



Flood Hazard News

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Two District Maintenance Projects Profiled

By Dave Bennetts, Senior Project Engineer, Design, Construction & Maintenance Program

Rock Creek Restoration Project

The Rock Creek channel restoration project is located within the Carolyn Holmberg Preserve at Rock Creek Farm in Boulder County. Rock Creek Farm is public open space owned and operated by Boulder County Parks and Open Space. As a response to urbanization upstream, Rock Creek has experienced significant increases in runoff volume and frequency of discharges. Due to these changes, the channel has become deeply incised and is experiencing severe stream bank erosion resulting in the loss of vegetation and wetlands.

The primary goal for the project was to provide channel stability and enhancements while blending them into the natural environment. In order to accomplish this, two innovative techniques were used, sculpted concrete drop structures and low-flow channel soil wrapped lifts.

Drop Structures

Six drop structures were constructed along a two mile reach to stabilize the channel bottom and prevent further degradation. Sculpted concrete drop structures were used instead of sloping grouted boulder drop structures since rock is not naturally found in the lower part of the watersheds in Boulder County. Sheet pile cutoffs were installed at the upstream and downstream edges of the drop structures. The subgrade was shaped and compacted to the desired drop structure configuration, steel was shaped to fit the drop contours and tied into the sheet pile, a weep drain system

was installed, and the structure was poured in one full depth pour.

The sculpted concrete was colored and shaped to mimic sandstone outcroppings. New to the process was texturing the wet concrete with a rubber stamping process that closely matched the patterns found in the rock outcroppings in the area. Six sculpted structures were constructed varying in height from two feet to eleven feet. On several of the structures, planting wells were installed and planted with native shrubs to soften the appearance of the structure.

Soil Lifts

In an effort to soften the vertical banks and create more riparian habitat, a bioengineering technique was chosen over buried and revegetated riprap. Soil wrapped lifts were selected because they could withstand the higher stream velocities and provide a place for plantings that would further stabilize the lifts. The soil wrapped lifts were constructed with a multi-layer erosion control fabric made with both biodegradable and permanent materials. The lifts were filled with imported topsoil instead of the onsite material to

avoid the introduction of noxious weed seeds from the area. The lowest lift was placed 1-2 feet below the final invert of the channel to prevent undercutting. The lifts were an average of 1 foot in height and placed at a 3:1 slope. In the steeper areas, 8 to 10 lifts were used to transition to the upper bank.

Revegetation and Restoration

Once the drop structures were constructed, channel grading completed, and soil lifts installed, extensive revegetation and restoration efforts were completed. Russian olive trees were removed and approximately 90 plains cottonwood and peachleaf willow trees were planted. Riparian shrubs and trees were also planted to improve wildlife habitat along Rock Creek corridor. In addition almost 9000 native plants were planted, not including the native seeded



Severe stream bank erosion and incised channel in Rock Creek



Large Drop Structure being poured



Soil lifts under construction



Sculpted concrete drop structure at project completion



Project completion



Six months after construction



Three months after construction

areas. These native plants were placed into the soil lifts and along the lower reaches of the channel. This work was accomplished by volunteers coordinated through Boulder County. Most of the plant material was hand watered during

the first summer season to ensure establishment.

The project was completed in the spring of 2005 at a final cost of \$800,000 and has been closely monitored by Boulder

County Parks and Open Space and the District. Site maintenance has included selective weed control and re-seeding of upland areas that did not establish after the first growing season. Since the project was completed, the drainageway

has seen several significant runoff events with no damage. The vegetation has established itself well and the site has flourished. The District will continue to monitor the project to evaluate the long term success of these two techniques.

Sanderson Gulch Project

The Sanderson Gulch project is located within the City and County of Denver approximately 1 mile upstream of the confluence with the South Platte River. The projects reach meanders through a park in a residential neighborhood established in the 1960's. Rapid urban runoff had caused channel degradation and bank failure along the 1000 foot channel reach. Several gabion basket drop structures built in the early 1970's had also failed. In addition to the drainageway problems, the Denver Parks Department wanted to upgrade the irrigation system and make several other improvements to the park. They



Incised channel upstream of Florida Avenue

teamed up with the District and were a funding partner on the project. The District's project goals included building two new drop structures, constructing headwalls at the upstream and downstream ends of culvert going under Florida Avenue to improve the hydraulics and safety, regrading the entire reach of the channel, and extensive tree and wetland planting efforts. The parks department project goals included 1100 feet of trail, a new trail crossing, an upgraded irrigation system, and adding several other park improvements such as park benches and picnic tables.

Several aspects of this project were unique. The two new drop structures upstream and downstream of Florida

Avenue were constructed using precast concrete blocks with exposed black aggregate in lieu of boulders. The drop structure upstream of Florida Avenue was constructed as an improved inlet with the concrete blocks forming the approach and drop into the inlet. The drop structure downstream of Florida Avenue used the precast concrete blocks to form a cascading stair approach to the plunge pool. Large boulders of varying sizes and shapes were placed to stabilize the structure for larger events. The boulders placement created pocket areas that were then planted with native shrubs and trees. Wing walls were constructed on both ends of the culvert with an architectural rail on top.

A 10-foot wide channel through the park was constructed to provide more sinuosity, reduce bank erosion, improve the channel hydrology, and to increase areas of vegetation for water quality. The outside bends of the channel were graded to a 6:1 slope to create pocket wetlands and were reinforced with coir biologs pre-planted with wetland plant material. This was the first project the District had used the pre-planted biologs. The plant material was fully rooted in the biologs that were then placed in small groves in the channel bottom. This process allows the plant material to immediately root and establish itself. Approximately 1320 lineal feet of biologs were installed as part of this project. The inside bends of the channel were graded to a 4:1 slope and protected with a biodegradable erosion control blanket planted with native grasses and shrubs.

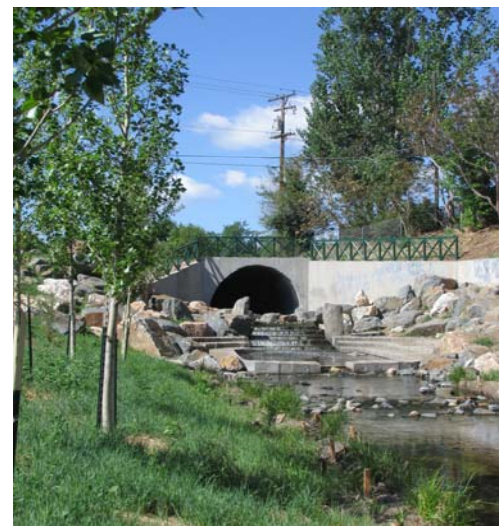
Extensive planting was completed once the final grading was complete. This included 112 trees, 325 shrubs, 4570 plant plugs and willow whips, and upland seeding. The upgraded irrigation system installed by the parks department was used to help establish the new vegetation. The project was



Biologs along low-flow channel



New channel upstream of Florida Avenue



New drop structure and headwall downstream of Florida Avenue

completed in the spring of 2006 at a cost of \$940,000.

Lloyd's Look

by Dave Lloyd

Timely Comment from the District's Executive Director



Hardly seems a year since Bill DeGroot was hammering me to get this article done for the last Flood Hazard News and here we go again. It must be an "age thing."

I was just scanning the quarterly newsletter for The Conservation Fund and came across an interesting article. Apparently, Disney, Travelocity, ESPN and others have recently partnered with The Conservation Fund to help neutralize greenhouse gas emissions through reforestation.

Travelocity now offers its online customers the option to purchase carbon offsets when purchasing vacation packages. They suggest that a \$25 donation negates air travel, a four-night hotel stay and a rental car for two people. The donations are apparently used in the reforestation of a grove in the Bogue Chitto National Wildlife Refuge in New Orleans.

I bring this up as I reflect upon a couple of field excursions I made this past year. One was made with our Board of Directors last May to look at a number of District and developer-constructed projects and the other with our administrative staff for their annual tour of District facilities (sometimes you just have to get them out from under the fluorescent lights).

So many of our projects along the major drainageways within the District are very successful in the promulgation of greenway corridors that were virtually nonexistent before the project. The many miles of linear wetland and riparian habitat created by so many of our stream stabilization projects create a

valuable resource to the neighboring public.

