

THE URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
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PRELIMINARY DESCRIPTION OF FLOODING OF MAY 6TH, 1973

by LEONARD RICE

Leonard Rice Consulting Water Engineers, Inc.

Preliminary analysis of rainfall and runoff data for the weekend of May 5 and 6 indicates that the Denver Metropolitan Region experienced a 24-hour rainfall event having a recurrence interval ranging from 5 to 50 years, or, in terms of probability, having a two to twenty percent chance of occurring in any year.

Because of the antecedent moisture conditions resulting from several prior snowstorms and greater than average rainfall in April and May, peak stream flows caused by the weekend rains were somewhat higher than would have been predicted under normal conditions.

The larger streams, such as the South Platte River, Plum Creek, Bear Creek and Clear Creek, which have a significant snow pack in the upper areas of their drainage basins, generally recorded peak flows exceeding what would have otherwise been caused by the Saturday and Sunday rains.

Table 1 lists the rainfall depths recorded at gauges throughout the region for the 24-hour period. For each

station the approximate recurrence interval of the recorded 24-hour rainfall is shown, along with the 100-year rainfall as determined from the Urban Drainage District Project REUSE Design Rainfall Tables.

From this table it can be seen that the storm was distributed relatively uniformly over the region.

Examination of data from Stapleton International Airport indicates the storm was primarily a long duration, uniform intensity event rather than a short duration, high intensity thunder-storm type occurrence as often happens in the foothills region during the summer months.

This fact is shown in Table 2, which lists the maximum depth recorded at Stapleton Airport for durations of 1, 6 and 24 hours. This also shows the corresponding recurrence interval for each duration. It is clear from these data that there were no short duration intervals of sig-

(Continued on Next Page)

Table 1

24-HOUR RAINFALL — MAY 5 & 6, 1973

Location	Township/ Range	24-Hour Rainfall (Inches)	Approximate Recurrence Interval		100-Year Rainfall (Inches)
			Years	%	
Gross Reservoir°		3.29			
Cheeseman Reservoir°	10S., 71W.	2.43			
Elevenmile River°	13S., 72W.	1.22			
Kassler	6S., 69W.	3.92	50-75	2-2.5	4.25
Ralston Reservoir	2S., 70W.	3.06	5+	Less than 20	4.80
Dillon°	5S., 77W.	0.46			
Winter Park°	2S., 75W.	2.30			
Sedalia	7S., 68W.	2.88	5-	More than 20	4.75
Greenland	10S., 67W.	2.59	5-	More than 20	4.50
Eastonville°	11S., 64W.	2.31			
Arvada	3S., 69W.	3.13	10	10	4.35
Greeley°	5N., 65W.	0.68			
Ft. Morgan°	3N., 57W.	1.23			
Brush°	3N., 56W.	1.83			
Byers	4S., 61W.	4.46	50-75	2-2.5	4.75
Kiowa°	8S., 63W.	3.5-4.0			
Woodland Park°	12S., 69W.	2.78			
6824 Owens St.	3S., 69W.	3.13	10	10	4.35
2056 S. Newton	4S., 68W.	3.40	20-	5	4.00
Boulder	1N., 70W.	2.1-2.6	2-5	50-20	4.62
Evergreen	5S., 71W.	2.68	5-10	20-10	4.00
Urad Mine°		17 (snow)			
Canyon Creek°		22 (snow)			
Idaho Springs°		6-8 (snow)			
Ft. Collins°	7N., 69W.	0.83			
Longmont	2N. 69W.	1.01	Less than 2	More than 50	4.31
Estes Park°	5N., 73W.	1.00			
Georgetown°	4S., 74W.	0.50			

°BEYOND LIMITS OF DISTRICT DESIGN RAINFALL DATA.

Preliminary Description of Flooding

(Continued from Page 1)

nificant intensity, but that the total rainfall over the 24-hour period was a significant event.

Table 3 shows that recorded peak flows for the South Platte River and several principal tributaries caused by the rains of May 5th and 6th were equivalent to recurrence intervals ranging from 5 to 50 years. This table contains the recorded peak flow and corresponding recurrence intervals, the estimated 100-year flows, and the maximum flow of record at each location.

