

Colorado Division of
Water Resources

COLORADO DAM SAFETY BRANCH

2013 Colorado Flood Forum
Function of Dams During Flooding

Broomfield, CO
February 27, 2014



Opportunity to Improve DSE's to CFM's Communication

- Pre April 2013
 - Relatively unaware or unmotivated?
 - Dam safety and floodplain management rarely intersected
 - 100-yr floodplain vs PMF floods and Sunny Day failures
- Post April 2013 – FEMA CRS 630 – Dams
 - Becoming aware, very motivated
 - Need to learn from each other where dam safety and floodplain management roles intersect

CRS 630 – Dams - 5 Criteria for Credits

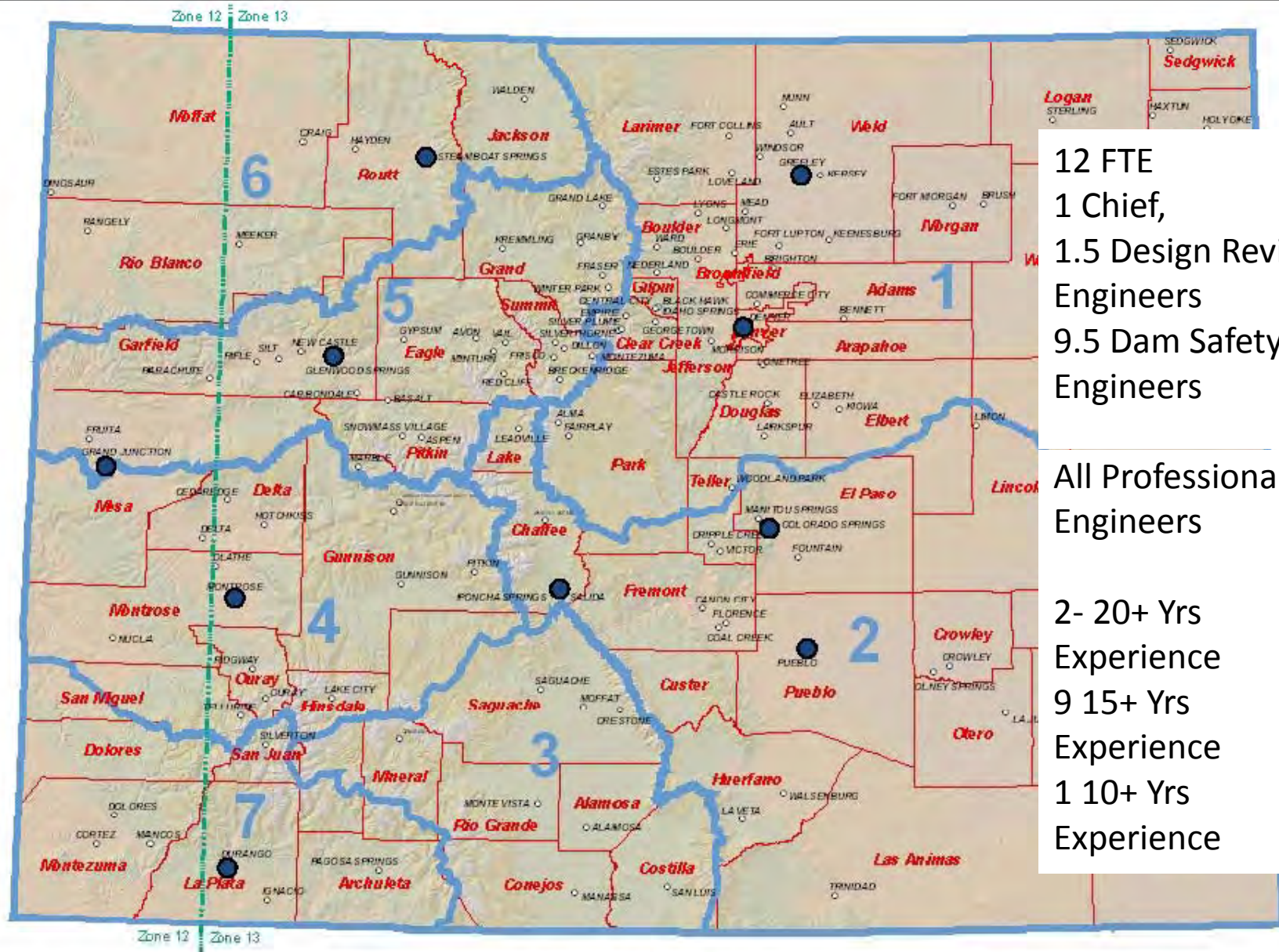
- The state's dam safety program that sets construction, maintenance, and data provision standards for dams (DSE's)
- A system to advise local emergency managers of a potential dam failure (EM's and ER's)
- A warning system for the areas downstream of the dam (EM's and ER's)
- A plan of action to minimize the threat to life and property during the flood (EM's and ER's)
- Coordination with critical facility operators (Dam Owners)

CRS 630 - Dams - Other

- “communities that would be affected by the failure of an upstream high-hazard-potential dam” (DSE’s)
- To receive additional dam safety credit, communities must have a dam failure threat recognition system, a means for warning dissemination, a response plan and a mechanism to coordinate with critical facility owners. DSE’s, (EM’s and ER’s, Dam Owners)
- Documentation must be provided by communities including a dam failure inundation map or evacuation area map. (DSE’s, EM’s, Dam Owners)

Introductions – CO Dam Safety

- Chief of Dam Safety - Salida
- Design Review Engineer - Denver
- Ten Dam Safety Engineers
 - Greeley (2)
 - Denver
 - Colorado Springs
 - Pueblo
 - Durango
 - Montrose
 - Grand Junction
 - Glenwood Springs
 - Steamboat Springs



12 FTE
 1 Chief,
 1.5 Design Review
 Engineers
 9.5 Dam Safety
 Engineers

All Professional
 Engineers

2- 20+ Yrs
 Experience
 9 15+ Yrs
 Experience
 1 10+ Yrs
 Experience

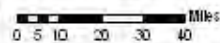


Source:
 Elevation: USGS 30 meter National Elevation Database
 Counties: Colorado Department of Local Affairs

Projection: Universal Transverse Mercator,
 Zone 13, North American Datum 1983, Meters



