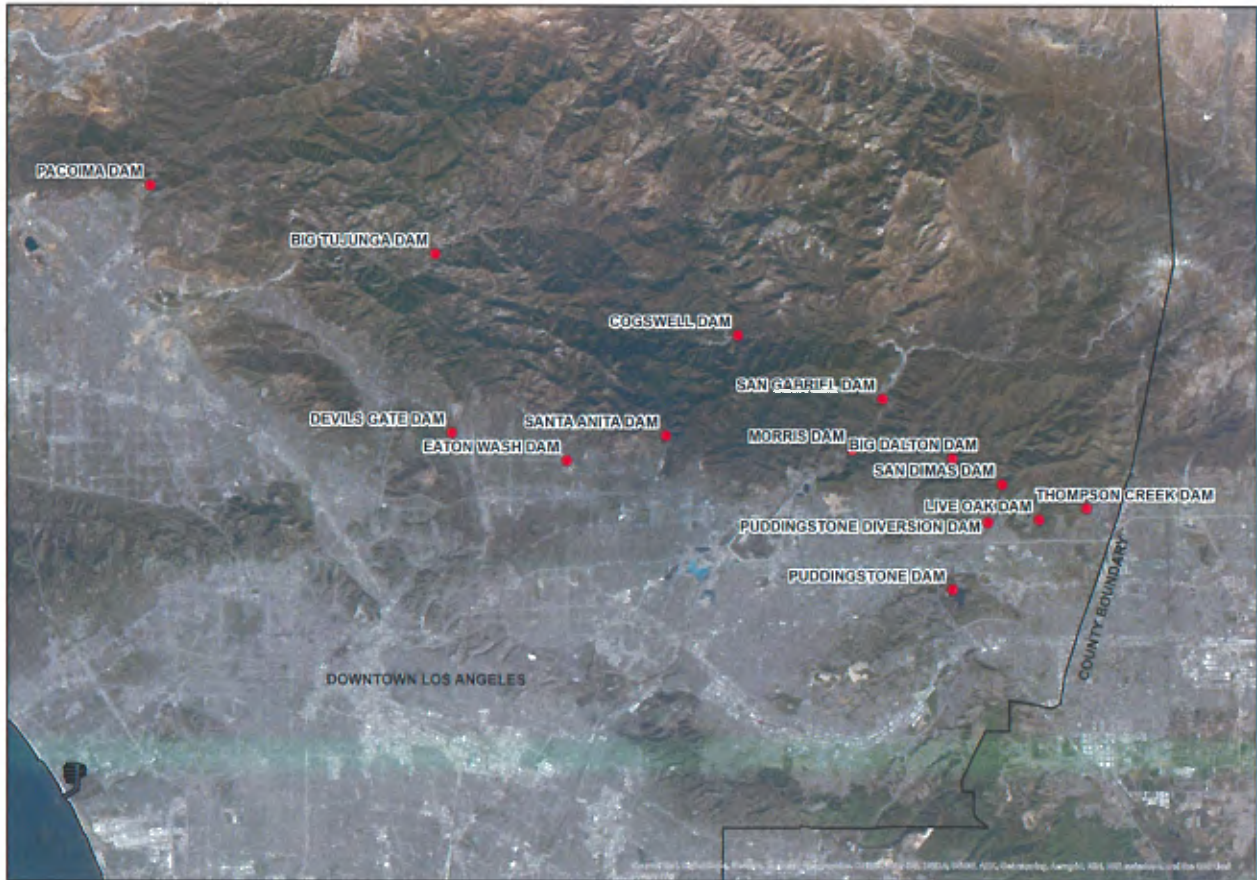
- Sediment Removal Projects to restore reservoir capacity at Devil's Gate, Big Tujunga, Pacoima, Cogswell, and San Gabriel Dams.
- Dam safety improvements at Puddingstone and Santa Anita Dams and Sawpit Debris Dam.

For other County-owned flood control facilities that are outside of the dam program, Public Works conducts routine inspections, repairs, and maintenance activities to ensure these flood control facilities are reliable and effective for storm and groundwater recharge operations. Additionally, improvement projects are implemented at these facilities on an as-needed basis to support the safety and efficiency of the overall flood control system.

The US Army Corps of Engineers (Corps) operates and maintains 4 major dams and a significant amount of the other stormwater management infrastructure in Los Angeles County. The Corps carries out their own safety programs when operating these facilities. Public Works routinely interacts with the Corps to ensure that interconnected facilities do not create any additional risk potential for County-owned infrastructure. The Corps has indicated that there is currently an estimated \$175M in deferred maintenance and repair needs throughout their infrastructure that have not sufficiently been funded through the federal budget.

