# High Hazard Dam Release -Floodplain Impacts Ranking Tool and Database

Floodplain Management Workshop

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**COLORADO Division of Water Resources** Department of Natural Resources

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# Goals of Discussion

- Show a Flooding Hazard related to dam operations that has been identified
- Show the High Hazard Dam Release -Floodplain Impacts Database and Ranking Tool
- Discuss next steps Uses to reduce risk to communities, uses for additional CRS Credits



#### 1,850 Program Dams



### Hazard Classification

Based on an evaluation of consequences of dam failure absent of flooding conditions

Assumes the reservoir is at the high water line.

Hazard Classification	Description
High	Loss of human life is expected in the event of a failure
Significant	Significant damage is expected, but no loss of human life
Low	No significant damage and no loss of human life
No Public Hazard (NPH)	No loss of human life and damage only to dam owner's property

#### Dam Failure



# Dam Safety and CRS

#### • CRS Coordinators Manual, Section 630/631

Because of the threat of flooding from <u>dam failure or dam operations</u>, the Community Rating System (CRS) credits cooperation among state dam safety officials, dam owners and operators, and local emergency managers. Credit is for state and local dam safety programs that:

- Help make the needed information available,
- Improve communications among operators of the dams and downstream communities, and
- Develop warning and response plans for dam failures.

The credit is keyed to addressing the areas at risk from the failure of a highhazard potential dam. A "high-hazard-potential dam" is one for which <u>failure</u> <u>or operational errors</u> will probably cause loss of human life downstream. Communities must contact their state dam safety office to determine if they are affected by such a dam.



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# Inundation Mapping Primer

Location	100-year Peak Flow	Routed Dam Failure Peak Flow
Ward Creek at 11.5 miles below Ward Lake dam	1,010 cfs (USGS)	33,709 cfs
		Deep Ward Lake Dam

### Why so large?

- Dam is fully breached in one-hour or less.
- Assumes dams below Ward Lake fail due to overtopping; cascading and cumulative flows



# Inundation Mapping Primer

Ward Lake Inundation -Mapping



#### FEMA 100-yr floodplain

#### Normal Operation



#### Flood Operation - Button Rock Dam 2013



# Oroville Dam





#### **Barker and Addicks Dams**



- Water surface in reservoir rising at <sup>1</sup>/<sub>2</sub> ft per hour
- Outlets opened releasing 4,000cfs

#### Neighborhoods around Addicks and Barker Reservoir



## What Did We Learn?

- Colorado in 2013, Oroville and Houston in 2017 show dams operating as designed but still cause flooding downstream
- Emergency Action Plans have maps for dam failure inundation - of no use in operations release flooding scenarios



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# Project to highlight the Gap?

- \$95,000 project, Funded by FEMA Grant (\$45K) and Colorado Water Conservation Board grant (\$50k)
- Created a High Hazard Dam Release -Downstream Floodplain Impacts Database and Ranking Tool
  - Dam Information
  - Spillway data
  - Outlet data
  - Population at risk
  - Compares spillway and outlet flows to FEMA 100-year flows, basin areas, etc
  - Promote and share the database and tools with Floodplain and emergency managers

