



Flood Hazard News

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E-470 Major Drainageway Design Enhanced Through Regional Cooperation

By

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E-470 is the eastern one-half of the Denver Metropolitan Area's beltway system. The total length of the E-470 Tollway is approximately 48 miles long, extending from a south connection with I-25 at C-470 to a north connection with I-25 at approximately East 158th Avenue. The initial configuration for the tollway is four lanes with a grassed median. The limited access roadway has interchanges at numerous intersecting major arterial roads and highways. The ultimate configuration includes eight lanes and potential for light rail or other HOV use in the median. Construction was completed in four major segments over a 12-year period beginning in 1991.

The Public Highway Authority (PHA) and a team of consulting engineers and environmental planners commenced planning and preliminary routing years earlier. Early in the process, the PHA and the District endeavored to cooperate on regional drainageway planning and implementation. The strategy was to locate regional flood attenuation facilities, or detention ponds upstream of roadway crossings, which could be sized for a lower discharge rate. This strategy worked well in implementing District master plans, reducing highway construction costs, and fostering sound floodplain management policies. The various local governments that make up the E-470 Public Highway Authority all benefited from these regional drainageway planning efforts. Quincy Pond on West Toll Gate Creek, Gun

Club Road Ponds on Tributary T to First Creek and the Second Creek Pond at Denver International Airport (DIA) are all examples of cooperative efforts completed during the first three segments of E-470 that resulted in regional drainageway benefits.

The fourth and final segment of E-470 is approximately 12 miles long and traverses through portions of Commerce City, Brighton, Thornton, and unincorporated Adams County from East 120th Avenue to I-25. This segment of E-470 crosses the South Platte River, Big Dry, Todd, Second and Third Creeks, and several tributaries. The design team for this segment was a joint venture of Washington Group International and Parsons Transportation Group. The construction group was a joint venture of Washington Group International and Kiewit Construction Company. Staffs from PHA, the design/build group and several local, regional and federal agencies worked on solving the various design problems. Final design plans for Sack Creek, Short Run, Second Creek, Fox Run (a tributary in Direct Flow Area 0053) and Third Creek all involved extensive coordination and cooperation in order to provide adequate roadway design and at the same time implement portions of District master plans. The best example of design team/agency cooperation is in the Third Creek drainageway area.

The Third Creek basin originates upstream from Denver International Airport (DIA) and flows northwesterly to the confluence with the South Platte River, draining a total of 32 square miles. Adams County and the Cities of Commerce City and Brighton are all affected by Third Creek. Several irrigation canals traverse the basin and several wetland areas are adjacent to the creek. The basin below DIA is presently rural in nature; however rapid development is expected as a result of the E-470 and DIA projects. Third Creek has been studied extensively beginning with a Flood Hazard Area Delineation (FHAD) study prepared by the District in 1976. The District subsequently published an Outfall Systems Planning (OSP) Study in 1990. The Federal Emergency Management Agency (FEMA) published a Zone A floodplain based on the FHAD study. The influence of DIA was identified in a hydrologic update, "Third Creek Implementation Plan", prepared by the District in October of 2000. The FHAD identified a 100-year discharge of approximately 6,000 cfs through the project reach. The OSP identified a 100-year discharge of 10,000 cfs without detention and 4,600 cfs with

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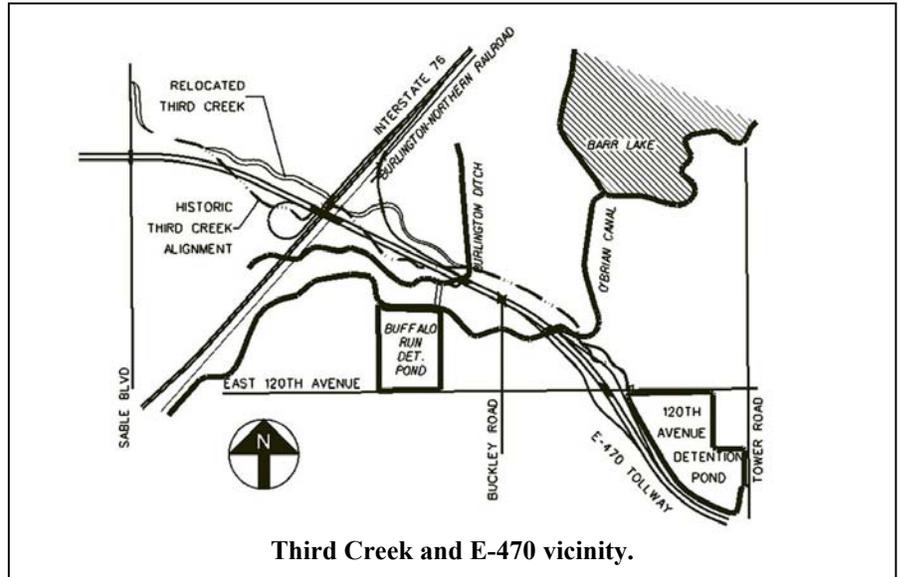
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the public in 2004**

E-470 (continued from page 1)

detention at Interstate Highway 76 (I-76). The attenuated flows include the effects of two proposed detention ponds within the study reach, in addition to DIA detention facilities.

Because of environmentally sensitive vegetation within the basin between Buckley Road and I-76, the E-470 alignment was located near or on the thalweg of Third Creek through this reach. Placing a roadway on embankment within the floodplain produced significant impacts requiring careful mitigation. The Third Creek thalweg had to be relocated through much of the project reach. Buffalo Run, a 2.4 square mile tributary, crosses E-470 immediately upstream of its confluence with Third Creek west of Buckley Road. The O'Brien Canal crosses Buffalo Run, Third Creek and E-470. The Burlington Canal and Buffalo Run share a combined E-470 crossing structure.

The problem was to place the E-470 highway embankment along Third Creek with minimal impact to the wetlands vegetation and 100-year floodplain. Early conceptual planning ruled out channelization as envisioned in the OSP due to environmental and groundwater concerns. A plan was developed that utilized elements from the original OSP, modified to accommodate E-470. The plan included using borrow pits resulting from roadway embankment excavations for regional detention ponds. The first pit, located south of East 120th Avenue was designed as a 267 acre-foot online peak shaving detention pond. This pond replicates OSP pond number 261 in terms of general location and function. The OSP identified a second regional detention pond offline from Third Creek, upstream of I-76 to further reduce 100-year peaks discharges to the northwest. That site was needed for wetlands mitigation. The design team identified a borrow pit south of the O'Brien Canal and along Buffalo Run as a potential regional detention pond replacement site. Preliminary design was performed to insure that the borrow pit size was adequate to reduce downstream 100-year peak discharges



Third Creek and E-470 vicinity.

on Third Creek to approximately the OSP values. Additional analysis and design were performed to identify a future pond outlet system beneath the O'Brien Canal and discharge channel beneath the E-470 mainline bridges. Commerce City, the District and several development groups subsequently completed a separate Buffalo Run master plan effort. The Third Creek low flow channel between East 120th Avenue and I-76 and beyond to Sable Boulevard (State Highway 2) was relocated and widened to minimize impacts to the floodplain. The E-470 design effort was coordinated with CDOT's I-76/Third Creek bridge replacement project.

Coordination between the design team, FEMA and the District was required to update floodplain hydrology for Third Creek. The District provided revised floodplain hydrology, based on existing basin conditions in accordance with FEMA criteria. Floodplain hydrology in this case differed from design discharges, which were based on developed basin conditions. The 100-year discharge at I-76 was estimated at 3,500 cfs while the design discharge at this same location was estimated to be 4,800 cfs. Both a Conditional Letter of Map Revision and final Letter of Map Revision were prepared for the project reach. The District completed the technical review on behalf of FEMA under the Cooperative Technical Partners program.

Because existing wetlands along Third Creek were impacted, a mitigation plan was required. Cooperation with Army Corps of Engineers, Environmental Protection Agency, Brighton, and Adams County, was required to provide an acceptable mitigation plan. The plan included designing the relocated low flow channel as a wetland bottom facility and constructing four wetland mitigation sites adjacent to the creek. The mitigation plan was approved by local jurisdictions and federal agencies.

Cooperation between E-470 PHA-providing the land, the Contractor-completing the pond excavation, CDOT-providing approval of revised hydrology at I-76 and Sable Boulevard, and the District and Commerce City-accepting the borrow pit for use as a future regional detention facility was required to make this plan acceptable. The hard work and cooperative spirit of the stakeholders was essential in developing, reviewing, and approving the proposed Third Creek improvement plans. Time is money on design/build projects. The coordinated effort of the stakeholders allowed construction of the fourth segment of E-470 Tollway to be completed ahead of schedule. At the same time two additional master planned regional detention facilities were constructed and are in place ahead of the development that is expected to follow the highway.

Tucker-Talk

by L. Scott Tucker

Timely Comment from the District's Executive Director



The District will celebrate its 35th year anniversary in June 2004. The legislation creating the District was passed on June 7, 1969 and Governor Love signed the bill into law on June 14, 1969. A lot of water has flowed by, so to speak, since June 1969.

The District can trace its creation to the June 1965 flood on the South Platte River. It was a flood of colossal proportions never before experienced in recorded history. It roared through the metro area sweeping away everything in its path and causing enormous damage. The flood brought home the message to the community that flooding and drainage do not respect city and county boundaries. An intergovernmental cooperative approach was needed.

Out of this realization a group of concerned engineers called the Five-County Engineers Group with Ted Dieffenderfer from Boulder as chairman began addressing the problem in 1967. The group transitioned into the Urban Drainage Advisory Committee of the Denver Regional Council of Governments. One of their first activities was to develop the *Urban Storm Drainage Criteria Manual* that was made possible with a grant from the Department of Housing and Urban Development. The resulting Criteria Manual was the first of its kind and became a model for other similar documents that have been prepared throughout the United States and the world.

The group recognized the need for an institutional structure to address drainage and flood control on a regional basis. Senator Joe Shoemaker who was an attorney as well as an engineer worked with the group. Joe also had been Manager of Public Works for

Denver and he had an appreciation for drainage and flooding problems. In 1969 Senator Shoemaker sponsored legislation that would be adopted that year as the Urban Drainage and Flood Control Act and would create the District. The population of the metro area has more than doubled from 1969, growing from about 1.2 million to a present day population of about 2.5 million.

The first meeting of the Board of Directors was convened on July 28, 1969. Commissioner John Nichols of Arapahoe County was elected as the first Chairman of the Board of Directors. The first Board consisted of 13 local government elected officials and two registered professional engineers appointed by the Board. The first Executive Director, James Quinn, was hired and started with the District in February 1970. The Urban Drainage and Flood Control District was off and running, and as they say the rest is history.

The 35 years have gone by so fast we have not taken time to have a birthday party along the way. Consequently, we have decided to take time in 2004 to recognize the District's 35 years of service to the community. Some of our thoughts are to prepare a video documenting the creation and evolution of the District, having a celebration near the South Platte River in June of 2004, and modifying our stationery next year to reflect the 35th year. We will send invitations to those with whom we work, locally elected officials, state legislators, and others, of the details of the celebration as June 2004 approaches.

A lot has changed since I joined the District in March 1972. There was just

the secretary and myself as staff and the Board of Directors outnumbered the staff by 15 to 2 at that time. We now have 21 permanent employees with 19 being fulltime and two part time. In addition we have eight part time student interns. The Board has also grown to 20 members. so permanent staff and the Board now number about the same. Our basic approach has been to contract with the private sector for most of our activities, thus keeping our staff size at a minimum. We contract for just about everything including drainageway maintenance, planning projects, design work, maintenance of the library, construction work, meteorological services, floodplain delineation, and personnel support services.