As mentioned above, stream flows tended to be somewhat higher than corresponding rainfall because of the antecedent moisture conditions, which caused the ground to be close to saturation. As a result, there was a greater percentage of runoff than would have occurred if the soil were dry and capable of absorbing more of the rain that fell.

Another factor which tends to increase the stream flow peaks resulting from a given rainfall is the continued urbanization of the Denver Metropolitan Area. This involves the conversion of open, absorbent land into concrete and asphalt surfaces which shed the rain more quickly and in greater amounts.

The data discussed in this article were provided by the U.S. Weather Bureau, the U.S. Geological Survey, and the State Engineer's Office and are preliminary figures subject to verification and adjustment. The cooperation of these agencies in providing the preliminary data so quickly after the event is appreciated. Estimated recurrence intervals for rainfall events and streamflows were obtained from the Urban Drainage and Flood Control District Project REUSE publication, RAINFALL-RUNOFF INFORMATION.

Table 2

1, 6 AND 24-HOUR RAINFALL
STAPLETON AIRPORT

Duration (Hours)	Maximum Recorded May 5-6, 1973 (Inches)	Approximate Recurrence Interval	
		Years	%
1	0.36	2-	50+
6	1.39	2+	50-
24	3.50	25-50	4-2

Progress on Little Dry Creek

The Board of Directors at the May 17th meeting approved Phase A of the Little Dry Creek Project, and authorized me to advise the engineer to proceed into Phase B. We are still working with the City of Cherry Hills Village and property owners in the affected area regarding the improvement of two reservoirs in Cherry Hills Village. We hope to resolve this issue in the next two to three weeks so that we can proceed into Phase B of the project and complete the Master Plan.

Phase A of the Little Dry Creek project was completed in early February. Since that time we have held a series of public meetings and briefings, in order to arrive at an alternative acceptable to all local entities.—L.S.T.

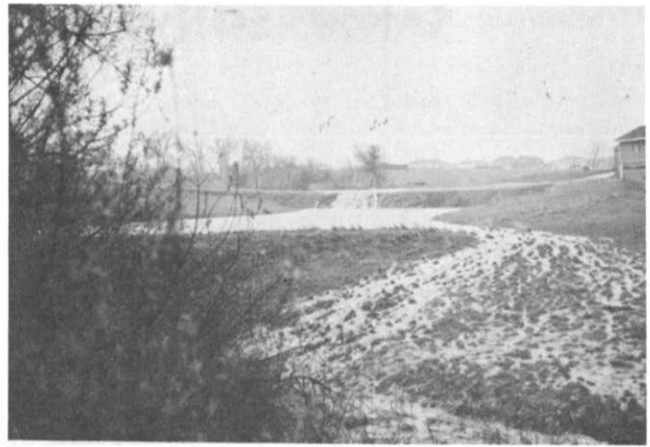
Table 3

PEAK FLOWS

Stream	Location	Peak Discharge May 5-7, 1973 (c.f.s.)	Approx. Years	Recurr. Int. %	100-Year Discharge (c.f.s.)	Max. of Record (c.f.s.)
Bear Creek	@ Morrison	1,350	5+	20-	11,034	8,600
	@ Sheridan	3,900	25	4	7,634	8,150
Cherry Creek	near Frankton	5,000	10+	10-	16,025	9,170
Clear Creek	@					
Plum Creek	near Louivers	6,000-10,000	10-20	10-5	125,493	154,000
South Platte	@ Waterton	3,300	10-20	10-5	7,507	5,700
	@ Littleton	11,500	10-20	10-5	97,133	110,000
	@ Denver	17,500	25-50	4-2	30,102	40,300
	@ Henderson	24,000	50+	2-	29,873	29,600



Looking down Mississippi Avenue
from Main Reservoir



Overflow at north end of Henry's
Lake Reservoir

DENVER AREA FLOOD SCENES, MAY 6th, 1973

Bear Creek near West Hampden Ave.



