

Flood Warning Program Activities

by
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After reviewing an interesting collection of state and local flood-related news stories for the past year, it is the author's opinion that the events that attracted the most media attention were the historic accounts and memorial activities marking the 25th anniversary of the Big Thompson Canyon flash flood. This historic flood occurred during the late evening hours of 31 July 1976, when 12 to 14 inches of rain fell in the canyon area downstream of Estes Park. Considered by many to be Colorado's worst disaster, the flood devastated nearly everything in the canyon and claimed 144 lives. The Big Thompson flood is credited with providing the motive for many local flood warning systems that are in place today, both in this region and elsewhere.

While the District was fortunate to avoid flood disaster once again, the 2001 flood season was not without problems. The District's 23-year-old flash flood prediction program (a.k.a. F2P2) experienced an above average number of "message days" with 42, compared to an average of 36, a record high of 52 in 1996, and a low of 23 in 2000. The National Weather Service issued flash flood watches affecting the District on 13 days in July and August, setting a record. Flash flood warnings were issued for 3 days, during the same week in July. Eleven straight days of flood potential occurred from July 5-15, setting another District record for most consecutive "message days." Brief descriptions for a few notable events are provided later.

Meteorological Support

HDR Engineering, Inc. provided the F2P2 forecast services during 2001. John Henz, former president of Henz Meteorological Services, acted as HDR's senior project manager. Bryan Rappolt served as lead meteorologist. John and Bryan are both veterans of the program. This is the first year in the program's history that an engineering firm was selected as the meteorological support provider. With HDR being one of the District's more experienced

hydrologic/engineering consultants, this new role for them may open the door for other professional engineering firms to consider offering operational hydro-meteorological services. The F2P2 provides forecast and notification services directly to District local governments from mid-April through mid-September each year.

Flood Warning Research

Dr. Eve Gruntfest and Kim Carsell with the University of Colorado at Colorado Springs are working with the District to evaluate the effectiveness of Boulder's local flood warning program. The Boulder/Boulder County Office of Emergency Management is the local sponsor of this research project. The study is using the latest findings and lessons from recent Colorado and U.S. flood disasters to assess the effectiveness of Boulder's program and recommend ways to improve it. Successful aspects of other well-known local flood warning programs are being identified. A community survey was conducted to learn what floodplain residents understand about their community's flood threat, the warning process, and personal flood safety. The final report will be completed by next spring and made available to interested parties. Eve was also involved with the behavioral science research conducted by CU-Boulder for the District after the Big Thompson flood.

GIS Flood Threat Recognition

The District began efforts to develop its Geographic Information Systems (GIS) capabilities in 1998 and recently initiated a project that applies this technology to recognizing flood threats. Bruce Rindahl, project manager for Brown and Caldwell, assisted the District in 2001 by developing a GIS interface that processes real-time radar and lightning data from the District's satellite downlink and from the ALERT system. The radar data interface relies on software from Meteorlogix (formerly Kavouras) to convert data to a standard GIS format used by ArcView™. Kavouras has been providing radar data

to the District since 1979. The Internet was used to establish the ALERT data interface, making integration of other useful data sets possible. The next logical step will be to link site-specific flash flood guidance and decision aids contained in basin flood warning plans with GIS and build quantitative forecasting capabilities for use in the F2P2. This work is expected to begin in January and will be operationally tested during 2002. Eventually, GIS products will be disseminated to local governments and made available on the Internet with the expectation that flood threats will become easier to recognize, thereby enabling more timely and specific flood warnings.

Self Help Gets Noticed

What can individuals, families, and businesses do to protect themselves from floods? By choosing to better understand the risk, learn some safety rules, write a simple plan, and spend a few dollars to protect personal property—much can be done to keep damages to a minimum and prevent loss of life when the next big flood hits. Boulder and Denver, with assistance from the District, are developing flood protection handbooks and web pages to help citizens help themselves. The publications will be completed by the 2002 flood season, but the real success of this effort will be determined by the willingness of individuals to act. Marketing this idea will take some creative thinking and it will be interesting to observe this process. We hope it will not take a flood disaster to generate public interest, but it may.

ALERT System News

The ALERT system continues to provide valuable early flood detection and decision support for the District. It now includes 148 gaging stations that provide 134 real-time rain measurements, stream and reservoir water levels for 68 locations, and weather data from 16 mesonet stations.

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Warning (from page 7)

The District's ALERT web server had the desired effect this past year by logging more than 1.7 million individual requests for products. In addition, over 170,000 real-time data tables were automatically sent to a NWS server in Boulder where the data is processed and subsequently disseminated to other systems for use in research, education, and other purposes.