The issues and attitudes have changed a lot since 1969. Stormwater quality was just beginning to be discussed, but was generally not a consideration. Due in large part to Federal regulations stormwater quality has become a concern of most urban communities in the US. Grass lined trapaziodal channels with a maintenance trail that could also be used as hiker/biker trails were considered "green" in the early 1970's. We now restore channels to look natural; and wildlife, riparian habitat, trail corridors, and open space uses make our drainageways popular with the public. The world of regulation has changed dramatically. There were not many regulations 35 years ago. Now there are 404 permits, municipal stormwater quality permits, construction stormwater quality permits, endangered species issues, and environmental impact statements. The regulatory environment now drives much of the

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District Projects Receive Awards

by
Dave Lloyd, P.E., Chief, Design and Construction Program

Pinehurst Tributary to Bear Creek
Drainage and flood control improvements to the Pinehurst Tributary of Bear Creek in Lakewood offered a unique opportunity to develop a multi-use open space project. The project was initiated due to the need for a regional detention pond and 100-year capacity flood diversion channel. The project was located on the property of the Colorado Academy, a private liberal arts K-12 school. The goal of Colorado Academy was to convert the undeveloped portion of the property into an educationally oriented nature preserve.

Project sponsors, including the City and County of Denver, Urban Drainage, and the Colorado Academy, decided to combine the goals into a single multi-use open space project. Jefferson County agreed to hold the easements as the project was mostly in Jefferson County. During the design process, the master plan for the Alumni Nature Preserve was incorporated into the drainage improvement project. The nature preserve was designed to represent the various eco-zones found in

Colorado, as well as offer a trail for hiking and cross-country running events. The flood control structures would reduce the flooding of local residences and help provide the educational opportunities desired by Colorado Academy.

The result of the project was that a relatively unattractive vacant field was transformed into a 13 acre-foot detention facility and nature preserve with over 3,000 feet of trail through varying landforms and eco-zones. By pooling the financial and open space resources, the project sponsors were able to accomplish their goals much more effectively than if they were conducted as independent and potentially conflicting projects.

This project received an Honor Award for Outstanding Achievement from the Colorado Association of Stormwater and Floodplain Managers at their annual conference in September.

Marcy Gulch Channel Stabilization Project

Marcy Gulch in Highlands Ranch has a

drainage basin of approximately 3.3 square miles and prior to development was an ephemeral stream. Commercial and residential development began in this basin in 1994 and with resulting increased runoff, the steep sandy channel began to experience severe erosion. The drainageway displayed a high potential for instability which was typified by channel degradation, lateral migration, and high sediment transport. This stream erosion was causing damage to existing infrastructure (utilities, storm sewer outfalls, trails, etc.), threatening several residential lots with encroachment by the actively moving channel, and in general, degrading the overall quality and safety of the open space corridor.

Between October of 2000 and May of 2002, Urban Drainage and the Highlands Ranch Metro District partnered together to construct 18 soil cement drop structures, 400 lineal feet of soil cement bank protection, 3,000 lineal feet of bioengineered bank protection, and 6 trail crossings.

The completion of the project resulted in a raised and flattened channel bed stabilized with drop structures to achieve bed slopes of approximately 0.5 percent. Vertical eroded banks were laid back and reinforced with vegetation and a variety of bank protection measures. These measures protected existing infrastructure and homes, and provided a safer environment for open space users. The stabilized channel also reduced the bed load significantly which allowed the downstream reaches to clean-out and water quality to improve.

This project has received an Honor Award for Outstanding Achievement from the Colorado Association of Stormwater and Floodplain Managers, the International Erosion Control Association's Environmental Excellence Award and the APWA Colorado Chapter's Project of the Year Award in the Utility, Drainage & Environmental – Medium Community Category.



Marcy Gulch project after completion (Photo courtesy of Muller Engineering)

Floodplain Management Program Notes

by

Bill DeGroot, P.E., Chief, Floodplain Management Program

FEMA map modernization

The most significant event in the field of floodplain management in 2003 was the \$200 million FEMA received to begin its proposed Map Modernization Program. This 5-year \$750 million program is intended to convert paper Flood Insurance Rate Maps to Digital Flood Insurance Rate Maps (DFIRM) with the ultimate goal to distribute the maps on the internet and get away from paper maps.

The funding came almost half way into the Federal fiscal year and led to a mad scramble to allocate funds and get projects underway before the end of the year. The District and the Colorado Water Conservation Board (CWCB) fared well under those circumstances.

I reported last year that we had reached agreement with the CWCB that if funding became available, the District would be given the responsibility for map modernization for the seven counties all or partially within the District. However, when the first grants were offered by FEMA, all of the suggested projects in Colorado involved those counties within the District. That was too much of a work load for us to handle so we reworked our understanding with the CWCB and were jointly able to take on every project offered by FEMA.

The first project funded was DFIRM conversion for the City and County of Denver. FEMA provided a \$150,000 grant, and the District and CWCB each contributed \$25,000. Denver contributed the GIS base mapping, contour mapping and orthophotos, as well as significant staff time. The District is managing the project which is being completed by Merrick and Company. This is an early implementation effort which has a completion date of January 30, 2004.

Another early implementation project is the DFIRM conversion of Douglas County, including four incorporated

areas. To make this one happen, we divided the project into the area located within the District and the part outside. The District is managing the project inside the District and the CWCB is managing the remainder. FEMA is contributing \$240,000 and the District and CWCB \$30,000 each for the District portion of the county, which includes Lone Tree and Parker. Each of the local governments is contributing their GIS base maps and staff time. Our contractor is Icon Engineering. The CWCB is managing the conversion of the rest of the county. FEMA is contributing \$260,000, the CWCB \$35,000 and Douglas County and Castle Rock a total of \$35,000 plus the GIS base maps and staff time. The contractor is URS Corporation.

The Boulder County DFIRM conversion will be managed by the CWCB. The contractor is PBS&J. FEMA is contributing \$200,000, CWCB and the District \$25,000 each and the county and incorporated areas will provide GIS base mapping and staff time. Completion is scheduled for June, 2005.

Finally, FEMA has provided funding for updating flood data for two drainageways. The District will manage a study of seven miles of Plum Creek and East Plum Creek in Douglas County and the CWCB will manage a study of South Boulder Creek in Boulder and Boulder County.

For Plum and East Plum Creeks FEMA will contribute \$75,000 and the District \$25,000. We are obtaining topographic mapping now and hope to complete the engineering in time to slip the data into the Douglas County DFIRM near the end of the appeal period.

The South Boulder Creek funding has not been settled but Boulder will contribute \$200,000 and the District \$25,000 toward a \$495,000 budget. Throughout this process the CWCB, FEMA Region 8 and Michael Baker Jr. have been easy to work with and

everyone has been concentrating on getting the job done without worrying about credit or blame.

Jefferson County DFIRM conversion

A Jefferson County DFIRM was published in mid-2003. The conversion was completed by Michael Baker Jr. It is not as complete a conversion as those we are doing as described above. It does have a GIS base map coordinated among the county and several of the incorporated areas, so it is a definite improvement over the previous version. Nevertheless it can still be improved and I hope that we will be able to do that soon, although the 2003 effective date means it won't be a priority for FEMA anytime soon.

Broomfield DFIRM conversion

The City and County of Broomfield is in the final stages of required appeals procedures before their DFIRM becomes official. This DFIRM conversion was a joint effort between the District and FEMA (Michael Baker Jr.), and will be the first true DFIRM in Colorado.

Adams and Arapahoe Counties

As this is written I'm optimistic that FEMA will fund DFIRM conversions for Adams and Arapahoe Counties, including Aurora, in FY 04. If that happens we can have the entire District converted to DFIRMs (with the Jefferson County caveat) in 2005.

LOMC pilot project

On July 1, 2001 we began a pilot project with FEMA to assume the responsibility to review requests for Letters of Map Change for the 32 communities within the District that are participating in the National Flood Insurance Program. We are now three months into the third year of the project. Our reports on the results of the first two years are available on our web site.

My vision for the future of DFIRMs

I think that it is entirely possible that
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Design and Construction Program Notes

By
David W. Lloyd, P.E., Chief, Design and Construction Program

The year 2003 saw the District's Design and Construction Program committing over \$7.4 million to design and construction projects throughout the Denver Metropolitan area. The Capital Program still maintains some 90+ projects in the process of design, obtaining lands and easements, or construction.

Noteworthy this past year was the bidding of the Van Bibber Creek Flood Control Project by the Corps of Engineers. This \$14.2 million flood control project was awarded in October by the Corps to Arapahoe Utilities and Infrastructure, Inc. of Englewood. Groundbreaking for the project is scheduled to take place on January 5, 2004 with completion tentatively set for the spring of 2006. This project has been in the planning and design phases since the mid-1980s and is now finally coming to fruition. The City of Arvada is the Local Project Sponsor for the construction portion of the project. The District and City will ultimately contribute over \$7.2 million in lands, easements, utility relocations and cash toward this long awaited drainage and flood control project. Completion of this project will remove several homes and businesses from the 100-year floodplain of Van Bibber Creek primarily in the area between Kipling and Garrison Streets along West 58th Avenue.

A more recent effort in the City and County of Denver saw the selection of five engineering consultants for the design of improvements to five separate outfall systems in Denver. Even though the District does not have any funding identified for the design of these improvements, we do have monies designated in future years for the construction of improvements to the Montclair Outfall, University/Mexico Outfall, Globeville Outfall, Harvard Gulch Outfall, and the 27th and Federal Outfall. Denver has well over \$100 million in bond money designated for these projects. The District looks forward to our continued fine working

Project	Participating Jurisdiction(s)	Status
South Trib. Slaughterhouse Gulch	Littleton	Complete
Lakewood Gulch at Tennyson	Denver	Complete
Parker/Mexico Outfall	Arapahoe County	Complete
Lena Gulch @ Mountain Side	Jefferson County	Complete
Irondale 80 th Ave. Outfall	Adams County	Complete
Piney Creek	Arapahoe County, Centennial	Complete
Lena Gulch	Golden	Complete
Upper Big Dry Creek	Highlands Ranch	Complete
Lena Gulch	Jefferson County	Complete
Lake Erie Tributary 1	Adams County, Thornton	Complete
Utah Junction Outfall	Adams County	Complete
McKay Outfall	Adams County	95% Complete
Little Willow Creek	Douglas County	90% Complete
Kalcevic Reservoir	Adams County	80% Complete
South Lakewood Gulch	Lakewood	75% Complete
Globeville Outfall	Adams County	75% Complete
Arvada Channel	Arvada	30% Complete
Piney Creek	Aurora	70% Complete
Hoffman Drainageway	Adams County	10% Complete
Drainageway B	Lakewood	5% Complete

Project	Jurisdiction(s)	Cost	Status
Cottonwood Creek	ArapCo, Greenwood	1,360,200	Complete
Brookridge/Grant Outfall	Arapahoe County	996,000	Complete
Drainageway 4	Lafayette	400,000	Complete
Pinehurst Tributary	Denver, Jefferson Co.	769,000	Complete
Baldwin Gulch	Douglas County	1,017,000	Complete
Goose Creek	Boulder	3,480,000	Complete
Park Hill Outfall	Denver	1,849,000	Complete
Happy Canyon Creek	Douglas County	301,000	Complete
Plaster Reservoir	Broomfield	475,000	Complete
Clear Creek at Washington St.	Golden	3,322,000	Complete
Slaughterhouse Gulch Trib.	Littleton	675,000	Complete
Sulphur Gulch	Parker	1,275,000	Complete
Park Hill Outfall Phase II	Denver	1,600,000	Complete
Kenneys Run West Fork	Golden	2,293,000	95% Complete
30 th & Magnolia	Denver	3,230,000	40% Complete
Virginia Village	Denver	800,000	25% Complete

relationship with Denver in the design and implementation of these much needed drainage and flood control projects.

Another project of note this past year was the completion of the Cottonwood Creek project located near Peoria. Six different parties were involved in this project to include in addition to the District, the City of Greenwood Village, Arapahoe County, Cherry Creek Basin Authority, Arapahoe Water and Wastewater Authority and the Landmark Metropolitan District. This project provided much needed capacity improvements along this stretch of

Cottonwood Creek as well as water quality features designed to reduce the phosphorus load into Cherry Creek Reservoir. Paul Hindman, Senior Project Engineer, is to be congratulated for bringing this project to completion while juggling the needs of six different project sponsors.

The year 2004 looks to be another busy year for the Design and Construction Program with over \$9.6 million identified for 38 new or existing projects.

SOME OBSERVATIONS ON ATMOSPHERIC DUST FALLOUT

by

Ben R. Urbonas, P.E. and John T. Doerfer

INTRODUCTION

For a full paper on this topic go to <http://udfcd.org/techpapers.htm>.

