



# FLOOD HAZARD NEWS

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## Multiple Use - A Valuable Tool

by

Bill DeGroot P. E.

Chief, Floodplain Management Program

### INTRODUCTION

Throughout its 20 year existence, the Urban Drainage and Flood Control District has pursued the concept of multiple use, the utilization of publicly owned facilities and rights-of-way for joint public use and benefit. Not only does the District's enabling legislation require cooperation with park and recreation districts and other governmental agencies "for the development and use of drainageways for recreational and park purposes" if possible and feasible, it just plain makes good sense - from both a cost and a public benefit perspective.

The types of joint uses which have been the most frequently used and most successful are detention facilities and parks, maintenance and recreation trails, parks and open space in floodplains, and golf courses in floodplains. Examples of these multiple uses are described below.

### DETENTION/PARKS

Detention facilities can be either on-line or off-line. On-line facilities pass all flood waters from all events through them. Off-line facilities by-pass the more frequent events, diverting only the peak portions of larger floods into the detention area. Off-line facilities require less volume and are flooded less frequently than on-line facilities. Either type of facility will work. The key to the design of either type is to recognize how they function, and to design the park amenities accordingly.

### Herbert Hosanna Athletic Complex

Herbert Hosanna Athletic Complex is an off-line detention facility constructed on Englewood High School property adjacent to Little Dry Creek by the City of Englewood and the District.

*Flood Control Benefit: Decreased size of downstream flood control facilities built in conjunction with this facility, plus this site was the only feasible location for a detention facility. Routine maintenance performed by park personnel.*

*Recreation Benefit: A new irrigated blue grass park with two soccer fields, one baseball field, bleachers and a press box. Flood related maintenance performed by the city with possible assistance from the District.*

### George Wallace Park

The District, Denver, and the Goldsmith Metro District jointly funded the construction of two on-line detention facilities in conjunction with the development of Wallace Park at the Denver Tech Center on Goldsmith Gulch. Each entity funded one-third of the flood control cost of the facility,

and the metro district funded the park improvements (irrigation, landscaping, playground, etc.). In return for the metro district participation in the flood control cost, Denver waived on-site detention requirements for the Denver portion of the Denver Tech Center.

*Flood Control Benefit: Reduced right-of-way costs and reduced downstream flood hazard.*

*Recreation Benefit: A major park which buffers the residential neighborhoods from the office park, and provides recreation opportunities to both the neighborhood residents and the office park workers.*

### Jefferson High School Athletic Field

The Jefferson High School Athletic Fields are located on the South Tributary to Sloan Lake. They were subject to frequent flooding due  
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Looking upstream at the flood pool for the upper on-line detention facility at George Wallace Park.



# 1990 Professional Activities of District Staff

## **Scott Tucker, Executive Director**

- \*Presenter on Financial, Legal and Regulatory Issues at WPCF pre-conference workshop on ASCE Manual of Practice for Design and Construction of Urban Stormwater Management Systems in Washington, DC, October.
- \*Moderator and presenter for a session at the American Water Resources Association annual conference in Denver, Nov.
- \*Panelist on Impact of Regulations on Local Governments at EPA's New Stormwater Regulations for American Bar Association Seminar: Update: EPA Regulatory Developments Under the Clean Water Act, in Washington DC., Nov.
- \*Keynote speaker at Stormwater Management Workshop sponsored by the City of Colorado Springs, November.
- \*Participant in East Asia Regional Workshop on Natural Disaster Reduction, in Honolulu, August.
- \*Participant in U. S./Taiwan Bilateral Meeting on Natural Hazard Reduction in Taipei, Taiwan, August.
- \*Speaker on Local Government's View of Corps of Engineers Programs at the Corps' Senior Leadership Workshop in Denver, January.
- \*Luncheon speaker on Update on NPDES at Colorado Association of Stormwater and Floodplain Managers conference in Vail, May.
- \*Speaker on Political and Economic Issues in Urban Drainage Decisions at UDFCD/Colorado Division of Wildlife workshop on Urban Drainage and Wildlife in Denver, February.
- \*Speaker on NPDES Permits-Municipal Storm Sewers at meeting of the Water Resources Group of the Colorado Section of ASCE in Denver, May.

## **Bill DeGroot, Chief, Floodplain Management Program**

- \*Re-elected Secretary/Treasurer of the Colorado Association of Stormwater and Floodplain Managers.
- \*Appointed "Field Trip Coordinator" for the 1991 annual conference of the Association of State Floodplain Managers in Denver.

## **Kevin Stewart, Project Engineer, Floodplain Management Program**

- \*Speaker at the Winter Meeting of the ALERT Users Group in Sacramento, CA, January.
- \*Attended Seminar on Flood Warning/Preparedness Systems sponsored by the Interagency Floodplain Management Task Force and the Interagency Committee on Flood Warning & Response Systems in Washington, DC, February.
- \*Speaker on flood warning preparedness at the Spring Meeting of the Colorado Emergency Management Association (CEMA) in Silverthorne, CO, April.
- \*Recipient of the CEMA 1989 President's Award for Outstanding Service.
- \*Attended NOAA's Forecast Systems Laboratories Mesonet Upgrade Meeting in Boulder, CO in May and appointed chairman of the Mesonet Users Group.
- \*Speaker at the ALERT Users Group Annual Conference in Asilomar, CA, May.
- \*Speaker on the use of meteorological support services for flood prediction at the Colorado State University short course on Dam Safety: Design & Rehabilitation in Ft. Collins, CO, June.
- \*Conducted orientation and tour of the District's Flash Flood Prediction Program and ALERT early detection system for the National Council of Industrial Meteorologists in Denver, CO, June.
- \*Speaker at the National Weather Service Warning & Preparedness Meteorologists (WPM) Conference in Boulder, CO, July.
- \*Instructor at the U.S. Bureau of Reclamation/Handar Training Course on Early Warning Systems in Salt Lake City, UT, August.
- \*Hosted the Third Annual Conference of the Southwestern Association of ALERT Systems (SAAS) in Denver, September.
- \*Elected President of SAAS for November 1990 through October 1992.
- \*Presented future growth projections and data applications of ALERT systems in the United States to the Interdepartment Radio Advisory Committee (IRAC) and to the Assistant Secretary of Commerce for Communications and Information in Washington, DC, November.

## **Ben Urbonas, Chief, Master Planning & South Platte River Programs**

- \*Co-authored, with Peter Stahre of Malmo, Sweden, "Stormwater Detention" which has been published by Prentice Hall.
- \*Continues to serve as Chairman of ASCE's Subcommittee on Urban Gaging Networks sponsored by the USGS.
- \*Chaired a session on Urban Hydrology at the American Water Resources Association annual conference in Denver, Nov.
- \*Described the Denver Metropolitan Area approach to stormwater hydrology at the annual water resources meeting of the Minneapolis/St. Paul Section of ASCE.

## **Barbara Benik, Project Engineer, Master Planning & South Platte River Programs**

- \*Attended the Colorado State Trails Conference in Pueblo, May.
- \*Helped the National Park Service organize and lead a training field trip of UDFCD projects for the NPS Rivers and Trails Conservation program, June.
- \*Led a field trip of the South Platte River for the American Water Resources Association annual conference in Denver, Nov.

## **Dave Bennetts, Field Maintenance Supervisor, Maintenance Program**

- \*Presented a talk on soil bioengineering techniques and the Clear Creek demonstration project to the Water Resources Group of ASCE.

## **Michael Sarmento, Inspector/Technician, Maintenance Program**

- \*Received certification for Concrete Field Testing Technician Grade I from the American Concrete Institute, February.
- \*Received a Bachelor of Arts degree in Writing (Technical Emphasis) from the University of Colorado at Denver.
- \*Took the certification exam for Certified Engineering Technician from the National Institute of Certified Engineering Technicians.



# Tucker-Talk

by L. Scott Tucker

*Timely Comment from the District's Executive Director*



## **NPDES Stormwater Permits**

As reported by Ben Urbonas in his presentation of Master Planning Program activities, the District is working with Denver, Aurora, Lakewood and Arapahoe County in developing information for their preparation of applications for NPDES stormwater permits. As P-Day for the promulgation of regulations by EPA approaches, an honest effort is being made to get a head start in preparing the applications. The work is based on the proposed regulation and it is hoped there will be no significant changes in the final regulations that will undo these early efforts.

Preparation of the applications for the permits will be a big paper chase and the financial impacts on local governments will not be trivial. Compliance requirements with the eventual permits is an unknown quantity at this time and the eventual cost to local governments is a big concern.

An issue is developing beyond the immediate problem of preparing permit applications that has long-term serious ramifications. The regulations as proposed do not apply water quality standards to the discharges from municipal storm sewers. This approach was justified and explained in the preamble to the proposed EPA regulations. For example, the preamble stated, "when enacting this provision Congress was aware of the difficulties in regulating discharges from municipal separate storm sewers solely through traditional end-of-pipe treatment and intended for EPA and NPDES states to develop permit requirements that were much broader in nature than requirements which are traditionally found in NPDES permits for industrial process discharges or POTWs." As Senator Stafford explained, municipal storm sewer system permits "will not necessarily be like industrial discharge permits. Often, an end of the pipe treatment technology is not appropriate for this type of discharge."

The Preamble goes on to say, "A shift toward comprehensive storm

water quality management programs to reduce the discharge of pollutants from municipal storm sewer systems is appropriate for a number of reasons. First, discharges from municipal storm sewers are highly intermittent, and are usually characterized by very high flow rates occurring over relatively short time intervals. For this reason, municipal storm sewer systems are usually designed with an extremely high number of outfalls within a given municipality, to reduce potential flooding. Traditional end of pipe controls are limited by material management problems that arise with high volume, intermittent flows occurring at a large number of outfalls.

"Second, the nature and extent of pollutants and discharges from municipal systems will depend on the activity occurring on the lands which contribute runoff to the system. Municipal separate storm sewers tend to discharge runoff drained from lands used for a wide variety of activities. Given the material management problems associated with end of pipe controls, management programs that are directed at pollutant sources are often more practicable than relying solely on end of pipe controls."

EPA is correct in their logic and concluded that a source control program based on best management practices was the logical way to proceed. However, in a recent memorandum from an EPA region to EPA headquarters, it was concluded, with OGC staff level concurrence, that water quality standards do apply to the discharges despite the new MEP level of control in the Clean Water Act, for municipal storm water discharges.

It was noted that the California early permits do not contain numerical effluent limitations which ensure compliance with water quality standards because the states felt that there is currently insufficient information to determine the best means for achieving information concerning pollutant sources and loadings. Additional BMPs may be required if the initial BMPs do not result in compliance with water quality

standards. The memo went on to point out that because of the absence of numerical effluent limitations, NPDES permits that have already been issued for Los Angeles County and Santa Clara Valley, California have been challenged by environmental groups.

EPA has made the correct decision in fashioning the NPDES storm water applications and permits towards source control through best management practices. Environmental groups are already challenging this approach, however, and Region 9 EPA is implying that water quality standards do apply to storm water discharges as noted above. While it may be appropriate in some instances to look at end of pipe approaches, it is simply ridiculous to think in terms of meeting water quality standards at the end of every pipe. The cost of monitoring all discharges in and of itself would be fiscally irresponsible and impossible to perform.

Because the Clean Water Act is the law and because of the requirements of the EPA regulations, local governments will have to make solid and honest efforts to reduce the pollutants in storm water discharges. However, local governments must be alert for and resist any attempt to push the requirements beyond what is already being promulgated. At some point in time they simply will not be able to squeeze any more blood from the local government turnip.

## **UDFCD Role In Stormwater Quality**

The role of the Urban Drainage and Flood Control District in quality is still evolving and not yet determined. In 1988, when I discussed this issue in this column, I indicated that the District would play no role in stormwater quality. Okay, so I was wrong. Now, two year later at this time, as reported elsewhere in this issue of *Flood Hazard News* by Ben Urbonas, the District is quite actively involved in coordinating the development of information that local governments will use to prepare

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## DESIGN AND CONSTRUCTION NOTES

by  
B. H. Hoffmaster  
Chief, Design and Construction Program

This year saw the completion of a project long in design and construction. The Upper Sloan Lake Project started with the preparation of the master plan, "Major Drainageway Planning, Sloan Lake Basin" dated December 1977. The project actually started with the signing of an inter-agency agreement for planning between the Urban Drainage and Flood Control District, City and County of Denver, City of Edgewater, City of Lakewood and the City of Wheat Ridge dated January 5, 1976. With the master plan completed in December 1977, a design effort started August 16, 1978, when the above entities signed an agreement for design with URS Engineers. Construction began with the opening of bids on January 12, 1982, for the reach from Sloan Lake at 18th Avenue extended, to 20th Avenue and Ingals Street. Since then there have been three more contracts let to extend the storm drain to the Rocky Mountain Ditch near 26th Avenue at Yarrow Street east of Wadsworth Boulevard. Acceptance of the final phase occurred May 25, 1990.

The construction included a trapezoidal grass lined channel from Sloan Lake to 20th Avenue and Ingals Street, and storm drains ranging in size from an 8 foot by 6 foot box culvert at 20th Avenue and Ingals Street to a 30 inch diameter pipe at 26th Avenue and Rocky Mountain Ditch. Also included in the project is a 24 acre-foot detention reservoir at the southeast quadrant of Wadsworth Boulevard and 26th Avenue. Two structures were built to separate storm drainage that had been intercepted by the Rocky mountain Ditch from the normal irrigation flow. One of these structures included a turnout gate at the ditch. This turnout gate allows the City and County of Denver to take their water right through the drainage facilities to Sloan Lake, where it is used to improve the water quality of the lake.

The construction cost for this project was \$5,903,400. The project affords 25-year flood protection above Ingals Street and 100-year flood protection between Ingals Street and Sloan Lake.