Division of Water Resources
 State of Colorado
DIVISIONS



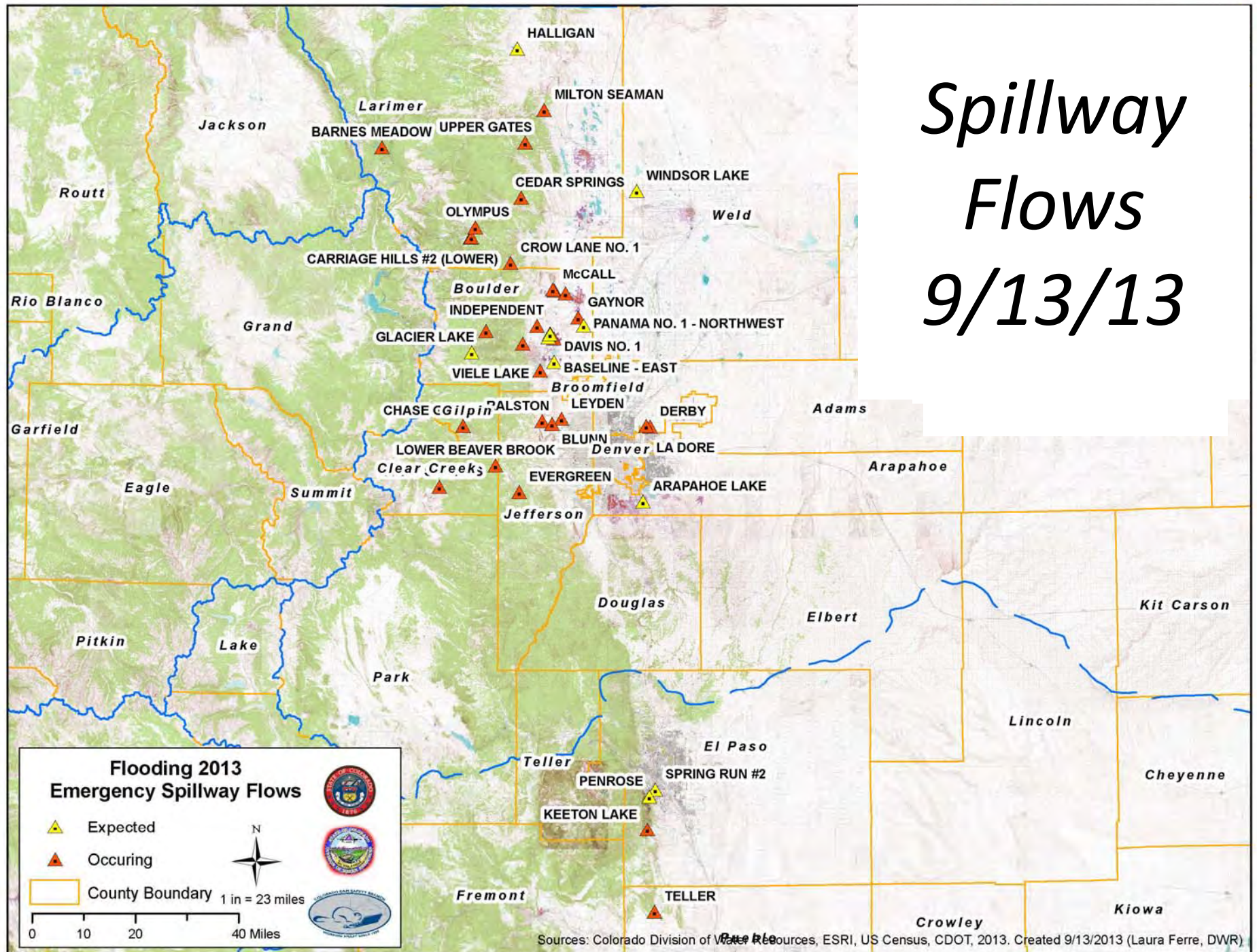
Legend



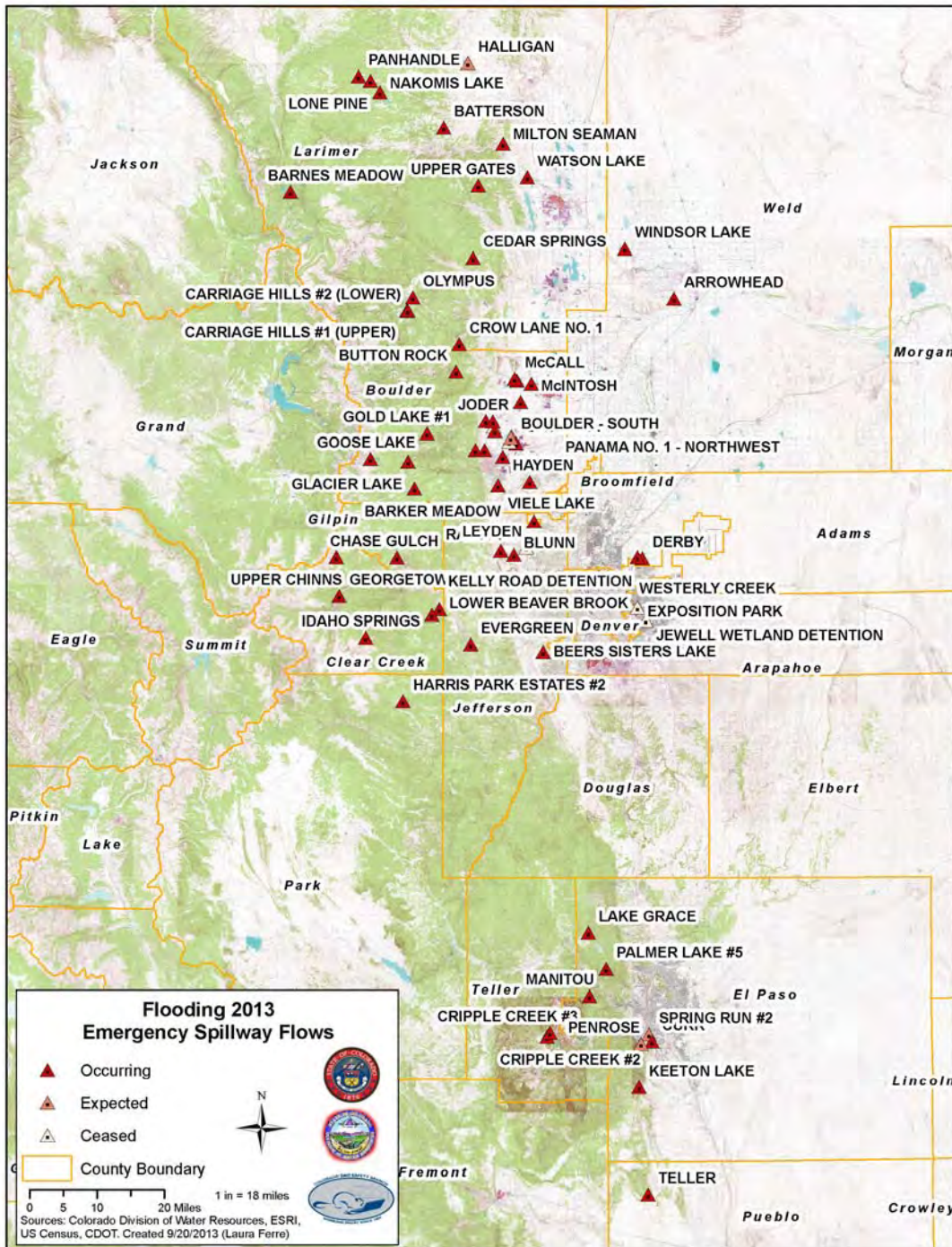
Function of Dams During 2013 Flooding

- Summary
 - High and Significant Hazard Dams functioned well, as designed...mostly
 - PMP spillways vs 100-1000 yr rains
 - Low hazard and smaller dams did not function as well
 - 25-100 yr spillways vs 100-1000 yr rains