One classic example is the Lower Massey Draw project completed a little over a year ago. Prior to the project, the erosion and degradation along this reach of Massey Draw had eliminated the potential for any sustainable wetland and riparian vegetation. Through the collaboration of several partners including Jefferson County, Lockheed Martin, Denver Botanical Gardens, Corps of Engineers and the Chatfield Basin Authority, as well as our design team of Muller Engineering and ERO Resources, the project was successful in stabilizing this reach of channel and creating a valuable stretch of wildlife habitat in this urban corridor.

Organizational and Staff Changes

This past year saw some major organizational changes that we believe will allow us to better serve our local governments. Mark Hunter and Paul Hindman, Managers of our Maintenance and Design and Construction Programs, had taken a week of vacation this past spring to go backpacking in the Grand Canyon. They came back with a suggested organization change which involved combining their two programs into what is now the Design, Construction and Maintenance Program (not very creative, I know, but what do you expect from a bunch of engineers).

The advantage of this change is that it now provides a single point of contact for our local governments for both maintenance and capital projects. It also allows a single project engineer to administer both programs within their respective counties. We believe this will allow us to be more effective in our

day-to-day operations and provide better relationships with our local government partners.

We were saddened when John Doerfer decided, this past spring, to vacate his position as Project Hydrologist here at the District. John has moved on to new opportunities in Kalamazoo, Michigan where he and his wife have family ties. We wish John nothing but the best in his future endeavors.

Taking John's place in the District Master Planning Program is Ken MacKenzie who previously worked as a Senior Project Engineer in the Design and Construction Program. We're confident that Ken will develop his own niche in the areas of drainage master planning and stormwater quality.

Taking Ken's place in the newly created Design, Construction and Maintenance (DCM) Program is Richard Borchardt who came to us from the City of Thornton. We're very pleased to have Rich on staff and know that he will be a valuable addition to our program.

The creation of the Design, Construction and Maintenance Program also brought with it two new positions for Construction Managers. Both of those positions have now been filled. We're very pleased to have Joe Williams, who comes to us from the City of Littleton and Darren Bradshaw from Sellards and Grigg. Joe will be working in the Design, Construction and Maintenance Program while Darren will be working in the District's South Platte River Program replacing Steve Materkowski who transferred into the DCM Program. We look forward to having Joe and Darren on staff here at the District.

Master Planning Program Notes

By Ben Urbonas, P.E., Manager, Master Planning Program

Staff Changes

After 15 years with the District and the Master Planning Program, John Doerfer decided to move to Kalamazoo, Michigan with his wife to be closer to his wife's family and grandchild. We wish him continued success in his personal and professional life and thank him for the wonderful work at the District. We will miss his expertise, especially in water quality and regulatory dealings.

Ken MacKenzie, P.E. now occupies the position John held in the Master Planning Program. Ken started with the District in 1995 as a student intern and after he graduated we hired him as a project inspector in the South Platte River Program. When a Project Engineer's position opened in the Design and Construction program he successfully competed for it and moved to that department. The same happened when the position opened in the Master Planning Department earlier this year and he is now a Project Engineer with this program. Since he first joined us in 1995, Ken has been very productive in helping to develop standard engineering details and in the development of "intelligent" spreadsheets, all of which are available for download from our web site. I am very happy to have him on my staff and look forward in working with him.

Planning Projects

Nine planning projects were completed in 2006; seven projects were under way; and we hope to begin five new planning projects in 2007.

We now have a total of over 135 completed watershed-level major drainageway and outfall system plans in our inventory, including updates of master plans completed in the past.

Urban Storm Drainage Criteria Manual

All three volumes of the Urban Storm Drainage Criteria Manual (USDCM) are posted on our web page www.udfcd.org for you to download. If however, you

STATUS OF PLANNING PROJECTS

Project	Sponsor(s)	Consultant	Status
Denver Criteria Update	Denver	Wright Water	Complete in 2006
Broomfield & Vicinity	Broomfield & Westminster	Kiowa	Complete in 2006
Upper Goldsmith OSP	Arapahoe Co. Greenwood Village, Centennial	Moser Assoc.	Complete in 2006
Massey Draw & SJCD (S)	Jefferson Co., Arapahoe Co.	n/a	Complete in 2006
Yankee Doodle OSP	Arvada	n/a	Complete in 2006
Lemon and Scott Gulch OSP	Douglas Co.	CH2MHill	Complete in 2006
Coal Creek in Superior	Superior	n/a	Complete in 2006
Brighton Watershed Update	Brighton	WRC	Complete in 2006
Toll Gate Creek Hydrology	Aurora	Kiowa	Complete in 2006
Four Mile Canyon & Wonderland Cr. Updates	Boulder.	Love & Associates	65% Complete
Murphy Creek Update	Aurora	Moser Assoc.	65% Completed
Big Dry Cr. (AdCo) North Tributaries Update	Thornton, Adams Co., Broomfield	Wright Water	75% Completed
Clear Creek Update	Wheat Ridge, Jefferson Co., Adams Co., Golden, Denver	Icon	75% Completed
Dutch Cr./Lilley G. Update	Jefferson Co., Denver, Lakewood	PBS&J	60% Completed
Hoffman Drainage	Adams Co. & Thornton	Moser Assoc.	50% Completed
Lena G. Update d/s of Maplegrove Reservoir	Wheat Ridge	GCC	50% Completed
Little Dry Cr & Greenwood Gulch u/s of Holly	Douglas Co. Centennial, Greenwood Village, Lone Tree, S. Suburban Parks	n/a	Start in 07
Cottonwood Cr. W.Q Update	Arapahoe Co., Centennial, CCBWQA, Lone Tree, Douglas Co.	n/a	Start in 07
Hidden & Bates Lakes OSP	Adams Co, Arvada	n/a	Start in 07
First Creek (Upper) OSP	Aurora	n/a	Start in 07
Westerly Creek d/s of dam	Denver, Aurora	n/a	Start in 07

would like to order a printed three-ring binder for Volumes 1 and 2 we have a limited supply still in our inventory and you can purchase them by contacting our front office. Each chapter is marked with the revision date and I encourage you to check for the latest updates. This year we posted several updated chapters to Volumes 1 and 2 as well as many of the figures in the Manual in AutoCAD format. Each update of the manual is accompanied by an update of the supporting spreadsheet, if one exists.

Software and Criteria Manual Users Support Group

To help us support the Criteria Manual and the District's supported software and spreadsheets we set up a user group with a website address titled: *UDFCD Computational Tools and USDCM Support Group* at <http://groups.google.com/group/UDFC-D-support>. We will post notices

through it whenever a new version of the spreadsheets, software or Manual updates are uploaded to the District's web site.

In setting up this support group we are looking forward to a free exchange of ideas by users and questions they may have. Through it you will be able to share any problems you encounter in the use of the software or spreadsheets or in understanding of the recommendations in the Manual. In other similar user support groups, many of the solutions and "fixes" are suggested by the users themselves. Regardless, if they are posted, we will be able to address them should the need arise. It will also provide us an vehicle to reach Manual holders and software and spreadsheet users with suggestions on how to address problems they encounter or questions they may have.

If you have not already done so, go to the above “groups” website and sign on. We suggest that you check the option to receive one of the e-mail formats to stay in the loop with notices and current developments. It is a simple matter to delete the ones that you are not interested in, but unless you get these e-mails, you may miss important announcements or information.

District’s Software

As reported last year, we have completed our effort to integrate the District’s *CUHP* software with the new, Windows-based, EPA *SWMM* 5.0. To download EPA’s *SWMM* software free of charge go to the EPA’s web page <http://www.epa.gov/ednmrml/models/swmm/index.htm>. To download the District’s new *CUHP* 2005 go to our website at www.udfcd.org and then select “Downloads” followed by “Software”.

We continue to examine the *CUHP* model, especially how it simulates surface runoff from smaller catchments. By early 2007 we are hoping to have completed that task and have an updated

version of the *CUHP* 2005 software available for your use.

Ken MacKenzie has authored more refinements to the spreadsheets for the design of stormwater inlets, analysis of street flow (*UD-Inlet.xls*), open channels (*UD-Channels.xls*) and detention basins (*UD-Detention.xls*). If you have not yet had a chance to download these spreadsheets or others, I urge you to do so.