This project demonstrates what can be accomplished when four

## STATUS OF DISTRICT DESIGN PROJECTS

Project	Participating Jurisdiction(s)	Status
Cherry Creek Erosion Study	Arapahoe County Denver Glendale	50% Complete
Goldsmith Gulch Cherry Cr. to Dartmouth	Denver	Prelim. Design on Hold
Gunbarrel Area	Boulder County	Prelim. Design Complete
Hays Lake Dam	Arvada Oberon Ditch Co Rio Grande RR	25% Complete
Lena Gulch 20th Ave. to Youngfield	Lakewood	Complete
Isabell Crossing	Jefferson County	95%
Little Dry Creek (ADCO) Clear Cr. to Lowell	Adams County	95% Complete
South Jefferson County	Arapahoe County, Nevada Ditch Co., Last Chance Ditch Company, Littleton	Complete
Lakewood Gulch/Dry Gulch	Denver	75% complete
Van Bibber Cr.	Arvada, Corps of Engineers	Feasibility 57% Complete
Lower Hoffman Drainage	Thornton, Adams County	75% Complete
Coal Creek Improvements	Boulder County, Louisville, Lafayette	90% Complete
Slaughterhouse Gulch Powers Park to Littleton Blvd.	Littleton	Complete
4 Square Mile- Basins 2 and 3	Arapahoe County	Complete
Westerly Basin	Arapahoe County	Start
First Ave Trib. Phase 1B	Lakewood	Complete
Mississippi & Jason Phase III	Denver	Complete
West/Gay Lake Channel	Broomfield	Complete
University/Mexico Phase V	Denver	Complete
I-25/35th Av. Phase II	Denver	Complete
Tucker Gulch	Golden	Complete
Sloan Lake North Trib.	Edgewater, Wheat Ridge	Complete
Louisville Drainageway B	Louisville	Complete
Kalcevic Gulch	Adams County	Start
Ralston/Leyden Creek	Arvada, Corps Engineers	Feasibility Start
Timberlake/Cottonwood Villas Detention	Westminster	Complete
Four Lakes	Arapahoe County	Start

government agencies cooperate and join together by agreeing on the project, agreeing on a cost sharing formula and funding the project. The District's place in the scheme was to provide not more than half the cost and manage the design and construction. Lakewood provided the right-of-way services to secure the necessary lands, easements and rights-of-way. The project's municipal agencies were given an award by Denver Regional Council of Governments for their demonstration of cooperative effort.

Little Dry Creek (Adams County) is another project where biting off small pieces each year has

seen the reduction of the flood hazard so that a large number of homes are no longer in the 100-year floodplain. The Counties of Adams and Jefferson, Cities of Arvada and Westminster and the District began the project on June 3, 1977, when an agreement with Merrick and Company, consulting engineers, was signed to provide floodplain mapping and a master plan for improvements. The master plan, "Major Drainageway Planning - Little Dry Creek (ADCO)" was completed in April, 1979.

On November 15, 1982, Westminster and the District entered into an agreement for the design and construction of improvements to Little



Dry Creek to implement the master plan. In a series of six construction contracts, improvements were made to Little Dry Creek so that the properties within Westminster are now free of the 100-year flood hazard. The City and District have spent \$5,964,900 for the project.

Rotary Park Detention Pond, the last of the six projects, required substantial inter-agency cooperation. This project involved Westminster, Adams County, Hyland Hills Park and Recreation District and the District. The project was designed by Sellards and Grigg, Inc. under an agreement between Westminster, Adams County and the District. Westminster desired to have the construction start this year and so entered into a construction agreement with Adams County, Hyland Hills, and the District. Adams County and Hyland Hills did not participate financially in the project. However, the park is located in Adams County and is owned by Hyland Hills and the agreement spells out the inter-relationship. The construction rebuilt the dam along US-36 and lowered the park. Therefore, removal of poor drainage, new sod and sprinkler system was included in the construction. The flood control benefits are located within Westminster which shared the costs with the District. The construction cost for this project was \$351,600. Bill Christopher, City Manager for Westminster, writes "The modifications (to the Park) will not only provide needed flood protection to Westminster residents, but also provides a very attractive and functional park for area residents. Furthermore, this project reflects the cooperative spirit which exists with Hyland Hills Park and Recreation District."

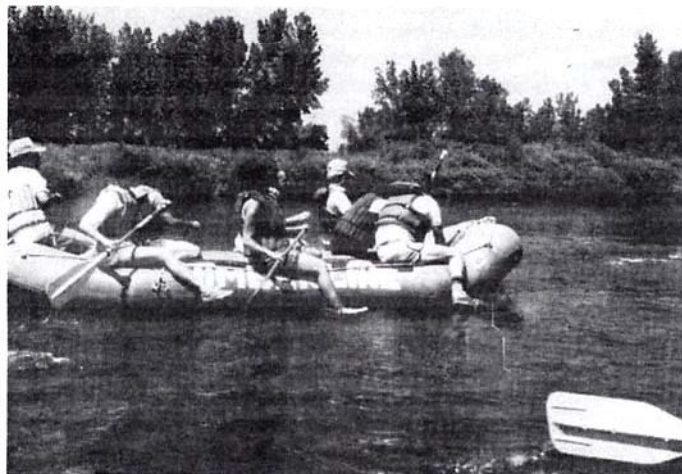


The recently completed Rotary Park Detention Pond.

### STATUS OF DISTRICT CONSTRUCTION PROJECTS

Project	Jurisdiction(s)	Cost	Status
Clear Creek at Pecos	Adams Co., CO Dept. of Hwys	\$124,000	Complete
Lena Gulch Schedule V	Wheat Ridge	\$262,800	25% Complete
Little Dry Cr (ADCO) D5	Westminster	\$107,700	Complete
Little Dry Cr.(ARAP) Santa Fe to Cinderella City	Englewood, Co Dept. of Hwys	\$500,000	95% Complete
Parker/Mexico	Arapahoe Co, Aurora	\$96,700	Complete
Weir Gulch 1st Ave. Tributary Sch. III	Denver	\$313,200	Complete
Westerly Creek Dam Lowry AFB	Denver, Aurora, Corps of Engineers	\$12,100,000	90% Complete
Hays Lake Outfall	Arvada	\$645,000	Complete
Upper Sloan Lake Schedule IV	Lakewood, Denver	\$517,000	Complete
Mississippi/Jason	Denver	\$1,554,900	75% Complete
Spring Creek at Phillips Ave	Arapahoe County	\$240,900	Complete
Coal Creek Improvements	Boulder County, Louisville	\$342,000	10% Complete
Louisville Drainageway B	Louisville	\$501,000	Complete
Four Sqaure Mile Area Basin 2	Arapahoe County	\$804,000	Start
Boulder Creek Right-of-Way	Boulder	\$750,000	Start
Gunbarrel Detention	Boulder County	\$150,000	Complete
Huron Outfall	Adams County Co Dept of Hwys	\$48,900	Start
Rotary Park Detention	Westminster	\$500,000	Complete
Upper Sloans Lake North Branch	Edgewater	\$1,150,000	75% Complete
Timberlake/Cottonwood	Westminster	\$58,700	Complete
Villas Detention			
University/Mexico Drainage Schedule V	Denver	\$922,000	40% Complete

### *Rafting the Platte - July, 1990*



On July 13, 129 people participated in the District's sixth annual "Raft the Platte" tour. The purpose of the trip is to familiarize elected and appointed officials with different reaches of the river, as well as the problems and opportunities that exist along the river. This year's trip went from C-470 near Chatfield Dam to the Englewood Golf Course, with a root beer float stop at Riverfront in Littleton. Following the trip the participants adjourned to Zang Brewing Co. for dinner. Co-sponsors of the trip were Denver, Littleton and Englewood.



# South Platte River Program Notes

by

Ben Urbonas, Chief, and  
Barbara Benik, Project Engineer,  
South Platte River Program

## Maintenance of South Platte River

This year, the South Platte River routine maintenance work included an equivalent of 100 miles of mowing, eight miles of tree trimming and pruning, and 81 miles of debris removal. Trash and debris continues to be an ongoing problem, with about 130 truck loads of debris, totaling about 1000 cubic yards of material, having been removed and disposed of at area land fill sites.

Restoration of the deteriorating river channel and its appurtenances in 1990 included: scour protection of two bridges in Sheridan and one bridge in Littleton, repair of erosion damage along the maintenance trail and repair of the trail in Denver, restoration and revegetation of 750-feet of bank in Brighton, installation of an overflow and water level equalization weir on a berm between the river and an adjacent lake in South Platte River Park, and the construction of a large boulder grade control structure upstream from 19th Street and downstream from the Denver water resources flow gage operated by the State Engineer's Office. This last item was jointly funded by the District, the State, and the Denver Water Department. Two more boulder grade control structures are planned for construction this fall.

Much of the restorative maintenance work provides us with an opportunity to expand or enhance the riparian vegetation cover along the river. As a result, we now have trees, brush and shrubs, in addition to native grasses, growing along banks that used to be either bare or covered by trash, debris and rubble.

As mentioned in our last issue, most of these restoration maintenance projects required 404 Permits. A general permit was issued in 1987, which has greatly facilitated the 404 process. Since 1987, we have received a total of 16 authorizations for work under the general permit. The average turnaround time under the general permit continues to be less than ten days, which is one order of magnitude less than the processing of individual permits used to take in the past. This rapid response by the Corps of Engineers to our general permit work authorization requests permits this

District to address problems on a timely and cost effective basis.

## Cooperative Activities

This year we successfully completed two cooperative projects. The Edward Getz project included 560-feet of bank restoration, stabilization and revegetation. It remedied severe bank erosion, damage to property and destruction of riparian habitat.

The Platte River Farms project resulted in nearly 64 acres of riverine corridor being dedicated as easement to the District. In exchange, the District restored about 2200-feet of river bank that was totally denuded of vegetation, was too steep for access, and was covered with concrete rubble by owners before Platte Valley Farms acquired this property. Now that the District owns a flowage and maintenance easement along this reach, the channel will be maintained as a riverine corridor to carry floods and provide wildlife habitat similar to what used to be there before damage occurred.

There are four requests for projects in 1991 under the cooperative program. To the extent our funds permit, we look forward to working with each of the property owners to help them repair eroding banks and restore lost riparian vegetation along the South Platte River.

## Capital Improvement Activities

This year we initiated three construction projects. One of these is a grouted boulder grade control structure north of Colorado Highway 224 (74th Avenue). It is jointly funded

with the Colorado Highway Department and Adams County, and will control river degradation through Interstate Highway 76 upstream.

Another is a project being jointly funded with Adams County to install a large boulder grade control structure adjacent to the Adams County Regional Park. The river in this reach is degrading rapidly and causing severe bank and property damage. We expect this check structure to help slow this degradation and bank erosion.

Last, but not least, is a bank restoration project between 78th and 88th Avenues being jointly funded with Thornton. We have completed construction of Phase I (2000-feet) and will begin revegetating the site early in 1991. In the past this area was used as a dump for large concrete pipe and slabs. The dumped concrete material has been removed or buried, the banks have been sloped back, and the toes of the slopes have been protected from erosion by light riprap. Funds permitting, we hope to continue this work over the next three years to rehabilitate a total of 8,000-feet of river bank in this reach of the river.

Last year a preliminary design for an area known as "Globeville and North Areas" was initiated. The Alternative Evaluation Report was completed and submitted to the District by Hydro-Triad, Ltd., and an alternative was jointly selected by the District, Adams County, Denver and Commerce City. Hydro-Triad, Ltd. currently is writing the final preliminary design report. This project should be completed in the

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The new grade control structure at 19th Street. Note the boat passage at the right side of the structure.



# MAINTENANCE PROGRAM ACTIVITIES

by  
Mark R. Hunter, P.E.  
Chief, Maintenance Program

## Program Direction

The 1990 Maintenance Program budget was \$5,148,562. This was the smallest budget in several years. Completing most of our projected large projects in 1989 allowed us to keep the budget fund balance carried into 1990 relatively small.

Most major drainageway facilities are owned by the cities and counties within the District. The District owns very few facilities. Consequently, the thrust of the Maintenance Program is to assist the local governments in the maintenance of their major drainageway facilities. With that in mind, the Maintenance Program works closely with the 36 cities and counties within the District to identify and prioritize their drainageway maintenance needs.

The Maintenance Program continues to operate through three sub-programs, namely, routine, restoration, and rehabilitation. Maintenance activities range from routine trash and debris removal and channel mowings, to restoration of deteriorated facilities and major rehabilitation of drainage channels. The highlights of each sub-program are discussed below.

## Routine Maintenance

Each year the routine portion of the Maintenance Program expands to include mowing and debris removal on more drainageways, and 1990 was no exception, even though the expenditures for routine work decreased by 17% from 1989. We credit our contractor selection process and the competitive bidding climate for the favorable results.

In some of the less urbanized drainage areas we have directed the mowing contractor to leave small pockets of cattails and native grasses at mature height. We will monitor these areas to be sure they do not adversely affect the drainageway.