Spillway Flows 9/13/13

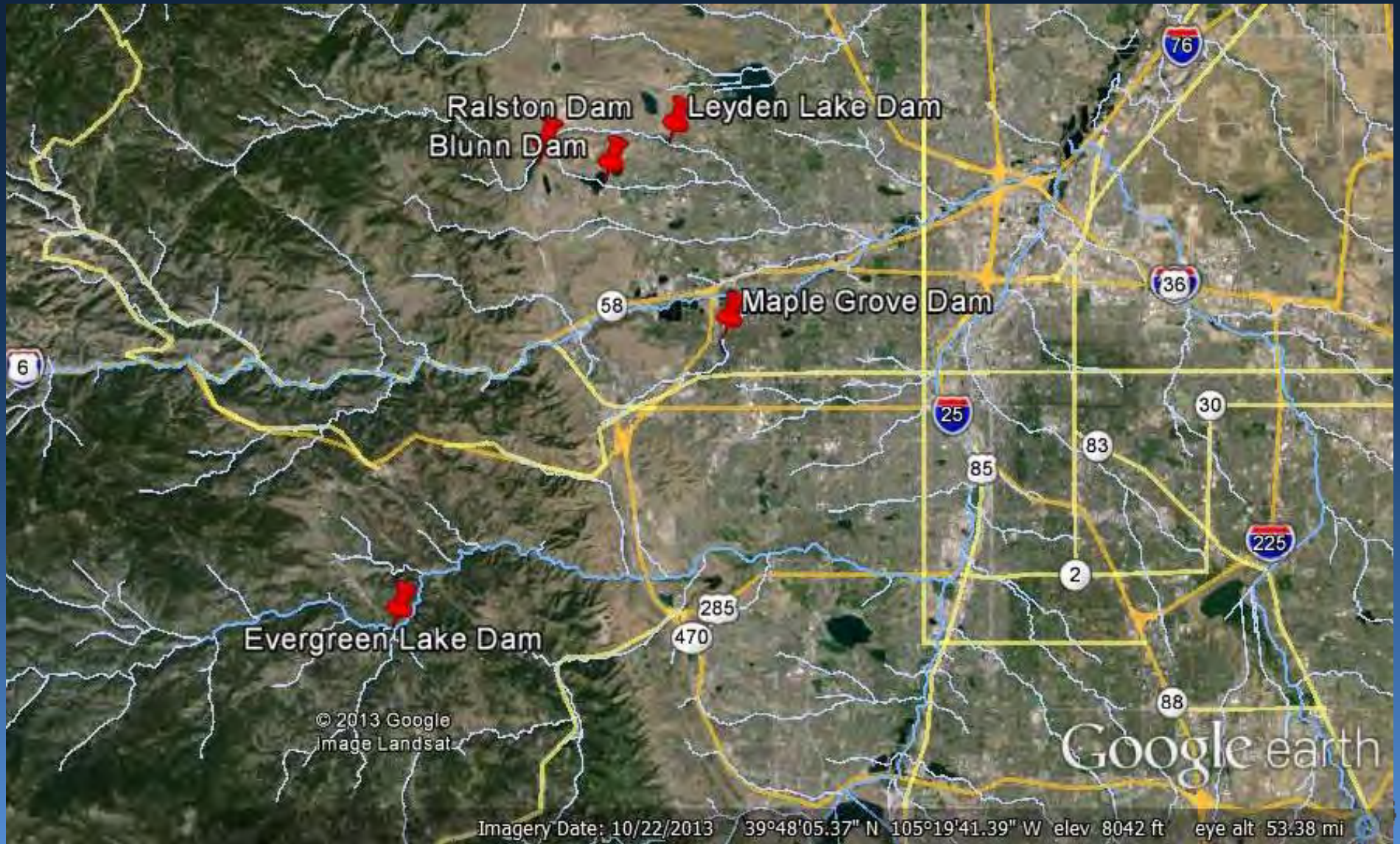


Spillway Flows 9/20/13



Colorado Division of
Water Resources

High Hazard Dams – Jefferson County

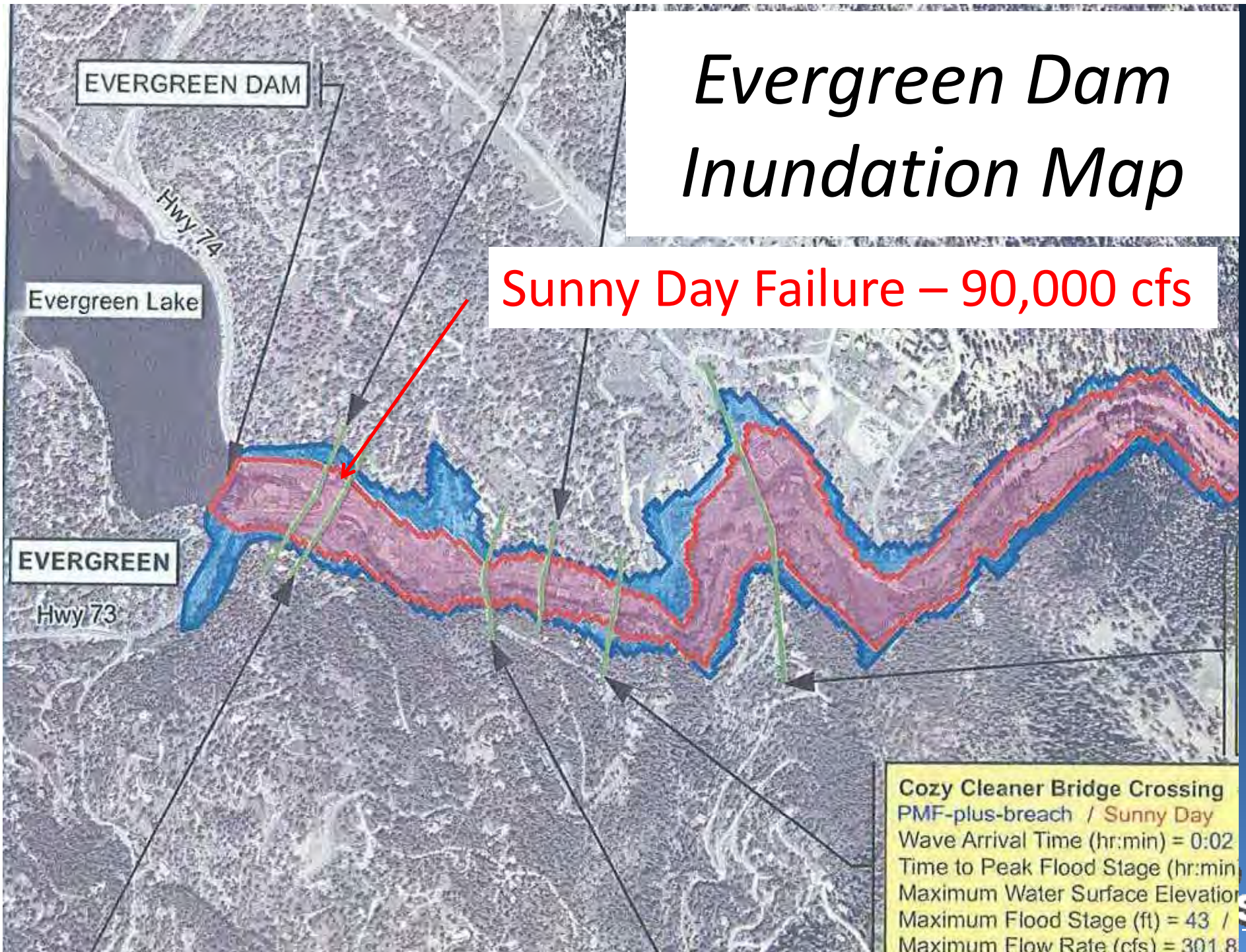


Evergreen Dam



Evergreen Dam Inundation Map

Sunny Day Failure – 90,000 cfs



Cozy Cleaner Bridge Crossing
PMF-plus-breach / Sunny Day
Wave Arrival Time (hr:min) = 0:02
Time to Peak Flood Stage (hr:min)
Maximum Water Surface Elevation
Maximum Flood Stage (ft) = 43
Maximum Flow Rate (cfs) = 301.8