Dust fallout, as a contributor to the pollutants found on urban surfaces, has been discussed for years and many studies have been done to quantify it (Sartor and Boyd, 1972; Pitt and Amy, 1973; Pitt, 1979; Mustard *et. al.*, 1985; Schroder and Hedley, 1986; Schroder *et. al.*, 1987; NADP, 2003 (full citations are given in the paper posted on the web). Despite these, there remains controversy as to how much of the total pollutants that are present on various urban surfaces come from atmospheric fallout. This paper reports on the findings of atmospheric fallout observed in 2003 on a roof of single-family residence and in a winterized swimming pool, both located in Denver, Colorado.

ROOF GUTTERS

In May of 2003, a roof gutter not cleaned for about 5- to 7-years serving approximately 700 square feet of a single-family residence was cleaned and the materials were collected and weighted. These materials consisted of wet leaves, fine sediment and grit materials typically found on asphalt-composition roofs. The following were observed:

- 1) Total weight of material removed was between 30 to 40 lbs.
- 2) Approximately 1/3 of the mass was grit particles from the composition roof.
- 3) Approximately 1/3 of the mass was wet leaves and water.
- 4) Approximately 1/3 of the mass was very fine sediments.

From these approximations, it was concluded that the gutter accumulated about 12 lbs of very fine sediment that would be classified as part of the Total Suspended Solids (TSS) when found in stormwater runoff, or about 2 lbs of TSS per 100 square feet of roof (870 lbs/acre). This loading rate compares favorably with a value reported by other studies. What is not known is the

quantity of fine solids that were not trapped in the gutter during these years and were washed down the gutter onto the lawn or onto the streets and paved alleys that hydraulically connect to the streams in the Denver area. Clearly, this example illustrates that roofs in the Denver area are significant sinks of atmospheric fallout and contributors of TSS to stormwater runoff. Similar to the findings were reported by Beecham (2001) in Sydney, Australia, namely an average load of 5 kg (11 lbs) of sediment being generated from a typical single-family residential roof on an annual basis.

A SWIMMING POOL

On Memorial Day weekend the cleanings of a residential swimming pool were sampled and analyzed. Photograph 1 in the full paper posted on the web page illustrates the difference in the pool bottom before and after cleanout. Photograph 2 in the full paper shows a Ziploc™ bag filled with fine sediment that was collected from 200 to 250 square feet of the pool's bottom. This sample does not contain all of the sediment that was on the cleaning equipment filter (approximately 15% to 25% of the sediment was not captured and went down the drain during the washing of the filter). These data indicate:

1. The total wet weight of the sample is 3 lbs.
2. The weight of the solids removed is around 1.5 lbs, or around 0.9 lbs of solids per 100 square feet of surface. Extrapolating this to a 12-month period, we get 1.2 lbs/100 s.f. (700 lbs/acre) a year.
3. This material would become part of the TSS load in stormwater runoff.

A gradation test was performed to determine the distribution of particle sizes contained within the atmospheric fallout sample taken from the swimming pool. The results of the gradation test are shown in Figures 1 and 2 of the posted paper. One-third of the sample can be classified as fine sand (> 74 microns) and two-thirds of the sample as silt and clay. Little more than 20-

percent of the particles are clay sized (≤ 2 microns). Studies have shown an inverse relationship between particle size and pollutant concentration on street surfaces (Sartor and Boyd, 1972; Pitt and Amy, 1973; Pitt, 1979) and in bottom sediments in the South Platte River (Steele and Doerfer, 1983). Because of their small size, the clay- and silt-sized particles are the most difficult to remove from runoff by sedimentation processes.

WHAT DOES THIS MEAN?

These observations imply that atmospheric fallout is a significant contributor of TSS found in stormwater runoff in the Denver area. In a semi-arid climate wind picks up much dust and fine sediment from many surfaces within and adjacent to the urban area. Unlike climates with more rainfall and humidity, the atmosphere in a semi-arid climate does not have many opportunities to cleanse itself. In addition, native vegetated surfaces comprised of bunch grasses instead of turf grasses do not protect the soils from scour by wind, nor do they provide the trapping of dust particles that turf-forming grasses provide after particles settle to the ground.

It was also found in studies by Sartor and Boyd (1972), Pitt (1979), Mustard *et. al.* (1985) that TSS buildup rate on impervious surfaces initially occurs rapidly and then approaches an asymptotic equilibrium. This phenomenon can be attributed to wind resuspension and scour of deposited particles so that the buildup of TSS does not continue at the same rate forever. In a swimming pool, all solids that fall out of the atmosphere cannot resuspend into the atmosphere. As a result, a swimming pool, a pond or a lake acts as a perfect sink for these solids.

The findings reported in this paper are not based on accurate scientific measurements, but do provide a realistic assessment of atmospheric fallout in the Denver area and how it affects stormwater runoff quality. It is

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South Platte River Program Notes

by

Ben Urbonas, P.E., Chief, South Platte River Program

Capital Projects

Globeville Phase 3 Project

The South Platte River Capital Program has been very active this year on several fronts. Much effort was spent on the redesign of the Globeville Phase 3 project. This final phase of Denver's project should remove approximately 200 acres of highly urbanized land from the FEMA designated 100-year floodplain. The design is taking longer than expected because of the project's unusual complexity that includes many utility relocations, approval by a railroad company of a new railroad bridge, groundwater flows, keeping the diversions to the Burlington Ditch unobstructed and the railroad in service during construction and unusual geometry of the diversion structure and its headworks.

The Colorado State University Foothills Hydraulics Laboratory in Fort Collins completed physical model studies of the diversion structure and river modifications early in 2003. The findings of this study give us much confidence that the completed system will perform as designed. The only thing remaining is to put the finishing touches on the design, have Denver reach agreements with the ditch company and build it. To assist with this, in 2003, the District initiated an agreement with Denver to add another \$500,000 of District funds to the project fund.

Floodplain Acquisition

The District entered into another agreement with Adams County in its continuing efforts to acquire land within the South Platte River floodplain. Adams County and the District have jointly identified two parcels near McKay Road for acquisition. Once acquired the buildings and other materials will be removed and the land returned to a more natural state, creating new terrestrial wildlife habitat.

Zuni/Sun Valley Reach Project

Last year the District entered into an agreement with Denver to participate in

a U.S. Army Corps of Engineers project to provide environmental enhancements along the Zuni/Sun Valley reach of the South Platte River of the Upper Central Platte River Project. While the Corps has been doing the final design, Denver has pursued land acquisition for this project.

Unfortunately, the final design effort had to be halted in the middle of 2003 when the U.S. Congress failed to provide \$200,000 in their appropriations that was needed to complete the design. We are hopeful that this money will be appropriated in the 2004 budget. In addition, we are hopeful that Congress will also appropriate the \$10,000,000 to \$15,000,000 needed for the construction of this project in the 2005 budget. Regardless of the budgetary outcome, the District and Denver are committed to implementing this project and are continuing to acquire the needed land.

Maintenance Activities

Routine Maintenance

In 2003, South Platte River routine maintenance efforts included:

- 192 river miles (equivalent) of trash and debris pickup and removal
- 3.6 acres of string-trim mowing at access ramps and rest areas
- 78 miles (equivalent) of recreation/maintenance trail edge mowing
- 9.1 miles of tree pruning along the trail
- Approximately 190 truckloads of trash and debris were removed from the river and taken to landfills.

We have continued to add more areas of the South Platte River to our maintenance coverage. The ultimate goal will be coverage of the entire reach, from Chatfield Reservoir to 168th Avenue. Colorado Total Maintenance, Inc. was re-contracted to perform these services in 2003.

For the seventh consecutive year we participated in the Greenway Foundation's annual NIMBY (Not In

My Back Yard) Fest volunteer trash pickup, during which an additional 65 cubic yards of trash were removed. In addition, government personnel and volunteer groups have picked-up and removed trash from the river corridor throughout the year. Trash is also regularly removed from trash receptacles that are maintained by park personnel along all recreational trails.

Not only does our routine contractor remove lightweight debris, but also many heavier items such as 200 cubic yards of reinforced concrete pipe, heavy equipment tires and scrap metal. This effort has not only made the river more scenic but has also improved safety for recreational users. In many cases, recreational users are the ones to alert us to potential hazards, especially to boating. Based on calls we received, several large pieces of protruding metal were removed from the river by our contractor. Due to these efforts, the boatability of the South Platte River continues to improve.

Routine maintenance continues to be the most cost effective program in terms of environmental enhancement and public service. Without it, the trash along and in the river would accumulate tremendously, decreasing the enjoyment of the public as well as creating safety and sanitation issues. The routine maintenance program now completes more than twice the number of trash pickups and trail mowings along the South Platte River than we did 15 years ago. This has enhanced the environment along the river and helped increase the utilization of this corridor by the public.

Noxious Weed Management

We continue to be aggressive in controlling the many varieties of invasive vegetation that have taken hold along the river. Working closely with Adams County, the City and County of Denver, the City of Sheridan, and the South Suburban Parks and Recreation District, we have removed Tamarisk, Russian Olive and a variety of weeds through cutting and selective and



Overland Pond – Before. Note vertical bank erosion threatening mature trees and trail.



Overland Pond – After. Note vertical boulders protecting trees and trail.

careful application of herbicides when needed. This is followed by the plantings of Plains Cottonwood, Willow and various dry land grasses.

Restoration Maintenance

In 2003, the following restoration maintenance projects were completed:

- Enlarged the outlet structure of the Mann-Nyholt Lake to the South Platte River at the Adams County Regional Park at 129th Avenue.
- Construction underway for a new sloping grouted boulder grade control structure at approximately 116th Ave. in response to observed degradation.
- Constructed grouted boulder grade control structure at 16th Street in Denver; replacing an old concrete cutoff wall and a bunch of rubble.
- Constructed a boulder edge lining at Overland Pond in Denver to stabilize erosion that threatened the river maintenance/recreation trail and mature cottonwoods.
- Reconstructed the trail area at the 36th Street storm drain that had repeatedly been damaged by high velocity discharges at the outfall
- Provided design and construction funding assistance for bank stabilization work at the new Denver park at the South Platte/Cherry Creek confluence

The enlargement of the Mann-Nyholt lake outlet was a cooperative design and construction effort between the District, Adams County Parks, and the Riverdale Dunes Golf Course management. Mann-Nyholt Lake is the downstream terminus for Brantner Gulch. During minor rainstorms the lake elevation

would rise significantly, causing inundation of an adjacent fairway for several hours. The original outlet structure, a 24-inch pipe, was too small to adequately drain the lake in a timely fashion even during daily rainfall events. At the request of Adams County Parks, a new parallel 6'x3' concrete box culvert was constructed to adequately discharge at least 100 cubic feet per second before the lake's emergency spillway kicks in. The culvert entrance was constructed to include a weir to control the desired water surface elevation of the lake. A trash rack was installed on the inlet and a metal flap gate placed on the outlet to inhibit undesirable fish migration from the river to the fishing lake.

In 2004 we expect the program to include the following restorative maintenance projects:

- Extension of the river recreation trail northward under 104th Avenue jointly funded with Adams County
- Restoration and stabilization of west riverbank at the newly purchased Adams County open space property just north of 104th Avenue
- Several bank stabilization and restoration projects in Adams County, Thornton, and Littleton

Cooperative Projects with Private Property Owners

Cooperative projects are constructed on flowage and maintenance access easements dedicated to the District by private property owners adjacent to the river in exchange for river restoration

work. This year we obtained an additional 20 acres of easement area. To date over 650 acres of such easements have been dedicated, resulting in over 25 bank stabilization and/or river grade controls and riparian revegetation projects since 1988. Several of these easements now contain the river recreation trail, which doubles as river maintenance access.

Two new cooperative projects are underway this year. At 120th Ave in Adams County, we are in the process of constructing 1,200 feet of soil riprap bank rehabilitation and stabilization in cooperation with Asphalt Specialties Company. The second cooperative project underway this year is located along the west bank just upstream of 104th Avenue. Approximately 1200 feet of soil riprap bank rehabilitation and stabilization will be constructed on a 29-acre easement dedicated by Aggregate Industries.