## Restoration Maintenance

The restoration program completed a little over \$1.0 million worth of work in 1990. This has been our average annual level of work except for 1989 when we did \$1.5 million of restoration work. Over 75

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# STATUS OF MAINTENANCE REHABILITATION PROJECTS

Project	Jurisdiction(s)	Cost	Status
<u>ADAMS COUNTY</u>			
Big Dry Creek-	Westminster	design- \$50,794	100%
Cotton Creek.Trib.		const- \$137,500	100%
Grange Hall Creek	Northglenn	design- \$55,000	100%
		const- \$300,000	0%-phase 2
Niver Creek	Thornton	design- \$74,014	100%
Baffle drop		const- \$105,000	15%-phase 1
<u>ARAPAHOE COUNTY</u>			
Little Dry Creek	Cherry Hills	design- \$26,157	100%
Drop Structures	Village	const- \$173,600	100%
Little Dry Creek	Arapahoe Co.	design- \$32,260	30%
Erosion repair		const- \$300,000	0% phase 1
Big Dry Creek	Arapahoe Co.	design- \$33,106	50%
Branch 2		const- \$300,000	0%
W. Toll Gate Creek	Arapahoe Co.	design- \$24,732	100%
Marina Pk. Trib.		const- \$54,600	100%
W. Toll Gate Creek	Aurora	design-\$115,628	100%
Summer Valley Ranch		const- \$414,446	100% phase 1
Willow Creek	Arapahoe Co.	design- \$45,309	100%
Spring Creek Trib.		const- \$176,926	100%
Willow Creek	Arapahoe Co.	design- \$43,749	5%
Erosion repair		const- \$300,000	0% phase 1
Cherry Creek	Arapahoe Co.	design- \$32,400	100%
Iliiff Drop		const- \$214,462	5%
Lee Gulch	Littleton	design- \$25,980	90%
		const- \$100,000	0%
Piney Creek	Arapahoe Co.	design- \$21,194	100%
Smoky Hill Detention		const- \$80,422	100%
<u>BOULDER COUNTY</u>			
Fourmile Canyon Creek	Boulder Co.	design- \$39,193	100%
		const- \$245,000	0%
Wonderland Creek	Boulder	design- \$68,641	100%
		const- \$229,142	100%
<u>DENVER COUNTY</u>			
Cherry Creek	Denver	design- \$56,650	100%
Bank protection		const- \$341,818	100%
Cherry Creek	Denver	design- \$62,128	100%
Drop structures (University)		const- \$435,756	100%
Cherry Creek	Denver	design- \$40,268	100%
Corona/Wash.drops		const- \$205,000	0%
Cherry Creek	Denver	design-\$103,389	15%
Creekfront		const- \$347,500	0%
Cherry Creek	Denver	design- \$12,200	50%
Stability		const- N/A	N/A
Montbello Channels	Denver	design- \$20,000	20%
Replacement		const- unknown	0%
Goldsmith Gulch	Denver	design- \$15,400	100%
Trash Rack		const- \$35,000	0%
Lakewood Gulch	Denver	design- \$59,402	75%
Channel repair		const- \$250,000	0% phase 1
<u>DOUGLAS COUNTY</u>			
Tallman Gulch	Parker	design- \$35,000	5%
prelim. design		const- unknown	0%
Cherry Creek	Douglas Co.	design-by other	100%
Access trail		const- \$11,700	100%
<u>JEFFERSON COUNTY</u>			
McIntyre Gulch	Lakewood	design- \$65,697	100%
South Branch A (Alameda)		const- \$250,000	0%
Ralston Creek	Arvada	design- \$42,096	95%
		const- \$150,000	0% phase 1
Big Dry Creek	Westminster	design- \$48,590	100%
Ketner Trib.		const- \$208,804	100%
Dry Gulch	Lakewood	design- \$14,522	95%
14th ave.		const- \$57,000	0%



# PLANNING PROGRAM ACTIVITIES

by  
Ben Urbonas  
Chief, Master Planning Program

## PLANNING PROJECTS

Master planning program activity in 1990 was the highest in the District's 20-year history. As a result, 1991 should see a reduction in the number and the budget for planning projects. The table titled "STATUS OF PLANNING PROJECTS" lists the projects that are under way and the ones expected to begin in 1991.

We rely totally on consulting engineering firms to help us put together all of our outfall system and major drainageway master plans. The firms are selected for these projects jointly by the District and the local sponsors on the basis of their professional expertise in hydrology, hydraulics, multi-disciplinary project skills, ability to communicate, and their environmental and social issues sensitivity. We are fortunate to have a large number of firms in Denver with these attributes and hope to maintain the long standing public-private sector partnership in our master planning program.

For those firms that have completed master plans for the District and local sponsors, or are working on them at this time, we thank you for your contribution. For those that have not and have an interest in this type of work, we sincerely hope to see your pursuit of these projects.

## TECHNOLOGY TRANSFER

The University of Colorado at Denver offered a short course last August on the design of storm sewers and the use of Version 3.0 of the UDSEWER program. Similar short courses will be offered as a need for them arises or sufficient demand becomes clear. For information on what may be coming up in the future, contact Dr. James C.Y. Guo at 556-2849.

## SOFTWARE

Adams County, Arapahoe County, Douglas County, Aurora, Boulder County, Greenwood Village, Littleton, Denver, Thornton and the District continue to fund the development of PC software covering the technical sections of the *Urban Storm Drainage Criteria Manual*. The University of Colorado at Denver has completed the development of a storm

## STATUS OF PLANNING PROJECTS

Project	Sponsor(s)	Consultant	Status
Thornton Criteria	Thornton	WRC Engineers	In Review By City
Westminster Criteria	Westminster	WRC Engineers	In Review By City
Denver Criteria	Denver	WRC Engineers	5% Complete
Cottonwood Creek	Arapahoe Co.	Environmental Consultants	90% Complete
Dry Creek (ADCO)	Thornton &	Wright Water	Completed in 1990
- North	Adams Co.	Engineers, Inc.	
First & Irondale	Adams Co., Denver,	Wright Water	Completed in 1990
	Aurora, Brighton &	Engineers, Inc.	
	Commerce City		
Second & Third Cr.	Adams Co., Denver,	Kiowa Engineering	Completed in 1990
	Aurora, Brighton &	Corporation	
	Commerce City		
Beebe Draw	Brighton, FRICO &	Wright Water	50% Complete
	Adams Co.	Engineers, Inc.	
Jackass Gulch	Littleton	Centennial Engineering	90% Complete
Sable & Granby Update	Aurora	Kiowa Engineering	75% Complete
Moon Gulch	Jefferson Co. &	HDR Engineering	25% Complete
	Arvada		
Western Hill Outfalls	Adams County	WRC Engineering	10% Complete
Bullhead Gulch	Lafayette &	Greiner	15% Complete
	Louisville		
Happy Canyon Creek	Douglas Co. &	Kiowa Engineering	Just beginning
	Arapahoe Co.		
Columbine Basin	Arvada &	Muller Engineering	10% Complete
Outfalls	Wheat Ridge		
Toll Gate & Tributaries	Aurora	Kiowa Engineering	95% Complete
Upper Lena Gulch	Jefferson Co.,	n/a	Agreement
Update	Lakewood & Golden		Being Executed
Upper Westerly Update	Aurora	n/a	Scheduled for 1991
Lower Slaughterhouse	Littleton &	n/a	Scheduled for 1991
Outfall Update	Arapahoe Co.		
Niver Creek Update	Thornton,	n/a	Scheduled for 1991
	Adams Co. &		
	Federal Heights		
Cherry Creek at Lincoln	Parker &	n/a	Scheduled for 1991
	Douglas Co.		

sewer design package, a normal depth (i.e., prismatic) open channel design and evaluation package, and is now completing the stormwater detention design package. Anyone willing to volunteer to test software packages as they are developed, please contact Dr. Guo at University of Colorado at Denver.

This is truly a major effort supported by a large number of cities and counties in the District. When the work is completed, it will provide software that is consistent with the local drainage practices. The sponsors and most other communities in the District will be familiar with this software. This should provide some consistency in how projects are designed and/or reviewed by cities and counties in the metropolitan area.

However, as often is the case, these types of projects take longer than expected. Last year we reported that it will take 18 months to complete. That has not changed and we now currently expect this project to take 18 months to complete.

## STORMWATER QUALITY Colorado's Stormwater Quality Management Task Force.

Last year I reported that the State of Colorado's Water Quality Control Division (CWQCD) established a Task Force to study the stormwater quality issue leading up to the development of Colorado's stormwater management program. The task force has completed its work and turned over its findings and recommendations to Pat Nelson of



CWQCD. Pat is now developing a draft of the proposed stormwater program, which will be reviewed by the Task Force. We trust its input will be considered as these documents are finalized.

The program, including permit application and enforcement provisions, will have to be eventually adopted by the Water Quality Control Commission. At that time everyone will have a chance to state their case at the public hearings that will be a part of the rule making process of the State.

**Denver Area Cities and Counties Efforts to Prepare Applications for NPDES Separate Storm Sewer Discharge Permits.**

The final NPDES separate stormwater permit application regulations became effective as of October 31, 1990. Scott Tucker and I have been working with Denver, Lakewood, Aurora and unincorporated Arapahoe County to develop a consistent approach for applying for these permits. The three cities have populations over 100,000 and will have to submit their Part One of the Application to the State within approximately 12 or 18 months after the final rule is published. At the time this article was written, it was not clear if the unincorporated portion of Arapahoe County will be required to do likewise. All other local governments within the District will have until October, 1992, before they are scheduled to begin the application process.

CH2M Hill was selected to help us develop procedures on how various information is to be collected and then reported in support of the application. So far, CH2M Hill has helped us develop protocols for map exhibits and dry weather outfall discharge screening. In addition, a training course was put together on dry weather screening of major outfalls. It was given in October to the field personnel of the four medium and large local governments. This same course will be made available to local governments having populations less than 100,000 when their time approaches to prepare their NPDES applications. The course was video taped. We hope to eventually have it edited into a workable training tape.

In addition to the work being performed by CH2M Hill, the District prepared a set of base maps covering the four local governments by enlarging USGS Quadrangles to a scale of 1-inch = 1,000 feet. These

maps meet the permit regulation requirements. Each applicant will show on these maps the location of all stormwater outfalls and their tributary watersheds, along with the location of NPDES permitted wastewater dischargers, municipal waste handling and disposal facilities, stormwater quality control structures, etc.

Each major outfall identified on the maps has a data base containing information on land uses, runoff coefficients, population, industrial facilities, public land ownerships, dry weather screening data, and other data about the tributary watershed and its drainage system. All of the data are input and managed using a menu driven software package developed by Michael Jansek under a contract to the District.

We are also happy to report that interagency cooperation is evident throughout this process. As an example, DRCOG provided information about population distribution and the locations of industrial facilities throughout the four local governments. The Colorado Water Quality Control Division participated in most of the coordination meetings and provided valuable and timely interpretation of what may constitute acceptable information in support of the new NPDES applications.

As the four local governments move through the NPDES separate stormwater permit application process we will learn how to best accomplish various tasks. What we learn from the ongoing activities will be made available to other local governments when the time comes for them to prepare their applications. In the meantime, we will expand the coverage of the base map described above to the entire 1608 square mile area of the Urban Drainage and Flood Control District. These maps will be available to all cities and counties that want them at the time they prepare their NPDES applications.

**MEET THE NEW BOARD MEMBERS**



**LYNN M. EASTON**

Mayor, City of Arvada

Mayor Easton has an A. A. degree in General Studies from Community College of Denver and an M. A. in Social Sciences/Public Administration from the University of Northern Colorado. He has spent 25 years in information systems, and is currently Chief, Branch of Computer Technology, Bureau of Mines.

In addition to his duties as Mayor, he serves as a member of the Metro Cooperation Group, member of the Arvada Economic Development Corporation, and Chairman of Columbine/Ralston Neighborhood Association.

Lynn and his wife Pamela have four children.

<p><b>UPCOMING CONFERENCE ENVIRONMENTAL REGULATION: HAS THIS PENDULUM SWUNG TOO FAR?</b></p>
<p>APRIL 25-26, 1991</p>
<p>TOPICS TO INCLUDE: GROUNDWATER QUALITY, STORMWATER QUALITY, SOLID &amp; HAZARDOUS WASTE MANAGEMENT &amp; DISPOSAL, SURFACE WATER ISSUES, WETLANDS, AND RISK ASSESSMENT.</p>
<p>SPONSORS INCLUDE ENGINEERING, PUBLIC WORKS, AND LEGAL ORGANIZATIONS.</p>
<p>TO RECEIVE THE TENTATIVE LIST OF SPEAKERS, PLEASE CALL BARB BENIK AT (303) 455-6277.</p>



# STORMWATER QUALITY ENHANCEMENT CAPTURE VOLUMES

by  
Ben Urbonas, P.E., Chief,  
Master Planning Program

Last year we described a procedure to size a capture volume for stormwater quality enhancement facilities. An example was presented using 40 years of hourly rainfall data from Denver's National Weather Service rain gage. This investigation was expanded to test the procedure using rainfall data from Colorado Springs and Fort Collins. The goal was to see if the sizing procedure would yield significant differences between various rainfall records along the front range of Colorado.

The findings are presented in two figures. These figures present the findings for the 80th percentile runoff event, because rapidly diminishing returns in effectiveness occur beyond this size. It is estimated that this volume can remove 80 to 90 percent of the annual total suspended solids (TSS) load, while doubling this volume increases the removal rate by less than two percent.

Figure 1 is for detention ponds with permanent pools. For these we assumed that the design maximum surcharge capture volume drains in 12-hours. Figure 2 is for detention facilities that empty out completely between storm events. Because of the different pollutant removal process, the latter facilities are designed to empty in 40-hours. Both figures relate the capture volume in watershed inches to the percent imperviousness of the watershed. As a result, it is no longer necessary to find the runoff coefficient to estimate the water quality capture volumes.

Virtually no differences were observed between Fort Collins and Denver. There is an apparent difference between these two communities and Colorado Springs, with the latter requiring 10 to 20 percent more capture volume than the other two. Whether this is statistically significant is questioned. While the NWS rain gage records for Denver and Fort Collins were of similar length and were continuous, the record for Colorado Springs is much shorter and is not continuous. It may be that the differences in the length and quality of the data record bias the results. Maybe a longer rainfall record would produce a closer agreement between

the findings for Colorado Springs and the other two cities. Until such data are available, we are unable to state that the differences seen between the

findings for Colorado Springs and the other two cities are statistically supported.

