

STATE OF CALIFORNIA DEPARTMENT OF WATER RESOURCES OROVILLE DAM SAFETY COMPREHENSIVE NEEDS ASSESSMENT

## Results of Alternative Plan Formulation and Evaluation

Ad Hoc Group Meeting No. 7 June 26, 2020



# Initial Outline of Comprehensive Needs Assessment

#### January 12, 2018 DWR Letter to FERC

STATE OF CALIFORNIA - CALIFORNIA NATURAL RESOURCES AGENCY

DEPARTMENT OF WATER RESOURCES 1416 NINTH SIREEI, P.O. 80X 942836 SACRAMENTO, CA 94236-0001 (918) 653-5791 EDMUND G. BROWN JR., Governo

January 12, 2018

Mr. Frank L. Blackett, P.E. Regional Engineer Federal Energy Regulatory Commission 100 First Street, Suite 2300 San Francisco, California 94105-3084

FERC Project No. 2100 – Oroville Dam, Dam Safety Comprehensive Needs Assessment Plan and Schedule

Dear Mr. Blackett

By letter dated June 28, 2017, the Department of Water Resources (DWR) informed the Federal Energy Regulatory Commission (FERC) of its intent to initiate a Comprehensive Needs Assessment (project) to identify measures to bolster the safety and reliability of Oroville Dam and the appurtenant structures. Over the past several months, DWR has working the orowing the tables.

- Task 1 Alternatives Evaluation to Restore Spillway Design Capacity to Pass the Probable Maximum Flood
- Task 2 Operations Needs Assessment to Support Development of Alternative Reservoir Outflow Enhancements
- Task 3 Flood Control Outlet Enhanced Reliability
- Task 4 Alternatives Evaluation for Low-level Outlet
- Task 5 Oroville Dam Embankment Reliability and Improvements
- Task 6 Instrumentation and Monitoring for the Oroville Dam Complex

#### The project ties closed under to be gim de manny 46, 2040 and compluded by Becamber 64, 🚥 🖷

2019. A list of prioritized dam safety and operational reliability needs will be produced through completion of the project. Those needs will then be evaluated by DWR management and scheduled as projects through normal practices and procedures. As met project progresses, met project manager may load in projects and provide

significant public safety and risk reduction benefits. Such projects may be submitted to DWR management for early implementation. DWR will comply with FERC and other regulatory agencies' submittal, review, and approval processes as part of the implementation. By letter dated June 28, 2017, the Department of Water Resources (DWR) informed the Federal Energy Regulatory Commission (FERC) of its intent to initiate a Comprehensive Needs Assessment (project) to identify measures to bolster the safety and reliability of Oroville Dam and the appurtenant structures. Over the past several months, DWR has

2019. A list of prioritized dam safety and operational reliability needs will be produced through completion of the project. Those needs will then be evaluated by DWR management and scheduled as projects through normal practices and procedures. As

## **Summary of CNA Mission**

- Identify and prioritize dam safety and operational needs.
- Identify *Measures* to improve the safety and reliability of Oroville Dam and its appurtenant structures.
- Identify potential *Plans (Projects)* for DWR Management to evaluate for future implementation and prioritization through normal practices and procedures.