Next year the McIntosh Farm Company property is scheduled to receive needed bank rehabilitation and stabilization along the west bank of the river. Left unstabilized, this bank will ultimately degrade to the point where it will disrupt dairy farm operations that have been in place for over 100 years. Last year the farm company dedicated 31 acres of riparian area in order to get District assistance along their property. This work should be completed in 2004.

Master Planning Program Notes

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

Planning Projects

Ten planning projects were completed in 2003; 12 projects are in progress; and we hope to begin six new planning projects in 2004. It is clear that the planning activities continue to be strong as the cities and counties continue to expand urban areas and begin to address the water quality issues mandated by the stormwater discharge permit program of the Federal Government as administered by the State.

We now have a total of over 120 completed watershed-level major drainageway and outfall system plans in our inventory. Some of these studies are updates of master plans completed many years ago. When completed, the master plans serve as a roadmap for how to deal with major drainageways as the lands develop and redevelop, and as a guide for the District's programs.

One unique feature in three of the master planning projects was the development of project web pages. To help reach the affected public, web sites were developed for the Cherry Creek Corridor – Reservoir to Scott Road, Denver High Line Canal and Little Dry Creek, and the Rocky Mountain Ditch master planning projects. The use of these web pages by the public was mixed and the District will evaluate whether the use of web sites is an effective way of reaching the affected public for future projects. We suspect that the more controversial or visible projects will benefit from web sites, while lesser projects will not. It will be up to the project sponsors to decide if any specific project should have one.

Urban Storm Drainage Criteria Manual

We no longer publish in printed form updates to the Urban Storm Drainage Criteria Manual (USDCM) and remind all owners and holders of this manual that all revisions and updates are posted on our web page. Updates for Volumes 1 and 2 are under www.udfcd.org/usdcm/vol1&2.htm for

STATUS OF PLANNING PROJECTS

Project	Sponsor(s)	Consultant	Status
Oak Gulch & Stroh Ranch	Parker & Douglas Co.	Knight Piésold	Completed in 03
Applewood OSP	Jefferson Co.	Kiowa	Completed in 03
Horse Creek OSP	Adams County & Aurora	Knight Piésold	Completed in 03
NE Sheridan OSP	City of Sheridan	Moser Assoc.	Completed in 03
Plum Creek OSP - FHAD	Douglas Co.	WRC	Completed in 03
RMA 815 & Adj. Areas (Prairie Gateway OSP)	Commerce City, Adams Co.	Love & Assoc.	Completed in 03
Rocky Mountain Ditch	Denver	HDR	Completed in 03
Todd Creek & DFA0052	Adams Co. & Thornton	Kiowa	Completed in 03
Unnamed Tributary to W. Toll Gate Creek	Arapahoe Co., ECCV & Aurora	Kiowa	Completed in 03
Upper Piney Cr. & Tribs	Aurora	Olsson Assoc	Completed in 03
Cherry Creek MDP u/s of Cherry Cr. Reservoir	Parker, Douglas Co., Arapahoe Co., Centennial	URS	99% Complete
Broomfield & Vicinity MP Update	Broomfield & Westminster	Kiowa	95% Complete
Denver High Line Canal Marcy G. to Mississippi Av	Denver Water & WMD, Greenwood Village, S. Suburban Park & Rec. Dist., Littleton, Cherry Hills Village, Arapahoe Co.	WRC	90% Complete
Second Creek (Lower) MP Update	Adams Co., Brighton & Commerce City	Kiowa	75% Complete
Four Mile Canyon & Wonderland Cr. Updates	Boulder.	Love & Associates	65% Complete
Fairmount Area OSP	Jefferson Co., Golden	Moser Assoc.	60% Complete
Kinney Creek & Fonder Draw	Douglas Co.	WRC	50% Complete
Lower Brantner Gulch	Adams County, Thornton	Love & Assoc.	50% Complete
Third Creek (Lower) MP Updates	Adams Co., Commerce City, Brighton	Kiowa	25% Complete
Massey Draw & SJCD (S)	Jefferson Co., Arapahoe Co.	n/a	Mapping Complete
Yankee Doodle OSP	Arvada	n/a	Begin Mapping
Rock Creek in Superior	Superior	n/a	Begin mapping
Big Dry Cr. (AdCo) North Tributaries Update	Thornton, Adams Co., Broomfield	n/a	Start in 04
Lemon and Scott Gulch OSP	Douglas Co.	n/a	Start in 04
Murphy Creek Update	Aurora	n/a	Start in 04
Toll Gate Creek Hydrology	Aurora	n/a	Start in 04
Upper Goldsmith W.Q.	Arapahoe Co. Greenwood Village, Centennial	n/a	Start in 04
Upper North Marston Lake	Denver, Denver Water, Jefferson Co.	n/a	Start in 04

free downloads of the revised pages in Adobe PDF format. Although there were no updates to the Manual in 2003, everyone should keep checking our web page www.udfcd.org for revisions and corrections to USDCM.

Volume 3 of the USDCM is no longer available in printed form. It is now available for free download from www.udfcd.org/usdcm/vol3.htm. You can choose to download the entire document or download the latest revision of any single chapter.

Several of the spreadsheets that assist with the calculations and design of facilities recommended in the manual, along with a few AutoCAD™ details were updated and/or added to our list of tools available for downloading. There is no charge for any of the documents, software or spreadsheets that are made available to the public on our web page.

District Software

We now have a very stable beta test version of *UDSWM* software (FSA GUI with SWMM 2000) available for downloading. This version provides a graphical user interface for the *UDSWM* and is designed to import old input files for this software. In addition, we hope to have the entire *UDSWM* and *CUHP* packages rewritten in VB.NET in 2003 as a combined software package that will be windows compliant and network capable. In time we hope to integrate the *CUHP* and *UDSWM* into a single package with a continuous simulation option.

In addition, *UDPOND* and *NeoUDSEWER*, both coded in Visual Basic are also available for downloading free of charge. Both have been totally rewritten by John-Michael O'Brian with the help and guidance of John O'Brian and Prof. James C.Y. Guo.

At this time we are working at developing a graphical interface for the preparation of inputs for the current *UDSWM* package.

BMPs in Semi-Arid Regions

In April of 2003, the District was a co-sponsor along with CASFM of a one-day seminar on the experience with BMPs in Colorado and semi-arid climates. It was chaired by Jonathan Jones and its organizing committee had representatives from public and private sectors of the stormwater management profession. The attendance by 240 participants from municipalities, federal and state governments, consultants and other organizations made this seminar a great success. The proceedings for this event are available from:

<http://udfcd.org/conferences/conferences.htm>

Douglas and Arapahoe Counties Criteria Manual Update Project

The District is helping to fund and otherwise assist with the preparation of updated stormwater criteria manuals for Douglas and Arapahoe Counties and the City of Centennial. The effort began in 2003 and is expected to be completed in 2004. All three manuals will base their technical recommendations on the District's *Urban Storm Drainage Criteria Manual*. However, each will have specific requirements for development/redevelopment projects within their jurisdictions and will add details and aesthetic features that the District's *Manual* does not have.

Denver is preparing a BMP Implementation Manual

Under the leadership of Terry Baus of Denver's Wastewater Management Division, Denver has contracted with Wright Water Engineers, Inc. and its sub-contractors to develop a BMP implementation guidance document. All departments of the City are participating in this effort and the District has also been invited to be a member of the project's advisory committee. This promises to result in a thoroughly rich document that will offer an array of options of how to make BMPs work in an ultra-urban infill and redevelopment areas as well as land development projects with more elbowroom.

In addition, many issues specific to Denver and similar cities across the United States will be addressed to one degree or another. For example, two issues of importance are: (1) what may be feasible to retrofit on a regional or sub-watershed basis versus on-site BMPs, and (2) aesthetics of stormwater management facilities within an urban setting. We look forward to continuing our participation in this project and towards the final product that will be produced to guide us in the selection, design and site integration of BMPs into the urban landscape.

Reporting on District's BMPs Testing

Since early 1990s the District has been testing several BMPs at the Lakewood Public Works Maintenance facility. We were hoping to report on the results in

this issue, however the drought and an epidemic of equipment problems required us to extend field testing for one more year. Look for a report on the results of this testing effort on our website to appear by mid- to late-2004. A summary of the findings will be presented in the next annual issue of *Flood Hazard News*.

Ben Urbonas Receives ASCE 2003 State-of-the-Art Civil Engineering Award.

The American Society of Civil Engineers presented an award to Ben Urbonas of our staff, along with Jonathan Jones of Wright Water Engineers, Inc. and Eric Strecker, P.E. of GeoSyntec for the development of the National BMP Database. The three were the Co-Principal Investigators for this ASCE project funded by the U.S. Environmental Protection Agency. The database can be accessed through its own web site at <http://www.bmpdatabase.org>.

This database provided the first compilation of scientifically defensible data about stormwater Best Management Practices (BMPs) performance throughout the United States and countries outside the USA. Currently it has data from approximately 200 structural and non-structural BMP test sites and more are being added as data become available. Along with the data for water quality, it contains information on local precipitation and climatic conditions when the data were taken, peak flow and storm volumes recorded at the test site and a plethora of detailed design information about each BMP's structural installation or non-structural practice. The combination of all this information provides engineers, scientists and other professionals with scientifically defensible data to develop relationships between various BMPs, their design and performance.

Flood Warning Program Activities

by
Kevin G. Stewart, P.E., Information Systems Manager, Floodplain Management Program

Introduction

This past year marks the 25th year of operations for the District's flash flood prediction program (a.k.a. F2P2). Many individuals involved with the program when it began in 1979 are still involved today. Some of the more notable personalities include: District Executive Director Scott Tucker and our Floodplain Management Program Chief Bill DeGroot; Eve Grunfest, Professor of Geography at the University of Colorado at Colorado Springs (*Eve was involved with the early research work for the District following the 1976 Big Thompson Canyon flash flood that led to establishing the F2P2*); Larry Stern, Boulder/Boulder County Director of Emergency Management (*Larry was a Sergeant with the Boulder County Sheriff's Department in 1979*); Don Van Wie, Principal with OneRain Incorporated (*Don was a Captain with the Boulder County Sheriff's Department and his company currently maintains the District's automated flood detection network*); John Henz, Senior Principal Meteorologist with HDR Engineering (*John was the President of GRD Weather Center, which became the first private meteorological service for the F2P2*); Bob Glancy, Warning Coordination Meteorologist with the National Weather Service in Boulder (*Bob was employed as a forecaster by GRD in 1979*).

I undoubtedly have missed mentioning a few other important players, but this list should give you some idea about the continuity of this long-running program and the commitment level of those involved. As for me, I was first introduced to the program in June of 1984 when I ruined my car on my way home from work by driving into a severe thunderstorm and flood in Wheat Ridge and Arvada, which happened just a few days after starting my new job at the District.

Public Information Projects

A flood protection handbook for Denver residents and businesses was completed last May and made available free to

anyone wanting a copy. It contains helpful advice on what individuals can do before, during and after a flood to protect their property and lives. The project was a joint effort between the Mayor's Office of Emergency Management and the District. The handbook was publicized by mailing 4500 English and Spanish language color brochures to Denver addresses in or near known floodplains. Printed booklets may be obtained from the District or Denver OEM, or by visiting the Denver Public Library. You can also download a color version of this handbook from both the District and Denver websites. This is the third handbook of its kind that the District has helped local governments develop. Early versions were developed for Arvada and Boulder County.

A new project is underway to develop a flood safety information website for Boulder, complete with video clips and other modern multimedia features. The District and the City of Boulder funded this \$30,000 initiative, which will likely be expanded to include other Front Range communities. Marshall Freck with the Texas Environmental Center will be conducting the work. To learn more about this project visit the TEC website floodsafety.com.

EMWIN Implementation Scheduled for 2004

Last year's issue of Flood Hazard News described plans to develop an Emergency Managers Weather Information Network for the Denver area. EMWIN is a National Weather Service program that allows communities to develop their own unique applications. In addition to providing an effective low-cost way to disseminate severe weather and flood information, it can also be used to relay civil emergency messages, thus having the potential to supplement interagency communications for homeland security purposes. With the District providing the initial \$15,000 in startup funds, local emergency managers secured an additional \$34,000 from a Homeland

Security Grant. This money will be used to acquire EMWIN radio equipment and software for use in emergency operation centers throughout the region. Adams County is planning to host the satellite downlink site and Xcel Energy is investigating their ability to host the rebroadcast station. Skywarn Systems, Inc. of Fort Worth, Texas is providing the design and consulting services, having developed a similar project for the Dallas/Fort Worth area. Initial deployment and testing is expected by late Spring or early Summer 2004.