Ken, in cooperation with many cities and counties within the District, has also been working with Colorado State University to do scale modeling for the types of inlets used in the Denver region. We hope this will improve on the design guidance that is in practice today. CSU’s progress has been slow, but we hope to have this testing program completed in 2007.

In addition to the above, new versions of *UDPOND* and *UDSEWER* that contain corrections and updates, including a profile plotter for the latter, are now available for downloading.

District’s Annual Seminar

According to those who attended, our April 11, 2006 seminar was a success. We had over 250 registrants, with over 240 actually attending. The proceedings are available for download from: <http://udfcd.org/conferences/conferences.htm>.

On February 20, 2007 we will have our next annual seminar. The program is still in development, but we know that it will be at the Stapleton Doubletree Hotel and the registration fee will be \$50.00. Register early and join us. We promise you a diverse and timely program.

Denver has updated its Stormwater Design and Technical Criteria

Denver’s Wastewater Management Division and the District have cooperated to update Denver’s *Stormwater Design and Technical Criteria*. The consultant, Wright Water Engineers, Inc., has completed this effort and the manual is now available through Denver’s web site.

Bradshaw, Williams Join District Staff



Darren Bradshaw has joined the District as a Construction Manager in the Design, Construction and Maintenance Program and he will be assisting with projects in the South Platte River. His previous experience has been in the private sector with Sellards & Grigg, Inc. where he spent the last seventeen years serving as a Senior Designer.



Joe Williams, Jr. has joined the District as a Construction Manager in the Design, Construction and Maintenance Program and he will be assisting with projects in Arapahoe County. Joe previously worked for the District from 1982-1985 when he was a college student. Joe has a B.S. in Civil Engineering Technology from Metropolitan State College of Denver. He has spent the last twenty years working as an Engineering Inspector for the City of Littleton. We feel very fortunate to have Joe back at the District.

Floodplain Management Program Notes

By Bill DeGroot, P.E., Manager, Floodplain Management Program

A Day at the District

On Wednesday, October 18, 2006, the National Association of Flood and Stormwater Management Agencies (NAFSMA) and the District, in cooperation with the Federal Emergency Management Agency (FEMA), held an event called "A Day at the Urban Drainage and Flood Control District". The event was held in the District's board room.

This event was structured to present how the District implements its comprehensive floodplain management effort, and how FEMA's Cooperating Technical Partner (CTP) program has assisted the District in its mission. The program started with an overview of the District's programs. That was followed by a discussion of the District's experience as a CTP and how that was integrated into the District's programs. That was followed with a presentation on Map Modernization.

There were also live on-line demonstrations of the Mapping Information Platform (MIP) and DFIRM tools. The final part of the day included a presentation of NAFSMA's "Guidance for Municipal Stormwater Funding," a round table question and answer period and a reception, where one-on-one and small group discussions continued. Program materials are available at www.nafsm.org.

Public Information Program

For the past 25 years or so we have annually mailed flood hazard information brochures to addresses located in or near 100-year floodplains delineated by the District. Each brochure was site specific and included a map of the floodplains for usually one, but sometimes several, drainageways using USGS quadrangle maps at a scale of 1" = 2000'. Each brochure included specific information about the drainageway(s), sources for the floodplain information, local government contacts and phone numbers, and information about flood warning plans if they exist for the drainageway. Also included was

standard language about flood hazards, flood insurance and a section on "What can you do?"

This year we made a significant change in the format. We still mailed brochures with all of the same information described above and tailored to a small number of drainageways each. However, instead of a map of each drainageway we included instructions on how to access a floodplain map on our web site using an address search engine to show floodplains on a photo background and a star on the requested address. The floodplain map is a compilation of all of the digital floodplains developed for completed or nearly completed Digital Flood Insurance Rate Maps (DFIRM's)

See Bruce Rindahl's excellent article elsewhere in this issue for more information on the technical aspects of this effort and first year results.

Floodplain delineation

We completed two flood hazard area delineation (FHAD) studies this year: Clear Creek through Adams County and Massey Draw and SJCD (South) in Jefferson County.

We have FHADs underway for Clear Creek in Jefferson County, Dutch Creek and Tributaries in Jefferson County, Lower Lena Gulch in Wheat Ridge and Hoffman Drain in Adams County and Thornton.

All of these studies are prepared in digital form compatible with FEMA's DFIRM specifications, and have been or will be incorporated into the appropriate DFIRMs.

DFIRM conversion projects

In 2004 we received FEMA DFIRM conversion grants of \$480,000 each for Adams County and Arapahoe County. The District has contributed \$70,000 for each county and the Colorado Water Conservation Board has contributed \$50,000 each.

The contractor for Adams County is ICON Engineering, and for Arapahoe County it is Merrick and Co.

Unfortunately, both projects have taken longer than anticipated, due primarily to the lack of backup data the Michael Baker Jr., Inc. library has been able to provide to us. We have had to scramble to find other reliable sources and this delayed the process. This was particularly true for Arapahoe County, where we had the additional problem of integrating Aurora and Littleton into the map.

The effective date for the Adams County DFIRM has been established at March 5, 2007. We are still hopeful that Arapahoe County will go effective in late 2007.

In 2004, the District received a \$240,000 grant from FEMA, to be matched by \$30,000 each from the District and CWCB, to convert the Jefferson County DFIRM to the NAVD 88 datum. This is not enough money to complete all of the required work and publish new panels, but it is a good start. The contractor is ICON Engineering

While we are at it we will use digital flood hazard area delineation study reports completed or underway to supplement or replace older data sources in the DFIRM. This will include Ralston Creek, Leyden Creek, Massey Draw and North Tributary, SJCD (South) and Tributaries, Clear Creek, Lena Gulch and Dutch Creek and Tributaries.

The Boulder County DFIRM conversion project, which is being managed by the CWCB has also been delayed, but should go effective sometime in 2007.

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 33 communities within the District that are participating in the National Flood Insurance Program. We

begin 2007 with a new grant to continue the project. Our final reports to FEMA on the results of the first four years are available on our web site. The fifth year report will be posted in early 2007.

We completed a second DFIRM maintenance pilot project, this time concentrating on incorporating new LOMRs into DFIRMs, and being able to quickly and economically print revised paper maps. This is in recognition that some communities and individuals still want paper products rather than digital ones. Our reports to FEMA on both pilot projects are on our web site.

Maintenance Eligibility

Our maintenance eligibility program continues to flourish under David Mallory's direction. See David's column elsewhere in this issue.

Implementation efforts

Implementation of portions of our master plans, particularly regional detention facilities, is always a challenge. We completed execution of an Intergovernmental Agreement (IGA) with Denver and Aurora regarding the implementation of regional detention

facilities in the Upper Second Creek watershed. We have also negotiated an IGA with Denver and the Rocky Mountain Arsenal (RMA) for the construction, operation and maintenance of a number of facilities on the RMA. That agreement is in the signature process.

We saw significant progress in the Irondale Gulch watershed in 2006. This is a particularly difficult area because there are no readily apparent major drainageways, and the entire drainage system has to be created from scratch. Two regional detention facilities were constructed and a third was underway. Also, approximately 9000 feet of open channel were constructed. Most of the facilities were constructed by developers who will be reimbursed for their efforts through drainage impact fees.

FasTracks Coordination

We continued to work closely with the Regional Transportation District (RTD) on their FasTracks project to add over 100 miles of new light rail, commuter rail and bus rapid transit corridors to its system.

The first corridor scheduled for implementation is light rail along the West Corridor. Portions of the alignment involve the South Platte River, Lakewood Gulch and Dry Gulch. We have identified three master planned projects that we will implement, in cooperation with Lakewood and Denver, with or ahead of the rail construction. We also recently completed our comments on RTD's 65% design drawings.

We are also working with RTD and their consultants on environmental impact statements for three other corridors.

Check these out on our web site

We have a photo album showing what we consider to be good examples for others to emulate. We also have an Activity Summary map that identifies all District studies completed or in progress. We 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 Permitting Support Activities

By Ken MacKenzie, Senior Project Engineer, Master Planning Program

The District continued to be active in the stormwater quality arena in 2006, with commitments to the following organizations and activities:

Colorado MS4 Stormwater Group:

The District continued to host quarterly meetings to discuss stormwater issues in 2006. These meetings were open to all Colorado communities affected by the Clean Water Act, which requires permits for municipal separate storm sewer system (MS4) discharges. These meetings served as a forum to exchange ideas and experiences, set up workgroups, and report on accomplishments.