## Introduction

Public Works operates and maintains the County's 14 major dams and 19 large debris dams. They are key components of the comprehensive flood control and stormwater capture system. Each dam is specifically engineered to the terrain and geology of its location. Therefore, various types of concrete and earth embankment structures are found across the County. Below is a map showing the general location of the major dams.



## Status of Dams and Rehabilitation Programs

Public Works has pursued a set of rehabilitation programs to maintain the safe operation of the dams, improve flood control and stormwater capture capacity, and meet current State standards.

The County's 14 major dams are under the jurisdiction of the State of California, Department of Water Resources, Division of Safety of Dams (DSOD). The DSOD has jurisdiction over nonfederal dams with a reservoir capacity over 15 acre-feet (AF) and a height above 25 feet, or a reservoir capacity greater than 50 AF and a height above 25 feet. The DSOD requires dams to meet requirements for seismic strength, flood capacity, and emergency drawdown. These standards have become more stringent in recent decades and are more intensive than those applied for most infrastructure. The DSOD requires high hazard dams to be capable of safely passing the probable maximum flood, a design flow rate based on the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in a particular drainage area. The DSOD also requires high hazard dams to be capable of withstanding the maximum credible earthquake, which is the design earthquake associated with the most severe ground motion potential based on the regional and local geological and seismological data.

### ***Seismic and Spillway Rehabilitation Program***

The standards and methodologies for seismic and flood analysis have changed since the County's dams were first constructed. Public Works conducted a reanalysis of the dams and spillways and it was found that some of the dams were actually constructed adequately for the current standards. In other cases, dams have required seismic strengthening and spillway enlargement projects. Since the Northridge Earthquake in 1994, Public Works has completed numerous seismic and spillway rehabilitation projects totaling over \$163 million. These projects have included concrete buttresses, spillway enlargements, crest modifications, and foundation and abutment improvements. A \$40 million spillway modification project at Santa Anita Dam is scheduled to begin in late 2017. Puddingstone Dam is currently being evaluated to address potential dam safety issues. As directed by the State, Puddingstone Dam is operated at a restricted reservoir level, which is considered acceptable for withstanding ground motions postulated for the dam site. Other dam rehabilitation projects may be planned upon further evaluations.



Construction of Big Tujunga Dam Seismic Rehabilitation - 2008

## ***Inlet/Outlet Works Rehabilitation Program***

The Dams Inlet/Outlet Works Rehabilitation Program is a plan to modify, rehabilitate, or replace all deficient gates, valves, actuators, and controls. The program aims to maintain reliability of critical equipment for flood control and stormwater capture operations. The improvement program also includes access roads, bridges, electrical systems, lighting, waterlines, buildings, cranes, hoists, generators, and other appurtenances that are essential for the safe and effective operation of the dams. Approximately, \$42 million worth of projects have been completed since the program was established in 2008 and additional projects totaling \$80 million are planned to be completed by 2025. The County's dams are designed for flood control operations and, as such, the outlet works capacities are consistently above the DSOD requirements for emergency drawdown, which requires the ability to lower a full reservoir by 10 percent within 7 days and draining its full contents within 90 days.



Valve Testing, Morris Dam Inlet/Outlet Rehabilitation, 2012

## ***Sediment Removal Program***

County dams and reservoirs were constructed to control flood flows, intercept and store sediment flows, and provide storage for water conservation. Sediment removal at these facilities has occurred since their construction. During storm events erosion normally occurs in watersheds upstream of the dams. The subsequent sediment flows are settled out in the reservoir while clear flow is released downstream. The sediment build-up in the reservoir reduces the storage capacity behind the dam, which increases the potential for uncontrolled spillway flows and decreases the water that can be captured for groundwater recharge. Several factors determine when a reservoir cleanout is warranted and is different for each reservoir due to the various designs of the dams. The ability for the dam to avoid debris flowing over the spillway and to keep all dam valves free of impacts from the sediment are two key considerations when deciding to initiate a sediment removal project. Wildfires can greatly increase the urgency for sediment removal projects as a watershed removed of vegetation can produce sediment inflows over ten times higher than that of an unburned watershed. The County has removed over 78 million cubic yards of sediment from the reservoirs over their history.

## ***Security Improvement Program***

Following September 11, dams were identified by the Department of Homeland Security as Critical Infrastructure that require increased protection from terrorist threats. The Security Improvement Program has been initiated to increase the detection, delay, and response to intruders to better protect critical infrastructure with heavy duty entrance gates, surveillance camera systems, alarms, and signage. Approximately, \$3 million worth of projects have been completed or are scheduled for construction since the program was established.