CoCoRaHS Update

The District has been a sponsor for the Community Collaborative Rain and Hail Study for the past two years. Nolan Doesken, Assistant State Climatologist, has led this unique program that recently gained national prominence as the recipient of a 3-year National Science Foundation grant totaling \$897,000. CoCoRaHS was started by the Colorado Climate Center at Colorado State University following the July 1997 Spring Creek flash flood in Fort Collins. Congratulations to Nolan and to the many CoCoRaHS volunteers, staff and partner organizations. Anyone interested in measuring rain, hail and snow where you live or work should consider becoming a CoCoRaHS volunteer. Just visit www.cocorahs.org and join with hundreds across Colorado who enjoy participating in this valuable climate study.

ALERT System News

The District's ALERT flood detection network continues to grow, providing valuable early flood detection and decision support for local emergency management and response agencies. The 165 station network includes 145 rain gages, 80 stream gages, and 17 weather stations (wind, temperature, humidity, pressure and other parameters). The District's ALERT webserver is highly relied upon for accessing real-time data and sending text messages when alarm thresholds are exceeded.

Nine new stations were added to the ALERT network in 2003. Three rain gages were installed at Chatfield Dam, the Denver Zoo and the Roslyn Public Works Facility in north Denver. A fourth rain gage was recently made ready for 2004 operations at Fire Station No. 12 in Aurora near I-70 and Airport Blvd. Four combination rain/stream gages were installed on East Plum Creek near Haskins Gulch in Douglas County, on Sulphur Gulch in Parker (the newest addition), on Sanderson Gulch in Denver, and on the South Platte River near the Denver Wastewater Management Division's 3rd Avenue office building.

A new weather station at Aurora Reservoir is the latest addition to the ALERT mesonet. The Urban Farm at Stapleton weather station was discontinued in June, but plans are moving forward to relocate it to another site near the old Stapleton Airport. A few more stations are expected for 2004 operations including rain gages on Shop Creek in Aurora and in the storm approach zone for Denver southwest of Marston Lake. New stream gages are anticipated for Lakewood Gulch and Goldsmith Gulch in Denver, and Sand Creek, Murphy Creek and the Gateway drainage area in Aurora. DIAD Incorporated (now OneRain) of Longmont provided the 2003 ALERT

maintenance services for the 12th consecutive year. DIAD's name change occurred this past fall when they merged with NEXRAIN, Inc. NEXRAIN is located in the Sacramento, California area where they specialize in estimating rainfall from radar and surface measurements combined.

Late season wild fires broke out in Boulder and Douglas Counties with the 2002 Hayman Fire and its recurring floods still fresh in the minds of many. ALERT data is relied upon for fire weather support almost as much as flood detection. The NWS forecast office in Boulder reminded us of this when they sent the following email: *"Just wanted to let you know that the ALERT mesonet data was very valuable for our support of the wildfires on October 29. The Button Rock, Calwood Ranch, and Sugarloaf stations were perfectly located to cover the fire near Jamestown and were used heavily, while the Highlands Ranch and Castle Rock stations aided our knowledge of the weather conditions in that area. There was a lot of variability of humidity and wind in both time and space on that day, but your network made the conditions at the fires perfectly clear. Those of us on shift that day were very glad to have the data!"*

Looking ahead, the District intends to continue improving its public webserver capabilities by implementing more data integration and interpretation features to further simplify the flood threat recognition process. The District is also planning to develop a second password-protected webserver with similar capabilities for emergency use. A new project in Boulder will soon be underway to further improve flood threat assessments and early notifications by incorporating GIS applications with a real-time hydrologic

30 Days with Flood Potential

April	23	1
May	9,10,15,18,23-25,30-31	9
June	17-19,29	4
July	18-19,26-29	6
August	2-3,8-9,11,18,23-24,29-30	10
September	None	0

2003 Peak Flows. Some notable peaks measured by the ALERT system

This table was unavailable at press time. Check our web version for this table.

model for Boulder Creek.

Meteorological Support

The District's flash flood prediction program provides forecast and notification services directly to District local governments from April 15 through September 15 each year with this past year being our 25th year of service. HDR Engineering Hydro-Meteorological Services of Denver provided the operational forecasts during 2003. Bill Badini was HDR's project manager and lead meteorologist. John Henz provided the overall training and support for HDR meteorologists. This was the third consecutive year for HDR as the District's meteorological services provider.

2003 District Floods

The 2003 flood season gave the District its usual number of trouble days, but passed by without major disaster. Once again we consider ourselves fortunate and wonder how long our good fortune will last given the flood history of this region. The March 17-20 snowstorm was without question the biggest single hydrologic event of the year with nearly 4 inches of liquid moisture falling over much of the District and our mountain watersheds. Rivers and streams were running high as the snow melted, but again we were fortunate that temperatures remained relatively mild during that period. If daytime



The new ALERT gage on Sulphur Gulch in Parker

temperatures had reached into the 70's, we would be telling a much different story about the March flood of 2003.

An early start to our severe weather season began on April 17 with a Tornado Warning being issued for the Denver metro area. Six days later we had our first "message day" with Aurora receiving more than 1.5 inches of rain. A total of 30 days had potential for flood-producing rainfall, while 24 of those days realized their potential according to HDR's annual report. The NWS issued flash flood warnings for District counties on 4 days (May 15, July 18, 27 and 29). Flood watches were issued for 2 other days (May 30 and July 28). Other than the March snowstorm, the July 29 Golden flood arguably caused the most flood damage in the District of any single event. ALERT rain gages set off alarms on 12 days (May 15; June 17 and 18; July 18, 19, 26 and 29; and August 8, 11, 18, 29 and 30). The following briefly describes some of the notable events:

Thursday, May 15. An early evening storm caused considerable excitement in Boulder County this day, with the NWS issuing its first flash flood warning of the season that affected the District. The warning area included Boulder Creek and other tributary streams west of Boulder. The storm system developed along a narrow north/south line in the foothills just west of the City. One CoCoRaHS observer reported 3.02 inches. The ALERT system generated its first rain rate alarm of the year at the Betasso gage at 7:28 PM, where the rainfall totaled 2.56" in just over an hour. Localized flood damage was reporting in the mountains, but by the time the water reached Boulder the flood had attenuated to non-threatening levels. The Boulder Creek gage at the bridge below Fourmile Creek rose nearly 2 feet in 30 minutes with an estimated peak discharge of 500 cfs. Peak snowmelt runoff occurred 2 weeks later with the flow rate exceeding 1000 cfs. The storm's small aerial extent kept the peak flows on the major streams relatively small with damages being limited mostly to mountain gravel roads.

Tuesday, June 17. A surprise storm hit the District in the early morning hours

between 2:30 and 3:00AM in the vicinity of US-36 and Sheridan Blvd. The storm caused some localized flood damage to private properties according to news reports. Rainfall intensities of 0.5 inches in 10 minutes occurred in Adams and Denver Counties. Notice of the storm came first from the NWS at 3:20AM. HDR forwarded the information to affected jurisdictions. The morning storms were minor in terms of flood impact but the cooperation between the NWS, HDR and District staff is noteworthy. The NWS deserves much thanks and credit for their coordination efforts. Later in the day the storm activity returned with rain reports of 1.5" to 2.5" in south Denver with 1" diameter hail.

Friday, July 18. Following the rains of June 17-19, summer heat and dryness set in with only one message day occurring in a 28-day period between June 20 and July 17. The extended dry period was broken this Friday evening when thunderstorms near the Wyoming border sent out strong gust fronts to the south, causing a line of intense storms to develop between Parker and western Aurora. Two inch per hour rainfall was measured in SE Denver causing flooding along Goldsmith Gulch. Messages were issued for Denver around 9:45PM and the NWS issued a flash flood warning at 10:09PM. Fortunately the storms weakened and dissipated after 60 to 90 minutes, but not before enough rain fell to flood the Logan Street underpass of I-25 (a.k.a. Lake Logan), causing T-REX to close the freeway until 10:30AM the next morning. Goldsmith Gulch rose nearly 5 feet at the Eastman Avenue ALERT gage and measured a peak flow of approximately 1100 cfs at 10:30PM. Downstream at Iliff Avenue some cars in a parking lot were flooded. This was due to debris blockage at the Iliff culvert trash rack, which has caused problems in the past. Efforts are moving forward to remedy this. Flood problems were not limited to Denver with Arapahoe County and Aurora also being hit by heavy rain.

Sunday, July 27. This was another flash flood warning day for the District in Douglas County, where a storm dumped an estimated 3 to 4 inches of

rain near Roxborough Park. This rather large storm missed being measured by both the ALERT system and CoCoRaHS observers, where highest reported amounts were 0.71 and 0.58 inches respectively. The ALERT measurement was made by the West Plum Creek gage on Pine Cliff Road. The 3-4 inch estimate was from the NWS doppler radar. No significant flooding was reported.

Tuesday, July 29. This day brought to a close a 5-day stretch of the most threatening rainfall potential of the year. The NWS issued their final District flash flood warning on this day when an early afternoon storm brought flooding to the Golden area. One report received by the NWS indicated that there was 4 feet of water "over" Colorado Highway 93. After following-up on this, it appeared that a more accurate account would have been that there was 4 feet of water across the highway, which forced the closure of one lane. Regardless, the media covered the event very well and a considerable amount of flood damage did occur to some homes in the area. The storm was very localized. The Van Bibber Creek ALERT gage on SH 93 measured 1.34" with 0.91" occurring in just 15 minutes. Media reports also noted that the flooding would have been much worse had certain drainage improvements not been completed.

More information about the District's local flood warning program, its ALERT system and the 2003 flood season can be found by visiting the website alert.udfcd.org. Annual reports by HDR Engineering and OneRain Incorporated are also available.



ALERT rain gage destroyed in the Boulder County fire.

Maintenance Eligibility Notes

by

David Mallory, P.E., Senior Project Engineer, Floodplain Management Program

Home mortgage rates hit a 40-year low in 2003

Interest rates have continued to remain at historical lows throughout the year. The result was a continued boom in land development activities. Residential development has slowed somewhat in the southern tier of the Denver Metropolitan Area, but has strengthened in the northern tier. Commercial development has slowed in general, however, strong commercial growth is expected for the next several years along the north I-25 corridor. We processed 230 construction plan submittals this year, about the same as last year. Eighty of those reviews resulted in construction approval letters. Terri Fead, P.E. continued to help out with plan reviews through the first half of this year. She also helped out with FEMA LOMR and CLOMR reviews. Terri's involvement has been a tremendous benefit to the maintenance eligibility program.

The District's maintenance eligibility database, updated bi-monthly, and the *Guidelines for Maintenance Eligibility Of Flood Control Facilities Constructed By Others* (Maintenance Eligibility Guidelines) have been available online throughout the year. This has proved helpful to local governments and consulting engineers alike. Another effective tool has been the practice of holding project meetings involving District staff, design consultants and local government representatives as a way to reach consensus and move construction plans quickly through the final review process. We are also available by e-mail, fax or telephone to answer questions on design criteria or the maintenance eligibility program.

Projects being considered for the District's maintenance eligibility program may also trigger requirements under Section 404 of the Clean Water Act. Sometimes problems arise when a developer (permit applicant) satisfies Section 404 permit requirements, which may be in conflict with District requirements. In some instances,

Section 404 permits have already been issued when we first review construction documents. The Corps of Engineers Denver Regulatory Office staff and District staff believe that meeting the goals of the Section 404 permit program and the District's maintenance eligibility program are both integral to the success of development projects located adjacent to major drainageways. It is important to remember that the Denver Regulatory Office and the District have never failed to find consensus on development projects when early coordination and planning resulted in early agreement on concepts. The Compark project located along Happy Canyon Creek in Douglas County is an example of successful collaboration. The design and environmental consultants worked closely with the Denver Regulatory Office and District staff to craft a project that met all program requirements. The final design of Happy Canyon Creek through Compark represented cooperation and compromise between the Corps of Engineers and the District without conceding any basic design or environmental principals held by either agency.