Concrete Dam, Ogee-Crested Spillway







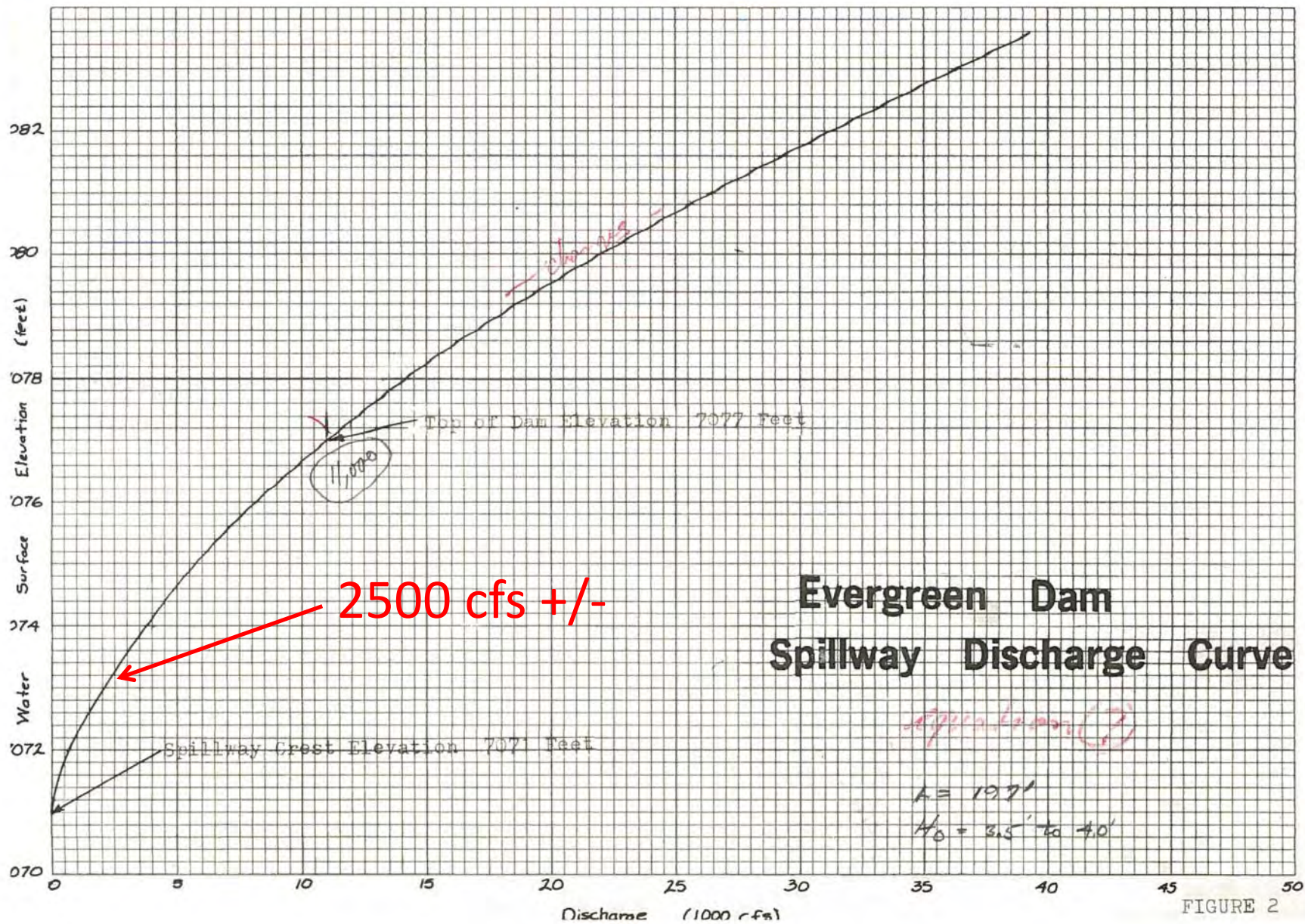
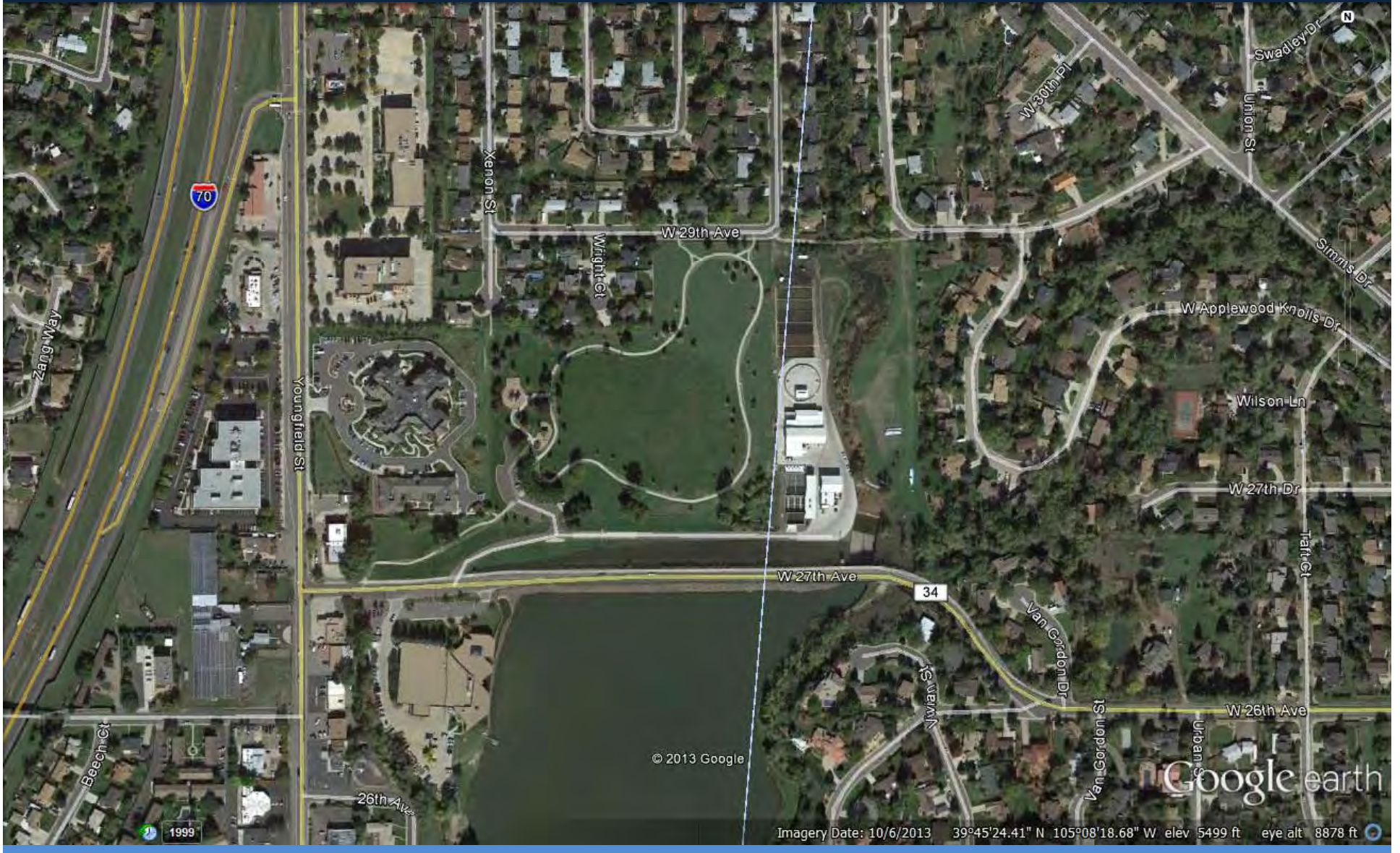