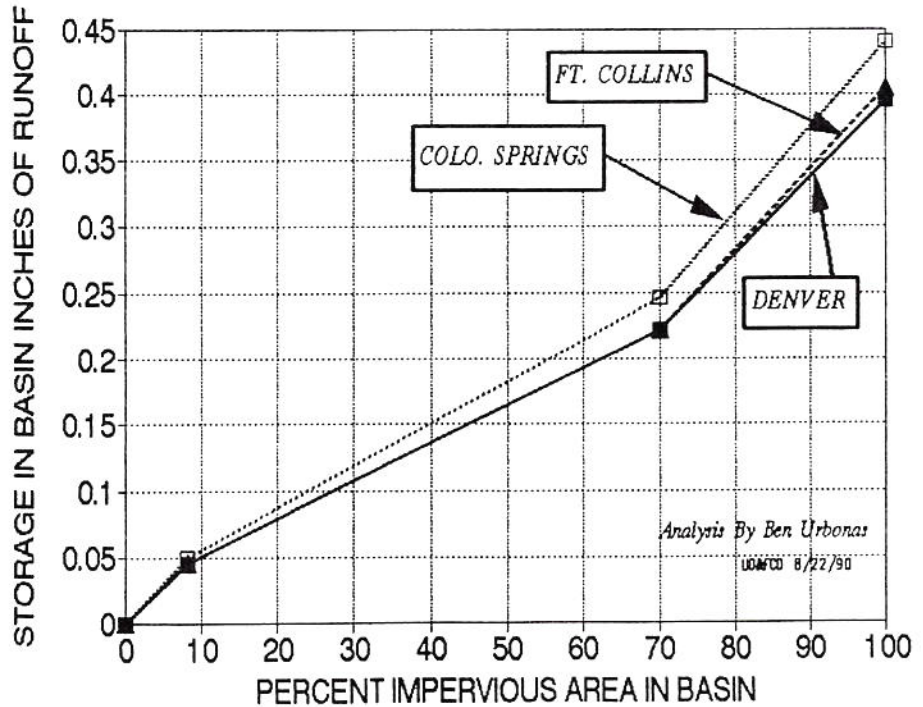


Figure 1 - Water Quality Capture Volume - 12-Hour Emptying Time & 80th % Event

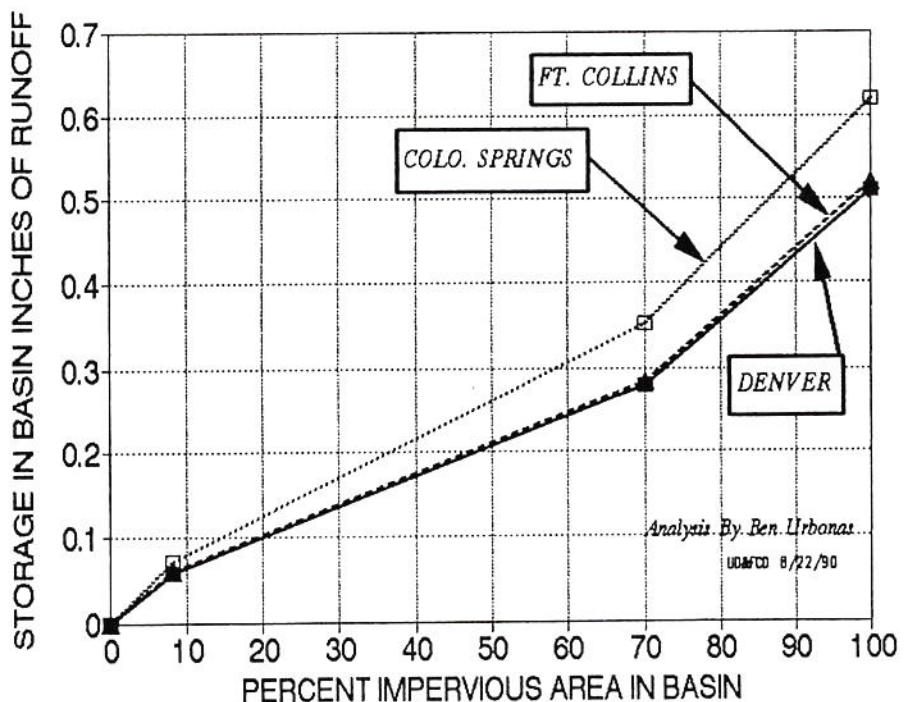


Figure 2 - Water Quality Capture Volume - 40 Hour Emptying Time & 80th % Event



## DESIGN NOTES

Supplement to Flood Hazard News (December, 1990)

# Grouted Riprap And Boulder Installations

By David Bennetts, Field Maintenance Supervisor, Maintenance Program and John Pflaum, Project Engineer, McLaughlin Water Engineers, Inc.

### Introduction

Grouted riprap is commonly used as a means of erosion protection in open channel drainageways. It has been used in many applications with both successes and failures. Over the years the District has refined and improved the grouted riprap process. Three grouted rock sections are shown on the detail drawing on the next page and are discussed below.

Grouted riprap can be used in applications where high velocities and tractive forces could pull away the rock in a typical dumped riprap section. Another application is its use in stilling basins below drop structures or pipe outlets. Grouted rock can also be used to construct rundowns which convey local drainage to the drainageway. Grouted riprap also works well to reduce the vandalism problem of rock being thrown into the drainageway.

There are disadvantages to grouted riprap as well. It can be unsightly if not installed properly. Having the grout level too high results in a gray mass of grout and rock that is unattractive. Failure to achieve complete penetration between the rocks can result in large voids that serve as major routes for seepage. Another problem with grouted riprap is failure due to runoff around and under the edges which undermines the grouted riprap system. This problem is created by failure to prevent water from undermining the section.

Failure can also be caused by not providing weep holes or lateral drains for subsurface water to escape. This can cause the bedding or subgrade to become saturated and fail, thereby removing support for the grouted riprap. In addition, weep holes relieve uplift forces created by high channel velocities. Although weep holes may not be required, it is generally a good idea to install them.

This article will discuss these problems and offer some suggestions to avoid them. The riprap sections discussed are grouted riprap, a vertical grouted boulder wall, and grouted sloping boulders.

### Grouted Riprap Placement

The rock used for grouted riprap is different from the standard

gradation of riprap in that the smaller rock has been removed to allow greater penetration by the grout. The riprap and grout specifications are on the detail sheet. Riprap smaller than Type MG should not be grouted.

The applicable size of riprap is placed on the subgrade or layer of bedding as specified. For specific criteria for bedding, refer to the *Urban Storm Drainage Criteria Manual*. As the riprap layer is placed, a cutoff trench should be excavated around the rock section at the top of the slope and at the upstream and downstream edges. The trench should be the full depth of the riprap layer and at least 1' thick. This trench is filled with grout to prevent water from undermining the grouted rock mass.

After the riprap has been placed to the required thickness and the trench excavated, the rock is sprayed with clean water which cleans the rock and allows better adherence by the grout. The rock is then grouted using a low pressure (less than 10 psi) grout pump with a 2" maximum diameter hose. Using a low pressure grout pump allows the work crew time to move the hose and vibrate the grout. Vibrating the grout with a pencil vibrator assures complete penetration and filling of the voids. After the grout has been placed and vibrated, a small hand broom or gloved hand is used to smooth the grout and remove any excess grout from the rock. The finished surface is sealed with a curing compound.

### Vertical Bank Erosion Protection

This type of bank protection works particularly well where right-of-way is limited and vertical bank erosion exists. In these instances, a vertical rock wall can be installed with minimum disturbance to the surrounding area and within the limited right-of-way. The resulting wall will be more aesthetic than a typical sloping riprap bank, and works well in parks or along private property where the look of the final product is of concern. The cost of installation of the rock wall is comparable to or cheaper than the cost of a standard vertical concrete wall with footing.

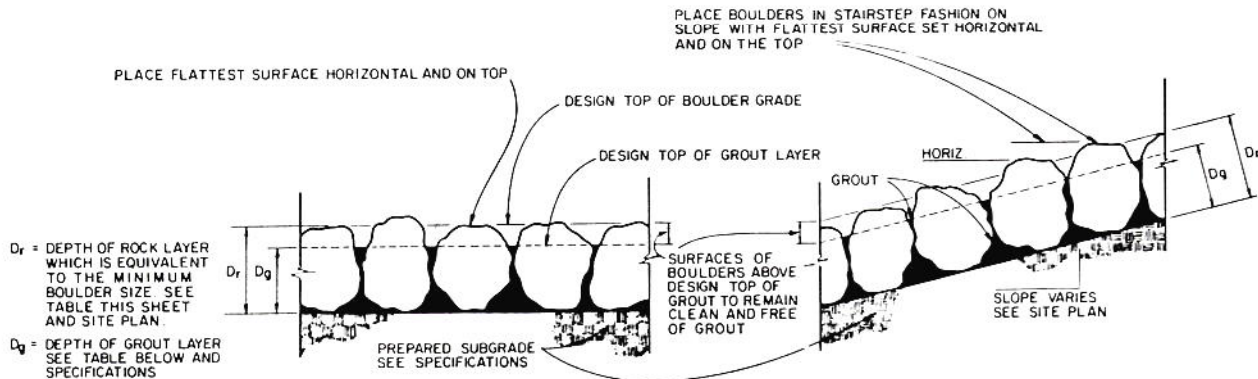
Construction of the vertical rock wall is straight forward and can be accomplished with standard construction equipment. A base of Type M riprap is placed in a trench

excavated to a 2' minimum depth below the invert. This provides the base on which the boulders set. The first row of boulders is set on the base 18" from the existing bank and placed as closely together as possible to minimize spaces for the grout to escape. It is important when setting the boulders to keep the top horizontal plane of the boulders as smooth and flat as possible. This flat surface will make placing the second layer of boulders much easier. Weep pipes are then placed between the boulders at 10 foot intervals. When placing the pipes, the burlap bag of gravel should be in contact with the earth bank behind the boulders. Place the pipes above the level of the expected low flow water surface. This will help keep the pipes from plugging with silt which may accumulate on the channel bottom.

Type MG riprap is then placed behind the boulders and around the weep pipes. When placing the riprap around the boulders, plug any spaces or holes between the boulders where the grout might escape. After the riprap has been placed the rock can be grouted. Use a low pressure grout pump and vibrate the grout into the voids with a pencil vibrator. Do not vibrate the grout around the burlap bag of gravel. This can seal the bag and prevent drainage from behind the rock wall. Keep the grout level a minimum of 4" below the top plane of the first boulder layer to allow the upper layer of riprap to lock in behind the lower boulder. A 2" X 4" keyway can be stamped into the wet grout to allow the next layer of grout to lock into it. In addition to the keyway, #4 rebar can be inserted 12" into the wet grout on 24" centers to tie the two layers together.

After the first layer has set, the next layer can be installed in a similar process. The only difference of note on the second layer is that the boulders should be set back from the vertical face of the first row of boulders a minimum of 4". If more than two layers are used, this setback should be used on each subsequent layer. This will help keep the mass of rock and grout back against the cut bank and keep it from becoming top heavy. Note that since this design is a retaining wall, each application and design should be analyzed for structural stability. The grout level on the top





$D_r$  = DEPTH OF ROCK LAYER WHICH IS EQUIVALENT TO THE MINIMUM BOULDER SIZE SEE TABLE THIS SHEET AND SITE PLAN.  
 $D_g$  = DEPTH OF GROUT LAYER SEE TABLE BELOW AND SPECIFICATIONS

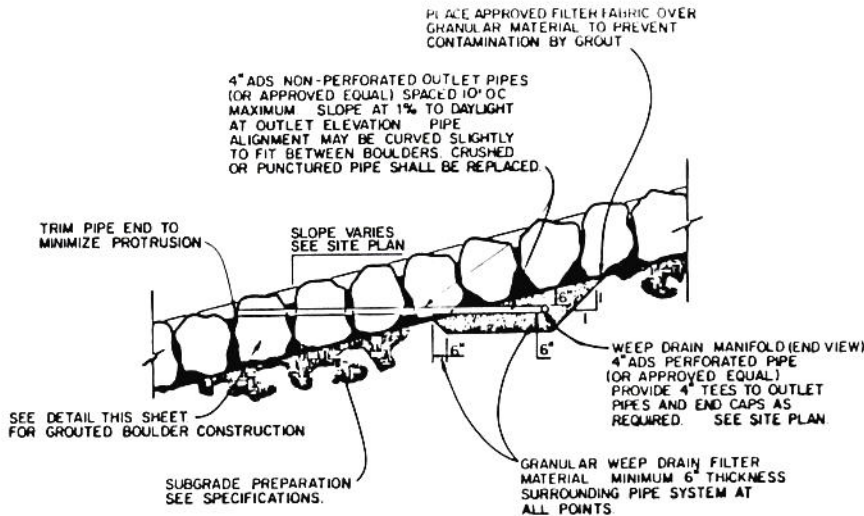
$D_r$	$D_g$
18	12
24	18
30	24
36	28
42	32

DIMENSIONS IN INCHES

- NOTES:
1. FINAL PLACEMENT OF BOULDERS TO BE APPROVED BY THE ENGINEER PRIOR TO GROUTING.
  2. BEFORE GROUTING, CLEAN ALL DIRT AND MATERIALS FROM ROCK THAT COULD PREVENT THE GROUT FROM BONDING TO ROCK.
  3. PLACE GROUT BY INJECTION METHODS AND USE A PENCIL VIBRATOR TO FILL THE VOIDS TO THE SPECIFIED GROUT DEPTH. CLEAN EXCESS GROUT FROM ALL EXPOSED SURFACES.
  4. THE CONTRACTOR SHALL CONTROL GROUT MIX AND PLACEMENT PROCEDURES TO ACHIEVE THE SPECIFIED THICKNESS AND GRADE OF THE GROUT LAYER.