An equally important consideration is remaining within permit requirements during construction. Developers, engineering consultants and contractors are all responsible for compliance with permit requirements. If in doubt, do not proceed with field changes without first verifying they are legal.

Denver Regulatory Office Contact Information:

US Army Corps of Engineers
Denver Regulatory Office
9307 S. Wadsworth Blvd
Littleton, CO 80128-6901

Phone: 303-979-4120

Fax: 303-979-0602

Web:

<http://www.nwo.usace.army.mil/html/od-tl/tri-lakes.html>

In the field

An integral part of the maintenance eligibility process is construction oversight. Construction activity has increased this year over past years. At any given time, we typically have 120 to 150 active construction projects spread out over 1600 square miles in many different local jurisdictions. We heavily depend on networking and partnerships developed with local governments and various engineering consultants over the years to adequately cover construction oversight. In some cases, local government inspection staffs have conducted construction observations on the District's behalf. Field reports and/or digital photos are typically provided to us through e-mail. We also rely upon local inspection staff, engineering consultants and in some instances, contractors to keep us apprised of construction progress and the need for District construction site visits. During 2003, District staff completed nearly 100 construction site visits. Over 35 current projects were completed and recommended for construction acceptance during the preceding 12 months. Another 20 previously approved projects were re-inspected for adequate vegetative cover and received final approval.

District wins accounting award

For the fifteenth year in a row the District has received a "Certificate of Achievement for Excellence in Financial Reporting" from the Government Finance Officers Association of the United States and Canada.

The certificate is presented to government units whose comprehensive annual financial reports achieve the highest standards in government accounting and financial reporting. Congratulations to Frank Dobbins, Chief of Finance and Accounting, for continuing this string of awards.

Maintenance Program Activities

by

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

Routine Maintenance

In 2003 \$730,300 was spent for mowing and debris pickups under the routine maintenance program. This work was done on approximately 254 different sections of urban drainageways within the Urban Drainage and Flood Control District (District) boundaries. The table below summarizes the miles of drainageways within each county in the District on which we performed regularly scheduled mowing and/or debris pickup maintenance.

Adams County	19.8 miles
Arapahoe County	37.5 miles
Boulder County	16.8 miles
Broomfield County	0.2 miles
Denver County	44.7 miles
Douglas County	6.1 miles
Jefferson County	29.1 miles
TOTAL	154.2 miles

The routine program is primarily debris pickups and native grass mowing. This is fairly straight-forward work, yet we are open to adjusting the frequency, schedules, and limits of work of the pickups and mowings to suit the changing needs of the community and character of the drainageway. In last year's *Flood Hazard News* article we stated that it is common for urban drainageway corridors to be prized as neighborhood amenities. Along with that outlook comes the community desire for a level of drainageway maintenance that goes beyond our original flood control debris pickups and mowings.

In contrast to these highly urbanized drainageways there are sections of creeks that can accommodate a less manicured look. These drainageways often have a wider corridor, fewer structures, a lower level of use, and more variability in the grading. On some of these drainageways during 2003 we reduced the number of mowings and allowed the grasses to grow taller between mowings. The advantages of fewer mowings are improved habitat, a more natural look,

better opportunity for wetland plants to thrive, and more shade for the soil. We recognize that the relatively dry summer contributed to our being able to reduce the mowings. In 2004 we will continue to monitor the comments of the neighbors and the appearance of the drainageways particularly for the presence of weeds.

Restoration Maintenance

In 2003 the restoration program completed \$1,718,500 of work. Restoration projects typically address isolated drainage problems where the construction will cost from a couple hundred dollars up to \$150,000. Eighty-seven individual activities were completed during the year. A major advantage of the restoration program is the ability to use it to react quickly to local drainage needs.

Much of the work we do in the maintenance program can be summarized by a few observations. The narrower the stream corridor, the less natural the drainageway, the more constrained the drainage system, and consequently, the more structural the channel. In this summary one can see some of the elements of Lane's equilibrium concept for a stable stream channel which balances flow rate and channel slope against sediment load and size of bed material.

In last year's article we described a two-year-old drop structure on **Little Dry Creek** in Cherry Hills Village that had been repaired with an injected product. The material was injected in a grid pattern under the grouted boulder cutoff wall to seal off the water that was passing under the structure. The solution has been in place for a year and a half with no evidence of failure or renewed water bypass. We will continue to monitor the status of this practical alternative to drop structure repair.

About six miles further upstream on **Little Dry Creek** west of Uinta Street

in Arapahoe County a very different problem had occurred. A previous maintenance project had seen renewed erosion. The original construction had left a portion of the creek flowing over a bedrock outcrop which appeared to be serving as a drop structure. However, once exposed to air and erosive power from the creek the poorly consolidated shale and siltstone bedrock quickly failed. This very narrow corridor allowed no room for erosion or stream meandering. Additional grouted boulder drop structures were built and the work was extended both upstream and downstream to connect to stabilized facilities.

A recent extension of Federal Boulevard in Westminster crossed **Big Dry Creek** at 122nd Avenue. The creek has continued to meander and it now threatens the Federal Boulevard right-of-way. A severe bend in the creek includes a 25-foot tall near-vertical bank that is eroding toward the roadway. The current plan being discussed with the permitting agencies is to relocate a short portion of the creek so the erosive energy of the creek will not be directed toward Federal Boulevard.

In our semi-arid climate trees are a desired landscape feature, but when a drainageway corridor becomes thick with water-loving trees the flood-carrying capacity of the channel is reduced. We removed overgrown trees from the channel of **Cherry Creek** through Denver in 1983-84; (\$93,000), 1988; (\$82,000), and 1995; (\$76,000). Coordinated with the City and County of Denver, we will spend about \$120,000 in 2003 removing trees from the Cherry Creek channel.

As more detention ponds and water quality ponds are built the maintenance of them becomes more visible. A detention pond on the **Long's Way Tributary** to Cherry Creek in Parker was built in the mid-1990s. The original metered outlet had a perforated riser pipe buried in a gravel mound.

This outlet was too easily plugged with the result that the pond never completely drained and was impossible to maintain because of the resulting bottom of muck. We rebuilt the outlet with a concrete apron and a slotted weir with metering plates to match the effective openings of the original design. The pond now drains between runoff events and is far easier to maintain.

The **Montbello** area of Denver is served by nearly 10 miles of concrete lined drainage channels. They were constructed 25 years ago as the subdivisions were built. Their top widths vary from 12 feet up to 35 feet with depths ranging from 4 to 10 feet. We rebuilt about 1400 linear feet (2 separate locations) of channel with our most recent push to replace the very worst sections of these concrete drainageways. Our replacement concrete panels include weep holes and steel reinforcement while most of the original panels did not.

We are participating with the Denver Parks Department in preparing several reports that document the current conditions and future needs for both drainageway and recreational uses. Studies for **Harvard Gulch, West Harvard Gulch, and Sanderson Gulch** have been completed. These reports inventory the condition of existing facilities and structures, develop preliminary cost estimates for repairs or replacement, and prioritize the severity of drainageway problems. Final design is underway for a section of West Harvard Gulch where funds from multiple parties will be combined to solve several problems.

Englewood Dam creates a regional detention pond on **Willow Creek** in Arapahoe County. As runoff enters the wide flat area at the upper end of the flood pool the sediment load is dropped. After years of this imperceptible aggradation the sediments had flattened the slope of the channel so much that water was backing up causing long-standing pools and often depositing sediment on the pedestrian trail under Dry Creek Road. We coordinated closely with the neighborhoods, South Suburban Parks District, and the

STATUS OF MAINTENANCE REHABILITATION PROJECTS

Project	Jurisdiction		Cost	Status
ADAMS COUNTY				
Clear Creek – S. Platte R. to York St.	Adams County	Design	\$112,842	100%
Build drop structure to control grade.		Const.	295,100	100%
ARAPAHOE COUNTY				
Little's Creek – Gallup to Elati	Littleton	Design	33,620	100%
Drops and channel repair.		Const.	75,948	100%
Willow Creek – N. of County Line Rd	Centennial	Design	142,738	100%
Build drops to control grade.		Const.	484,844	100%
BOULDER COUNTY				
Dry Creek #2 – East of 55 th Street	Boulder	Design	43,875	50%
Replace 3 broad drop structures.		Const	Next year	0%
Rock Creek – Farm west of Hwy. #287	Boulder County	Design	70,516	20%
Channel, bank repair and trails, partic.		Const	Next year	0%
BROOMFIELD COUNTY				
City Park D'way – Emerald to Midway	Broomfield	Design	33,678	90%
Channel and bank repair.		Const	Next year	0%
DENVER COUNTY				
Goldsmith Gulch, - North of Hampden	Denver	Design	66,480	100%
Channel and bank repair, participation.		Const.	800,000	90%
Cherry Creek – South Platte confluence	Denver	Design	Included	100%
Bank repair and access, participation.		Const.	75,000	10%
West Harvard Gulch – Zuni to Clay St.	Denver	Design	73,579	80%
Corridor study, drops, channel repair.		Const.	Next year	0%
DOUGLAS COUNTY				
Tallman Gulch – At Siebert Circle	Parker	Design	56,159	95%
Drops, channel repair, and trails, partic.		Const.	325,000	0%
JEFFERSON COUNTY				
Dutch Creek – Sheridan Blvd. to Eaton	Jefferson County	Design	49,941	10%
Drops and repair channel.		Const.	Next year	0%
Lakewood Gulch – Van Gordon-Welch	Lakewood	Design	Included	95%
Drops and repair channel, participation.		Const.	200,000	0%
Lena Gulch – Colfax at Zeta Street	Golden	Design	20,000	80%
Drops and repair channel, participation.		Const.	Canceled	0%
Lena Gulch – From 20 th to Youngfield	Lakewood	Design	25,000	70%
Drops and repair channel, participation.		Const.	200,000	0%
Lilley Gulch – East of Pierce Street	Jefferson County	Design	51,054	100%
Drops and repair channel, participation.		Const.	242,908	100%
McIntyre Gulch – West of Holland St.	Lakewood	Design	Stalled	100%
Repair channel banks, participation.		Const.	265,000	0%

permitting agencies to make sure everyone recognized the same problem and envisioned the same solution. The eventual solution was a low impact regrading of the low flow channel through the accumulated sediments. Naturally, sediments will continue to accumulate requiring similar work in the future, but for now the riparian character of the area has been preserved.

Rehabilitation Maintenance

Sixteen rehabilitation projects were at various stages of design or construction during 2003. Those projects are listed in the accompanying table titled "STATUS OF MAINTENANCE REHABILITATION PROJECTS." Rehabilitation projects typically are designed by private consultants and built by private contractors. They are intended to correct severe problems that have occurred on a previously improved

urban drainageway. By the end of 2003 the District will have spent about \$1,799,400 on rehabilitative design and construction for the year. A few of the unique projects are discussed below.

Vertical degradation on the South Platte River has migrated upstream in the channel of **Clear Creek** to the point that a previously installed bio-engineering bank protection project has been undermined and severely damaged. The encasement for a recent utility crossing has also been exposed. A seven foot tall grouted boulder drop structure was built on Clear Creek near its confluence with the South Platte River to control the grade of the channel. Our contractor cooperated with us in delaying the construction until the spring snow-melt runoff had passed.

Recent upstream urbanization in the **Willow Creek** basin in Douglas County resulted in renewed down-cutting and bank erosion just north of County Line Road in Arapahoe County. Four isolated grouted boulder drop structures were built with very little work done between the structures. This allowed most of the existing native grasses and thick trees to remain in what will now be a more stable setting. Since the Willow Creek watershed is in the plains we did not have to alter the construction schedule because of snow-melt runoff from the foothills. What we could not predict was the frequent runoff events as thunderstorms frequently rumbled across the southern part of the Denver area. Our contractor endured multiple weather delays during the construction.