FIGURE 2



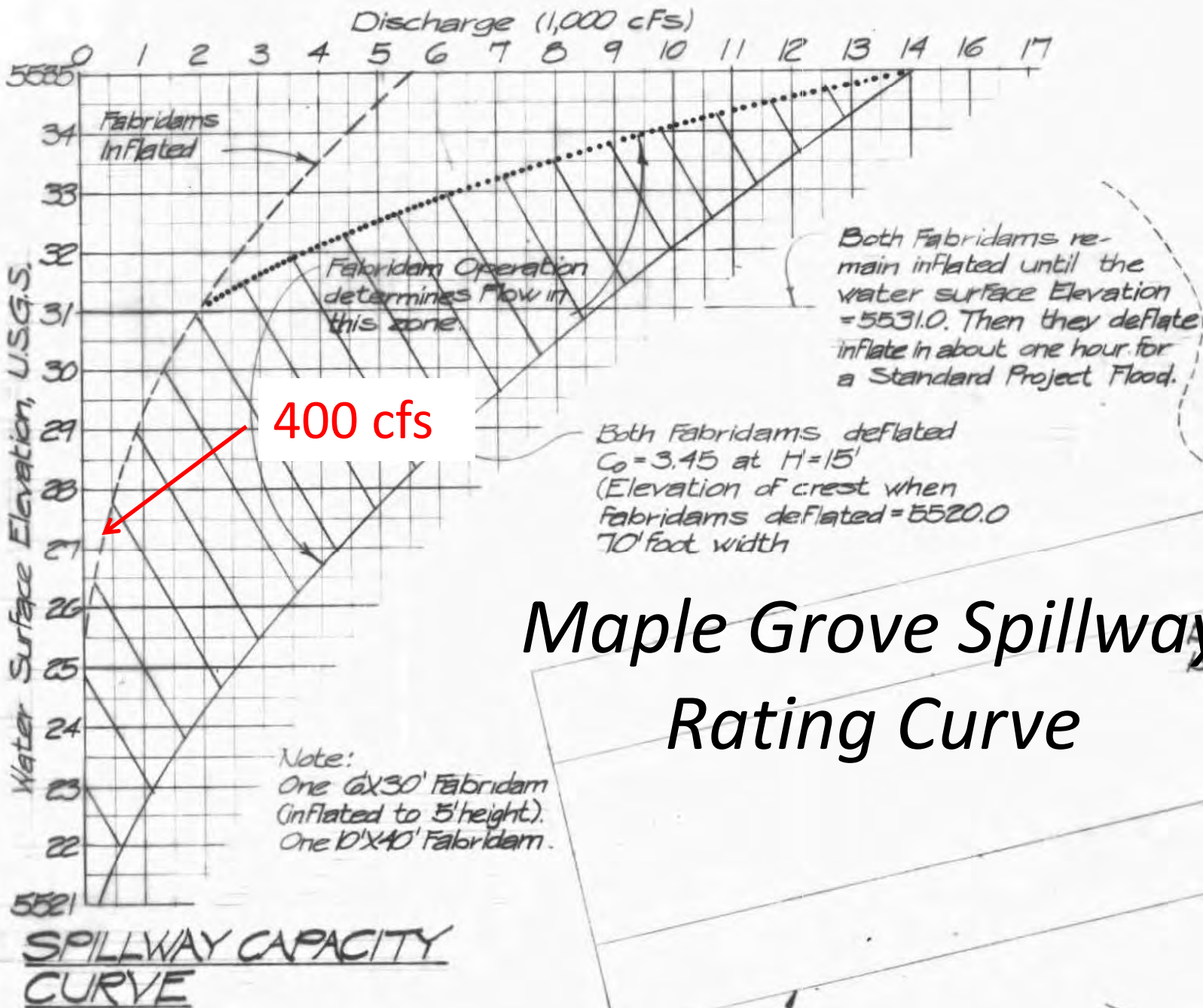
Maple Grove Dam



Float-controlled 6' and 10' Spillway Gates



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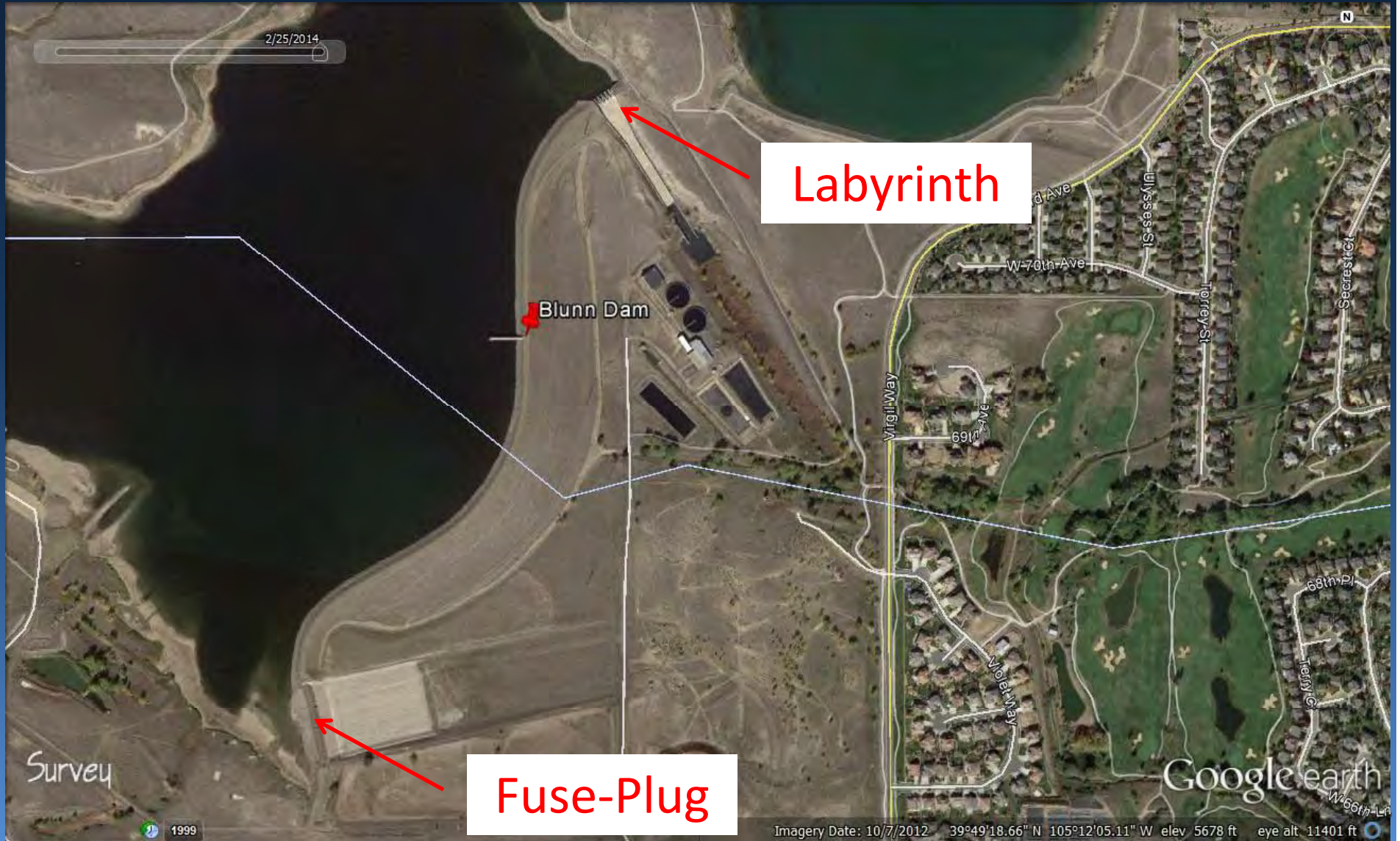