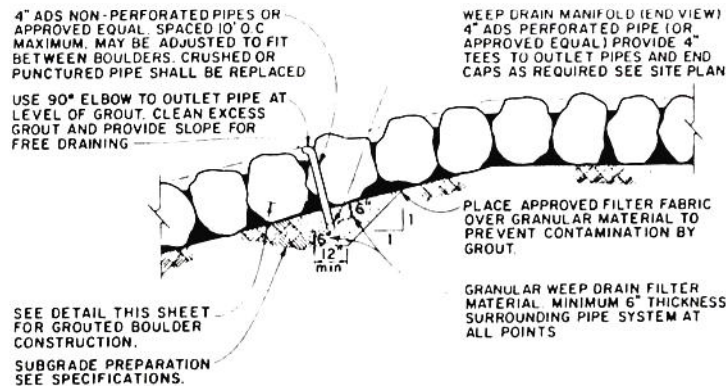
## TYPICAL GROUTED BOULDER PLACEMENT

NTS



## WEEP DRAIN SYSTEM-TYPE A TYPICAL

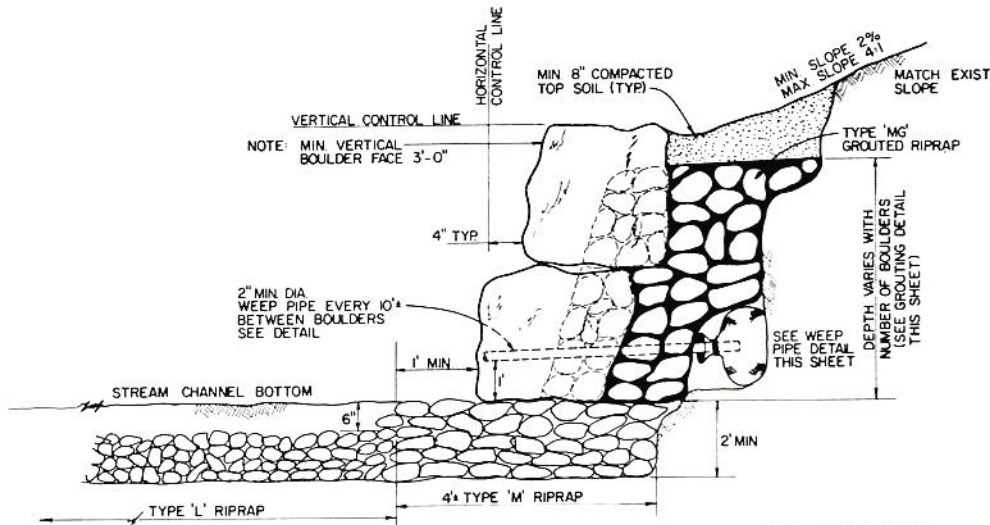
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## WEEP DRAIN SYSTEM-TYPE B TYPICAL

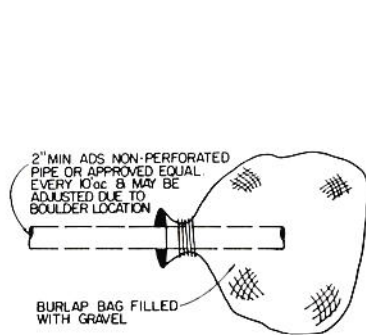
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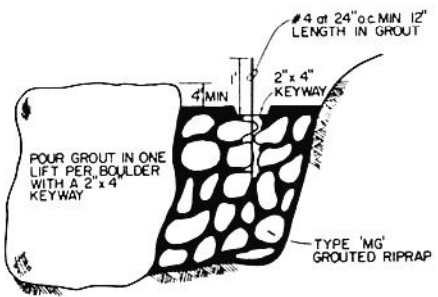
**TYPICAL VERTICAL BANK EROSION PROTECTION - TYPICAL CROSS-SECTION**

NTS



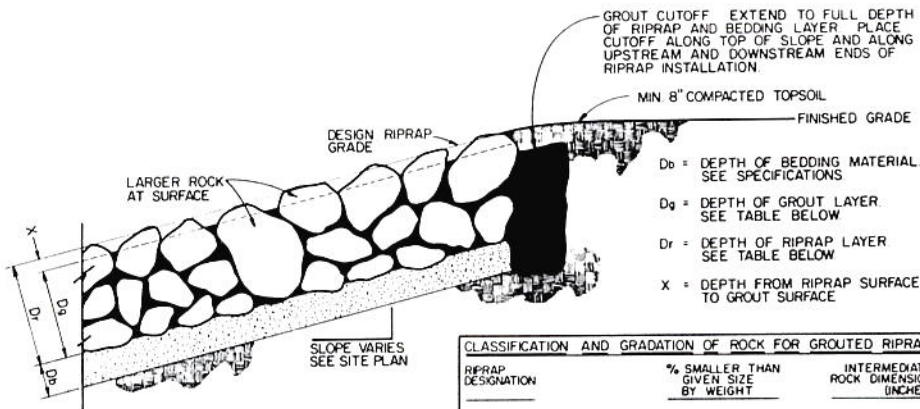
**WEEP PIPE DETAIL**

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**BOULDER BANK GROUTING DETAIL**

NTS



REQUIREMENTS FOR GROUT*	
CEMENT**	TYPE II, 6 SACKS/C.Y.
AGGREGATE	30% 3/8-INCH COARSE ROCK 70% NATURAL SAND (FINES)
COMPRESSIVE STRENGTH	2,000 PSI MIN. OF 28 DAYS
SLUMP	7" ± 2"
AIR ENTRAINMENT	75% ± 15%
FIBER REINFORCEMENT	1.5 LBS./CY. FIBERMESH OR APPROVED EQUIVALENT

\*REFER TO SPECIFICATIONS FOR DETAILED REQUIREMENTS.  
 \*\*A MAXIMUM OF 25% FLY ASH MAY BE SUBSTITUTED FOR THE CEMENTITIOUS MATERIAL.

CLASSIFICATION AND GRADATION OF ROCK FOR GROUDED RIPRAP*		
RIPRAP DESIGNATION	% SMALLER THAN GIVEN SIZE BY WEIGHT	INTERMEDIATE ROCK DIMENSION (INCHES)
TYPE MG	70 - 100	21
	50 - 70	18
	0 - 5	12
TYPE HG	100	30
	50 - 70	24
	0 - 5	18
TYPE VHG	100	42
	50 - 70	33
	0 - 5	24

\*REFER TO SPECIFICATIONS FOR OTHER REQUIREMENTS FOR ROCK AND GROUT

RIPRAP TYPE	Dr	X	Dg	Db	NOTES:
MG	21	3 to 5	16 to 18	REFER	1. FINAL PLACEMENT OF RIPRAP TO BE APPROVED BY ENGINEER PRIOR TO GROUTING 2. BEFORE GROUTING, CLEAN ALL DIRT AND MATERIALS FROM ROCK THAT COULD PREVENT THE GROUT FROM BONDING TO ROCK 3. PLACE GROUT BY INJECTION METHODS AND USE A PENCIL VIBRATOR TO FILL VOIDS TO THE SPECIFIED GROUT DEPTH. CLEAN EXCESS GROUT FROM ALL EXPOSED SURFACES. PROVIDE A BROOM FINISH FOR GROUT SURFACE. 4. THE CONTRACTOR SHALL CONTROL GROUT MIX AND PLACEMENT PROCEDURES TO ACHIEVE THE SPECIFIED THICKNESS, PENETRATION AND GRADE OF THE GROUT LAYER.
HG	30	6 to 10	20 to 24	TO	
VHG	42	8 to 12	30 to 34	SPECS	
DIMENSIONS IN INCHES					

**TYPICAL GROUDED RIPRAP PLACEMENT**

NTS



layer should be held down at least 8" to allow for a good soil depth which can be revegetated.

### **Grouted Boulder Placement**

The grouted boulder section can be used as a stilling or impact basin for larger drops or pipe outfalls. Grouted boulders can also be used in a grouted sloping boulder (GSB) drop structure. The District installed two GSB drops in Cherry Creek in Denver during 1990 at Cherry Creek Park, adjacent to the new Cherry Creek shopping center. These drops have a high aesthetic value and blend in well with the shopping center's landscaping. Three similar structures will be completed on Cherry Creek in 1991.

Construction is similar to that of grouted riprap with a couple of variations. No bedding is used and the grouted boulder section is only one boulder thick. You can control the thickness of rock by specifying the minimum size of the boulders. The boulders should be placed as closely together as possible without disturbing the subgrade. Boulders should also be placed with the flattest surface horizontal and on top. All fines and small rock are removed prior to grouting, and boulders should be clean for optimal grout adherence.

Experience has shown that the best method for handling the boulders is to have a "thumb" or grapple on an excavator. This allows the rock to be easily and safely handled and provides for quick installation and adjustment of the boulders.

When constructing a GSB drop, begin at the lowest elevation, place the rocks in a stepped fashion with the bottom of the uphill rock below the top of the downhill rock as shown in the drawings. Arrange the boulders with a flat surface upward and horizontal in a "stairstep" fashion. Boulders shall be set in contact with each other and interlocked as much as possible. Boulders may need to be removed and reset until the desired result is achieved.

Two alternative methods for weep drains at GSB drop structures are shown on the detail sheet. Type A is comprised of a perforated manifold collector pipe installed parallel to the slope and connected to a series of non-perforated outlet pipes that drain to daylight. This system is suitable for higher drop structures where sufficient fall is available to daylight the outlets.

Type B weep drain is a similar manifold system, but with outlet pipes that are placed normal to the slope to

minimize the length to daylight. This type of system is appropriate for smaller drops and other locations where space is limited. A continuous manifold is preferred over a "point" system for weep drainage of a drop structure as it provides more complete interception of subsurface drainage.

The weep systems described above can be difficult to construct. The pipes can be crushed by the boulders and alignment of the pipes between the boulders is difficult. Flexible outlet pipes can be used to allow alignment of the pipes around the boulders. Also the pipe is not destroyed if a boulder is displaced and crushes the pipe.

After the boulders are set, grouting can take place as with the standard grouted riprap section. Vibrate the grout to fill all voids between and under the boulders from the subgrade level up to the specified grout depth. If large areas of grout exist between the boulders, smaller rock can be hand placed into the wet grout to provide a better appearance. To maximize the visibility of the rock, the grout should be held below the surface of the boulders as shown on the detail sheet. Excess grout and inadvertent spillage should be removed from the rock surface.



Setting the boulders in place using a back hoe.



The finished structure at low flow conditions.



Placing the grout and vibrating it into place.



The finished structure during a minor flood event.



**Tucker-Talk** (from page 3)  
NPDES stormwater permits. The District has committed over \$100,000 to this effort in 1990 and over \$300,000 is included in the 1991 budget for stormwater quality activities. A potential long term involvement as the permit process proceeds will be to coordinate a wet weather monitoring effort for the Denver region. This will make sense if the implementation of the regional monitoring program will be less costly than each individual city and county developing its own monitoring program. Whether or not this will be the case remains to be seen. Another likely possibility is in the development of best management practices criteria for the Denver area. To go much further, however, will probably require changes in District enabling legislation and increased funding capabilities.

As stormwater quality features are incorporated into stormwater quantity facilities, the District will most likely be asked to assist with required maintenance. I think this will be a logical extension of District activities. Whether or not it can be done without additional funding is yet to be considered.

But, why worry, it's only money and everybody knows that local governments have plenty of that. And, besides, when EPA or the state says jump, the only thing local governments are supposed to do is ask how high.

#### **Funding Regional Detention**

Local governments and the District have completed many drainage master plans for basins throughout the Denver area. The most logical technical solution to reduce the impacts of anticipated future development in many of the master plans has been to recommend the construction of regional detention facilities. When included, all participants have agreed that regional detention facilities are less expensive, more effective, and easier to maintain than a multitude of randomly sited developer constructed on-site detention facilities. A problem arises, however, in funding regional facilities. The detention ponds have to be located somewhere and when a developer is proposing to develop that "somewhere" we face the terrible reality of not having the wherewithall to pay for it.

One idea we are exploring in a couple of drainage basins is to establish a system development fee (SDF) that would be paid by developers as property is developed

based on the amount of impervious surface in the development. The SDF would be committed to fund specific regional detention facilities. As a basin develops, funds would accumulate and the detention facilities could be constructed as funds permitted. If the basin developed over a short period of time, the funds would also be collected over a short period of time and the facilities could be constructed accordingly. If the basin took twenty to thirty years to develop the need to construct detention facilities would likewise be spread over that period of time. The concept of basin development fees is not new but it has not been tried in the Denver area for basins that include more than one governmental jurisdiction.

#### **The Day We Shook The Money Tree and Nothing Fell Out**

It has always been obvious to me in terms of operating the Urban Drainage and Flood Control District that resources are limited. Congress has never understood this, however, and has been running up the national debt to astronomical levels.

I get the feeling that John Q. Citizen is becoming concerned about this and wants to throw the rascals out, control the spending, and do all this without increasing their taxes. It seems almost impossible for John Q. Citizen to have an impact at the federal level and I am concerned he will strike where he does have an impact; at the local level of government. For example, Colorado this year had a draconian tax limitation amendment before the voters in November. Fortunately, the amendment failed by a whopping 51% to 49% margin. Had the tax limitation amendment passed, local governments' ability to address problems would have been severely curtailed, yet the federal government would go on its merry way without blinking an eye. It is my perception that local citizens are generally satisfied with the services provided by local governments. They are, in general, concerned about the large and ever increasing federal debt, however, and local and state government may end up being the punching bag.

Such voter reaction, if it works out that way, will severely curtail the ability of local government agencies to provide expected services. However, it may be necessary for us at the local government level to severely reduce costs and programs in the not too distant future. Think of this specter in light of new federal regulatory

requirements that are continually placing additional burdens on local governments. Can we shake the money tree anymore and expect anything to fall out?

## **1990 Staff Changes**

by  
L. Scott Tucker  
Executive Director

Cindy Griego left the District in September to embark on a new career as a flight attendant for American Airlines. Cindy joined the District in November, 1981 as the Secretary for the District. Cindy and the job grew considerably from 1981 to 1990. As the Executive Secretary for the District Cindy was responsible for all of the secretarial and clerical related functions for the organization. She was responsible for keeping the paper flow moving and she had developed a well-oiled machine to accomplish that task.

In addition, I relied on Cindy as a "top sergeant" to accomplish many other difficult tasks. For example, she was responsible for the remodeling project in the office which had to be accomplished in stages and involved moving people from place to place as each phase was accomplished and keeping the operation moving while the remodeling was taking place. Also, Cindy was responsible for the annual raft, trip which has developed into a logistics challenge involving the enjoyment and safety of over 100 rafters.

We will miss Cindy but wish her well in her new career. I am sure she will do very, very well. We will all be looking for her in the friendly skies of American.

Linda Schmidt joined the District in September, 1990 as Executive Secretary. Linda replaced Cindy and will be responsible for the secretarial and clerical activities of the District. Linda came to us from the Dixon Paper Company where she was Executive Secretary to the Vice-President of Marketing.