**Outlet Portal** 

## **Revised Extension of DWR Asset Management Risk Matrix**

Likelihood Annual Probability		Comprehensive Needs Assessment – Extension of DWR Division of Operations & Maintenance Asset Management Risk Matrix													
		1 Insignificant	2 Minor	3 Moderate	4 High	5 Major	6 Extreme	7 Catastrophic	8	9	10	11			
Likely to occur 10 times a year	10								Tole	erable Risk	Guideline	s for			
Likely to occur within 1 year	9									n Safetv (Li	ife Loss) fr	om FERC			
Likely to occur within 3 years	8.5							****	and other Federal Agencie						
1/10 – 1/3	8										Ū				
1/30 – 1/10	7.5														
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Negligible															
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Consequen	ce					Con	sequence L	evel							
Category		1 Insignificant	2 Minor	3 Moderate	4 High	5 Major	6 Extreme	7 Catastrophic	8	9	10	11			
Public Safe (including Perso Safety)	ty nnel	No injury	Near miss, minor injuries	Minor injuries	Single injury	Multiple injuries, perm. disability	<b>0 – 1</b> fatalities	<b>1 -10</b> fatalities	<b>10 – 100</b> fatalities	<b>100 – 1,000</b> fatalities	1,000 – 10,000 fatalities	<b>&gt; 10,000</b> fatalities			
Financial Impa (Direct and Indir	rect)	< \$100k	\$100k - \$1M	\$1M - \$10M	\$10M-\$100M	\$100M - \$1B	\$1B - \$10B	\$10B - 100B	\$100B - \$250B	\$250B - \$500B	\$500B - \$1T	> \$1T			

#### **Estimated Risks for CNA PFMs – Existing Conditions**

Likelihood Annual Probability		Comprehensive Needs Assessment – Extension of DWR Division of Operations & Maintenance Asset Management Risk Matrix												
		1 Insignificant	2 Minor	3 Moderate	4 High	5 Major	6 Extreme	7 Catastrophic	8	9	10	11		
Likely to occur 10 times a year	10	🔵 🔷 та	◆ Task 1 Emergency Spillway (8) Tolerable Risk Guidelines for											
Likely to occur within 1 year	9	🗎 🔶 Т	Task 3 FCO Spillway (37) Task 3 FCO Spillway (37)											
Likely to occur within 3 years	8.5	<mark>О</mark> 🔷 Т	Task 4 Hyatt PP/Outlets (33)     A and other Federal Agencies											
1/10 – 1/3	8	🔾 🔷 ा	Task 5 Embankments (51)											
1/30 – 1/10	7.5	129 PFM:	129 PFMs; 54 PFMs considered <i>Negligible</i>											
1/100 – 1/30	7	Circular sym	bols (105) de	note Life Loss	as dominant	consequence,	,							
1/1,000 – 1/100	6	diamond syı	nbols (24) dei	note Financial	Impacts as de	ominant conse	equence							
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	ty	No injury	Near miss,	Minor injuries	Single injury	Multiple	0 – 1	1 -10	10 – 100	100 – 1,000	1,000 – 10 000	> 10,000		
Safety)	mei		minor injuries			disability	fatalities	fatalities	fatalities	fatalities	fatalities	fatalities		
Financial Impa (Direct and Indii	a <b>cts</b> rect)	< \$100k	\$100k - \$1M	\$1M - \$10M	\$10M-\$100M	\$100M - \$1B	\$1B - \$10B	\$10B - 100B	\$100B - \$250B	\$250B - \$500B	\$500B - \$1T	> \$1T		