## ***Debris Dam Rehabilitation Program***

In addition to the 14 major dams, the County owns 19 debris dams. Debris dams are large debris basins with the height and capacity criteria to fall under DSOD jurisdiction. These dams are equipped with free flowing outlet towers, so they do not hold water for extended periods of time, but may temporarily fill during storms. The debris dams are critical for attenuating floods and for capturing debris from the foothills, which could otherwise block storm drains and cause downstream flooding. The Debris Dam Rehabilitation Program includes thorough inspections and assessments to identify issues and prioritize projects. A series of rehabilitation projects have been completed at the debris dams and additional projects are planned. At the time of construction, many of the outlet towers were not designed to meet current seismic criteria, so they are being systematically replaced with a new design for improved strength and drainage. Common maintenance issues of erosion and overgrown vegetation impacting the dam structure are being addressed with rock riprap or concrete facing slab. Improvement projects are also looking at ways to increase the efficiency of routine maintenance and sediment removal. Evaluations are also being conducted to identify opportunities to improve stormwater capture operations at the debris dams to increase local water supply, this may include outlet works modifications and structural improvements to the debris dams to hold water for extended periods of time.

### **Status of Debris Dams**

All debris dams are currently operational and have been found to be in acceptable condition by the DSOD inspections in 2016. Two of the debris dams were recently retrofitted with seismically stable outlet towers. Supplemental inclined outlet towers were installed at six of the debris dams to improve flow out of the basin. Projects are planned to upgrade outlet towers at three more facilities and further analysis is being conducted to prioritize additional outlet tower upgrades. Continuous maintenance is being performed to remove sediment and debris to preserve flood control and debris retention capacity.

Santa Anita Debris Dam will be upgraded with improvements to the embankment, outlet tower, and spillway. The design process has been completed and construction is expected to begin in late 2017. This project will allow the dam to impound water, adding 112 acre-feet of water storage capacity to the County overall stormwater recharge system.



Rubio Debris Dam



Little Dalton Debris Dam - Upgraded Outlet Tower 2013

## Status of Dams

## BIG DALTON DAM



### **Multiple Arch Concrete**

Year Completed:	1929	Crest Elevation:	1711 ft
Height of dam	146 ft	Crest Length:	480 ft

### **STATUS:**

#### **SEISMIC – *MEETS OR EXCEEDS STANDARD***

The dam structure has been analyzed and found to be capable of withstanding the maximum credible earthquake. A seismic rehabilitation was completed in 1999 to buttress the dam arches with mass concrete.

#### **SPILLWAY – *MEETS OR EXCEEDS STANDARD***

Parapet walls on Arches 2, 5, and 6 were increased in height in 1999 to create an auxiliary spillway on the crest of the dam. Hydraulic analysis has determined a combined spillway capacity of 8,310 cubic feet per second (cfs), which exceeds the probable maximum flood of 8,280 cfs.

#### **INLET/OUTLET WORKS – *PROJECT PENDING***

New outlet works including valves, actuators, and control system were installed in 2000. Outlet works are operational for flood control and stormwater capture operations. A sluice gate rehabilitation project is planned to be in construction in 2018.

#### **INSTRUMENTATION AND MONITORING – *MEETS OR EXCEEDS STANDARD***

The dam is monitored with adequate instrumentation and the dam was determined to be in acceptable condition by the DSOD during its inspection in October 2016.

#### **SEDIMENT MANAGEMENT – *MEETS OR EXCEEDS STANDARD***

The reservoir has a current capacity of 1.7 million cubic yards (cy), which is adequate to hold multiple design debris events of 460,000 cy. Approximately, 148,140 cy of sediment was removed during a sediment removal project completed in April 2008.

## BIG TUJUNGA DAM



### Thickened Concrete Arch

Year Completed:	1931	Crest Elevation:	2302 ft
Height of dam	200 ft	Crest Length:	505 ft

### STATUS:

#### SEISMIC – **MEETS OR EXCEEDS STANDARD**

The dam structure has been analyzed and found to be capable of withstanding the maximum credible earthquake. A seismic rehabilitation project was completed in 2012 to buttress dam with mass concrete.

#### SPILLWAY – **MEETS OR EXCEEDS STANDARD**

Crest spillway was completed in 2012 to increase spillway capacity. Hydraulic analysis determined the spillway capacity is 113,035 cfs, which exceeds the probable maximum flood of 111,570 cfs calculated for this location

#### INLET/OUTLET WORKS – **MEETS OR EXCEEDS STANDARD**

New outlet works including valves, actuators, and control system were installed in 2012. Outlet works are operational for flood control and stormwater capture operations.

#### INSTRUMENTATION AND MONITORING – **MEETS OR EXCEEDS STANDARD**

The dam is monitored with adequate instrumentation and the dam was determined to be in acceptable condition by DSOD during inspection in February 2016.