NPDES Phase I Joint Task Force: In 1990, the cities of Denver, Aurora, and Lakewood joined forces with the District to form the Joint Task Force (JTF). The three cities are "Phase I" MS4 communities under EPA

regulations because their populations are greater than 100,000. This group continues to work together on permit-related stormwater activities, including stormwater monitoring and assessing the effectiveness of management programs. The District, in cooperation with the U.S. Geological Survey (USGS), manages a storm-event monitoring program of the South Platte River and tributaries for the JTF, and in 2006 stream water was sampled for quality at five locations and during eight storms. This group is currently focusing on an operations and maintenance manual for stormwater Best Management Practices (BMPs), and is pursuing the creation of a program of scientific investigation by which new BMP technologies may be evaluated for site-specific appropriateness.

Colorado Stormwater Council: The District is pleased to support this newly

established organization of Colorado MS4 permittees. This Colorado non-profit will provide education for its members, aid in the development and implementation of stormwater programs at a local level, and a voice for its members when representation at regulatory hearings or other meetings of decision makers is warranted.

Structural BMP Testing: The District's program to monitor and test structural BMPs continued in 2006. Several storms were sampled at an extended-detention basin at Grant Ranch and at a porous-concrete pavement site in Lakewood. Design is currently underway for a new open-bed sand filter BMP for the Lakewood city shops, an industrial setting where the District has put many BMPs to the test over the past twelve years.

Design and Construction Program Notes

By Paul A. Hindman, P.E., Manager, Design, Construction, and Maintenance Program

In 2006 the Design and Construction program continued to assist local governments in designing and building many major flood control projects. Internally, we reorganized the programs which are described in an article found elsewhere in this *Flood Hazard News*.

Throughout the entire program, in 2006 we committed \$5.8 million to projects. As shown in the attached table, the Design and Construction Program continues to manage over 100 projects. Some have been ongoing for many years with multiple phases while others are just getting started.

This past year a couple of projects were of special note. The first project is the **Cherry Creek Open Space** in Arapahoe County. This project incorporated a new type of drop structure called a “Riffle” drop that was designed by Muller engineering. It mimics a mountain stream bed by using a variety of different types and gradations of rock, both fractured and cobble.

Several dignitaries were in attendance at the project opening festivities, which included a western barbeque and a mule wagon ride on a wagon path that was created as part of the project. Even the mules agreed that the project was a success.



Cal Hoffman with his mule train

The second project of note for 2006 was the **Van Bibber** project in Arvada. This was a joint project with the City of Arvada and the Corps of Engineers. It took over twenty (20) years to complete.

Status of Current District Design Projects

Project Name	Participating Jurisdiction(s)	Design Status (% complete)	Construction Status (% complete)	Construction Cost (X \$1000)
Adams County				
Brantner Gulch	Adams	20	0	
Cozy Corner	Westminster	2	0	
Dahlia/Kenwood Outfall	Adams	40	0	
Globeville Outfall	Adams	50	0	
Hoffman Drainageway	Adams	30	0	
McKay Pond	Adams	100	0	
McKay Pond: Outfall	Adams	100	0	
Niver-Trib L @ Pecos St.	Federal Heights	100	100	237
North Outfall - Baseline Road	Brighton	90	0	
Park Hill Outfall	Denver/ Commerce City	25	0	
Quail Creek	Westminster	10	0	
School Trib.	Thornton	100	0	
Silverado II Detention Pond	Aurora/Denver	100	10	906
Shaw Heights Trib.	Westminster	20	0	
South Outfall	Brighton	20	0	
Triangle Point	Adams	10	0	
Arapahoe County				
Big Dry Creek: Allen WTP LOMR	Englewood	95	NA	
Big Dry Creek Maintenance Trail	Englewood	50	0	
Cherry Creek: Drops #20 & #21	Arapahoe County	100	10	920
Cherry Creek Open Space	Arapahoe County	100	100	1,020
Cherry Crest West-Retrofit	Centennial	100	0	0
Goldsmith Gulch at Berry	Greenwood Village	20	0	
Granby Ditch Inlet	Aurora	100	50	
Holly Hills Detention	Arapco.	100	25	
Little Dry Creek at Arapahoe Road	Centennial	95	0	
Normandy Gulch	Columbine Valley	25	0	
Piney Creek: u/s of E-470 (Sampson Gulch)	Aurora	95	0	
Quebec / Iliff Outfall	Arapco	100	60	
Quincy Reservoir Drainage	Aurora	100	5	1,054
Sable Detention	Aurora	10	0	
Sand Creek	Aurora	100	99	4,100
Southwood Village Outfall	Centennial	90	0	
Utah Park	Aurora	100	15	
Boulder County				
Drainageway G-Phase 2	Louisville	90	0	
Detention Facility No. 1026	Erie	90	0	
Detention Facility No. 1045	Erie	100	40	
Elmer's Two Mile Greenway Project Phase I	Boulder	50	0	
Reach BP20	Erie	90	0	
Valmont Bridge on South Boulder Creek	Boulder County	100	100	1,591
Wonderland Cr.-Boulder White Rock	Boulder	30	0	
Wonderland Creek Diagonal Hwy	Boulder	100	50	
Broomfield County				
City Park Drainage	Broomfield/ Westminster	15	0	

A big thanks to Ken MacKenzie of our staff who persevered through the final design and construction of the project. On the next page are several pictures of the completed projects.



Riffle drop on Cherry Creek



Congressman Bob Beauprez speaks at the Van Bibber Creek project ground breaking ceremony

Project Name	Participating Jurisdiction(s)	Design Status (% complete)	Construction Status (% complete)	Construction Cost (X \$1000)
Denver County				
30th & Magnolia Phase II	Denver	100	25	
Cherry Creek: Drop No. 24	Denver	100	100	360
Globeville / Utah Junction-Phase 1	Denver	100	0	
Goldsmith Gulch Retrofit	Denver	75	0	
Harvard Gulch/University-Hills-Phase 1	Denver	75	0	
Fastracks-Denver	Denver	65	0	
Lakewood Gulch: 10th Ave. bridge retrofit	Denver	100	100	275
Lakewood Gulch: Tennyson - Sheridan	Denver	50	0	
Lakewood Gulch: Wolff Bridge	Denver	75	0	
Montclair OSP	Denver	75	0	
Park Hill Phase III	Denver	100	50	
Douglas County				
Cherry Creek: Apache Plume	Parker	100	100	908
Cherry Creek: Stroh Ranch	Parker	100	0	
Happy Canyon Creek-Phase 2	Douglas County	90	0	
Newlin Gulch @ W. Parker Rd.	Douglas County	100	25	
Jefferson County				
Arvada Channel	Arvada	100	0	
Coyote Gulch	Lakewood / Jeffco	50	0	
Drainageway B	Lakewood	100	80	1,670
Drainageway G	Jefferson	10	0	
Fastracks-Lakewood	Lakewood	40	0	
Hays Lake Outfall	Arvada	100	100	118
Kenney's Run	Golden	100	100	2,000
Lakewood Gulch-Welchster Park	Jeffco	100	0	
Lena Gulch: 10th Ave. through Orion St.	Jefferson County	100	100	982
Lena Gulch-Isabell	Jeffco	95	0	
Raccoon Creek	Jeffco	95	0	
South Lakewood Gulch: CCU Detention Pond	Lakewood	100	100	1,140
Van Bibber	Arvada	100	95	9,174
Other Projects				
Storm Sewer Inlet Study	All	80	NA	



The Van Bibber Creek project was very complex, requiring the use of grass-lined channels, vertical wall channels and a large box culvert.

Maintenance Program Activities

By Mark R. Hunter, P.E., Manager, Maintenance Program

The Urban Drainage and Flood Control District (District) Maintenance Program budgeted a total of \$6.8 million in 2006 to maintaining publicly-held drainageways in the Denver metropolitan area. Our maintenance work covers the spectrum of drainageway work. It includes debris pick-up and mowing, localized repair to damaged and eroded channels or detention facilities, and consultant-designed reconstruction of long reaches of deteriorated drainageways.

Most of the drainageways we maintain have been improved in the past as part of a subdivision development or a capital improvement project. They are typically open channels with native-grass-lined banks, riprap or vegetative erosion protection, and rock or concrete grade control structures.