Denver Parks Department initiated a large project on **Goldsmith Gulch** north of Hampden Avenue to control the low flow channel through an urban wetlands and to revitalize the recreational uses of the area. The project will also restore the ground water level for the wetlands. We joined with the parks department to assist with some of the channel restoration and to extend the project further south to repair a damaged channel in a commercial area. Two drop structures were built using a reinforced concrete foundation with a colored sculpted concrete covering.

This gives the appearance of a natural rock outcrop. The District's Capital Program has built several of these structures over the past couple years including several in an award winning project.

Similar to last year several multi-purpose projects were funded this year through intergovernmental agreements. The result of this combined funding is projects that meet a variety of neighborhood needs. In one of the older Lakewood neighborhoods **Lakewood Gulch** had been relegated to being little more than a drainage ditch. The original development of the area pushed the creek around and between the lots simply to get it out of the way. The roadway crossings plus the dangerous erosion and steep banks will be addressed through a project using funding from the City of Lakewood, the Capital Program, and the Maintenance Program. The Town of Parker has a very different problem with **Tallman Gulch** which enjoys a



Willow Creek at County Line Rd. before and after.

relatively wide open-space corridor. We will participate by funding the drop structures to limit the down-cutting of the gulch while Parker will pay for the trail relocations and improvements.

Maintenance Program GIS Activities

by
David Bennetts P.E., Senior Project Engineer, Maintenance Program

The District is currently in the process of converting all of our Routine Maintenance aerial photographs to a GIS application. This is part of a larger effort by the District staff to create an integrated GIS system utilizing existing data developed by the District.

The District has approximately 500 11" X 17" aerial photographs, which are used for the Routine Maintenance Program. The photographs show drainageway location information, property boundaries, and work limits for mowing and debris removal. The photographs are part of the contract documents for the routine contractors, and are also used by District staff and

other interested parties. These photographs quickly become outdated as adjacent areas are developed or other changes occur in the field.

The new images will utilize MRSID aerial photographs obtained from DRCOG. The new photographs are fit into our existing format, and a geodatabase with street names for all streets within the District boundaries was added to help locate drainageways. Mowing and debris removal limits and match lines were then added in a GIS shapefile format. Attributes in the shapefile will also include local government information, reach id's, and any specific notes for the particular

location. The current plan is to update these photographs as needed to keep pace with development and changes in the field.

Once this conversion is completed, cost-tracking information will be added for all drainageways on which maintenance has been performed. This will then allow the District and interested local governments to track how much money was spent on a specific drainageway for a given period of time.

Tucker (continued from page 3)
cost, timing and design of our projects.

Regulation of floodplains by local governments was usually a battle in the early 1970's. Developers typically wanted to channel the creeks into underground conduits or concrete channels, do as little as possible, reclaim as much developable land as possible. Drainaways were viewed as liabilities. Now floodplain regulation is accepted by the development community and many developers see creeks as assets and preserve and enhance them as

amenities to their projects. In the early days we relied almost entirely on floodplain regulation to control development in floodplains. With the support of the public through the financing of open space programs many floodplains have been purchased and preserved. The District since the mid 1980's has set aside monies each year for floodplain purchases.

And we cannot forget the computer. It has had a tremendous impact on the way we do business. I remember the analog hydrology/hydraulic models that required monster computers that

required large investments in hardware, programming, and space. We can now do more on a PC than we could do 35 years ago on one of those huge machines.

So next year, 2004, we want to celebrate 35 years of drainage and flood control work. After all if we don't do it who will. We hope that our friends, partners, contractors, elected officials, etc. will join us in this celebration. See you in June.

Scott Tucker named Top Ten Leader

Scott Tucker, District Executive Director since 1972, was named one of the Top Ten Public Works Leaders of the Year by the American Public Works Association (APWA) at its International Public Works Congress and Exposition in San Diego in August. The purpose of the award is "to inspire excellence and dedication in public service by recognizing the outstanding achievements of individual public works professionals." Following is the awards program description of Scott's achievements.

Since 1972, L. Scott Tucker has been the Executive Director of the Urban Drainage and Flood Control District, which encompasses 12,200 square miles consisting of six counties and 28 cities and towns. During his 31-year tenure as Executive Director, he has seen the District grow from a relatively small agency focused on the planning of flood control improvements to a major force in the design and construction of flood control projects throughout the Denver metro area's numerous urban waterways.

Tucker facilitated the District and FEMA in executing the first Cooperating Technical Partnership agreement in the U.S. in May 1999. He believed that because of the continuing growth of the Denver region it was important to work with FEMA to create and maintain accurate, up-to-date flood hazard data for the 32 communities

participating in the National Flood Insurance Program, which are served by the District.

Tucker has been a member of APWA since 1972. His involvement with the association includes President, Vice President, Secretary, Treasurer, and Chapter Delegate of the Colorado Chapter (1976-1980), Executive Council Member, Institute for Water Resources (President 1984-1985), and the Product Users and Suppliers Council (1990-1993). He is also a member of the American Society of Civil Engineers, Denver Regional Council of Governments, EPA Federal Advisory Committee on Phase II Stormwater Sources, and the Metro Wastewater Reclamation District.

Governor Owens Reappoints Ben Urbonas to the CCBWQA Board

Governor Bill Owens reappointed Ben Urbonas to the Board of Directors of the Cherry Creek Basin Water Quality Authority to a term expiring July, 2007. Ben was originally appointed by the Governor to serve on this board in 2001 after the State legislature redefined the board's structure. As redefined at that time, the board has to have one elected official from each of the five municipalities within the Cherry Creek watershed, one representative from the special districts operating within the watershed and six citizens appointed by the Governor. The latter have to have two members with water quality expertise, two to represent recreational interests and two to represent

environmental interests. Ben was appointed as one of the two with water quality expertise.

District Conference Scheduled

Mark your calendars now for the District's "Stormwater Planning and Design: Current Issues and Guidelines" conference to be held April 28, 2004, at the Holiday Inn, Northglenn.

The tentative agenda includes:

- Recent Developments in Drainage Law
- Maintenance Eligibility and Master Plan Implementation
- Common Mistakes made during CLOMR/LOMR Submittals
- Design of Drainageway Structures for New Development
- Inspection Procedures at Drainageway Construction Sites
- West Nile Virus Update
- Design Considerations for Water-Quality BMPs
- Report on Field Testing and Design of Structural BMPs
- New Development Programs under Municipal Stormwater Permits

Watch your mail or our web site for more information.

Floodplain (continued from page 5)

within a couple of years we could be in the position of maintaining all aspects of the DFIRMs for the District's seven counties, including base map revisions, Letters of Map Revision and new floodplain delineations. We will be exploring that possibility with FEMA over the next year.

Other program activities

The other major activities within the program are flood warning, maintenance eligibility, flood hazard area delineation and master plan implementation by others. Kevin Stewart continues to assure that we have the best possible flood detection and warning system, and he continues to be in demand as an expert in this field. See Kevin's column elsewhere in this issue. Our maintenance eligibility program continues to flourish under David Mallory's direction. See David's column elsewhere in this issue.

Floodplain delineation

We completed two flood hazard area delineation (FHAD) studies this year, for Cherry Creek from Cherry Creek Reservoir to Scott Road and for Little Dry Creek and Tributaries in Arapahoe County. Both were completed as part of outfall systems planning efforts for the two watersheds.

We have FHADs underway for Ralston and Leyden Creeks in Arvada; Kinney Creek and Fonder Draw in Douglas County, as part of an outfall systems planning study; and a re-study of the South Platte River through Adams County. We will begin FHADs for Clear Creek through Adams County, and Massey Draw and SJCD (South) in Jefferson County in 2004.

All of these studies are prepared in digital form compatible with FEMA's Digital Flood Insurance Rate Map (DFIRM) specifications. In fact, the Cherry Creek, Kinney Creek and Fonder Draw results will be incorporated into the Douglas County DFIRM.

Implementation efforts

Implementation of portions of our master plans, particularly regional detention facilities, is always a challenge. Involving other entities in these efforts, including private sector parties, is important to our successes in this area. One of the best examples of this is the 12-year collaboration between the District, the E-470 Public Highway Authority and others which is the subject of our cover story.

Last year we completed an Environmental Assessment (EA) of alternatives for the Irondale Gulch

watershed within the Rocky Mountain Arsenal (RMA). This year we received a FONSI (Finding of No Significant Impact). The FONSI has allowed us to move forward with negotiations for intergovernmental agreements between the District, Denver and RMA; and between the District, Commerce City, Adams County and RMA for the construction, operation and maintenance of these facilities on the RMA.

On our web site

We have added a photo album of good projects to our web site, and are updating it as we obtain additional photos of what we consider to be good examples for others to emulate. The photo album has chapters on drop structures, pedestrian/bicycle bridges, low flow channels, formal channels, stormwater detention facilities, integrating the floodplain into a development, and multiple use facilities.

We have also added an Activity Summary map that identifies all District studies completed or in progress. We are trying to update the status of all our studies quarterly. It would be a good idea for anyone working on a drainage study in the District to check this map for existing or on-going studies that might affect their work.

Stormwater Permit Activities

by

John T. Doerfer, Project Hydrologist, Master Planning Program

A major deadline occurred on March 10, 2003 when all "Phase II" municipalities in Colorado needed to submit their initial stormwater permit applications to the state Water Quality Control Division (WQCD). In addition, the larger "Phase I" cities of Denver, Aurora, and Lakewood were reissued permits for a second 5-year permit term in March. The District assisted its member governments in 2003 with these efforts, and will continue to do so in 2004.

Phase II Municipalities

"Phase II" municipalities are defined in Environmental Protection Agency (EPA) regulations as cities, towns, districts, and unincorporated parts of counties within "Urbanized Areas" of

the 2000 census. Most of the cities and counties in the District qualify as Phase II entities, with the exception of the Phase I cities noted above and towns with less than 1000 population that were granted waivers (Bow Mar, Lakeside, Morrison, and Mountain View). Other publicly-owned municipal separate storm sewer systems (MS4s), such as school districts and special districts, also had to obtain permits. The District did not need a permit because it does not own a MS4—Board policy has been that local governments retain ownership of stormwater facilities.

The District hosted a series of monthly meetings of the Municipal Workgroup of the Colorado Stormwater Task Force to discuss permit application

requirements. These meetings covered the six management programs that a Phase II MS4 will develop, implement, and enforce. These are: (1) Public education and outreach; (2) Public involvement and participation; (3) Illicit discharge detection and elimination; (4) Construction site runoff control; (5) Post-construction runoff management in new development and redevelopment; and, (6) Pollution prevention and good housekeeping for municipal operations. "Measurable Goals" required to judge permit compliance were also included.

Of the 53 Phase II municipalities in Colorado, all submitted their applications on time. Congratulations!

Phase II MS4s have a period of 5 years to fully implement their programs. The District will continue to provide assistance to its local governments as requested and with the support of the Board. The District plans to hold quarterly meetings in the future.

Phase I Municipalities

The cities of Denver, Aurora, and Lakewood are "Phase I" MS4s under the EPA discharge regulations because of their population size (greater than 100,000). The cities prepared permit applications in 1992 and WQCD issued permits originally in 1996. The cities have fully implemented all of their original permit requirements. Permits for a second 5-year permit term were renewed on March 20, 2003.

Three significant changes were made to the permit conditions. One was to shift emphasis from inspection of industrial sites to education of industries. The second change was to revise the Construction Sites Program to be applicable to proposed developments greater than 1 acre (the previous criteria was 5 acres). The third change was additional reporting requirements in the wet-weather monitoring program. In 2003, the District developed a 5-year work plan with the U.S. Geological Survey that is designed to assess long-term trends in stormwater quality for watershed planning.

Protecting Trees from Beaver Damage

By Steve Materkowski, EIT,
Engineering Inspector, South Platte River Program

An integral part of re-vegetation along the South Platte River has been the planting of Plains Cottonwoods and other native tree species. Unfortunately, many of these trees have been damaged or killed by beavers. Given the time, difficulty and expense of growing trees to maturity, these losses, in the limited areas of riparian growth in an urban environment, are not tolerable.

Originally we tried to protect trees using "chicken wire" cages. These proved to be mostly ineffective. Beavers can rip down this light wire or bite through it. The more recent practice suggests using a welded wire cage. Although this system works, it is unsightly.