#### SEDIMENT MANAGEMENT – **PROJECT NECESSARY**

There is currently 2.1 million cy of accumulated sediment in the reservoir. Since the 2009 Station Fire, 1.3 million cy of additional sediment has been deposited in the reservoir. Design of a project to remove sediment is nearly complete and permitting is in progress. A four year sediment removal project is scheduled to begin in 2018.

## COGSWELL DAM



### Rockfill Concrete Face

Year Completed:	1934	Crest Elevation:	2405 ft
Height of dam	265 ft	Crest Length:	585 ft

### STATUS:

#### SEISMIC – **MEETS OR EXCEEDS STANDARD**

The dam structure has been analyzed and found to be capable of withstanding the maximum credible earthquake.

#### SPILLWAY – **MEETS OR EXCEEDS STANDARD**

In 1990, a parapet wall was constructed across the dam crest to increase its spillway capacity. Analysis determined the spillway has capacity to pass the probable maximum flood of 59,900 cfs.

#### INLET/OUTLET WORKS – **PROJECT PENDING**

The outlet works are currently operational for flood control and stormwater capture. An inlet-outlet works rehabilitation project is planned for construction between 2019-21.

#### INSTRUMENTATION AND MONITORING – **MEETS OR EXCEEDS STANDARD**

The dam is monitored with adequate instrumentation and the dam was determined to be in acceptable condition by the DSOD during its inspection in October 2016.

#### SEDIMENT MANAGEMENT – **PROJECT NECESSARY**

The reservoir currently has 2.9 million cy of sediment in the reservoir, 1.4 million of that has been deposited since the 2009 Station Fire. A sediment removal project to remove up to 3.3 million cy is scheduled between 2018-20.

## DEVIL'S GATE DAM



### Concrete Gravity Arch

Year Completed: 1920    Crest Elevation: 1070 ft  
Height of dam: 100 ft    Crest Length: 310 ft

### STATUS:

#### SEISMIC – **MEETS OR EXCEEDS STANDARD**

The dam structure has been analyzed and found to be capable of withstanding the maximum credible earthquake. Rehabilitation was completed in 1997 with a mass concrete buttress installed on the downstream side of the dam and the foundation was grouted.

#### SPILLWAY – **MEET OR EXCEEDS STANDARD**

Analysis has determined the dam has a combined spillway capacity of 34,450 cfs, which is sufficient to pass the probable maximum flood of 33,700 cfs calculated for this location. Spillway rehabilitation was completed in 1997 along with a lowered and enlarged spillway.

#### INLET/OUTLET WORKS – **MEETS OR EXCEEDS STANDARD**

Outlet works are operational for flood control and stormwater capture operations.

#### INSTRUMENTATION AND MONITORING – **MEETS OR EXCEEDS STANDARD**

The dam is monitored with adequate instrumentation and the dam was determined to be in acceptable condition by the DSOD during its inspection in October 2016. A monitoring report was also submitted to DSOD in fall 2016.

#### SEDIMENT MANAGEMENT – **PROJECT NECESSARY**

A sediment cleanout project to remove up to 2.4 million cy of excess sediment from the reservoir is scheduled to start in late 2017. The project is expected to take 3 to 5 years.

## EATON WASH DAM



### Earthfill Clay Core

Year Completed:	1937	Crest Elevation:	902 ft
Height of dam	62 ft	Crest Length:	1525 ft

### STATUS:

#### SEISMIC – **MEETS OR EXCEEDS STANDARD**

The dam structure has been analyzed and found to be capable of withstanding the maximum credible earthquake. In 2015, the seismically deficient outlet tower was demolished and a new hydraulic power system was installed for gate valve operations.

#### SPILLWAY –**MEET OR EXCEEDS STANDARD**

Analysis determined the spillway capacity is 34,450 cfs, which is sufficient to pass the probable maximum flood of 33,700 cfs.

#### INLET/OUTLET WORKS – **MEETS OR EXCEEDS STANDARD**

Outlet works are operational for flood control and stormwater capture operations. Rehabilitations and upgrades were completed in 2015.

#### INSTRUMENTATION AND MONITORING – **MEETS OR EXCEEDS STANDARD**

The dam is monitored with adequate instrumentation and the dam was determined to be in acceptable condition by DSOD during its inspection in October 2016.

#### SEDIMENT MANAGEMENT – **PROJECT NECESSARY**

The reservoir has a current capacity of 1.0 million cy, which is inadequate to capture two design debris events totaling 1.4 million cy. Work on a sediment removal project will be initiated following the completion of more urgent reservoir cleanout projects.