Flooding near West Jewell and
South Wadsworth



State Legislature Increases District Mill Levy

The Colorado State Legislature passed legislation on April 19 raising the District's mill levy from 1/10 of a mill to 5/10 of a mill. The Legislature specified that 1/10 of a mill will continue to be used for planning and operating the District, with 4/10 of a mill earmarked for implementing drainage and flood control projects. The Governor signed the bill, on May 7th while many parts of the District were assessing flood damage and starting tedious clean-up efforts after the May 6th storm.

The assessed valuation of the Urban Drainage and Flood Control District as of 1972 was \$3,156,000,000. The present planning and operating revenue is therefore, about \$316,000 per year. The monies that will be available for implementation of drainage projects will be approximately \$1.3 million per year.

It will be the responsibility of the Board of Directors of the Urban Drainage and Flood Control District to

appropriate and commit funds each year for the implementation of drainage projects. The Board of Directors is now in the process of developing criteria for the commitment of District funds for project implementation. One of the criteria most likely will be that matching funds will have to be provided by the local entities involved.

The flooding that occurred on Sunday, May 6, emphasized the need for developing Master Plans for the various gulches tributary to the South Platte River and for implementation of those plans. The increased mill levy will provide District monies for about two projects per year, assuming at least 50% matching funds from local governments.

The bill, HB 1265, was introduced into the House by Rep. Ted Eaker from Lakewood. The bill was sponsored in the Senate by Senator Joe Shoemaker with the support of Senator Ted Strickland from Westminster.

SANDERSON GULCH DRAINAGE PROJECT

by DOMINICK J. GIANOLA

Civil Engineer

Urban Drainage and Flood Control District

Several significant steps have been taken toward implementation of the Master Plan, "Major Drainageway Planning—Sanderson Gulch/Weir Gulch, Volumes 1 and 2." This Master Plan was completed in August, 1972.

This is a comprehensive planning study financed by the Urban Drainage and Flood Control District and the local jurisdictions, as is the case with the entire series of Master Plans. Like the others, it calls for implementation, when and as authorized, to be performed by an approved Consulting Engineer. The Master Plan defines and locates the 100-year flood plain, and includes a preliminary design of the drainage improvements.

Now that the Master Plan for Sanderson and Weir Gulches has been completed, the implementation undertaken is for drainage on Sanderson Gulch only, which was held to have high priority.

MONEY ALLOCATED FOR IMPROVEMENTS

Through the efforts of the Urban Drainage and Flood Control District, money has been allocated by the federal and state governments for drainage improvements on Sanderson Gulch. The District has been awarded a water and sewer facilities grant of \$503,000 from HUD (Department of Housing and Urban Development). An appropriation of \$350,000 has been made by the State of Colorado, through the Colorado Water Conservation Board of the Department of Natural Resources.

Based upon these allocations, the local jurisdictions have committed matching funds for their share of the improvements on Sanderson Gulch. This amounts to \$290,000 by the City and County of Denver, and \$340,000 by the City

of Lakewood. The total committed funds for the Sanderson Gulch drainage project are \$1,483,000 and this sum includes final design, property acquisition, and construction.

A tentative schedule has been developed for the project. Bid preparation is scheduled for the month of October, and bids are scheduled to be due around December with actual construction to begin in January, 1974. The construction is projected to be completed in March, 1975.

The Sanderson Gulch drainage basin includes five reservoirs which are located in Lakewood. An agreement has to be developed between the City of Lakewood and the respective reservoir owners stating that the reservoir owners will agree to retain present flood control function in perpetuity or agree to sell or donate to the City of Lakewood an equal storage volume that would remain in City ownership should the dam be destroyed.

TYPICAL PROBLEMS WORKED OUT

It may be of interest to review the nature of the numerous problems encountered in working out implementation for the Sanderson Gulch project, since these are fairly typical of the situations met with in developing multi-jurisdictional flood control operations.