Mowing and Debris Pick-up

For the year 2006 we awarded eight contracts for debris pickups and native-grass mowing under our routine maintenance program. Three of those contracts were awarded as renewals of the prior year contract. The value of each of these renewed contracts was adjusted to match the change in the regional Consumer Price Index over the prior year. The other five contracts were awarded through a competitive bid process in March.

Mowing and debris pick-up work was done on 275 different sections of urban native-grass-lined drainageways within the District's boundaries. The contractual value of the work was \$757,525. The table below summarizes the miles of drainageways within each county in the District

Routine Maintenance Summary for 2006

Adams County	20.9 miles
Arapahoe County	40.8 miles
Boulder County	17.6 miles
Broomfield County	0.2 miles
Denver County	44.4 miles
Douglas County	12.3 miles
Jefferson County	34.1 miles
TOTAL	170.3 miles

on which we performed regularly scheduled mowing and/or debris pickup maintenance.

Construction Activities

Through October of 2006, \$4,457,000 of maintenance work has been performed under our various construction contracts. The smaller projects typically address isolated drainage repairs where the construction will cost from a few hundred dollars up to \$400,000. Within this cost range ninety-nine individual activities have been completed or are under contract with our "Drainageway Contractors." Smaller work items in this category of work are directly awarded to individual contractors. The larger projects are bid among all contractors from our group of eleven contractors who have qualified for open-ended contracts with the District. A major advantage of work under the open-ended contracts is the ability to use them to react quickly to local drainage needs.

When project construction will cost more than \$400,000 the work is designed by a private consultant and then put out for public bid to be built by a private contractor. These larger projects typically address severe problems that have occurred on previously improved urban drainageways. Seventeen large projects were at various stages of design or construction during 2006. Our major projects for the year are summarized in the accompanying table titled "STATUS OF MAJOR MAINTENANCE PROJECTS."

Channel Repairs

High water on **Massey Draw** in 2004 caused damage to the channel downstream of the area that experienced the flooding conditions. Part of the length of the channel had been improved in the past and received little damage. However, damage occurred further downstream once the flood waters encountered an unimproved reach of channel. Most of the channel is tucked between the backyards of residences. The most severe locations

were repaired shortly after the damage occurred. A longer reach of the channel was designed with drop structures to reduce the gradient of the creek. Construction of this work is nearly complete.

The City of Lakewood has residential areas similar to the area described above where the drainageway is pinched between rows of residences. A section of **Lakewood Gulch** west of Garrison Street suffers from this narrow configuration. The result has been infrequent maintenance and it made the reconstruction of the channel difficult and expensive due to the poor physical access. The channel alignment had changed over the years such that additional easements were acquired by Lakewood in order to contain the channel.

Some reaches of drainageways don't respond as expected to erosion control treatments. The situation is compounded when multiple channel elements are modified during a series of major reconstructions. The Reach of **Goldsmith Gulch** between Iliff Avenue and Yale Avenue has seen many changes over the last 25 years. During the subdivision phase the channel was given a very linear earth-lined configuration. A few years later the whole reach was riprap lined followed shortly by the inevitable impacts from a new sewer line paralleling the channel. Spot repairs were done until the full reach was reconstructed in the early 1990s. The longitudinal grade appears to be flat enough, yet these new improvements eroded and secondary channels formed. Spot repairs have continued with little success. The area is again under study, including the detention pond and box culvert entrance at the lower end of the reach. The project will stabilize the channel and insure that the corridor remain accessible to the neighborhood.

Multi-purpose Projects

In last year's *Flood Hazard News* we described several projects where we had cooperated with other local

governments to fund multi-purpose projects. Since drainageways and parks often share the same corridor the repair of damage can be a combined effort.

West Harvard Gulch at Clay Street was completed in mid-2006. The narrow park corridor left little room for the incised channel. The coordinated project resulted in a well-reinforced open channel with a comfortable and attractive parallel trail.

Sanderson Gulch at Florida Avenue presented unique opportunities for a multi-purpose project because it is not a narrowly confined drainageway. The extensive parks improvements included a better trail alignment, picnic and play areas, and many tree and shrub plantings. Some of the drainage features, including drop structures, were relocated to improve water flow as well as to accommodate the parks elements.

A patch of undisturbed indigenous prairie grasses and shrubs adjoins the proposed channel and trail work on **West Harvard Gulch** at the South Platte River. While we have been slowly moving forward with the right-of-way acquisition and final funding arrangements we have been able to protect the legacy vegetation area from the churning wheels of dirt-bikes. In anticipation of the final project we have used our "Drainageway Contractors" to install fencing, and reconfigure parts of the trail.

Multi-purpose projects occasionally take us into irrigated bluegrass parks. In Broomfield we used wrapped soil lifts reinforced with vegetation to provide low flow bank protection on **City Park Drainageway** south of Midway Boulevard. Since we were in an improved park a narrow concrete "mowstrip" was installed at the interface behind the upper soil lift to provide an edge strip for the bluegrass and a solid surface for mower wheels. Broomfield would like to continue with similar work on the same drainageway north of Midway Boulevard.

The linear corridors provided by drainageways are ideal avenues for neighborhood trails. The reconstruction of the drop structure immediately east of University on **Cherry Creek** includes

STATUS OF MAJOR MAINTENANCE PROJECTS

Project	Jurisdiction		Cost	Status
ADAMS COUNTY				
Big Dry Ck, Cozy Cnr Trib – 116 th Av. & Sheridan. Repair channel and pond	Westminster partic.w/ Westy	Design	local gov	70%
		Const	next year	0%
Line B – S. Platte River to Southern St. Build drop, remove substantial sediment	Brighton partic.w/ Brighton	Design	26,000	90%
		Const	next year	0%
Niver Creek – York St. at Coronado Pkwy. Remove sediment and repair pipe outfalls	Adams County	Design	24,683	100%
		Const	169,870	100%
ARAPAHOE COUNTY				
Big Dry Creek – B'dway to Littleton Blvd. Trail const. and assoc. bank protection	Littleton partic w/S.Suburb	Design	local gov	100%
		Const	86,112	100%
Greenwood Gulch – W-Monaco&Orchard. Rebuild drop structure and regrade chanl	Centennial	Design	41,440	100%
		Const	89,500	100%
Greenwood Gulch – E.-Monaco&Orchard. Build drop structures and repair erosion	Centennial	Design	50,000	50%
		Const	next year	0%
Little Dry Creek – East of Colorado Blvd. Local small drops and channel repair	Centennial	Design	81,768	100%
		Const	280,875	80%
Westerly Creek – Alameda and Havana. Clean and regrade sediment trap	Centennial	Design	in-house	100%
		Const	92,752	100%
BOULDER COUNTY				
Coal Creek – Centaur Village&S.Bldr Rd. Remove sediment/debris and thin trees	Lafayette	Design	in-house	100%
		Const	28,500	100%
Dry Creek #2 – N.E. of 55 th St. & Arap. Replace 3 broad drop structures	Boulder	Design	100,204	100%
		Const	341,517	100%
Rock Creek – Farm west of Hwy. #287. Channel repair, drops, trails, and plants	Boulder County partic.w/Bldr Co	Design	76,178	100%
		Const	831,835	100%
BROOMFIELD COUNTY				
City Park D'way – Emerald to Midway. Channel and bank repair	Broomfield	Design	71,919	100%
		Const	295,036	100%
DENVER COUNTY				
Cherry Creek – University south of 1 st Av. Rebuild drop and improve trail	Denver partic. w/ Denver	Design	39,990	70%
		Const	560,000	0%
Cherry Creek – U/s Havana & Hampden. Rebuild large drop structure	Denver partic. w/ Denver	Design	52,000	50%
		Const	418,000	0%
Goldsmith Gulch – Iliff to Yale at Monaco Repair channel, trash rack and det. pond	Denver	Design	87,239	75%
		Const	next year	0%
Sanderson Gulch – At Florida Avenue Repair banks and add & repair drops	Denver	Design	100,138	100%
		Const	885,862	100%
West Harvard Gulch – Platte R to Railroad Drops, channel repair, and trails	Denver partic. w/ Denver	Design	149,413	95%
		Const	857,377	0%
West Harvard Gulch – Zuni St. to Clay St. Corridor study, drops, channel repair	Denver partic. w/ Denver	Design	176,268	100%
		Const	572,000	100%
DOUGLAS COUNTY				
Big Dry Ck, Wildcat Trib – W of Quebec Sediment removal, curb, design sed. trap	Douglas County	Design	29,669	100%
		Const	48,817	100%
Big Dry Ck – SW of C-470 & Quebec Add a drop to protect upstream drop	Douglas County partic w/D.Water	Design	51,969	100%
		Const	72,611	100%
Tallman Gulch – At Siebert Circle Add 1 more drops to stabilize channel	Parker	Design	previous	100%
		Const	95,276	100%
JEFFERSON COUNTY				
Dutch Creek – SW Wadsworth,Coalmine Large sediment removal and a flood wall	Jefferson County partic w/Foothills	Design	in-house	100%
		Const	79,821	100%
Lakewood Gul – Garrison to Independence Drops and repair channel	Lakewood	Design	15,558	100%
		Const	380,526	100%
Massey Draw – NW Wadsworth & C470 Drops and channel repair	Jefferson County	Design	86,557	100%
		Const	442,627	85%
Massey Draw,N trib – S Chatfield-Allison Repair seep and eroded channel banks	Jefferson County	Design	65,907	100%
		Const	229,340	100%
Ralston Creek – At Ward Rd.& at Quaker Repair eroded local channel	Arvada	Design	in-house	100%
		Const	80,209	100%