## LIVE OAK DAM



### Concrete Curved Gravity

Year Completed:	1922	Crest Elevation:	1500 ft
Height of dam	70 ft	Crest Length:	303 ft

### STATUS:

#### SEISMIC – **MEETS OR EXCEEDS STANDARD**

The dam structure has been analyzed and found to be capable of withstanding the maximum credible earthquake. A rehabilitation project was completed in 1982, which included grouting the three transverse contraction joints, installing grout curtains in each abutment, and installing additional drainage to reduce uplift pressure.

#### SPILLWAY – **MEETS OR EXCEEDS STANDARD**

Auxiliary spillway completed in 1939 to increase spillway capacity. Analysis has determined the spillway's capacity is 2,400 cfs, which is sufficient to pass the probable maximum flood.

#### INLET/OUTLET WORKS – **PROJECT PENDING**

Outlet works are operational for flood control and stormwater capture operations. A project to upgrade and refurbish the outlet works is scheduled to start in late 2017.

#### INSTRUMENTATION AND MONITORING – **MEETS OR EXCEEDS STANDARD**

The dam is monitored with adequate instrumentation and the dam was determined to be in acceptable condition by the DSOD during its inspection in October 2016.

#### SEDIMENT MANAGEMENT – **MEETS OR EXCEEDS STANDARD**

The dam currently has over 380,000 cy of available capacity, more than two times the design debris event of approximately, 150,000 cy. Approximately, 80,667 cy of sediment was removed during a sediment removal project completed in November 2008.

## MORRIS DAM



### Concrete Gravity

Year Completed:	1935	Crest Elevation:	1175 ft
Height of dam	245 ft	Crest Length:	800 ft

### STATUS:

#### SEISMIC – **MEETS OR EXCEEDS STANDARD**

The dam structure has been analyzed and found to be capable of withstanding the maximum credible earthquake.

#### SPILLWAY – **MEETS OR EXCEEDS STANDARD**

In 1980, the dam crest and abutments were modified to act as an auxiliary spillway to safely pass the probable maximum flood of 204,000 cfs with approximately, 136,000 cfs passing over the main spillway and 68,000 cfs over the dam crest.

#### INLET/OUTLET WORKS – **PROJECT PENDING**

Outlet works are operational for flood control and stormwater capture operations. A recent project upgraded all valves, piping, and control system. A project to install a low-flow valve is currently being designed.

#### INSTRUMENTATION AND MONITORING – **MEETS OR EXCEEDS STANDARD**

The dam is monitored with adequate instrumentation, and the dam was determined to be in acceptable condition by the DSOD during its inspection in October 2016.

#### SEDIMENT MANAGEMENT – **MEETS OR EXCEEDS STANDARD**

Sediment inflow into Morris Dam is limited as the majority of upstream area is controlled by San Gabriel and Cogswell Dams. Currently, there is approximately, 36 million cy of capacity in the reservoir. No cleanouts are scheduled in the foreseeable future

## PACOIMA DAM



### Constant Angle Concrete Arch

Year Completed:	1929	Crest Elevation:	2015 ft
Height of Dam:	365 ft	Crest Length:	640 ft

### STATUS:

#### SEISMIC – **MEETS OR EXCEEDS STANDARD**

The dam structure has been analyzed and found to be capable of withstanding the maximum credible earthquake. On January 17, 1994, Pacoima Dam was severely shaken by the Northridge Earthquake. A complete seismic rehabilitation was performed to strengthen the dam and abutments.

#### SPILLWAY – **MEETS OR EXCEEDS STANDARD**

A spillway modification project was completed in 2004. Analysis determined the spillway's capacity is 24,700 cfs, which exceeds the probable maximum flood of 24,000 cfs.

#### INLET/OUTLET WORKS – **PROJECT PENDING**

The outlet works are operational and in satisfactory condition for flood control and stormwater capture operations. An inlet-outlet works rehabilitation project is planned for construction in 2020.

#### INSTRUMENTATION AND MONITORING – **MEETS OR EXCEEDS STANDARD**

The dam is monitored with adequate instrumentation and the dam was determined to be in acceptable condition by the DSOD during its inspection in October 2016.

#### SEDIMENT MANAGEMENT – **PROJECT NECESSARY**

Project design and permitting are in progress to remove 3 to 5.4 million cy of sediment. Currently, half of the reservoir capacity is filled with sediment and there is significant risk for sediment to buildup and clog the intake structures and damage the outlet works. Sediment removal activities are planned to start in Spring 2019 and take up to 5 years to complete.

## PUDDINGSTONE DAM



### Three Concrete-Faced Earth Embankments

Year Completed:	1928	Crest Elevation:	982 ft
Height of dam:	147 ft	Crest Length:	1085 ft

### STATUS:

#### SEISMIC – **PROJECT NECESSARY**

The dam structure has been analyzed and found to be capable of withstanding the maximum credible earthquake at a restricted reservoir level. DSOD restriction limits the reservoir to elevation 945 ft, which is 25 feet below the spillway elevation site. Rehabilitation projects may be planned upon further evaluations, and could restore capacity for flood control and stormwater capture.