#### **Estimated Risks for L2RA PFMs – Existing Conditions**

Likelihood Annual Probability		Comprehensive Needs Assessment – Extension of DWR Division of Operations & Maintenance Asset Management Risk Matrix												
		1 Insignificant	2 Minor	3 Moderate	4 High	5 Major	6 Extreme	7 Catastrophic	8	9	10	11		
Likely to occur 10 times a year	10	Oroville	Main Dam (45)					Tolerable Risk Guidelines for						
Likely to occur within 1 year	9	Bidwell I	Bar Canyon Sa	addle Dam (31	)		Dam Safety (Life Loss) from FER							
Likely to occur within 3 years	8.5	Parish C	amp Saddle D ıcy Spillway (1	am (15) I1)			and other Federal Agencies							
1/10 – 1/3	8	FCO Hea	dworks Struc	ture (21)										
1/30 – 1/10	7.5	FCO Spi	llway Chute (1 ake/Powerplaı	0) nt (15)										
1/100 – 1/30	7	River Va	lve Outlet Sys	tem (7)										
1/1,000 – 1/100	6	Palermo 165 PFMS;	Tunnel Outlet 98 PFMs cor	: (10) nsidered <mark>Ne</mark> d	gligible									
1/10,000 - 1/1,000	5	,		•										
1/100,000 – 1/10,000	4		13 12 14	16	6	19	1				22			
1/1,000,000 – 1/100,000	3				1 2 4 5 14	5		15	4 18		33 1 10			
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Consequen	ce				8 9	Con	isequence L	evel	21 1 16 17 18 19	9 20 21 22 7	38 41 43	35 39 40 42		
Category		1 Insignificant	2 Minor	3 Moderate	4 High	5 Major	6 Extreme	7 Catastrophic	7 8 23 25 28 29 9 10 11 12 13 1	9 30 31 32 8 4 33 10	10	11		
Public Safe (including Perso Safety)	r <b>ty</b> nnel	No injury	Near miss, minor injuries	Minor injuries	Single injury	Multiple injuries, perm. disability	0 – 1 fatalities	<b>1 -10</b> fatalities	15 16 17 18 4 6 7 8 9 10	<b>100 – 1,000</b> fatalities	<b>1,000 –</b> <b>10,000</b> fatalities	> 10,000 fatalities		
Financial Impa (Direct and Indii	a <b>cts</b> rect)	< \$100k	\$100k - \$1M	\$1M - \$10M	\$10M-\$100M	\$100M - \$1B	\$1B - \$10B	\$10B - 100B	\$100B - \$250B	\$250B - \$500B	\$500B - \$1T	> \$1T		

## **Existing Conditions-CNA PFMs Addressed by Measures**

Likelihood Annual Probability		Comprehensive Needs Assessment – Extension of DWR Division of Operations & Maintenance Asset Management Risk Matrix													
		1 Insignificant	2 Minor	3 Moderate	4 High	5 Major	6 Extreme	7 Catastrophic	8	9	10	11			
Likely to occur 10 times a year	10	🔵 🔷 Та	ask 1 Eme	rgency Spi	llway (2)				Tole	erable Risk	Guideline	s for			
Likely to occur within 1 year	9	🔴 🔶 Та	ask 3 FCO	Spillway (	13)			Dam Safety (Life Loss) from FERC							
Likely to occur within 3 years	8.5	🔵 🔶 Та	Task 4 Hyatt PP/Outlets (7)												
1/10 – 1/3	8	Task 5 Embankments (9)													
1/30 – 1/10	7.5	31 PFMs	31 PFMs Addressed by Measures												
1/100 – 1/30	7	Circular sym	bols (23) den	ote Life Loss a	as dominant c	onsequence,									
1/1,000 - 1/100	6	diamond syr	nbols (8) deno	ote Financial II	npacts as don	ninant conseq	uence								
1/10,000 - 1/1,000	5														
1/100,000 – 1/10,000	4				0	*	4								
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Category		1 Insignificant	2 Minor	3 Moderate	4 High	5 Major	6 Extreme	7 Catastrophic	8	9	10	11			
Public Safe (including Perso Safety)	e <b>ty</b> nnel	No injury	Near miss, minor injuries	Minor injuries	Single injury	Multiple injuries, perm. disability	<b>0 – 1</b> fatalities	<b>1 -10</b> fatalities	<b>10 – 100</b> fatalities	<b>100 – 1,000</b> fatalities	1,000 – 10,000 fatalities	> <b>10,000</b> fatalities			
Financial Impacts (Direct and Indirect)		< \$100k	\$100k - \$1M	\$1M - \$10M	\$10M-\$100M	\$100M - \$1B	\$1B - \$10B	\$10B - 100B	\$100B - \$250B	\$250B - \$500B	\$500B - \$1T	> \$1T			

## **CNA Major Findings**

- No dam safety deficiencies were identified (FERC and DSOD standards)
- For the handful of PFMs that are the highest, additional analysis is required
  - o Flood control outlet structural analysis
  - o Embankment/monolith 31 seepage potential
- Some PFMs could actually be an order of magnitude higher or lower as there is still some uncertainty (this was a semi quantative risk analysis)
- Opportunity to further reduce risk of failure and reduce risk of flooding both identified and articulated

**Outlet Portals** 

## **Revised Dam Safety Finding Language**

"All of the risk estimates made by the CNA teams fell into either broadly acceptable or tolerable risk zones. No unacceptable risks (those that might fall above the tolerable risk reference line) were identified. As a result, no dam safety issues were identified that exhibit a need for immediate risk reduction actions. This finding, and the use of these risk tolerance guidelines, are consistent with risk-informed decision making practices in use by federal agencies with large portfolios of dams and dam safety programs guided by risk-based approaches."