#### Database



#### Colorado Division of Water Resources

High Hazard Dam Release - Downstream Floodplain Impacts Study

ming Revision Date: 6/23/2017

	Dam Info	Spillways	Outlet Works	Dam	Streamflow Statistics at Dam	Initial Ranking	Secondary Ranking	FEMA	Hydraulic Analysis
	Expand >	Expand >	Expand >	Expand >	Expand >	Expand >	Expand >	Expand >	Expand >
Dam Name	Dam ID NID ID kmz	Controlled Capacity (cfs)	Outlet Capacity (cfs)	Total Max. Controlled Discharge (cfs)	Dam and/or Main Channel Drainage Area (mi <sup>2</sup> )	Initial Ranking by Dam Not Total Considered	Secondary Ranking by Dam Not Total Considered	FIS Profile	Hydraulic Analysis Performed by:
GREEN MOUNTAIN	360106 CO01658 Google Earth	25,000	1530.0	26530.0	582.28	35	27	FIS Profile	
JOHN MARTIN	670215 CO01283 Google Earth		13780.0	13780.0	18482.30	152	80	N/A	
MAPLE GROVE	070219 CO00203 Google Earth	13365	102.0	13467.0	10.40	2	2	FIS Profile	YW
GRANBY	510108 CO01656 Google Earth	12000	435.0	12435.0	312.08	72	100	N/A	
CHATFIELD	080324 CO01281 Google Earth		8300.0	8300.0	3020.77	5	4	FIS Profile	YW
CHERRY CREEK	080116 CO01280 Google Earth	0.004	8100.0	8100.0	385.67	12	12	FIS Profile	YW
WILLIAMS FORK	510127 CO00717 Google Earth	6400	620.0	7020.0	230.07	36	49	N/A	
OLYMPUS	040134 CO01662 Google Earth		5767.0	5767.0	155.20	46	72	FIS Profile	
PUEBLO	140133 CO00299 Google Earth		5767.0	5767.0	1546.84	45	22	FIS Profile	
TRINIDAD	190122 CO00050 Google Earth		5500.0	5500.0	671.86	10	10	N/A	
MCPHEE RESERVOIR	710106 CO02707 Google Earth		5000.0	5000.0	819.12	111	141	FIS Profile	
DILLON	360104 CO00875 Google Earth		4400.0	4400.0	334.09	18	44	No Profile	
CTRONITIA CODINICE	000101 CO03310 Coople Famb		4000.0	1000 0	3507 70	F7	30	ric naséla	MA .

- Main Categories
  - Dam Information, dam ID, google earth KMZ
  - Spillway Capacity
  - Outlet Capacity
  - Total Controlled outlet
  - Stream flow
  - Ranking
  - FEMA
  - Hydraulic Analysis

### Warren Lake

- Facts
  - Dam Height 23 ft
  - Storage capacity 2185 cfs
  - Spillway Capacity 1045 cfs
  - Drainage Basin 0.44 sq mi
  - Outlet Capacity 74 cfs
  - 2-yr stream stat 97 cfs
  - 100-yr stream stat discharge 3610 cfs
  - Population at risk 2541
  - Ranking 306 of 416
  - FEMA no data
  - Safe channel capacity 40 cfs



#### Colorado Division of Water Resources

High Hazard Dam Release

Sownstream Hoodplain Impacts Study					
	W	ARREN I	.AKE		
DAM ID03NID IDCCCountyLAStreamCA	0330 000852 RIMER .CHE LA POUDRE RIVER	ι	Latitude Longitude	<u>Go to Google Earth</u> 40.535 -105.055	1
Dam Drainage Area, DA	(mi²)	1.45	Outlet Works	Capacity (cfs)	74
100-Yr StreamStats Disc	harge (Q <sub>100</sub> ) (cfs)	3610	Total Maximum Controlled 74		74
		Warren	Lake		
R1: DA/Q.org	195	anking Sumi	nary	R4: Q100/Qsur	339
R2: Q <sub>100</sub> /Q <sub>cont</sub>	195			R5: 1/Q <sub>mot</sub>	216
R3: Dist. To DS Town	142			R6: 1/Q <sub>sw</sub>	261
	Composite Ranking 306 LOW Ronkings reported out of 416 total doms				

Population at Risk (PAR) Social Vulnerability Index (SVI) 2541 -9.1 LOW

Estimated first impacted downstream road Estimated first impacted downstream structure <u>View in Google Earth</u> <u>View in Google Earth</u>

#### Warren Lake Inundation Map



#### Hydraulic Analysis Summary

Dam Name	WARREN LAKE
Dam ID	030330
Safe Channel Capacity (cfs)	40
Safe Channel plus Total Max. Discharge Qcont (cfs)	Controlled 114
	Safe Channel Capacity Mapping in Google Ear
Reference Flow 1 (cfs)	98
Reference Flow 1 Frequency a	and Source 2-year (SS)

Hydraulic AnalysisThe safe channel capacity of the reach downstream of Warren Lake Dam is estimated<br/>to be 40 cfs. The maximum controlled discharge is 74 cfs. For comparison, the 2-year<br/>peak discharge estimated by StreamStats is 98 cfs. The downstream impact area is<br/>urban with high density. The first impacted road downstream of the dam is Ziegler<br/>Road. A small portion of the road may be inundated by approximately 0.5 feet at a<br/>peak discharge of approximately 40 cfs. The first impacted structures downstream of<br/>the dam are located southwest of intersection of S Timberline Road and Timberline<br/>Lane. The structure may be flooded at a peak discharge of approximately 40 cfs.