#### SPILLWAY – **MEETS OR EXCEEDS STANDARD**

A DSOD restriction limits the water level in the reservoir to elevation 945 ft. Analysis has determined the dam has a spillway capacity of 30,000 cfs, which exceeds the probable maximum flood of 12,100 cfs.

#### INLET/OUTLET WORKS – **MEETS OR EXCEEDS STANDARD**

The outlet works are operational for flood control and stormwater capture operations.

#### INSTRUMENTATION AND MONITORING – **MEETS OR EXCEEDS STANDARD**

The dam is monitored with adequate instrumentation and the dam was determined to be in acceptable condition by the DSOD during its inspection in October 2016.

#### SEDIMENT MANAGEMENT – **MEETS OR EXCEEDS STANDARD**

Sediment inflow into Puddingstone Dam is limited as the majority of the upstream area is either developed or controlled by other dams. No sediment removal project is scheduled at this time.

## PUDDINGSTONE DIVERSION DAM



### **Earthfill Concrete Face**

Year Completed:	1928	Crest Elevation:	1168 ft
Height of dam	38 ft	Crest Length:	825 ft

### **STATUS:**

#### **SEISMIC – MEETS OR EXCEEDS STANDARD**

The dam structure has been analyzed and found to be capable of withstanding the maximum credible earthquake.

#### **SPILLWAY – MEETS OR EXCEEDS STANDARD**

In 1997, the dam crest was raised to an elevation of 1,168 ft and the spillway capacity was increased to 24,900 cfs to meet the maximum probable flood event.

#### **INLET/OUTLET WORKS – PROJECT PENDING**

In 2005, modifications to the four slide gate outlets were completed. The outlet works are operational for flood control and stormwater conservation operations. A proposed project to increase the outlet works flexibility by installing an auxiliary outlet and is scheduled to be in construction in 2021.

#### **INSTRUMENTATION AND MONITORING – MEETS OR EXCEEDS STANDARD**

The dam is monitored with adequate instrumentation and the dam was determined to be in acceptable condition by the DSOD during its inspection in October 2016.

#### **SEDIMENT MANAGEMENT – PROJECT NECESSARY**

Approximately, 139,000 cy of sediment were removed from the reservoir during the 2008 Sediment Removal Project. Approximately, 30,600 cy of sediment have entered the reservoir since the 2008 Sediment Removal Project. The reservoir has a current capacity of 569,834 cy, which is inadequate to capture two design debris events totaling 755,039 cy.

## SAN DIMAS DAM



### Concrete Gravity Arch

Year Completed:	1922	Crest Elevation:	1470 ft
Height of dam	117 ft	Crest Length:	340 ft

### STATUS:

#### SEISMIC – **MEETS OR EXCEEDS STANDARD**

The dam has been analyzed and found to be capable of withstanding the maximum credible earthquake. In 1980, remedial measures included grouting both abutments, installing rock bolts, tendons, and inclinometers were completed to strengthen the dam for seismic conditions.

#### SPILLWAY – **MEETS OR EXCEEDS STANDARD**

In 1980, the dam crest and abutments were modified to act as an auxiliary spillway to safely pass the probable maximum flood of 28,600 cfs with approximately, 27,455 cfs passing over the spillway and dam structure and 2,060 cfs passing through the outlet works.

#### INLET/OUTLET WORKS – **MEETS OR EXCEEDS STANDARD**

In 2012, the outlet works including the outlet tunnel, slide gates, and hydraulic systems were retrofitted. The outlet works are operational for flood control and stormwater capture operations.

#### INSTRUMENTATION AND MONITORING – **MEETS OR EXCEEDS STANDARD**

The dam is monitored with adequate instrumentation and the dam was determined to be in acceptable condition by the DSOD during its inspection in October 2016.

#### SEDIMENT MANAGEMENT – **MEETS OR EXCEEDS STANDARD**

Approximately, 348,600 cy of sediment were removed from the reservoir during a sediment removal project in 2009, bringing the available capacity to over 2.5 million cy. No recent fires have occurred in the reservoirs watershed in the past five years.

## SAN GABRIEL DAM



### Zoned Earth and Rock Fill

Year Completed:	1939	Crest Elevation:	1481 ft
Height of dam	291 ft	Crest Length:	1500 ft

### STATUS:

#### SEISMIC – **MEETS OR EXCEEDS STANDARD**

The dam structure has been analyzed and it is capable of withstanding the maximum credible earthquake.