**Outlet Portals** 

Parking Area

Area Control Center

## Conclusion from 10th Part 12 Independent Consultant (in Draft)

"The project is suitable for continued safe and reliable operation. No emergency or remedial measures are necessary for continued safe operation."

**Outlet Portals** 

Area Control Center-

## **How We Formulated Alternative Plans**

- Identified themes, per IRB recommendation.
- Considered mixtures of different *Measures* in compatible combinations.
- Built Alternative Plans that meet project objectives and constraints.
- Refined Alternative Plans as more information became available.

**Outlet Portals** 

Area Control Centre

## Evaluation Criteria for Scoring Effectiveness of Alternative Plans

- Achieves Risk Reduction/Residual Risk
- Promotes Resiliency (Prepare, Absorb, Recover, and Adapt)
- Adherence to Best Engineering Practices

**Outlet Portals** 

Area Control Center-

## **CNA Alternative Plans**

	Recommended Measures	PLAN 1	PLAN 2	PLAN 3	PLAN 4	PLAN 5	PLAN 6	PLAN 10	PLAN 7	PLAN 8	PLAN 9
T1-A	Minimally improved pilot channel					Х			Х	Х	
T1-C	New Full length RCC chute				Х						
T1-E	New FCO gated reinforced concrete chute	Х	Х	Х			Х	Х			
T1-P	Hyatt Powerplant discharge portal bulkheads	Х	Х	X	Х	Х	Х	X		Х	Х
T1-Z	Secant Pile Wall buttress					Х			Х	Х	
T1-AW	Partial extension of RCC apron w/ minimally imp. Ch.								Х		
T3-AJ	Upstream bulkhead gates*	Х	Х	Х	Х	Х	Х	Х	Х	X	Х
T3-J	Structural upgrades/retrofit*	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х
T3-BH.2	Backup power, local starter, etc.*	Х	Х	X	X	Х	Х	Х	Х	X	Х
T3-	Debris control structures/devices	Х	Х	Х	Х	Х		Х			
T4-N	Rock bolts in Hyatt Powerplant	Х	Х								
T4-W	Palermo Intake landslide stabilization	Х	Х								
T4-0	Barrier around ACC and switchyard, landslide stabl.	Х	Х								
T4-U	Palermo Canal Lining	Х	Х	Х	Х	Х					
T4-C	New High-Level Outlet @ EI 775 ft	Х									
T4-E	New Low-Level Outlet @ EI 435 ft		Х	Х	Х	Х	Х		Х		
T4-G	New Low-Level Outlet @ EI 340 ft	Х									
T5-02	Modify portion of dam that wraps around Mon. 31*	Х	Х	X	Х	Х	Х	Х	Х	X	Х
T5-03	Modify the upper 40 ft of Main Dam	Х	Х	X							
T5-05	Raise Main Dam by 3 ft	Х	Х	X							
T5-B2	Raise Bidwell Bar Saddle Dam (BBCSD) by 3 ft	Х	Х	Х							
T5-P2	Raise Parish Camp Saddle Dam (PCSD) by 3 ft	Х	Х	X	Х	Х	Х	Х	Х	X	Х
	Total Weighted Benefit										
	(risk reduction, resiliency, and engineering only)	73	81	79	73	77	77	72	63	53	41

## **CNA Alternative Plans**

No dam safety deficiencies were identified

 Plans identified through the CNA will enhance system operations and reliability

 The benefits of each plan, along with their cost, will be considered through the SWP Asset Management Program Processes

**Outlet Portals**