Prior to developing the website, ALERT users had to either connect directly to the District's system by modem or request data from District staff. Now, only a handful of requests for data and remote access privileges are received annually. Due to an increasing demand for historic data, the District recently added archive data retrieval capabilities to the website. Users can now obtain data online back to August 21, 1985.

ALERT system expansion in 2001 consisted of four stations: 1) Urban Farm at Stapleton weather station; 2) Third Creek at DIA rain/stream gage; 3) Hidden Lake rain/stream gage; and 4) Little Dry Creek at 64th rain/stream gage. Funding agreements with Denver and Aurora were signed in December allowing further network expansion in 2002. One project will cover Marston Lake area in southwest Denver and the other will involve the Upper Sand Creek basin. New weather stations will be installed at Marston Lake and Aurora Reservoir. DIAD Incorporated may install a third weather station at their Longmont offices to facilitate testing of sensors and new equipment designs. DIAD provided the 2001 ALERT maintenance services for the District and Boulder County. More stations also appear to be on the horizon. Within the past month the City of Boulder expressed the desire to install at least two new rain/stream gages along South Boulder Creek downstream of Eldorado Springs. With such a high level of interest by so many, it is difficult to predict just how big the network will grow.

The 2001 Flood Season

The 2001 flood season may be remembered most for one week of particularly wet weather at a time of the

year when hot and dry tends to be the norm. The week ending July 14 had flash flood warnings on three days (8,10,13), flash flood watches for three others and a mid-week break with only marginal flood potential. July 8, without question, produced the worst flooding of the year for the District. Fortunately, the storm happened on a Sunday or it would have affected many Denver area commuters and the consequences might have been worse. The following briefly describes some of the year's more notable events:

May 3-5

Three days of steady upslope rain saturated soils along the Front Range. Rainfall amounts totaled 2 to 3 inches over much of the District causing some minor street flooding while larger streams like Cherry Creek and the South Platte River rose above normal. Two reservoirs monitored by the ALERT system recorded their annual peaks on May 5 (see table). No rainfall rate alarms occurred during this period.

Wednesday, June 20

At 7:20 p.m., heavy rain and damaging hail struck DIA causing more than \$49 million in damage. That estimate did not include undisclosed damages sustained by the airlines at DIA. Between 40 and 50 mobile homes were also damaged in the Watkins area. Messages concerning the possibility for storms were issued for the entire District at 4:10 p.m. No major flooding was reported.

Thursday, July 5

Fast-moving storms accompanied by high winds dropped 1.85 inches in less than an hour over Aurora during the rush hour. Rainfall rate alarms occurred at four ALERT gages in the general vicinity of I-225 and Sand Creek. Annual peaks were recorded for three stream gages in the same area. This day marked the beginning of 11 straight days of flood potential for the District and a 45-day siege of monsoon storms for the region.

Sunday, July 8

Serious street and stream flooding hit Denver hard between 4 and 6 p.m. The storms were accompanied by high winds and small hail. Damage to the Cherry Creek Arts Festival was a major news

Days having flood potential

April	None	0
May	2-5,27-28,30	7
June	7,13-14,20-21,26	6
July	5-15,23-26,31	16
August	1-2,6-9,13-15,22,30	11
September	14-15	2

story where one person was taken to the hospital after being struck by blowing debris from street displays. Flash flooding was observed on Harvard Gulch, Goldsmith Gulch, Cherry Creek, the South Platte River, and along I-25 where the infamous "Lake Logan" (Logan St./I-25 underpass) once again stopped traffic. The Harvard Gulch at Jackson Street rain gage measured the heaviest rainfall of 0.67" in 5 minutes and 2.48" in an hour. Additional reports of flash flooding were noted in Centennial and Englewood.

This was the main record-setting day for the ALERT system with rainfall rate alarms occurring at 17 stations. Annual peaks were recorded by 16 stream gages with 5 breaking their historic marks. The District and affected local governments were made aware of this day's flood potential before noon, thanks to the forecasting talent of Bryan Rappolt. In the morning the NWS did not believe the threat warranted a flash flood watch, but as conditions worsened in the afternoon appropriate flash flood warnings were issued.

A reconstitution of the storm performed by HDR Engineering showed that rainfall totals might have exceeded 4 inches along Colorado Blvd. between I-25 and Evans. The Harvard Gulch rain gage mentioned above is in this area and may have experienced considerable undercatch due to high winds—a well-known accuracy problem for ALERT rain gages. Harvard Gulch did experience a record flood, but it is somewhat unclear why the extent of flooding wasn't worse with much of the upper basin receiving more than 3 inches of rain according to the HDR study. Further study will be needed to answer this question.