In 2002, we became aware of the idea of painting trees to protect them from beaver damage. This "Beaver Paint" consists of a combination of latex paint and sand. Two areas along the South Platte River with active beaver populations were chosen for initial testing. Working closely with our routine maintenance contractor, we selected the type and color of paint to use and the proportions of sand to add to the paint. We found that using approximately 20 ounces of sand per gallon of exterior latex paint worked well. We painted a total of 100 trees at the two locations. The trees ranged from 2- to 24-inches in diameter. Some of them had recent beaver damage, which meant that the paint was applied not only to outer bark but to live inner fibers as well. So far the beavers have not damaged any more trees at these two sites. Secondly, after two growing seasons all trees in the test areas appear to be in good health.

Last summer, we had our contractor paint approximately 100 trees in South Platte Park. As of this writing, there has been no further beaver damage in those areas of the park. The Denver Parks Department is also experimenting with this method.

Based on our experience so far, we recommend the following paint-sand mix for beaver protection:

1 gal. exterior grade latex paint (match paint color to color of tree bark)
20 oz. playground sand
Mix in sand thoroughly.

It is very important to remove dirt from around the base of the tree and to paint, starting at the ground line, 3 feet up the tree. Apply a thick coat to all areas being painted. We suggest you experiment with the proportions and the color to get the best results. To match the color to the tree bark, get paint swatches from a supplier or have the supplier mix the color that you need.

Each application is unique but with proper mixing, only the beavers will know the paint is there. We do expect the trees will need to be repainted every few years. The exact maintenance cycle for this has yet to be determined.

Dust (continued from page 7)

recommended that these non-scientific initial data be better quantified through the use of more precise controlled measurements in existing sinks for atmospheric fallout (e.g., winterized swimming pools that have mesh type winter covers, lined ponds, etc.).

This less than formal data collection effort suggests that each 100 square feet of impervious surface can yield as much a 1.0 to 1.2 lbs (0.45 to 0.55 kg) of solids on an annual average basis. What fraction of this material actually makes it into stormwater has yet to be determined. If we assume 100% and an average of 30% of impervious surfaces in the metropolitan area have a direct hydraulic connection to the conveyance systems, each square mile of urban development here *can produce about 40 to 50 tons of TSS in stormwater runoff each year reaching our receiving water systems*. Considering that the Nationwide Urban Runoff Program data collected in the Denver area at commercial and residential sites by USGS indicates an average TSS concentration exceed 200 mg/L (EPA, 1983), the estimate using the unscientific samples collected this year compare well to the annual stormwater TSS loads one calculates using USGS data.

Conclusions

The observations made using simple atmospheric fallout dust capture techniques clearly show that:

- 1) Atmospheric fallout in the Denver area is a significant source of TSS in stormwater.
- 2) The fallout consists mostly of very fine particles that are hard to remove from the water column.
- 3) It does not matter what form the impervious surface takes, this fallout is shows up in stormwater runoff.
- 4) The less impervious surfaces that have a direct hydraulic connection to the conveyance system, the greater the chances for the turf lawns and landscaping to capture these fine particles before they reach the stormwater conveyance system.
- 5) The BMPs currently recommended in Volume 3 of the District's *Urban Storm Drainage Criteria Manual* are well suited for the removal of these fine solid particles from stormwater.

2003 Professional Activities of District Staff

Scott Tucker, Executive Director

- *2003 Top Ten Public Works Leader, awarded by the American Public Works association.
- *Speaker, Boston Society of Civil Engineers Hydraulics and Water Resources Group's Kennison Dinner, Boston, MA in May.
- *Presenter, National League of Cities workshop on Phase II Stormwater Regulatory Program, Nashville, TN, in December.
- *Member of Board of Directors and Co-Chairman of the Stormwater Management Committee of National Association of Flood and Stormwater Management Agencies (NAFSMA).
- *Member of American Public Works Association, American Society of Civil Engineers, and Water and Environment Federation.
- *Member, Stormwater Advisory Committee, Arapahoe County.
- *Member, Stormwater Management Advisory Committee, City and County of Broomfield.
- *Member, Independent Review Panel, City of Boulder.

Bill DeGroot, Chief, Floodplain Management Program

- *Chair of the Floodplain Management Committee of NAFSMA.
- *Chaired a session on Floodplain Management Issues at NAFSMA's annual meeting in Chicago in November. Also presented a paper on District DFIRM conversion projects.
- Attended a "by invitation only" meeting with FEMA in Atlanta in February. The purpose of the meeting was to develop criteria for the allocation of map modernization funds.
- *Co-authored with Kevin Long, FEMA Washington, and presented two papers on "Countywide Digital Conversion, City and County of Broomfield" and "Letter of Map Change Delegation to Cooperating Technical Partners" at the ASFPM annual conference in St. Louis in May.
- *Presented an update on the District's Letter Of Map Change pilot project at the CASFM conference in Breckenridge in September.
- *Presented "Converting Broomfield's Flood Insurance Rate Map to a Digital Product" at the GIS in the Rockies conference in Denver in October.
- *Presented an update on the District's DFIRM conversion and LOMC pilot project at the ASCE Colorado Section Water Resources Group meeting in February in Denver.
- *Member of ASFPM's State Business Plan Work Group, tasked with writing guidance for states to prepare business plans for managing components of FEMA's map modernization program.
- *Member of Association of State Floodplain Managers, American Society of Civil Engineers, and Colorado Association of Stormwater and Floodplain Managers.

Kevin Stewart, Information Systems and Flood Warning Program Manager, Floodplain Management Program

- *Chair of National Hydrologic Warning Council (NHWC) representing Southwestern Association of ALERT Systems (SAAS).
- *Member of U.S. Department of the Interior Advisory Committee on Water Information, Subcommittee on Hydrology
- *Invited speaker at American Meteorological Society's First Users Conference "Weather and Climate Services for Managing Water Resources and Surface Transportation" in Long Beach in February.
- *Speaker at ALERT Users Group meeting in Los Angeles in May.
- *Invited participant at National Weather Service Partners Workshop in Silver Spring, MD in September.
- *Speaker at National Safety Council, 90th Annual Congress & Exposition in San Diego in October.
- *Speaker & moderator at Fifth NHWC National Conference & Exposition in Dallas in October.
- *Invited participant at U.S. Department of the Interior, Water 2025 Science and Technology Workshop in Denver in November.

Ben Urbanas, Chief, Master Planning & South Platte River Programs

- *Gave a talk at the Northglenn Holiday Inn in April about BMP Effectiveness in Semi-Arid Climates at the District and CASFM co-sponsored one-day seminar on Experiences with BMPs.
- *Presented a paper in November on "Restoring Natural Waterways in Denver, USA Area" at the NATO Advanced Research Workshop on Enhancing Urban Environment in Rome, Italy.
- *Co-authored a paper with John Doerfer on Master Planning for presentation at the EWRI Annual Meeting in Philadelphia in August.
- *Was reappointed by Governor Owens to the Board of Directors of the Cherry Creek Basin Water Quality Authority until July, 2007.
- *Continued to serve on the Water Environment Research Foundation's Stormwater Technical Advisory Committee and on three of its research project development committees.
- *Received a 2003 ASCE State-of-the-Art Award for work on the development of the National BMP Database.
- *Elevated to a Life Member by the American Society of Civil Engineers.

Dave Lloyd, Chief, Design and Construction Program

- *Presented "Major Steam Restoration in the Denver Metropolitan Area" at the CASFM Conference in Breckenridge in September.
- *Member of Board of Directors on the Metro Wastewater Reclamation District.
- *Member of CASFM and APWA.

Cindy Thrush, Senior Project Engineer, Maintenance Program

- *Vice-Chair of the Board of Directors for the Colorado Association of Stormwater and Floodplain Managers (CASFM).
- *Editor of the CASFM newsletter.
- *Presented "Monitoring Stream Restoration Projects, Why We Should Always Look Back" at the 34th Annual International Erosion Control Conference in Las Vegas, NV in February.

*Co-Authored Paper entitled "Restoring Natural Waterways in Denver, USA Area." Presented by Ben Urbonas at the NATO Advanced Research Workshop on Enhancing Urban Environment in Rome, Italy in November.

Bryan Kohlenberg, Senior Project Engineer, South Platte River Program

*Continued as NSPE's scoring coordinator for the Jefferson Chapter and Colorado State MATHCOUNTS competitions for 7th and 8th graders.

*Co-authored paper with Ben Urbonas, Mark Hunter, and Cindy Thrush on "Restoring Natural Waterways in Denver, USA Area." Presented by Ben Urbonas at the NATO Advanced Research Workshop on Enhancing Urban Environment in Rome, Italy in November.

Paul Hindman, Senior Project Engineer, Design and Construction Program

*Co-authored and presented paper with Jeff Fisher titled "The Cost of Maintaining Water Quality Ponds", at the 2003 American Public Works Association (APWA) International Public Works Congress and Exposition in San Diego, CA.

*Chair of Education Outreach Committee for the Cherry Creek Stewardship Partners (CCSP).

*Organized Project WET workshop for elementary and middle school teachers in the Cherry Creek basin for CCSP. Co-Chair of annual conference for CCSP.

*Chair of the Site Selection Committee for the APWA International Public Works Congress and Exposition.

*Chair of Scholarship Committee for the Colorado Chapter of APWA.

John Doerfer, Project Hydrologist, Master Planning Program

*Chairman, Municipal Workgroup, Colorado Stormwater Task Force.

*Member, Urban Water Resources Research Council, Environment and Water Resources Institute (EWRI), ASCE.

*Secretary, Standards Committee - Management Practice for Control of Erosion and Sediment, EWRI/ASCE.

*Co-Author with Ben Urbonas, "Urban Watershed Master Planning for Stream Protection in the Denver Metropolitan Area," *Symposium on the Protection and Restoration of Urban and Rural Streams, June 23-26, 2003, Philadelphia, PA.* ASCE.

*Session Moderator, World Water & Environmental Resources Congress 2003, EWRI/ASCE, in Philadelphia in June.

*Member, Impacted Water Supplies Advisory Committee, Colorado Water Quality Forum.

Mark Hunter, Chief, Maintenance Program

*Committee member for the IECA-Mountain States Chapter.

*Member of IECA Technical Review Committee and Awards Committee.

*Co-Chairman, IECA Stream Restoration Technical Section

David Mallory, Senior Project Engineer, Floodplain Management Program

*Member of CASFM and ASFP.

David Bennetts, Senior Project Engineer, Maintenance Program

*conference Co-Chair for the 14th Annual CASFM Conference in Breckenridge in September.

Jeff Fisher, Engineering Inspector, Maintenance Program

*Co-authored and presented paper with Paul Hindman titled "The Cost of Maintaining Water Quality Ponds". at the 2003 American Public Works Association International Public Works Congress and Exposition in San Diego, CA.

Steve Materkowaki, Engineering Inspector, South Platte River Program

*Passed the FE Exam and registered as an EIT in Colorado

*Initiated into the Chi Epsilon Engineering Society

Maintenance and Construction Information Posted on Website

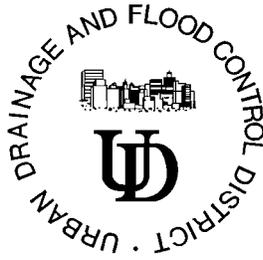
By Libby Kaiser, Student Intern

This past year the District added work program and construction information to its website to enhance awareness of Maintenance Program activities. The Maintenance page features the annual work program that outlines the anticipated work for the current year. The work is separated into three categories: Routine, Restoration, and Rehabilitation. Each line item gives drainageway name, project location and estimated project budget.

The Maintenance page includes a complete schedule for routine maintenance work items, which will allow residents to find out when mowing or debris removal will be done on drainageways in their area. The page can be found by clicking on the Maintenance link at the bottom of the District's homepage.

A list of ongoing construction projects has also been added to the website, so now residents can go online and find out information about projects in their

neighborhood. During construction there may be temporary impacts to parks, traffic, and street parking. The website will be updated regularly and allow residents to have the latest information about project schedules and anticipated completion dates. Construction information can be found by following the Construction link, also at the bottom of the homepage. If you have any questions regarding a specific construction project, contact information is also included on the website.



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Color versions of all of the photographs in this issue, and additional photos and figures, can be seen on our web site at:

www.udfcd.org

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