re-routing the trail to accommodate a difficult bend in the alignment. The design phase, including easement

acquisition by Denver, is nearly done. Construction will occur in 2007.

Detention Ponds and Sediment Control

The hydraulic design of an urban drainageway is an effort to balance the sediment-generating capability of the basin with the sediment-carrying capacity of the drainageway. The sediment balance of a drainageway changes with the urbanization and maturation of the basin. The outlet of **South Urban Channel (Line B)** in Brighton has a relatively flat grade where it joins the **South Platte River**. The District and Brighton are currently designing the sediment removal and grade control for this reach. A similarly flat reach of **Coal Creek** near Centaur Village in Lafayette had accumulated sediment which resulted in dense tree growth. With the guidance of the parks department we removed the sediment and debris and thinned the trees.

During the past year the Maintenance Program removed significant sediment from the sediment traps on **Willow Creek** south of Dry Creek Road in Centennial and on **Westerly Creek** northwest of Havana Street and Alameda. These facilities are functioning as designed, but that also means they need to be maintained when necessary.

An established subdivision southwest of Wadsworth and Coal Mine Road in Jefferson County has a well-defined trickle channel to carry the base flows of **Dutch Creek**. Our recent sediment removal and channel regrading returned the flow capacity to the creek and left it more appealing and accessible to the neighborhood.

Grade Control

Last year we mentioned that drop structures can be damaged when the channel gradient downstream from the structure is steeper than its equilibrium slope and nature then tries to flatten that slope by eroding upstream. If enough elevation is available, the erosive power of the stream can eventually undermine the foundation of the drop structure. In the Town of Parker we built drop structures two years ago on **Tallman Gulch** south of Main Street to reduce the channel and bank erosion that was occurring. The drops are working as intended by protecting the channel upstream from each of them. However, the downstream structure was unprotected against erosion migrating upstream toward it. We returned to the project area and installed an additional drop structure that was

designed to accommodate erosion downstream.

We are half-way through the design of the rehabilitation of the tall drop structure on **Cherry Creek** upstream of Hampden Avenue and Havana. This drop is also suffering from downstream erosion that has migrated up to the structure. The new drop structure will accommodate the deeper downstream channel as well as the design discharge from Cherry Creek Reservoir.

A much smaller drop structure on **Greenwood Gulch** downstream of Monaco Way in Centennial was suffering from similar downstream erosion. The rehabilitated structure had an enlarged cutoff wall and deeper toe protection at its downstream end.

Upstream of Monaco Way a design is underway on **Greenwood Gulch** to stop the uncontrolled erosion. The project will likely include drop structures to reduce the erosive power of the creek by reducing the longitudinal gradient of the channel.



West Harvard Gulch in Denver east of Clay Street. In this mature neighborhood there was little option to this linear alignment. The drop structure will control the grade of the stream and prevent the channel from again becoming incised.



Sculpted drop on Sulphur Gulch



Grouted sloping boulder drop on Greenwood Gulch

Maintenance Eligibility Program Notes

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

Construction Plan Reviews

A large number of construction plans were submitted for review through the maintenance eligibility program again this year. Southeastern Aurora, northern Douglas County, and the northern I-25 corridor have attracted the largest development interest for both commercial and residential projects. We typically receive between 250 to 300 construction plan submittals each year from communities within the District. Terri Fead, PE, CFM continues to provide us with effective support in completing these reviews. She also assists in the LOMC pilot and DFIRM conversion projects. I'm happy to announce that she will be part of the maintenance eligibility program again next year. We updated the *Guidelines for Maintenance Eligibility of Flood Control Facilities Constructed by Others* in March of this year. The guidelines and project eligibility status by community are available online.

Floodplain Preservation

For many years, the District has advocated the concept of floodplain preservation. We believe there is a universal benefit in preserving natural floodplain functions. Channelizing major drainageways produces single purpose projects, namely flood conveyance, and contributes to the decline of stream corridors. We believe the first choice should be multi-function preservation and restoration projects that enhance stream corridor function. The multi-function approach works well with regional trail and open space goals, outdoor recreation, environmental preservation and of course flood control. Stream channelization should always be a second choice, and when necessary should replicate natural stream systems, meaning land dedication, ecology and surface treatment receive careful consideration. It is the District's desire to reach the development community early in the referral process with this message and foster a productive working coalition that includes the developer, community staff, Army Corps of Engineers (ACOE) and the District. We have been working with

many communities throughout the District in recent months to develop a "marketing brochure" for the development team to receive from the community at the beginning of the planning approval process. The brochure will go beyond the *Urban Storm Drainage Criteria Manual* to promote better concepts relative to development adjacent to floodplains. Through thoughtful consideration earlier in the process, the developer can approach floodplains as amenities and position the project for maintenance eligibility from the District and 404 permit approval from the ACOE. Michelle Leach with Prospectiva has been assisting the District with this initiative. We will provide a project update at the District's annual conference in February.

In last year's article, I reported that we are coordinating our maintenance eligibility reviews with the ACOE's 404 permit review process with very positive results. We have continued to build on that relationship with the ACOE throughout this year. In June, the ACOE issued a policy directive regarding development projects in floodplains. The ACOE is now considering avoidance of impacts to floodplains as part of its alternatives analysis for activities involving a discharge of fill into jurisdictional waters of the U.S. For projects where filling of an existing 100-year floodplain is proposed in order to increase developable land, the ACOE has counseled caution. The directive caused quite a stir from local governments and the development community. The District hosted a round table discussion to provide an exchange of ideas and get a better understanding from the ACOE regarding floodplain preservation. One detail that was not lost on the development community was the ACOE's interest in floodplain preservation is only applicable to projects that require a 404 permit. Consequently, one recent trend is avoidance of the 404 permit process altogether with the idea that necessary stream stabilization projects can be

permitted later by the public sector after the developer has completed his or her project, including floodplain encroachment. The ACOE has indicated this approach may well lead to an enforcement action. We support a resource driven approach that treats the major drainageway as an asset to enhance rather than a problem to avoid or cover up. We encourage project proponents to make land use decisions that respond to the stream corridor, work with communities, the District and the ACOE to develop projects that address all stakeholder issues. For projects that implement District master plans and represent sound floodplain management, it may be appropriate for local government and the District to join the application as co-sponsors. The 404 permit application will be much stronger with such an approach and much more likely to succeed. I believe some floodplain encroachment is possible provided proposals reflect avoidance / minimization / mitigation of impacts to waters of the U.S. and preserve the floodway and beneficial floodplain function. ERO Resources have an informative posting on their web site at www.eroresources.com. Obviously this is an issue we will follow throughout the next year as we work with the ACOE.