2001 Peak Flows. Some notable peaks measured by the ALERT system.

Date/Time	Location	Peak in cfs
May 5 11:15	Maple Grove Res. on Lena Gulch	20 (Elev. 5527.1)
May 5 20:21	Englewood Dam	* 156 (Depth 17.6')
June 9 03:45	Boulder Creek near Orodell	** 630
July 5 19:46	Westerly Creek at Montview Blvd.	500
July 5 20:06	Havana Park Detention	350 (Depth 7.6')
July 8 04:44	South Platte River at Henderson	7,160
July 8 17:13	Goldsmith Gulch at Eastman Avenue	2,030
July 8 17:15	Harvard Gulch at Jackson Street	820
July 8 17:16	Harvard Gulch Park at Logan Street	* 2,080
July 8 17:25	Goldsmith Gulch at DTC/Temple Pond	640 * (Depth 14.5')
July 8 17:27	South Platte River at Dartmouth Ave.	2,730
July 8 18:24	South Platte River at 19th Street	9,220
July 8 18:27	Holly Dam	* 138 (Depth 19.8')
July 8 19:02	Cherry Creek at Steele Street	* 2,240
July 8 19:30	Cherry Creek at Champa Street	* 3,230
July 10 20:57	Niver Creek Detention	60 (Depth 13.4')
July 13 19:02	Ralston Creek at Carr Street	1,020
July 23 16:49	Slaughterhouse Gulch Detention at Grant St.	120 (Depth 7.0')
July 23 16:44	South Platte River at Union Avenue	1,540

* New record ** Peak due to snowmelt
 Visit alert.udfcd.org for a complete listing of record

This event came very close to causing much greater property damage. More serious consequences were avoided for two main reasons: 1) existing flood control and drainage improvements prevented major damages; and 2) the rain stopped before the capacity of these facilities was exceeded. Another inch of rain and it would have been different.

Tuesday, July 10

A fast developing storm formed over central Jefferson County dropping 1.5 inches in 35 minutes while a second foothills storm hit the Evergreen area with similar amounts. A flash flood warning was issued by the NWS for upper reaches of Bear Creek above Evergreen where one-hour radar rainfall estimates exceeded 3 inches. Rain rate alarms occurred at 8 stations and 4 annual peaks were recorded.

Friday, July 13

Dual "Friday the 13th" storms deluged Arvada and Aurora. Radar-estimated rainfall of 2 to 3.5 inches was noted in northern Arvada over Little Dry Creek. An observed 1.7 inches in less than an hour caused heavy runoff in the Toll Gate Creek basin and along Sand Creek in Aurora. Rain rate alarms occurred at 9 stations and 10 stream gages record annual peaks.

Saturday, July 14

A long track multi-cell storm complex developed over the northwestern Jefferson County foothills about 3 p.m. The storm produced severe weather in the form of damaging hail and high winds across the foothills north of Golden, Rocky Flats, Broomfield and west-central Adams County. A Thornton official reported the heaviest rainfall amount of 3.7 inches, which caused serious street flooding. High winds and heavy rain produced street flooding problems in northern Aurora, near Barr Lake, and at DIA. Intense rainfall was also measured by the ALERT system in the Parker area.

Monday, July 23

A highly localized storm impacted rush hour traffic around the Denver Tech Center. Hail, wind and

rainfall amounts exceeding 1.2 inches in 30 minutes slowed travel on I-25 and I-225. Funnel clouds were also reported. The South Platte River gage at Union Avenue recorded its record flow for the year, as did the Slaughterhouse Gulch detention basin at Grant Street. Rainfall rate alarms occurred once again in the Goldsmith and Harvard Gulch basins, but the flooding was not nearly as severe as July 8.

Thursday, August 9

The "final" big storm day of 2001 hit the Boulder and Jefferson County foothills with four active storms dropping more than one inch in 30 minutes. The heaviest rainfall was noted over Morrison (1.61"), Turkey Creek (1.50"), and South Boulder Creek (1.34"). Rain rate alarms were triggered by 6 ALERT gages and 2 stream gages in the Bear Creek basin recorded their annual peaks. Very active lightning accompanied these storms.

For more information...

A more comprehensive version of the above article can be found at udfcd.org. The web page contains related photos, figures, links and other information that could not be included in this printed edition of *Flood Hazard News* due to space limitations. One link to check out is the PowerPoint™ presentation of the July 8 flood that was presented by Bill DeGroot at the 2001 CASFM conference in Steamboat Springs.



Goldsmith Gulch upstream of Mexico Avenue on July 8, 2001. Many more during and after photographs can be seen on the District's web page at udfcd.org.