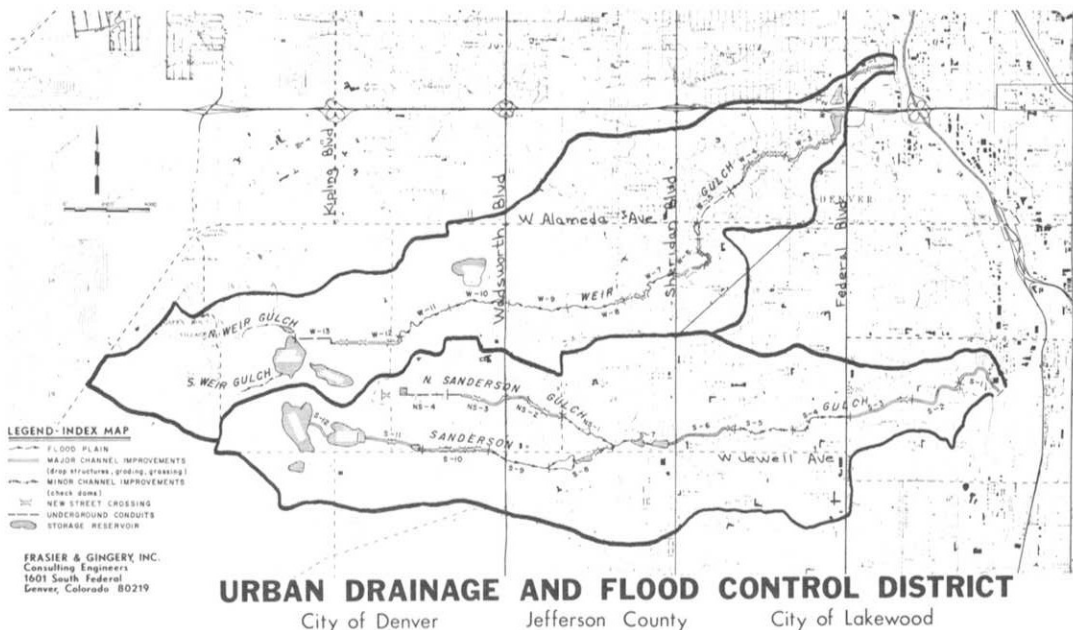
First was the complexity of providing a substantial sum of money through appropriations by several separate governmental entities. Next came drafting and winning approval for an agreement covering all aspects of the work to be undertaken.

In general, the agreement provides that the drainage improvements must be in accordance with the completed

(Continued on Page 5)

MAJOR DRAINAGEWAY PLANNING SANDERSON GULCH/WEIR GULCH

THE INFORMATION PORTRAYED ON THE FOLLOWING DRAWINGS IS FOR PLANNING PURPOSES ONLY AND IS INTENDED TO PROVIDE THE CAPABILITY FOR STAGED DEVELOPMENT OF A TOTALLY COMPATIBLE DRAINAGE SYSTEM. THE DRAWINGS ARE NOT TO BE CONSTRUED AS FINAL DESIGN DRAWINGS NOR ARE THEY TO BE USED FOR CONSTRUCTION PURPOSES. SEE SECTION VIII OF VOLUME I OF THIS REPORT FOR ADDITIONAL DISCUSSION OF THE INTENDED USE AND LIMITATIONS OF THE INFORMATION PROVIDED ON THESE DRAWINGS.



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SANDERSON GULCH
NEAR ZUNI
EXISTING CONDITION

alternative ideas for transforming
existing waterways into flood control
systems and linear parks



SANDERSON GULCH
NEAR ZUNI
PLANNED IMPROVEMENT

Sanderson Gulch—

(Continued from Page 4)

Master Plan, and that the construction costs be properly allocated to cover drainage, traffic, utilities, grassing and trails, property, contingency, and engineering.

The agreement specifies that improvements will be accomplished on schedule of priorities established to insure compatible construction along defined reaches or units of the stream or channel. The agreement specifies that the Flood Control District shall manage the finances to accomplish the final design, construction, land acquisition, and other related items.

Another group of problems in implementing such improvements focuses on the need for the utmost cooperation of all parties to such multi-jurisdictional projects. So far full cooperation has been achieved, and it seems proper to assume that this cooperation will continue — otherwise such improvements as the Sanderson Gulch Project could never become a reality.