page 2



#### Warren Lake - Zone X



### Fossil Creek

- Facts
  - Dam Height 42 ft
  - Storage capacity cfs
  - Spillway Capacity 88,100 cfs
  - Drainage Basin 29 sq mi
  - Outlet Capacity 393 cfs
  - 2-yr stream stat 516 cfs
  - 100-yr stream stat discharge 14,900 cfs
  - Population at risk
  - Ranking 74
  - FEMA no data
  - Safe channel capacity 616 cfs





Colorado Division of Water Resources High Hazard Dam Release Downstream Floodplain Impacts Study

#### FOSSIL CREEK

DAM ID	030135			Go to Google Earth	
NID ID	CO01165		Latitude	40.492	
County	LARIMER		Longitude	-104.994	
Stream	FOSSIL CREEK				
Dam Drainage	Area, DA (mi²)	29.09	Outlet Works C	apacity (cfs)	393
100-Yr Stream	Stats Discharge (Q <sub>100</sub> ) (cfs)	14900	Total Maximum	Controlled	202
Total Spillway	Capacity, Q <sub>sw</sub> (cfs)	88100	Discharge, $\mathbf{Q}_{cont}$	(cfs)	393



	Ran	king Sun	nmary		
R1: DA/Q <sub>cont</sub>	120			R4: Q <sub>100</sub> /Q <sub>sw</sub>	166
R2: Q <sub>100</sub> /Q <sub>cont</sub>	191			R5: 1/Q <sub>cont</sub>	89
R3: Dist. To DS Town	142			R6: 1/Q <sub>SW</sub>	10
	Composite Ranking	74	HIGH	Rankings reported out of 4	16 total dams

quence Analysis	
N/A	
N/A	
View in Google Earth	
View in Google Earth	
	uence Analysis N/A N/A <u>View in Google Earth</u> <u>View in Google Earth</u>

### Fossil Creek Dam - Inundation Map



#### Hydraulic Analysis Summary

Dam Name	FOSSIL CREEK		
Dam ID	030135		
Safe Channel Capacity (cfs)	616		
Safe Channel plus Total Max. Contro Discharge Qcont (cfs)	olled 1009		
Safe Ch	annel Capacity Mapping in Google Earth		
Reference Flow 1 (cfs)	516		
Reference Flow 1 Frequency and Sour	rce 2-year (SS)		
Reference Flow 2 (cfs)	3450		
Reference Flow 2 Frequency and Sour	rce 10-year (SS)		

Hydraulic AnalysisThe safe channel capacity of the reach downstream of Fossil Creek Dam is estimated<br/>to be 616 cfs. The maximum controlled discharge is 393 cfs. For comparison, the 2-<br/>year peak discharge estimated by StreamStats is 516 cfs; the 10-year peak discharge<br/>estimated by StreamStats is 3450 cfs. The downstream impact area is rural. The first<br/>impacted roads downstream of the dam are South County Road 5, South County Road<br/>3, and County Road 32 East. The roads may be overtopped at a peak discharge of<br/>approximately 616 cfs. The first impacted structure downstream of the dam is located<br/>at the end of Watson Drive. The residential house may be flooded at a peak discharge<br/>of approximately 616 cfs.

page 2

#### Fossil Creek Dam - Outlet Release



### Larimer County High Hazard Dam Release High Risk Rankings (21)



#### **Ranked Dams - Statewide**



## Message

- We know the Risk exists
- Colorado Dam Safety has attempted to define and rank the severity of the risk
- We now have a tool for screening level ranking
- Examples demonstrate utility of detailed evaluations



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## Next Steps

- We are encouraging Floodplain and Emergency managers can use this screening level information to assess their risks
- Working with Floodplain and Emergency managers on where additional detailed safe channel capacity analysis should be done
- Working on finding funding to conduct detailed safe channel capacity analysis on all High Risk dams?



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### **Questions?**

SUNDAY SEPTEMBER 15, 2013 + DENVERPOST.COM + THE DENVER POST

\*\* SECTION B

#### **DENVER & THE WEST**

DONATE: Contribute to flood-relief efforts. »28

FORECAST: More rain expected Sunday, 366

# "Normal has changed"

Fifth person presumed dead while authorities work to get hundreds to safety



Jon Cook drives down Hygiene Road with his father, Bob, while looking over flooding of neighboring properties Saturday in Hygiene. Resident of the town helped one another salvage personal belongings from flooded homes. crug r. waker, the Denverboat



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#### Image Source: Denver Post