We feel lucky to have found Linda and she has jumped into the job with a lot of enthusiasm and skill to match. The paper has continued to flow in an efficient manner and Linda has quickly learned the nuances of the District's system and how to keep it going. I have a lot of confidence in Linda and look forward to working with her in the years to come. Welcome to the District!



# FLASH FLOOD PREDICTION PROGRAM & RELATED ACTIVITIES

by

Kevin G. Stewart, Project Engineer  
Floodplain Management Program

## NEW METEOROLOGICAL SUPPORT SERVICE

The 1990 meteorological support contract for the District's Flash Flood Prediction Program (F2P2) was awarded to Henz Meteorological Services (HMS) of Denver. HMS offices are located in Suite 310-B of the Diamond Hill Office Complex at 2480 West 26th Avenue. For the previous seven years, the program was served by the firm of Henz Kelly and Associates (HKA) and prior to that, by GRD Weather Center, Inc. The program has now completed 12 years of serving Denver area emergency managers.

John Henz, President of HMS, has participated in the F2P2 since its beginning in 1979. Frank Robitaille is the most recent member to the team, having joined HMS in June. Frank has extensive background in atmospheric research having worked for the National Center for Atmospheric Research (NCAR) in Boulder from 1967 to 1975 and for the Alberta Research Council in Edmonton, Alberta, Canada from 1975 until January of 1989. Frank returned to Colorado in February of 1989 after accepting employment with a meteorological instrument manufacturer located in Boulder. The District appreciates the new perspectives and experience that Frank brought to the program.

## PROGRAM CHANGES REVEAL NEED TO FURTHER STREAMLINE COMMUNICATIONS

With the support of emergency managers from the six-county Denver area, the F2P2 operations were changed substantially this past year. These changes were made in response to a user survey completed following the 1989 flood season. The new operational procedures were designed to simplify communications for dispatchers and other individuals less familiar with the program's message codes and technical terms. While this new approach generally worked well, other problems surfaced which require further attention.

In prior years, three message levels were used to prompt various responses. For example, a MESSAGE 1 indicated that the potential for a flash flood exists and that appropriate preparedness actions should be taken. A MESSAGE 1 was considered

advisory in nature and not intended for public dissemination. A MESSAGE 2 was previously used to relay a National Weather Service (NWS) flash flood "watch" to local governments and add any specific information of concern. Similarly, a MESSAGE 3 was used to relay a NWS flash flood "warning."

While the three-message code format was not overly complex, the procedures used for issuing these messages did open the door for misinterpretation. For example, a MESSAGE 1 would be issued using supplemental number codes to indicate the type of flooding expected. Any one or combination of four flooding type codes would commonly be used by the meteorologist. A MESSAGE 1, TYPE 2 would mean that flash flooding of small streams and streets is possible. Another type code was used for "large streams" and still other codes for slow-rise flood predictions. If none of the flooding type codes applied, the meteorologist would issue a TYPE 5 code and indicate the expected flooding source. It was not uncommon for a MESSAGE 1, TYPE 2 to be interpreted as a MESSAGE 2 and consequently prompt an improper response. Also, the difference between "large" and "small" streams was not always clear to the user.

Without changing the basic three-message approach for initiating a "Ready-Set-Go" response, the dual number codes for MESSAGE 1 were eliminated for 1990 and new, more descriptive fill-in-the-blank forms were distributed to users. When communicating with a dispatcher, the meteorologist would indicate the most likely areas to be impacted by flooding with specific form check-offs provided for: mountain canyon streams; urban streams; and urban streets, intersections & low-lying areas. Also, the potential risk to life and property would be categorized as either low, moderate or high depending on the magnitude and probability of the flood prediction.

It was further specified that a MESSAGE 1 would only be issued when the rainfall prediction or quantitative precipitation forecast (QPF) called for 1-inch of rain or more to fall within a one hour period or when the predicted intensity exceeded a 5-year frequency (i.e. 0.5" within 10 to 15 minutes).

Considerable judgement was required by the meteorologist on when to and when not to issue a MESSAGE 1.

In addition, another advisory message was developed to address "garden variety" thunderstorms capable of producing only minor nuisance flooding. The issuance of a THUNDERSTORM ADVISORY or TA would not normally warrant an alert level response, but supplemental information was sometimes included concerning the possibility of severe weather. TA's were frequently issued and, due to their typically low danger threshold, generally recognized as non-emergency information. Consequently, TA's received low priority for message fanout. It was this program change that contributed the most to an information overload problem which, in some instances, resulted in a casual manner of handling information that turned out to be more important than expected. In 1990, TA's were issued on 78 days of the 167 days that the program operated. Communications that occurred preceding the July 11 hail storm probably best illustrate this problem.

The hail storm, which began in northern Boulder County around noon and moved south-southeast through the center of the metropolitan area over the next three hours, caused more than one-half billion dollars in property damage and sent 49 people, mostly kids, to area hospitals due to injuries received while enjoying Elitch Gardens amusement park. TA's were issued to all counties between 12:15 and 12:30 p.m. calling for severe thunderstorms with 1-2" diameter hail, 60 mph winds, 0.50-0.75" of rain lasting 30 minutes and active cloud-to-ground lightning. Boulder County was issued a MESSAGE 1. A number of key public safety officials never received this communication before the hail storm hit. The storm reached Elitch Gardens at about 2:30 p.m. This weather situation did not pose a flood threat but there is no question that this storm was dangerous.

The pre-1990 procedures also restricted the meteorologist's ability to upgrade the message code to a higher response level unless the NWS would first issue a flash flood watch or warning. To resolve this, it was agreed that the meteorologist should have the flexibility to issue a MESSAGE 2 or



MESSAGE 3 should conditions warrant. In defining such conditions, the term "life-threatening flood" would be used and the appropriate message level determined by either a high probability or imminent threat of occurrence. Also, should the NWS issue a flash flood watch or warning, the appropriate message would continue to be relayed as in the past.

Additionally, three new activities were tested in 1990: 1) a video tape archive program to record Limon radar data for all significant events; 2) a storm track FAX map program to enhance the bulletin board QPF product by providing spatial and timing information in an easy-to-understand format; and 3) a prediction evaluation program to assess the timeliness and accuracy of the various forecast products.

Using FAX communications has proven to be an effective means of disseminating weather information. Once received, certain users redistribute the FAX products to other users in their fanout network which may include ten or more additional contact points. Standard bulletin board products (i.e. daily outlooks, message status reports and QPF summaries) were also distributed by FAX at the request of participating public safety and public works agencies. Considering the favorable response this past year, it is likely the FAX service will be continued.

### EMERGENCY MANAGERS HELP SHAPE PROGRAM

By the end of the 1990 flood season it was clear that more communication refinements were needed. It was also clear that the program should not attempt to provide any specialized services dealing with other types of severe weather (i.e. tornados, hail, micro-burst winds, lightning, etc.). Originally, the idea of providing supplemental forecast information was rationalized by recognizing that a high percentage of heavy precipitation events are accompanied by other forms of severe weather. Advisories and warnings of severe weather are routinely issued by the NWS and broadcast to the public by the electronic news media. It was never intended for F2P2 users to rely on the District's program for this information.

To avoid contributing to information overload at emergency communication centers, the practice of issuing TA's will likely be discontinued. The focus of the program meteorologist will be to predict heavy precipitation and flood potential as

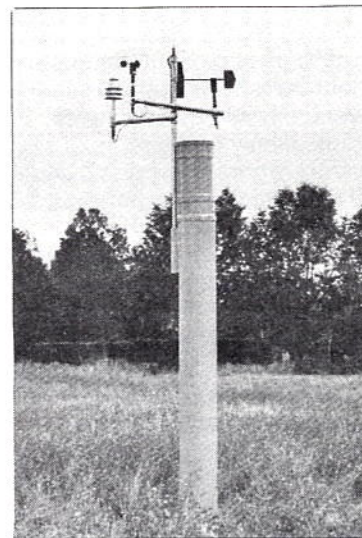
originally intended and the decision to communicate weather information will not be complicated by considering the threat of severe weather. The protocol for handling other message types should not be impacted by this change.

Under the leadership of Captain Warren Lumpkin, Deputy Director of Emergency Management for the City of Aurora, an advisory group comprised of Denver area emergency managers was formed to recommend further program improvements, including the adoption of a uniform policy of issuing "Red Flag" messages. This practice was originally adopted by Denver and Arvada in implementing flood warning plans for Westery Creek and Ralston Creek. The intent of the Red Flag message is to notify dispatchers that this information requires immediate attention. The procedure has proven to be an effective means of quickly getting critical weather information to key decision makers. Further direction is also being given concerning the use of the weather bulletin board and other written communications. The District greatly appreciates the high level of interest and expertise that Captain Lumpkin and his colleagues offer. With positive change being driven by the user, it is our belief that the program will have a much greater chance for success when the next flood disaster occurs.

### ALERT SYSTEM EXPANSION & IMPROVEMENTS CONTINUE

New automated rain and stage gages continue to be added to the District's ALERT system. Weather stations were also introduced to the system for the first time in January of 1990. The first ALERT weather station was installed at the Quincy Reservoir water treatment plant in Aurora as part of an early flood detection and warning project for the Toll Gate Creek basin. Two new weather stations will soon be installed in the foothills of Ralston Creek and Bear Creek.

The weather station at Quincy Reservoir is event driven and measures precipitation, wind speed and direction, relative humidity, temperature, barometric pressure and solar radiation. Weather stations provide valuable information for use in flash flood prediction before it rains and also encourage many multi-purpose uses. For example, the City of Aurora uses ALERT data in a major effort to conserve water. By incorporating the use of weather data from various sources with a new



Alert Weather Station

irrigation control system, the Parks Division estimates that a 12.5 percent annual savings can be achieved. The Denver Water Department also routinely uses data from the District's ALERT system for specifying ET lawn watering amounts for the entire Denver metro area. Real-time weather data is useful for assessing forest fire danger, managing fire fighting activities, evaluating air quality, directing emergency operations for hazardous material incidents, and many other applications.

New ALERT stations were added this past year to the Ralston Creek, Toll Gate Creek, District Wide and South Platte Networks. The Master Planning Program also installed an ALERT rain gage at a stormwater quality monitoring site on Shop Creek along Parker Road near Cherry Creek Reservoir. With today's technology, it is feasible to add water quality sensors to ALERT stations but, thus far, the District has not attempted any adaptations of this type.

Shaft encoders and ALERT transmitters were retrofitted at two existing USGS gaging stations on the South Platte River and Cherry Creek. Unfortunately, a programming error on the transmitter logic board caused erroneous data to be collected for these two sites. This problem was extremely difficult to isolate, but now is finally being corrected by the manufacturer. Land owner permission to install approximately 12 new stations for the Bear Creek flood detection network is in the process of being secured.

The ALERT system status table on the following page shows the total number stations in operation as of September 30, 1990. The table also



summarizes the type and number of sensors currently reporting data. The transmitters at most of the existing stations have been configured to conveniently add more sensors. For example, many of the stations which currently report only rainfall could be easily upgraded in the future to full weather station status.

As the ALERT system grows in size, new capabilities and improvements at the base stations are also evolving. Independent ALERT base stations are currently operating at the District, HMS, the City of Aurora, the Boulder County Sheriff's Department, The Consolidated Mutual Water Company in Lakewood and at the U.S. Bureau of Reclamation. The National Weather Service collects ALERT data at NOAA's research facilities in Boulder where data processing and display capabilities are being integrated in the design of a future hydro-meteorological workstation for use by NWS forecasters.

The District is continuing to improve the graphical interface for displaying ALERT data. As new graphical products are developed, user interpretation of the data will become more simplified and the decision making process greatly enhanced. The City of Aurora has incorporated the use of a large wall map board interface which, through the use of colored lights, continually shows where rainfall is occurring and which gages have exceeded alarm levels. Many other enhancements will continue to evolve, particularly as more users gain experience using the system.

**ALERT UPGRADE IN PROGRESS FOR BOULDER COUNTY**

Boulder County's aging STORMM (Sheriff's Telemetry Operated Rainfall and River Monitor) system, which has been successfully used by the Sheriff's Department for more than ten years, is nearing the end of its useful life. This system provides for real-time displays of rainfall, stream stage, alarm levels, and system status information using data collected by the existing ALERT network located in the mountains. The computer software developed by the County also incorporates a hydrologic model for Boulder Creek and a basin average rainfall mapping routine.

The District is cooperating with Boulder County on a major upgrade to this system. The current plan is to install two ALERT computers modelled after the District's system and run the STORMM system

<b>CURRENT ALERT SYSTEM STATUS:</b>				
<u>Network</u>	<u>Stations</u>	<u>Precip</u>	<u>Stage</u>	<u>Weather</u>
District Wide	9	8	9	
S. Platte & MP	4	3	3	
Lena Gulch	9	6	3	
Ralston Creek	11	10	8	
Westerly Creek	10	10	5	
Toll Gate Creek	11	11	8	5
Goldsmith/Harvard	5	5	4	
Boulder County	53	41	12	
TOTALS	112	(94)	(52)	(5) = 151 SENSORS

concurrently. The new ALERT computers will eventually replace the outdated system, but until a comfort level can be established and existing capabilities either duplicated or replaced, it was felt that a parallel operation would minimize disruption of a well-run flood warning program.

**COMPLEXITIES IN PREDICTING MOUNTAIN CANYON FLASH FLOODS**

In March of 1990, a report entitled: Simplified Mountain Canyon Flash Flood Guidance for Boulder Creek was completed by George V. Sabol Consulting Engineers, Inc. This study included the development of a hydrologic model for Boulder Creek using the Corps of Engineers' HEC-1 computer program. Since existing rainfall/runoff data for Boulder Creek was considered inadequate to perform valid model calibration, various model runs were compared with accepted design hydrographs and the result having the "best fit" was used for further analysis.

The Sabol report also presented historical storm reconstitutions for three major events: the Big Thompson Canyon flash flood of July 31, 1976; the Cheyenne, Wyoming flood of August 1, 1985; and the Masonville, Colorado flood of September 10, 1938. These storms were meteorologically transposed over the Boulder Creek watershed for further hydrologic investigation. The meteorologic portion of this study was completed by HMS.