RESPONSIBILITIES OF THE ENGINEER

A basic problem of implementing the project was development of the agreement between the District and the local entities, and the selection of a consulting engineer (Continued on Page 7)

Tucker-Talk

by L. SCOTT TUCKER



Timely Comment from the District's Executive Director

APPRAISING THE RECENT FLOODS

Leonard Rice of Leonard Rice Consulting Water Engineers, Inc., has commented elsewhere in this issue of *Flood Hazard News* on the magnitude of the storm that occurred in the Denver area on May 6, 1973. The problems and damages caused by flooding on the South Platte River, both in Denver and downstream in Adams County and Weld County were quite widely reported in the area newspapers as well as by radio and TV stations.

I spent Sunday, May 6 traveling about the city observing the effects of the prolonged rains on the smaller streams tributary to the South Platte River of the Denver Region.

The most dramatic and severe effects of flooding occur on the South Platte River because of the tremendous volumes of water that accumulate there. However, each of the many tributaries to the Platte were the cause of considerable problems.

On Weir Gulch the main spillway from Main Reservoir, for example, was operating with the result that water was spilling down Mississippi Avenue at curb level. At side streets the water would try to find its way back into Weir Gulch. Overflowing channels of Weir Gulch, the water forced its way through several homes adjacent to First Avenue.

Englewood Dam on Little Dry Creek in Arapahoe County held back all the water that was tributary to it. It worked very effectively and demonstrated the importance and value of the facility.

Greenwood Gulch, a tributary to Little Dry Creek, caused considerable flooding throughout Cherry Hills Village. Cherry Hills Country Club served as a very effective detention area, but serious flooding occurred downstream from the Country Club grounds. Several houses, cars and a church were inundated by five to ten feet of water.

Jack Gianola, our staff engineer, observed Lena Gulch and Ralston Creek at flood stage where these streams were causing considerable local problems in the Wheat Ridge and Arvada areas. His appraisal of flood conditions in the north part of the Denver region came to an abrupt halt, with his car stalled and mud-covered as water flowed in one door and out the other.

Several reservoirs in the Denver region were threatened, although fortunately none failed in critical urban areas. The storm was definitely an unusual event, but it was more of the 10-year variety as opposed to the rare 100-year kind. In a very real way, this period of flooding made me aware of the critical need for good drainage and flood control planning and for effective implementation.

HIGHLINE CANAL DRAINAGE PROBLEM

The Highline Canal, which leaves the South Platte River at Waterton and winds its way for approximately 60 miles to a point northeast of Denver, cuts across 22 major drain-

age basins, four cities and four counties. Many of the drainage basins empty directly into the Highline Canal instead of going over or under the large ditch.

During the May 6th storm, huge volumes of water were dumped into the Highline Canal at drainage crossings, spilling out at uncontrolled points. Homes were evacuated because of water from the Highline Canal, reservoirs were threatened and many basements were flooded.

As urbanization has occurred above the Highline Canal, more and more water is flowing into the Canal for a given amount of rainfall. The Urban Drainage District plans to initiate a preliminary study in cooperation with the Denver Water Board, with regard to the drainage problems of the Highline Canal, which is owned and operated by the Denver Water Board.

BIG DRY CREEK MASTER PLAN COMPLETED

The Master Plan study on Big Dry Creek has been completed by Wright-McLaughlin Engineers. The Big Dry Creek project involves Adams County, Westminster, and Jefferson County. This Master Plan includes the reach of Big Dry Creek from Standley Reservoir northeast to the Weld/Adams County line. Copies of the two-volume Big Dry Creek Report are available from the Flood Control District office at \$5.00 a set.

ANALYSIS OF MULTI-JURISDICTIONAL PROJECTS

The U. S. Office of Water Resources Research has awarded Colorado State University a grant of \$24,000 to perform a study on "Evaluation of Benefits and Costs of Multi-Jurisdictional Urban Drainage Projects."