Maple Grove Spillway Rating Curve



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Blunn Dam







Labyrinth Spillway Discharging

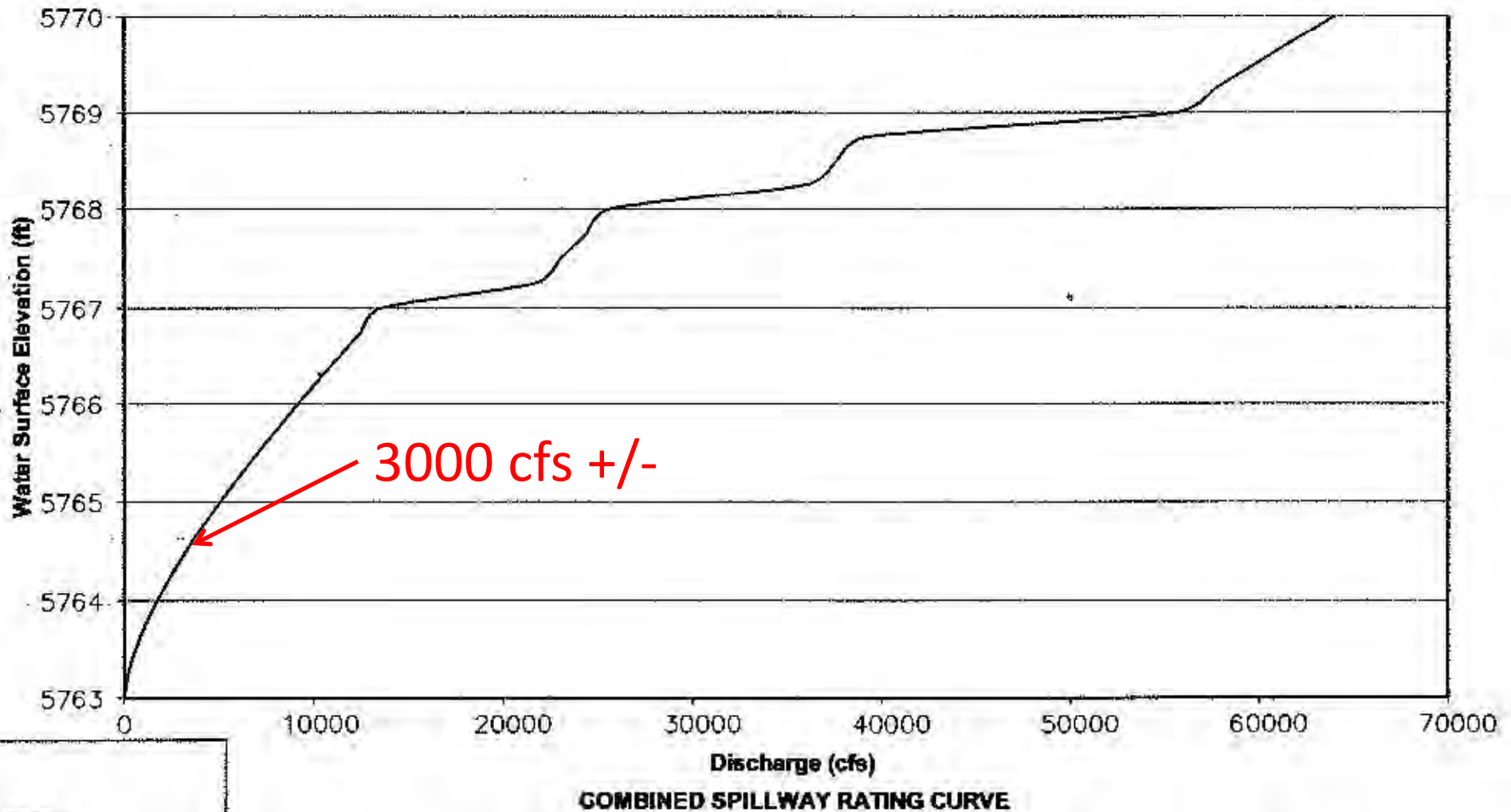


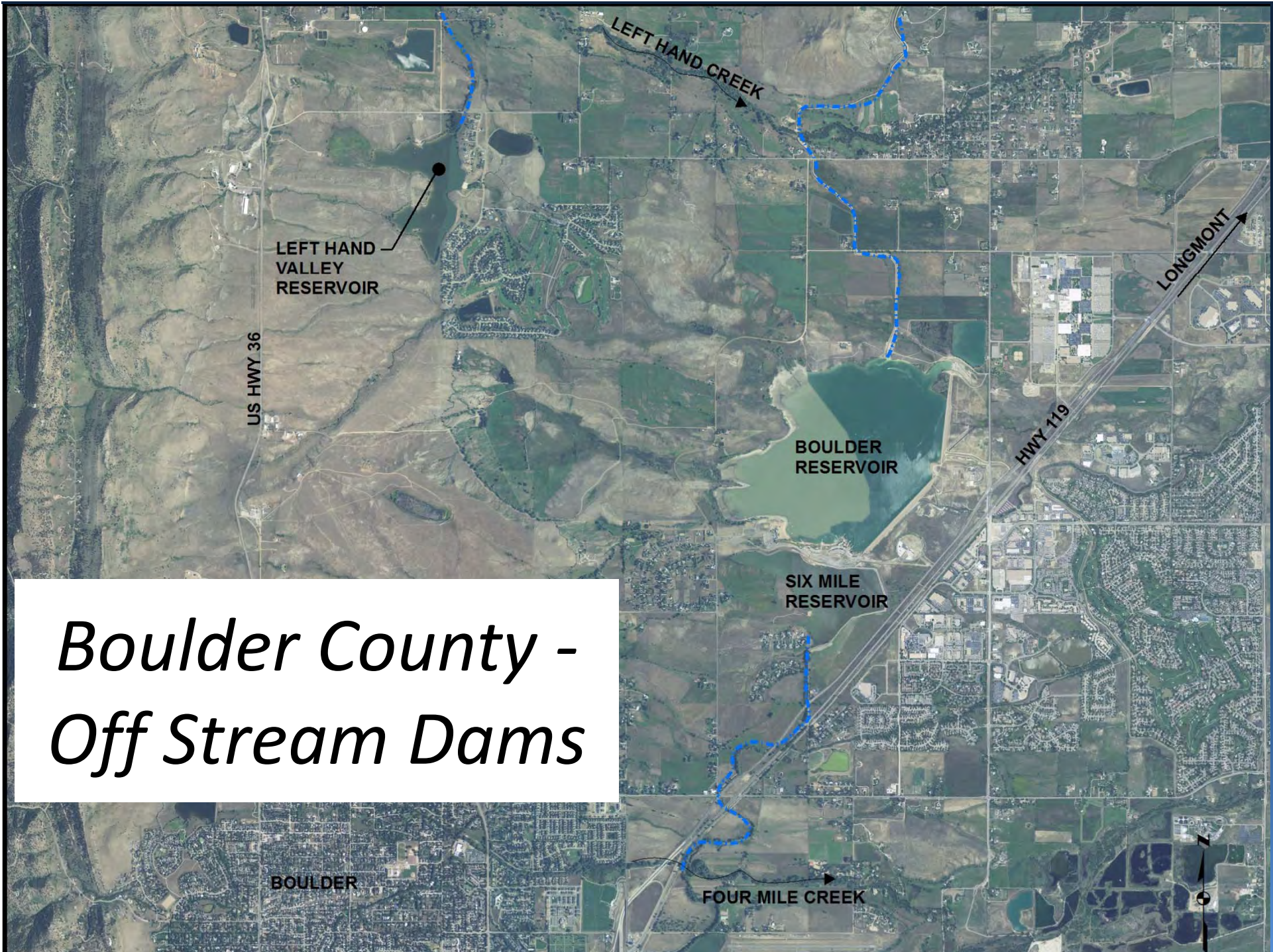






Combined Spillways Rating Curve





LEFT HAND VALLEY RESERVOIR

LEFT HAND CREEK

LONGMONT

US HWY 36

BOULDER RESERVOIR

HWY 119

SIX MILE RESERVOIR

Boulder County - Off Stream Dams

BOULDER

FOUR MILE CREEK



Left Hand Valley Reservoir



Left Hand Valley-Stepped RCC Spillway



LHV Spillway Rating Table

Table VI-1

Spillway Discharge Table

Peak Spillway Flow
During the
September floods,
181 (cfs)



Reservoir Water Surface Elevation	Gage Height (ft)	Service Spillway Discharge (cfs)	Emergency Spillway Discharge (cfs)	Combined Spillway Discharge (cfs)
5,351	45	0	0	0
5,352	46	47	134	181
5,353	47	171	735	906
5,354	48	366	1,619	1,985
5,355	49	628	2,724	3,352
5,356	50	955	4,018	4,973
5,357	51	1,345	5,480	6,825
5,358	52	1,796	7,096	8,892
5,359	53	2,307	8,853	11,160
5,359.5	53.5	2,585	9,782	12,367

Six Mile Dam - Earthen Spillway



Six Mile Dam Spillway - Damage



Boulder/Larimer County

ESTES PARK

Carriage Hills

Big Elk Meadows

LYONS

Button Rock Dam

Button Rock Dam



Button Rock Reservoir

Button Rock Dam, Roosevelt National Forest, Boulder County, Colorado 80540

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Google earth

Imagery Date: 10/6/2013 40°13'02.75" N 105°22'03.39" W elev. 6482 ft eye alt. 12337 ft







Table 5

Button Rock Dam
Reservoir and Spillway Characteristics

Elevation	Surface Area (acres)	Storage Capacity (acre-feet)	Elevation	Spillway Capacity (cfs)