The selected unit hydrograph procedure for the fifteen Boulder Creek sub-basins was based on mountain hydrology research completed by the U.S. Bureau of Reclamation for Buckhorn Creek near Masonville, Colorado. The runoff sensitivity of various infiltration algorithms and antecedent conditions was evaluated. Then, using the selected model, each of the three

major historical storms were analyzed. In all cases, the resulting peak discharge at the Canyon Mouth exceeded the 100-year discharge. The following table summarizes the results of this analysis:

<u>STORM</u>	<u>DISCHARGE</u>
100-year .....	9,700 cfs
Big Thompson .....	45,500 cfs
Cheyenne .....	33,800 cfs
Masonville .....	15,800 cfs

It should be noted that the adopted 100-year discharge for Boulder Creek is 11,600 cfs. After comparing the calculated hydrograph shapes, runoff volumes and timing factors with the design hydrograph developed by the Corps of Engineers, the hydrograph having a peak discharge of 9,700 cfs was selected. Boulder Creek historians may also recall that an earlier study by the Corps produced a 100-year discharge of 7,400 cfs. Additional model adjustments could have been made to force the peak discharge closer to the accepted design discharge, but this was not the focus of this project.

Subsequent calculations were made to develop a graph for estimating peak discharge at the Canyon Mouth for various antecedent conditions as a function of the maximum average 1-hour rainfall for an estimated 10 square mile storm area. While this approach may seem overly simplistic, the goal here was to develop a reasonable basis for recognizing when critical rainfall thresholds are exceeded or when quantitative precipitation forecasts warrant special attention. The transferability of this flash flood guidance to other mountain watersheds was also an objective.

The Boulder Creek hydrologic model will eventually interface with the ALERT database and be used for estimating flood magnitudes and arrival times during actual events. It is hoped that this study will prompt



future investigations to further refine flash flood prediction techniques for mountain streams. Users of such information should recognize the complex nature of forecasting spatial and temporal rainfall from both meteorologic and hydrologic perspectives, and given that knowledge, exercise care in directing emergency operations.

### **DENVER HOSTS ALERT CONFERENCE**

The Third Annual Conference of the Southwestern Association of ALERT Systems (SAAS) was held in Denver last September at the Hotel Denver-Downtown. Sixty-two people attended the conference from many parts of the United States, and one foreign guest from Stockholm, Sweden received special recognition. Twenty four speakers presented information on a variety of topics including: NWS modernization and training programs, system maintenance and lightning protection, alternative uses for ALERT, local flood warning programs, social science research, hydrologic radio frequencies, new software developments and applications, and many other interesting subjects. Equipment vendors were provided the opportunity to make formal presentations and display their products. A special workshop was held on hydro-meteorology for flash flood forecasting and field trips were conducted to the District's F2P2 and the NWS Forecast Office at Stapleton International Airport. By all accounts, the conference was a success and the District is pleased to have had the opportunity to host the event.

Associate membership in SAAS is open to anyone interested in the use of real-time environmental monitoring systems. Active or voting membership is currently limited to ALERT users from the states of Arizona, Arkansas, Colorado, Kansas, Louisiana, New Mexico, Oklahoma and Texas. For more information concerning SAAS and member benefits, contact Kevin Stewart at 303-455-6277.

### **HYDROLOGIC RADIO FREQUENCIES AT RISK**

ALERT users need to be aware that the future of their programs could be dramatically impacted by pending Congressional legislation and regulatory changes currently being considered by the Department of Commerce. On November 14, Kevin Stewart attended a meeting of the Interdepartment Radio Advisory

Committee (IRAC) in Washington, D.C. along with Mr. Philip Holland of the Santa Barbara County Flood Control District in California. Mr. Holland represented the ALERT Users Group which includes nine western states and Mr. Stewart represented the eight states comprising the Southwestern Association of ALERT Systems. A subsequent meeting was also held with the Honorable Janice Obuchowski, Assistant Secretary of Commerce for Communications Information. Ms. Obuchowski was extremely knowledgeable and sensitive to the issue and welcomed the opportunity to hear our concerns and develop a better understanding of our needs. There is no question that this issue is of major importance to all agencies and businesses that use any type of radio communications.

IRAC consists of representatives from 22 federal agencies, each competing for their fair share of the radio frequency spectrum. Problems of current congested use and future commercial needs have forced IRAC to look at narrow-banding alternatives to increase the number of available frequencies. Also, a bill has been introduced in Congress which, if signed into law, would effectively remove 200 Mhz from the spectrum currently allocated for federal government users. Hydrologic radio frequencies, both UHF and VHF, are classified as federal uses. ALERT systems fall into this category through the sponsorship of the National Weather Service.

A good working relationship has been established with the National Telecommunications and Information Administration (NTIA). NTIA regulates the federal spectrum and is essentially the counterpart to the better known Federal Communications Commission (FCC) which regulates all commercial uses of the spectrum. Both ALERT users groups intend to maintain this level of cooperation with NTIA and keep members informed on when specific actions are needed on their part. It has been suggested that ALERT users contact their Congressional Representatives to express concern and offer support.

### **WEATHER BULLETIN BOARD NOW A YEAR-ROUND OPERATION**

For the second consecutive year, the National Weather Service will make available to District Bulletin Board users certain public forecast products including special weather

statements, winter storm warnings and other weather advisories and information routinely issued over NOAA weather wire and weather radio.

The bulletin board was also used recently by the Boulder County Sheriff's Department to obtain weather forecasts in support of intense fire fighting operations that lasted for three days just north of the Boulder city limits. The Olde Stage Road Forest Fire, which destroyed ten homes and burned more than 2200 acres, was declared a disaster by Governor Romer. HMS provided the fire weather forecast services at the County's request.

The District is pleased to be able to serve the community in this way and will continue to keep the bulletin board operational during the non-flood season (September 16 through April 14) provided that its use not be relied upon exclusively for emergency services. Use of this system requires a computer and phone modem and access is limited to government agencies. The bulletin board is currently a one-way communications tool requiring the user to initiate the phone call. Any qualified agency can obtain user access information by contacting Kevin Stewart at 303-455-6277.

### **Floodplain Management Conference Comes To Denver**

The 15th Annual Conference of the Association of State Floodplain Managers, Inc. will be held June 10-14, 1991, in Denver. The conference will be hosted by the Colorado Water Conservation Board (CWCB), Urban Drainage and Flood Control District, University of Colorado at Colorado Springs (UC-CS), and Colorado Association of Stormwater and Floodplain Managers (CASFM).

The conference will be held at the Hyatt Regency Denver. The Conference Director is Bill Stanton (CWCB) and the Program Chair is Eve Gruntfest (UC-CS). This will be the premier floodplain management conference in 1991, and Colorado floodplain managers who are members of CASFM will have the opportunity to attend this conference at a significantly reduced registration fee.

For more information concerning the conference contact Bill Stanton at (303) 866-3441. For information on membership in CASFM contact Bill DeGroot at (303) 455-6277.



### **Multiple Use** (from page 1)

to the lack of any significant drainage facilities. As a part of construction of flood control facilities on the tributary, a joint use plan was developed in cooperation with the school district. The plan included the installation of a 5-year capacity storm sewer under the athletic fields and a berm and wall along the downstream end of the fields to provide flood storage. The facility acts as an off-line facility by passing the 5-year discharge under the fields while detaining the larger events.

*Flood Control Benefit: Reduced downstream flood hazard and reduced cost of downstream flood control facilities.*

*Recreation Benefit: Reduced frequency of flooding of the athletic fields and attendant reduction of maintenance costs.*

### **Rotary Park**

Rotary Park was an existing on-line park/detention facility owned by the Hyland Hills Metropolitan Parks and Recreation District. Located on the Shaw Heights Tributary to Little Dry Creek, the facility was too small to be effective. The District and the City of Westminster rebuilt the facility in 1990 by deepening the park and providing a low flow channel and improved spillway.

*Flood Control Benefit: Reduced right-of-way cost for the detention facility, decreased downstream flood hazard, smaller downstream flood control facilities, and less frequent flooding of the Boulder Turnpike.*

*Recreation Benefit: A brand new park with improved drainage, and new sod, irrigation system and playground.*

### **Citizens Park**

The District and the City of Edgewater are currently constructing an off-line detention facility in an existing city park on the north tributary to Sloan Lake. Discharges up to the 5-year discharge will be collected in a storm sewer system upstream from the park and will bypass the park. Larger flows, which will be in the street adjacent to the park will be diverted into the park where they will be detained and metered out to Sloan Lake.

*Flood Control Benefit: Reduced right-of-way costs, reduced downstream flood hazard and reduced downstream flood control facilities.*

*Recreation Benefit: A new and improved park for the citizens of Edgewater.*

### **Veterans Park**

Denver constructed an off-line detention facility in an undeveloped park site, and finished the park at the same time.

*Flood Control Benefit: Decreased frequency of downstream flooding (including I-25), and the ability to construct upstream drainage facilities to correct drainage problems in several upstream neighborhoods.*

*Recreation Benefit: Development of a new irrigated and landscaped park with softball and soccer fields.*

### **Huntington Acres Park**

The City of Greenwood Village annexed a subdivision which included an open space platted for on-line detention on the West Tributary to Goldsmith Gulch. The city has developed the open space into a formal irrigated and landscaped park while retaining the detention function.

*Flood Control Benefit: Flood detention function retained, with maintenance assumed by park personnel.*

*Recreation Benefit: Creation of a formal park for the citizens of Greenwood Village without significant right-of-way costs.*

### **Holly Dam**

Holly Dam is a flood control facility constructed by the District, Englewood, Arapahoe County, Cherry Hills Village and Greenwood Village. The District owns the dam itself while the South Suburban Recreation and Park District owns and maintains the flood pool. A pad for a soccer field was graded into the flood pool at the time of dam construction but has not been completed as yet. The park district has constructed a multi-level tennis complex in the flood pool, with the lowest courts at the 10-year flood elevation.

*Flood Control Benefit: Reduced downstream flood hazard. Shared right-of-way and maintenance costs.*

*Recreation Benefit: Shared right-of-way and maintenance costs.*

### **Englewood Dam**

Englewood Dam is a flood control facility constructed by the District, Englewood, Arapahoe County, Cherry Hills Village and Greenwood Village. The District owns the dam itself while the South Suburban Recreation and Park District owns and maintains the flood pool. While there are plans for some development of facilities in the edges of the flood pool, the bulk of the flood

pool will remain as open space, wetlands and wildlife habitat. Also, the property owner (developer) donated the right-of-way for the embankment in return for the county waiving on-site detention requirements.

*Flood Control Benefit: Reduced downstream flood hazard. Shared right-of-way and maintenance costs.*

*Recreation Benefit: Shared right-of-way and maintenance costs. Without the presence of the dam, the flood pool area would have been developed and the open space would have been lost.*

### **Hidden Lake**

The District needed right-of-way for service and auxiliary spillways from Hidden Lake. Hyland Hills Metropolitan Parks and Recreation District needed land for a little league baseball facility. The District, Adams County and Hyland Hills worked out an arrangement in which the county and Hyland Hills bought part of the needed land below the lake, upon which a service spillway and outlet channel were constructed along with a baseball field. The District bought the adjacent land for the emergency spillway. Hyland Hills leases the spillway right-of-way for \$1 per year, has constructed two additional baseball fields and provides routine maintenance of the area.

*Flood Control Benefit: Reduced downstream flood control facilities, reduced right-of-way cost and reduced maintenance costs.*

*Recreation Benefit: A baseball facility which otherwise was not affordable.*

There are many other examples of joint projects involving detention and parks including Addenbrooke Park and O'Kane Park in Lakewood, Utah Park and Expo Park in Aurora, Powers Park in Littleton, Southmoor Park and Barnum Park in Denver, a number of joint use facilities in the East Cherry Creek Valley Water and Sanitation District (in cooperation with the Arapahoe Park and Recreation District) and many more. We expect this concept to continue to be a valuable tool in the future.

### **TRAILS**

Another frequently used multiple use opportunity is trails. The District requires maintenance trails along all major drainageways, whether channelized or natural, as a condition of District maintenance assistance. These trails can, and often do, double as recreational trails. In some cases



the District will build a trail as part of a channel project, and simply allow its use for recreation. In other instances, the District will cooperate financially with a recreation provider on joint recreation and maintenance access trail projects. A few examples are given below.

#### **Cherry Creek Trail (Denver)**

When Denver and the District rehabilitated the three mile reach of Cherry Creek, which is located between 10 foot high concrete retaining walls, a series of ramps and a concrete maintenance trail were important elements of the project. The maintenance trail has since become perhaps the most popular recreational trail in the Denver area. It provides three miles of grade separated access from southeast Denver into downtown Denver.

#### **Bear Creek Trail**

The District cooperated with the Colorado Greenway trail project on Bear Creek in Sheridan, Denver and Lakewood. The intent of the Greenway project was to provide a recreational trail along Bear Creek from the South Platte River into the City of Lakewood. The District's Maintenance Program found it beneficial to contribute some money to the construction of the trail in order to provide maintenance access to portions of Bear Creek that were basically inaccessible before the trail was constructed.

#### **Lakewood Gulch**

The District and the South Platte River Greenway Foundation cooperated on the construction of a maintenance and recreation trail along Lakewood Gulch between the South Platte River and Rude Park. Again, the District's motivation was to provide access to a previously inaccessible reach of the gulch.

#### **Cherry Creek Trail (Parker)**

The District has assisted the Town of Parker in the construction of 6.25 miles of trail along Cherry Creek through the town. The trail provides maintenance access to a large area of open floodplain land.

#### **PARKS AND OPEN SPACE IN FLOODPLAINS**

Another common multiple use concept is parks or open space in floodplains. The number of examples of this type of use is extensive. The value of this approach is the compatibility of open park uses with

flood hazards. Parks can simply be developed in floodplains, or, as in the case of Weir Gulch discussed below, can be created as a part of a flood control project. Developers can be encouraged to set aside floodplains, or at least the floodway portion, for open space uses. The list of parks and open space areas is too long to list, but a few examples are given below.