This project is in cooperation with the Urban Drainage and Flood Control District, which will contribute \$6,000 in cash to the effort. Also involved in this project will be Leonard Rice, President of Leonard Rice Consulting Water Engineers, Inc., and W. Joseph Shoemaker, Attorney and Colorado State Senator. The Technical Advisory Committee of the Flood Control District will serve as a project advisory committee for the effort.

Using actual projects in the Denver region as case studies, this investigation will undertake to develop practical techniques for measuring benefits and costs for multi-jurisdictional urban drainage and flood control projects. An attempt will be made to prepare the results in such a manner that they may be of use in other urban areas. The methods developed will use existing methodology to the maximum extent possible in the quantification of social costs and benefits.

A second phase of the project, which would require additional funding, would extend the research to develop quantitative management models of urban drainage alternatives. Whether or not additional funding will be requested will depend on the results of the initial effort.

HIGHLINE CANAL DURING FLOODS OF MAY 6th, 1973



Breach near South Quebec Street
and East Evans Avenue



Highline Canal near breach on
South Quebec Street

Sanderson Gulch—

(Continued from Page 5)

to perform the final design. Such an agreement must include as much defined information as possible to alleviate intricate unsettled questions that might arise during the final design of the project.

The agreement must define the exact responsibilities of the engineer in order that the engineer can accurately estimate his fee for the performance of the work. A few of the items that should be defined in the scope of work are priority of construction; preparation of detailed right-of-way and easement information, including mapping, staking, and legal descriptions; obtain all the necessary field data to complete final design; define the exact relocation of all utilities in such detail that the entities can negotiate with the affected utilities within their respective jurisdictions; provide control staking throughout the entire project; and definition of the responsibilities of the engineer during the construction.

RIGHT-OF-WAY AND EASEMENTS

Acquisition of the required right-of-way and/or easements presents another type of problem. The required mapping, staking, and legal descriptions will be provided by the engineer, but actual acquisition will be performed by the local jurisdictions. Public bodies are vested with the power of eminent domain, by which the government may condemn and purchase private property for public use. Most governmental agencies try to avoid using the right of eminent domain, preferring to obtain the property by direct negotiation with the landowners. Condemnation is resorted to only when the landowners refuse to sell or when their demands are considered unreasonable.

ACCESS TO DRAINAGEWAY

Access to the drainageway will present some challenging situations, most likely. Sometimes it is difficult to convince a landowner that no damage will be done when a D-9 Caterpillar tractor traverses his yard in order to reach a drainageway. These problems must be anticipated in the

design of the project, with the actual costs of access roads definitely affecting the overall cost of the project.

AVAILABILITY OF MATERIALS

Another problem that will be encountered during construction is the availability of sources of construction materials. Gabions will be used extensively for the prevention of erosion. Available sources of gabion material will definitely reflect in the overall price tag of the project. The engineer will evaluate all sources of construction materials to insure the best overall project for the amount of money that has been allocated.

LOCATING BURIED UTILITIES

Determining the existing location of utility pipes and wiring that will be affected by the proposed improvements presents some challenges to the engineers. The best approach usually is to do sufficient excavation work to determine the exact location of these utilities, during the design phase. Then all necessary relocation work can be provided for by the contractor. While the design engineer will be responsible for detailing the relocations, the local jurisdictions will be responsible for negotiations with the affected utility companies.

Sanderson Gulch is the first drainage improvement project undertaken by the Flood Control District and as such has presented many challenges to the engineers. The local jurisdictions will let separate contracts covering work to be done within their respective areas, with the District coordinating the overall project to insure compliance with the overall master drainage plan, and per the requirements of the federal and state funding sources.

As each problem arises, the District, the City and County of Denver, and the City of Lakewood, will work with the designated Consulting Engineer to meet the challenges in the best possible way. It has been a difficult task to advance the Sanderson Gulch Project to its present stage, but all concerned are encouraged and feel that with a little more patience and a few more headaches the implementation of the Sanderson Gulch Drainage Project will become a reality.

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FLOOD HAZARD NEWS
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and to the health and safety of persons living in the urban area"*

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