#### SPILLWAY – **MEETS OR EXCEEDS STANDARD**

Analysis has determined a spillway capacity is 297,000 cfs, which is sufficient to pass the probable maximum flood.

#### INLET/OUTLET WORKS – **MEETS OR EXCEEDS STANDARD**

The outlet works are operational for flood control and stormwater capture operations. A project was recently completed to recoat, upgrade, and refurbish existing outlet works.

#### INSTRUMENTATION AND MONITORING – **MEETS OR EXCEEDS STANDARD**

The dam is monitored with adequate instrumentation and the dam was determined to be in acceptable condition by the DSOD during its inspection in October 2016.

#### SEDIMENT MANAGEMENT – **PROJECT NECESSARY**

Sediment within the reservoir has accumulated to a level near the intake structure, that could result in damage to the outlet works and hydroelectric generators. A project to remove 5 million cy over five years is scheduled to begin between 2019 and 2021, once the permitting and plans and specifications are completed.

## SANTA ANITA DAM



### Concrete Constant Angle Arch

Year Completed:	1927	Crest Elevation:	1325 ft
Height of dam	225 ft	Crest Length:	612 ft

### STATUS:

#### SEISMIC – **MEETS OR EXCEEDS STANDARD**

The dam structure has been analyzed and found to be capable of withstanding the maximum credible earthquake at a restricted reservoir level. Per the DSOD seismic standards, a new riser on the sluiceway outlet of the dam limits the maximum reservoir storage to an elevation of 1,230 ft. This riser was installed as part of the 2013 Riser Modification and Sediment Removal Project. Additional rehabilitation projects would be necessary to restore additional reservoir storage.

#### SPILLWAY – **PROJECT PENDING**

The Santa Anita Dam Spillway Modification Project is scheduled to begin construction in summer 2017. This project will construct a new spillway designed for 26,100 cfs. Analysis concluded the spillway has capacity to adequately pass the probably maximum flood.

#### INLET/OUTLET WORKS – **PROJECT PENDING**

New sluice and slide gates and debris racks were installed in 2013 as part of the Riser Modification and Sediment Removal Project. The outlet works are operational for flood control and stormwater capture operations. The pending spillway project will also include outlet improvements.

#### INSTRUMENTATION AND MONITORING – **MEETS OR EXCEEDS STANDARD**

The dam is monitored with adequate instrumentation and the dam was determined to be in acceptable condition by the DSOD during its inspection in February 2016.

#### SEDIMENT MANAGEMENT – **MEETS OR EXCEEDS STANDARD**

Approximately, 330,000 cy of sediment were removed from the reservoir in 2013 during the Riser Modification and Sediment Removal Project. Sediment elevation in the reservoir was reduced from 1,212 ft to 1,173 ft during the cleanout and an additional 185.4 AF of storage was restored.

## THOMPSON CREEK DAM



### Two Earth Embankments

Year Completed:	1928	Crest Elevation:	1648 ft
Height of dam:	66 ft	Crest Length:	1500 ft

### STATUS:

#### SEISMIC – **MEETS OR EXCEEDS STANDARD**

The dam structure has been analyzed and found to be capable of withstanding the maximum credible earthquake. A rehabilitation project was completed in 2001 to buttress embankments with compacting fill

#### SPILLWAY – **MEETS OR EXCEEDS STANDARD**

Analysis has determined the spillway has a capacity of 6,750 cfs, which exceeds the probable maximum flood of 6,293 cfs.

#### INLET/OUTLET WORKS – **MEETS OR EXCEEDS STANDARD**

The outlet works are operational for flood control and stormwater capture operations.

#### INSTRUMENTATION AND MONITORING – **MEETS OR EXCEEDS STANDARD**

The dam is monitored with adequate instrumentation, and the dam was determined to be in acceptable condition by the DSOD during its inspection in October 2016.

#### SEDIMENT MANAGEMENT – **MEETS OR EXCEEDS STANDARD**

The reservoir has a current capacity of 830,865 cy, which is adequate to capture two design debris events totaling 722,780 cy. No sediment removal project is necessary at this time.

## **Dam Safety Inspection and Monitoring Program**

Public Works implements an inspection and monitoring program involving staff with various technical expertise. The DSOD requires a Dam Safety Monitoring Program, routine inspections, and instrumentation reports for all jurisdictional dams and debris dams. San Gabriel Dam is equipped with hydroelectric generators, so it is also under the jurisdiction of the Federal Energy Regulatory Commission (FERC). FERC imposes additional inspections and reporting requirements for San Gabriel Dam.