In the Field

A number of projects "drop off the radar screen" for a variety of reasons somewhere between the concept approval and construction acceptance. The maintenance eligibility program has always offered a means to conduct after-the-fact reviews and acceptance for projects that meet District design criteria. Early this year, Douglas County decided to catch up on old projects in Highlands Ranch. Turns out there were scores of projects that never received design approval and/or construction acceptance. In May, Brian Schultz with Douglas County inspections and I started going through the list. We spent an average of two days a month doing field inspections of these old projects. Many sites had not been touched in 10 to 15 years. Brian researched old projects, dug up as-built

plans, and previewed the sites ahead of my visit. It's amazing how much vegetation is supported with a little water over several years. A number of storm sewer outfalls were really tough to find after all these years and all that growth. We were able to close out nearly 90 old projects with this initiative. I really appreciate Douglas County's efforts in closing these old projects. The next question is how do we find these sites again in the future when its time to perform maintenance? Douglas County will initiate a GIS location project next year. We are talking to them about importing that



Douglas County inspector Brian Schultz on the hunt for forgotten drainage projects in Highlands Ranch.

information into our GIS system in order to facilitate future maintenance efforts.

One interesting discovery was the condition of Dad Clark Gulch East Tributary between Summit View Parkway and Wildcat Reserve Parkway. Planned grade control structures between Pond 5 at Summit View Parkway and the outlet treatment at Wildcat Reserve Parkway were deferred until a later date. The stream reach experienced severe erosion resulting in several feet of scour into bedrock and heavy deposition in the pond. The accompanying pictures show the grade control structure installed with the Wildcat Reserve Parkway project.



Grade control structure located downstream of the Wildcat Reserve Parkway crossing culvert and impact basin. The degradation at structure face is 7 feet with another 3 feet in the plunge pool.

Notice stable channel between the culvert impact basin and grade control structure. The downstream condition is quite different. Imagine what the impact basin would look like without the grade control structure. The

message is clear; grade control structures protect stream systems.

That's all for this year. Be good and stay out of the floodplain.



Looking downstream over the grade control structure. Notice the severe erosion, 4 to 6 feet into bedrock.

Flood Warning Program Notes

By Kevin G. Stewart, P.E., Manager, Information Services and Flood Warning Program

This past year (*being the 30th anniversary of the Big Thompson Canyon flash flood*) brought the District a more normal flood season with 37 threat days, of which 27 days realized their potential by generating at least one heavy downpour. This statistic is in sharp contrast with the prior 4-year period of more drought-like conditions. While a few localized floods did catch the attention of the media, no major damaging flood occurred in the District in 2006. Our neighbors to the south in Douglas County were not as fortunate, having experienced a devastating flash flood in the area impacted by the 2002 Hayman Fire (see July 7 narrative).

37 Days with Flood Potential

May	22,31	2
June	21,24-25	3
July	2-10,17-18,20,25-26,31	15
August	1-3,6-7,11,13-14,18-19,21, 25-26	13
September	1,9-11	4

Boulder Flood Exercise-Largest Ever

Last year's issue of *Flood Hazard News* described the impact Hurricane Katrina had on disaster planning for this region. The 2006 annual Boulder Creek flood exercise was a testament to this. Efforts began early to prepare for what turned out to be the largest flash flood exercise ever held in Boulder. It should be noted that the community of Boulder, including the County and CU, have held annual flood exercises since the late 1970's and have long recognized the threat posed by Boulder Creek.

The exercise involved a Big Thompson-like flash flood scenario for Boulder Creek. The main event was preceded by a tabletop exercise; GIS support training; and other orientation and planning meetings. The April 18 exercise involved a fully operational emergency operations center (EOC) in which 136 people participated and 15 emergency support functions (ESF) were tested. In the "field" other related activities happened simultaneously, like moving 1900 Boulder High School

students to upper floors, evacuating 200 patrons from the Boulder Public Library, vacating certain city buildings, simulating underwater rescues, establishing a backup EOC at CU, and testing response plans for area hospitals. At the EOC, a real-time storm/flood simulation permitted hands-on use of available technologies including radar, ALERT data displays, hydrologic model outputs, alarms, text messaging, paging, GIS inundation mapping and weather/flood messages from the NWS and HDR Engineering. Local news media were present, automated reverse-911 flood warning test calls were made, and warning sirens sounded.

AMEC Earth and Environmental was contracted to help plan, develop and facilitate the exercise. Other consultants assisted with storm and flood simulations. Participants judged the overall outcome a success. Congratulations to everyone who contributed so much and made this experience so valuable.

Flood safety website still evolving

The flood safety information website <http://floodsafety.com/colorado> initiated in 2003 continued to evolve in 2006. This cooperative effort features flood videos, testimonials, descriptions of past floods, aerial photographs, flood inundation maps and a media kit for use by local newspapers and TV stations. A feature length video production for possible PBS broadcast is anticipated for 2007. The award-winning website designer and journalist, Marshall Frech, attracted the attention of The Weather Channel in their filming of the "It Can Happen Tomorrow" episode that features Boulder's flash flood vulnerability. The program premiered in February.

CoCoRaHS update

The District has been a CoCoRaHS sponsor since 2002. For information about how this valuable program performed during 2006, be sure to read the article written by Colorado's State Climatologist, Nolan Doesken. To view a combined display of CoCoRaHS and

ALERT daily rainfall totals visit: www.lrcwe-data.com/CoCoRaHS.svg.

EMWIN-Denver update

EMWIN is a National Weather Service satellite downlink/rebroadcast system that stands for Emergency Managers Weather Information Network. It allows communities to develop their own unique applications including civil emergency messaging. This low-cost system became operational early in 2006. A public website that provides access to NWS text and graphical products will be available soon. More information about this project can be found at <http://emwin.udfcd.org>.

ALERT System News

The District's 177-station ALERT system includes:

- 153 rain gages
- 87 stream gages
- 18 weather stations
- 7 Repeaters
- 6 base stations
- 3 web servers

Four new stations were added to the network in 2006: Sand Creek at Colfax (rain/stream); Boulder Creek at Broadway (stream); Boulder Creek at Green Ditch (stream); and the Marshall Test Site (rain). The Sand Creek station is part of Aurora's Upper Sand Creek basin flood detection network expansion project. The Broadway and Green Ditch stations were installed by the City of Boulder Water Resources Department for compulsory water rights monitoring of hourly flows, as well as flood detection. The Marshall rain gage is located in Boulder County at NCAR's (National Center for Atmospheric Research) field test site for precipitation gages. This will provide a unique opportunity to compare measurements from a standard ALERT rain gage with more sophisticated measuring devices and station configurations.

By spring of 2007, a new stream gage will be operational on Lakewood Gulch at 10th Ave. in Denver. System expansion projects are also anticipated for Aurora, Parker and Douglas County.

OneRain provided the 2006 field maintenance services for the 15th consecutive year. The Fort Collins engineering firm of Water and Earth Technologies provided monthly analysis of the District's ALERT database for quality assurance and control.

The ALERT system website continues to evolve. Be sure to read Chad Kudym's article to discover what's new.

Meteorological Support

Since 1979, the District's flash flood prediction program (a.k.a. F2P2) has provided flood threat notifications to District local governments from April 15 through September 15. HDR Engineering completed their sixth consecutive year of providing meteorological support in 2006.

The 2006 flood season

April, May and June passed with few noteworthy events. On June 21, an isolated storm in Douglas County west of Parker triggered the ALERT system's first rainfall rate alarm of the year, but no flooding was reported. Three days later (June 24), a Saturday afternoon storm pelted parts of metro Denver with golf-ball-size hail. Most of the metro area receiving half an inch of rain while Boulder was hardest hit. The Boulder County Justice Center rain gage measured 2 inches over a 20-minute period. Hail-clogged street inlets caused some minor flooding to businesses. Described as one of the worst hailstorms in decades, the Boulder area also picked up its average precipitation for the month in just over 30 minutes. Heavy rainfall was also measured in Lakewood at Maple Grove Reservoir and at Chatfield Reservoir in Jefferson County. That covers the news for the first half of the 2006 flood season.

By the end of June it was starting to look very much like another drought year for the region, but July changed that concern quickly. An early arrival of the Arizona monsoon occurred on July 2, causing a flash flood on Cherry Creek in the vicinity of Castlewood Canyon State Park in Douglas County. Messages were issued for the next 8 consecutive days, kicking-off the active second half of the flood season. This

week of monsoon rains caused annual streamflow peaks at many ALERT gages in the mountains of Boulder and Jefferson Counties.