6230	0.0	0.0	6400	0
6240	7.9	27.6	6401	325
6260	26.8	368.2	6402	918
6280	46.6	1,100.8	6403	1,686
6300	68.2	2,246.4	6404	2,596
6320	94.4	3,864.3	6405	3,628
6340	122.0	6,032.8	6406	4,769
6360	151.8	8,762.6	6407	6,010
6380	184.0	12,123.4	6408	7,343
6400	221.8	16,197.2	6409	8,762
6402		16,644.7	6410	10,262
6404		17,100.1	6411	11,839
6406		17,563.5	6412	13,489
6408		18,035.9	6413	15,210
6410		18,517.5	6414	16,998
6412		19,006.7	6415	18,852
6414		19,502.0	6416	20,768
6416		20,003.7	6417	22,745
6418		20,514.6	6418	24,781
6420		21,035.3	6419	26,875
6422		21,564.1	6420	29,024
6424		22,099.5	6420.1	29,255
6426		22,641.8	6420.2	29,498
6428		23,191.8	6420.3	29,749
			6420.4	30,005
			6420.5	30,268
			6420.6	30,535
			6420.7	30,807
			6420.8	31,083
			6420.9	31,364
			6421.0	31,648
			6421.1	31,936
			6421.2	32,227
			6421.3	32,522
			6421.4	32,820

Observed high
water mark on the
spillway.



Dam Overtopping – Meadow Lake







Dam Overtopping – Carriage Hills #1



October 2013 Aerial



Actions Before/During Flooding

- Collaborative Efforts Needed
- Dam Failure vs Spillway Operation
- Role of Dam Safety Branch
 - Safe Dams
 - Education on Dams and operations
 - Provide inundation mapping
- Role of Floodplain Managers
 - Plan for and manage spillway flows downstream of normally operating dams
 - Plan for and manage spillway flows in emergency situations
- Role of Emergency Managers
 - Manage Emergency Response
 - Emergency Responder Education
- Role of Dam Owners
 - Work with DSE's, EM's/ER's, CFM's to understand normal and emergency operations

Questions?