### ***Dam Safety Inspections***

A variety of dam safety inspections are conducted frequently at each of the dams. For the dams holding significant amounts of water, the dam operators are onsite and conduct routine inspections daily. At minimum, an inspection is completed once a week, including dams with dry reservoirs. On a monthly basis, the dam operators complete a conditions checklists and inventory of supplies. Public Works dam safety engineers typically inspect the dam on a monthly basis and more frequently during periods of high water levels in the reservoir, following earthquakes and major storms, or during construction projects. The engineers also complete condition assessment evaluations and prepare inspection reports. Public Works field personnel are well equipped to support specialized inspections involving confined space and fall protection.

The DSOD dam safety engineers conduct annual inspections of each of the County's dams and provide inspection reports with any observed deficiencies noted along with a timeline to remedy. Recent reports have all concluded that the dams are safe for continued use. The Federal Energy Regulatory Commission dam safety engineers inspect San Gabriel Dam annually.

### ***Dam Performance Monitoring and Instrumentation***

The dams are equipped with instrumentation to monitor the performance of the dam. Both manually measured and automated systems are used redundantly. The dam operators record measurements on a routine basis, typically once a week, but the frequency is increased for higher water levels in the reservoirs. The dam safety engineers review the data, looking for sudden changes or unusual trends. The following is a description of some of the types of instruments used:

#### ***Hydraulic Conditions***

- Reservoir Gage Boards – The dam operator reports daily readings of the reservoir level to the hundredth of a foot based on precisely calibrated gage boards.
- Reservoir Stilling Well – Automated pressure transducers or bubbler systems record daily reservoir levels.
- Piezometers – Monitor phreatic surface in embankment dams, uplift pressure on dam foundations, and abutment conditions.
- Leakage Points – Monitor the minor flow of water through or around the dam from the reservoir or local groundwater conditions.

- Weirs – Precisely monitor seepage or leakage flows concentrated at a single measuring point.

#### *Movement of the Dam*

- Precise Survey – Public Works survey crews conduct an annual precise survey of each dam to measure the slightest movements of the overall structure and abutments. A comprehensive report is prepared following each survey.
- Expansion Joints – Joints in the structure allow for minor movement of the dam, mainly due to seasonal thermal expansion. The measurement points monitor relative movement in each direction.
- Crack Meters – Existing cracks in the structure or surrounding rock forms can be closely monitored for trends or sudden changes.
- Pendulums – Pendulums provide an indicator for the tilt or yaw of a dam structure.

#### *Seismic Instruments*

- Accelerographs – The dams are equipped with electronic accelerographs that record the horizontal and vertical accelerations of an earthquake event.
- The United States Geological Survey (USGS) and California Geological Survey (CGS) – Public Works also permits the USGS and CGS to maintain seismic instrumentation at County dams. USGS and CGS share data in real-time.

### **Dams Automated Data Acquisition System**

The Dams Automated Data Acquisition System (DADAS) is a system of instrumentation, data recorders, and communications that automatically collects measurements and transmits data to Public Works headquarters with near real-time monitoring. The DADAS was initially implemented in 1999 and is now operating at all 14 major dams. This automated system allows for a quick review immediately following storms and seismic events and provides a continuous measurement to observe trends. The dam safety engineers regularly review the data and calibrate the instrumentation based on manual measurements. The DADAS continues to perform well and is a useful tool. However, a project is currently in progress to upgrade the DADAS to a modern interface, more reliable communications, and improved software capabilities.

### **Monitoring Reports**

Monitoring Reports are prepared to review and interpret the instrumentation data. Data is plotted to detect any unusual trends or sudden changes. Automated measurements are compared with the manual measurements for calibration.

- Monthly Monitoring – Dam safety engineers prepare monthly monitoring reports for each dam.
- DSOD Monitoring Reports – Comprehensive monitoring reports are regularly submitted to the DSOD for review and acceptance.
- FERC Monitoring Reports (San Gabriel Dam) – Annual monitoring reports are submitted to FERC for review and acceptance.

## ***Emergency Response Preparedness***

The County's dams are located above highly populated communities and the consequences of a dam failure could be severe. Public Works emphasizes emergency preparedness and has instituted the following measures to ensure fast and effective response to dam safety incidents:

- A dam safety engineer is on-call 24/7 to respond to unusual incidents or seismic events.
- Protocols have been established for incident reporting and online report forms for notifications.
- Protocol training for engineers and dam operators is conducted annually.
- Redundant communication systems including landline and mobile telephone, satellite phone, and radio are in place.
- A functional exercise for emergency response in a simulated earthquake event is conducted annually.
- Emergency Action Plans have been prepared for each dam that include communication with partner agencies including Sheriff, Fire Department, and cities.



JH/SEK:

P:\wrd\DAMS\Users\Jack\BOS 2017-02-14 - motion\Dams-BOSreport-2017-03-15x (3).docx