#### **Weir Gulch**

The District and Denver intended to construct a concrete channel for Weir Gulch at its confluence with the South Platte River. This was the most cost effective alternative for this reach. The South Platte River Greenway Foundation asked the District and Denver to consider building a combination blue grass lined channel and park if the Greenway would pay the additional cost. The District and Denver agreed and the result was a new Denver park which also provided the desired flood protection for the surrounding area.

#### **Lakewood Gulch/Dry Gulch**

The District and Denver are currently cooperating in the design of a multiple use project along Lakewood Gulch and Dry Gulch in Denver. This project will involve the development of pocket or neighborhood parks along the gulches, the preservation of existing open space, recreation and maintenance trails, and much needed drainage, flood control and bank stabilization improvements. The first phase of this project is scheduled for construction in 1991.

#### **GOLF COURSES IN FLOODPLAINS**

Golf courses have been built in floodplains for many years, starting long before anyone thought about multiple uses of flood hazard areas. Among the many courses located in floodplains over the years are Cherry Hills Country Club, Green Gables Country Club, Denver Country Club, Columbine Valley Country Club and the courses of South Suburban Recreation and Parks District and Foothills Metropolitan Recreation and Parks District.

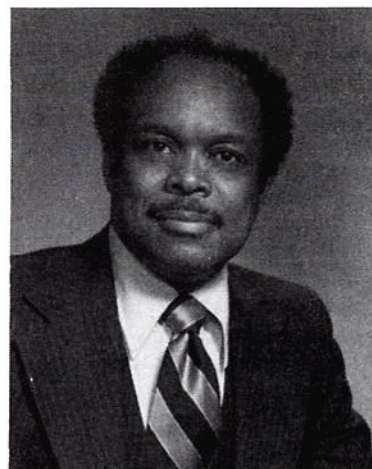
Recently, Louisville has opened their new Coal Creek golf course, Thornton has begun construction of Thorncreek golf course in the Big Dry Creek floodplain, and Lakewood has begun design of a course which will be partially located in the Bear Creek floodplain and that of a tributary.

#### **SUMMARY**

There are many benefits to multiple use of flood hazard areas and flood control facilities. First and foremost is reduced flood losses. Also included are shared costs for right-of-way, construction, and maintenance; provision of recreation opportunities to the community; and preservation of other beneficial values, such as wetlands and wildlife habitat.

The future promises continued demands from citizens for lower taxes and more services. The concept of multiple use offers our governmental entities a significant opportunity to provide services while holding the line on expenditures.

### ***MEET THE NEW BOARD MEMBERS***



#### **WILLIAM R. ROBERTS**

Deputy Mayor, City & County of Denver

Bill Roberts was appointed as Denver's Deputy Mayor and Manager of Public Works in Feb., 1990. Prior to his appointment, he had served on the Denver City Council for 18 years. During his years on council he was responsible for establishing the Denver Commission on Aging, and for restructuring the city's affirmative action program

For over 18 years he worked to relocate Stapleton International Airport, and as Manager of Public Works, he oversees the \$2.3 billion construction of the new Denver International Airport.

Bill is a life member of the NAACP, member of Greater Park Hill Community, Inc., Cleaves CME Church, Urban League of Metropolitan Denver, and the Georgia Civic and Social Club of Colorado. He is married and has three children.



**South Platte** (from page 6) spring of 1991.

The final design by McLaughlin Water Engineers, Ltd. of the lower Central Platte Valley flood control and river reclamation project is in its final stages. It covers the river channel and structure between Cherry Creek and I-25. One of the more challenging design items was the lowering of the Farmers and Gardeners diversion structure. A 1" = 20' scale hydraulic model was built at the Colorado State University hydraulic laboratories. Tests were conducted on the delivery of decreed flows to the Farmers and Gardeners Ditch, the performance of a

new boat chute, the drawdown and performance of the structure during the 100-year flood and the forces on the structure and upstream highway bridge. We hope that construction can begin on this project in 1991.

#### **Privatization in Action**

The entire South Platte River Program, just as all other of the District's programs, is operated with a minimum of staff (i.e., one-third program chief, two thirds project manager, and one temporary part-time student assistant). All maintenance, engineering design, surveying and construction work is contracted, with

the staff engineers managing the contracts and overseeing the work. We are convinced that using the private sector to perform the needed work is very cost effective and stretches the funds available for this program. This is only possible because of the effort on the part of the staff to keep the contractor selection process competitive, yet also to recognize and reward good work. We hope to preserve this approach, and we look forward to continue working with our private sector partners, whomever they may be, in the coming years.

## ***Hydraulic Model Used To Design South Platte River Improvements***

by

Brian S. Kolstad

McLaughlin Water Engineers

In 1988, the District and Denver retained McLaughlin Water Engineers, Ltd. (MWE) to complete an evaluation of different improvement alternatives for the South Platte River from the confluence with Cherry Creek (Confluence Park) to upstream of 8th Avenue. This analysis culminated with a Preliminary Design Report of the selected alternative, which includes major revisions to the existing diversion dam, Farmers and Gardeners Ditch intake and pipeline, the whitewater boat chute and the channel at Confluence Park.

MWE was then selected to complete the final design for the reach from the confluence with Cherry Creek to I-25. Due to the complexity of this area, normal hydraulic analysis procedures were not considered sufficient to accurately predict the new 100-year water surface elevation. Since the impact of the differences in the possible water surface could exceed one million dollars in construction costs, it was recommended that a physical model study be undertaken to confirm the 100-year water surface.

The MWE design team included Colorado State University Hydraulics Laboratory to build the model and perform the required testing. Due to the size of the area to be modeled, the scale of the model was chosen to be one inch in the model to 20 feet in the prototype. The area modeled is approximately one thousand feet along the river and three hundred and fifty feet wide, resulting in a model size of about sixty feet long

by eighteen feet wide, including piping and measuring equipment. The model is supplied with up to 10.8 cfs, which represents the 100-year flood event of 19,400 cfs for the actual structure.

The existing whitewater boat chute at Confluence Park will be enhanced with a new chute configuration and by widening the lower chutes and pools. Also included in the overall project is lowering the existing diversion dam and the upper part of the boat chute. The model testing will allow the designer to observe the complex flow and to make small changes in the chute design to create interesting whitewater effects that would not be obtainable by typical analytical methods.

The model testing will also assist with determining effects on the

100-year water surface when sediment is present just upstream of the dam. Since this model was not designed as a sediment transport model, the effects will be approximate. Also, forces on the existing Speer Boulevard and pedestrian bridge piers will be estimated to determine what the effects of the proposed improvements have on the existing bridges.

The testing and adjustments to the model should be completed in December, 1990, with the design to be completed around February, 1991. The results of the model study will provide the basis for confirming and adjusting the design in the Confluence Park area as well as aid in the design of the boat chute and the upstream channel.



Representatives from the District, Denver and other interested individuals tour the hydraulic model at the CSU hydraulic lab.



### Maintenance (from page 7)

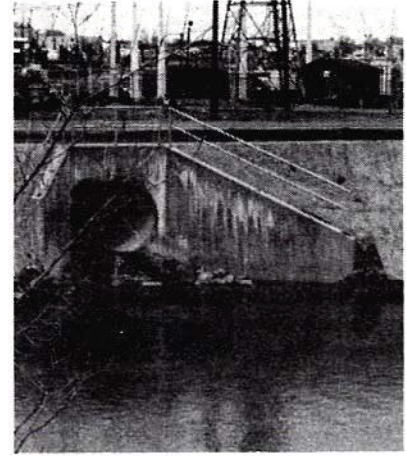
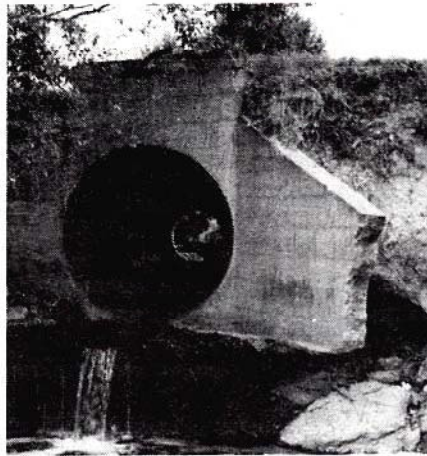
individual projects were done in 1990. As community groups and neighbors become more involved in public works activities in their neighborhoods, more lead time and coordination is needed to carry out a project. This will result in a more successful project, but the impact of this valuable interaction is felt in the lengthened processing and scheduling of restoration projects. Examples of restoration projects are given below.

On the south side of Cherry Creek at the extension of Yosemite Street, a 43" by 68" storm sewer has been undermined and severely damaged. The concrete headwall and wingwalls and six lengths of concrete pipe have all separated and dropped as much as five feet. The pipe and headwall/wingwall appear to be structurally intact so our plan is to build a drop manhole to lower the pipe invert to just above creek level and then relay the existing pipe and reset the headwall/wingwalls.

McIntyre Gulch, through much of Lakewood, has been relocated and channelized. At Holland Street the gulch had eroded an irrigated park on the north side and had encroached on private property on the south side. The right-of-way was limited, so sloping back the banks was not an option. The decision was to push the gulch back onto park property and then reinforce the banks to keep it from wandering. The inside bend of the gulch was stabilized with buried riprap and vegetation. The outside bend, against the private property, was built up with a foundation of 18" riprap upon which was stacked a two-boulder-high wall of 3-5 foot diameter boulders. The wall was then reinforced by pumping grout into the voids.

### Rehabilitation Maintenance

Twenty-eight projects were at various levels of active design or construction during 1990. Those projects are listed in the accompanying table titled "STATUS OF MAINTENANCE REHABILITATION PROJECTS". By the end of 1990 we will have spent about \$3.0 million on rehabilitative design and construction. Several large projects on Cherry Creek in Denver and a single large project on Summer Valley Ranch Tributary to West Toll Gate Creek in Aurora boosted the total above the annual average of \$2-2.25 million. A few of the unique projects for 1990 are discussed below.



A before and after example of a typical restoration project, in this case the repair of a headwall on West Harvard Gulch at the South Platte River.

**Lee Gulch** - This 660 foot long project, intended to be used to test several soil reinforcement blankets and interlocking precast concrete products, has stalled while waiting for permit approvals. Participation or support from several manufacturers and local interests has been diluted in the interim. None-the-less, we intend for this project to survive the delay because of the valuable field knowledge we expect to gain.

**Cherry Creek** - A combined drainage and parks improvement was built on Cherry Creek from University to Steele Street in the area of the Cherry Creek Shopping Center. The drainage maintenance portion of the work consisted of rebuilding the two existing drop structures. The existing sheet pile walls were reinforced by installing sloping grouted boulders on the downstream face of each eight foot high drop.

At Corona St. and at Washington St. existing drop structures will be rebuilt this winter. They will be reconstructed using the same sloping grouted boulder style as mentioned in the paragraph above. The Corona St. drop will be four feet high and the Washington St. drop will be a seven foot high extension below the existing ogee structure.

Between Market St. and Colfax Ave. the Maintenance Program is coordinating with the District's Capital Program and the City of Denver Bond Program to build a reinforced flood channel combined with an urban linear parkway within the vertical-walled portion of the creek. When complete this \$2,000,000 project will also provide a pedestrian connection between Larimer Street and the Colorado Convention Center.

**Branch 2 Tributary to Big Dry Creek** - This tributary is at a 2 to 3%

grade as it flows through the natural and open piece of park land north of Dry Creek Road east of University. A 500 foot long subreach of the creek was straightened and channelized several years ago. The result is an overly steep and eroding channel. Yet, one of the other subreaches is flat enough to be supporting wetland growth. Our preliminary scope of design work calls for retaining as much of the wetland character as possible and building drop structures where necessary to control the 2 to 3% grades.

**McIntyre Gulch** - The reach of this gulch along Alameda Parkway in Lakewood is similar to Branch 2 mentioned above in that it is 3 to 4% in grade. The similarities end there as this reach of McIntyre Gulch is sandwiched between the parkway and a frontage road. Due to projected costs we rejected the first preliminary design which called for more than 20 drop structures in the 1900 foot long reach. We re-evaluated the design and have selected a fully hard-lined channel section. This approach will provide hard-lined protection for up to the two-year flow with grassed slopes above. Construction should begin in the winter of 1990.

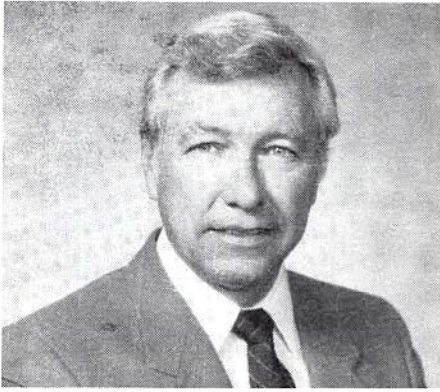
### Criteria Manual Revisions Due Out Soon

The District will be mailing revisions to the Urban Storm Drainage Criteria Manual to owners of record in February, 1991. The revisions include minor changes to the Rainfall and Runoff sections, and major rewrites of the Open Channels and Hydraulic Structures sections.

If you don't receive the revisions, and think you should have, let us know.



## MEET THE NEW BOARD MEMBERS



### GEORGE HOVORKA

Mayor, City of Westminister

George Hovorka is really not a new Board Member, having previously served on the Board for four years. He rejoined the Board earlier this year after a two year absence.

George has served on the Westminister City Council for 16 years. After eight years as Mayor Pro Tem he was elected Mayor in 1983, and is currently serving his fourth two-year term. Mayor Hovorka has served as Chairman of both the Adams County Council of Governments and the Jefferson County Council of Governments.

He is a retired educator, having been an elementary school principal for 25 years and a junior high teacher for seven. He is active in many community projects, including the Salvation Army, Westminister School District 50 Drug and Alcohol Resource Effort and is a member of the Westminister Elks.

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