Flash flood watches were issued by the NWS for July 3, 5, 8 and 9. Flash flood warnings were issued for July 2, 7 and 20, and August 1 and 3. The threat of heavy rainfall existed for 15 days in July, which is in sharp contrast to the previous July described as abnormally hot and dry with few thunderstorms.

The table lists the days in which ALERT rainfall alarm thresholds were exceeded during 2006. Heavy rainfall also affected the District on 14 additional days (May 31; July 7, 10, 17, 18, 26 & 31; August 2, 6, 11, 14, 21 & 26; and September 9). The following briefly describes some of the more notable events:

June	21,24
July	2,3,4,5,20
Aug	1,3,13,19
Sept.	10,11

Sunday, July 2

A remarkable flash flood on Cherry Creek was documented by the USGS with the assistance of a State Park Ranger. The USGS stream gage at Franktown recorded a 9-foot rise in less than 15 minutes. A post event analysis revealed that an isolated thunderstorm might have produced upwards of 7 inches in less than 2 hours. A CoCoRaHS observer near Franktown reported a 24-hour rainfall total of 4.28 inches. The flood washed out a number of small bridges in Douglas County downstream of Castlewood Canyon State Park. Because the area of storm was so small, the flood attenuated quickly causing no major problems in the District.

Rate alarms also occurred at 3 ALERT rain gages in Aurora and 7 stream gages recorded annual peaks in Aurora, Littleton and Arapahoe County (see



July 2, 2006 Cherry Creek flash flood at Castlewood Canyon State Park in Douglas County (Photo taken by Park Ranger)

peak flow table). Gun Club Road in Aurora was closed most of the evening between Alameda and Mississippi.

Monday, July 3

Aurora was hit for the second consecutive day with minor street and intersection flooding. RTD's light rail service in Denver was disrupted for about 20 minutes forcing crews to completely remove a train from its tracks.

The heaviest rainfall occurred in Douglas and Elbert Counties and parts of Aurora. The largest rainfall report of 3.14 inches came from a CoCoRaHS observer east of Sedalia. Rate alarms occurred at 6 ALERT rain gages (4 in Aurora, 1 in downtown Denver and 1 near Sedalia in Douglas County). Eight Aurora stream gages recorded annual peaks with a record peak noted for the Toll Gate at 6th Ave. station.

Tuesday, July 4

Independence Day was a weather-producer this year with nature contributing its own fire works. Denver and Arvada were the primary targets for heavy rainfall with many gages reporting more than an inch of rain. The Cherry Creek gage at Steele Street measured the greatest amount of 1.73 inches. Rate alarms occurred at 3 ALERT rain gages between 7:15 and 8:30 PM. The rainfall did not, however, prevent the anticipated celebrations from taking place. Five stream gages recorded annual peaks.

Friday, July 7

This day resulted in Colorado’s worst flash flood disaster of 2006. Large portions of State Highway 67 in the West Creek area of Douglas County were destroyed. The West Creek watershed is in the burn area impacted the 2002 Hayman fire that consumed over 138,000 acres. Photos and videos of the flood damage were reminiscent of the deadly Big Thompson Canyon flash flood that occurred on July 31, 1976. Estimated losses exceeded \$10 million.

Heavy rainfall also fell over the Bear and Turkey Creek basins and at Highlands Ranch in northern Douglas County. No flooding was reported from these areas.

Thursday, July 20

Heavy rains near Jamestown in Boulder County prompted the NWS to issue a flash flood warning. This area was affected by the Overland Fire in 2003 and has had repeated problems with mudslides. Rainfall alarms occurred at 5 gages in this area.

Tuesday, August 1

The heavy rains this day appeared to follow the C-470/E-470 corridor with amounts exceeding an inch at many locations. Aurora once again became the target for the highest totals, with one CoCoRaHS gage reporting 2.25 inches. Rate alarms occurred at 5 ALERT rain gages between 6:40 and 7:45 PM. Four stream gages recorded annual peaks.

Thursday, August 3

Leyden Creek experienced its largest flood in more than 25 years according to a Jefferson County official in charge of road repairs at Quaker Street where the creek overtopped the roadway by as much as 4 feet. Further upstream Leyden Road was also overtopped. The flood caused Leyden Lake to rise over 4 feet in just 4 hours. The spillway was not overtopped and no damages occurred downstream through Arvada. Improvements to the dam and spillway were completed by the District and the City of Arvada in 2001.

The Upper Leyden rain gage measured 2.91 inches in less than 2 hours. Rate alarms occurred at 4 ALERT rain gages.

Intense rainfall was also measured in the Lena Gulch basin.

Sunday, August 13

Multiple storms occurred during the evening hours causing the ALERT system to generate 11 rainfall alarms from 7 stations in Denver, Aurora and Golden between 8:15 and 10:40 PM. Annual peaks occurred at 8 stream gages on Harvard Gulch, Goldsmith Gulch, Westerly Creek and the South Platte River. This was another busy day for the ALERT system, but fortunately once again, no major damages were reported—just some nuisance flooding at a not-too-busy time of day. Consequently, this event attracted little media attention.

Monday, August 14

“On 17th Avenue, a river runs through it”...is how the front-page photo was titled on the August 15 issue of the *Rocky Mountain News*. The storm that caused the downtown Denver flooding dropped its rain right between the ALERT rain gages. Radar was the primary real-time observation tool and the early threat notification was issued well ahead of the storm. The Rocky reported that about 1.6 inches of rain fell between 4:10 and 5:00 PM in the Congress Park neighborhood, while other parts of the metro area received no precipitation.

One CoCoRaHS observer in the area measured 1.96 inches while nearby ALERT gages picked-up less than half an inch. This was probably the most remarkable bull’s eye street-flooder storm of the year. And once more, no major problems were reported.

Saturday, August 19

Denver was the primary target again with north Denver being the area hardest hit. Intense rainfall between 5 and 6 PM submerged a section of W. 38 Ave. at the railroad underpass near the Fox Street intersection. Public works crews responded quickly to this familiar flood hazard to make sure nobody fell victim to the deep floodwaters. A nearby CoCoRaHS observer reported 1.97 inches from this event. Heavy rains also fell at Tamarac Square causing some minor flooding along

Goldsmith Gulch. The side channel detention basin at Iliff filled to a depth of 0.3 feet and the ALERT stream gage at this location measured its annual peak.

More information about past storms and floods can be found on the bulletin board webpage at alert.udfcd.org.

2006 Peak Flows

Date/ Time	Location	Peak cfs Depth ft.
July 2 17:35	Confluence Pond on West Toll Gate Creek	1,030 Depth 3.6
July 2 18:10	Murphy Creek G.C.	TBD Depth 3.1
July 2 18:20	Horseshoe Park Drop/ West Toll Gate Creek	1,700 Depth 3.0
July 2 18:49	Powers Park on Slaughterhouse Gulch	0 spillway Depth 6.9
July 2 22:43	Englewood Dam on Willow Creek	160 Depth 19.0
July 3 20:01	Utah Park on Westerly Creek	156 Depth 3.9
July 3 21:13	Toll Gate Creek at East 6 th Ave.	* 3,720 Depth 8.5
July 3 21:15	Granby Ditch at East 6 th Ave.	38 Depth 6.3
July 4 00:54	Sand Creek at Mouth	1,230 GageHt 5.8
July 4 20:14	Ralston Creek at Carr Street	980 Depth 3.4
July 4 21:03	Cherry Creek at Champa Street	1,110 Depth 4.4
July 4 21:50	Goldsmith Gulch at DTC/Temple Pond	300 Depth 7.5
Aug. 1 19:08	No Name Creek at Quincy Ave.	220 Depth 3.6
Aug. 1 19:59	Holly Dam on Little Dry Creek	118 Depth 15.3
Aug. 3 18:19	Leyden Lake	0 spillway * Rise 4.2
Aug. 13 21:04	Harvard Gulch Park at Logan Street	620 Depth 5.3
Aug. 13 21:07	Montview Park on Westerly Creek	410 Depth 4.1
Aug. 13 21:35	Havana Park Detention Basin	76 Depth 7.0
Aug. 13 22:27	South Platte River at 19th Street	2,860 GageHt 6.8
Aug. 19 17:44	Goldsmith Gulch at Iliff Pond	500 Depth 5.1

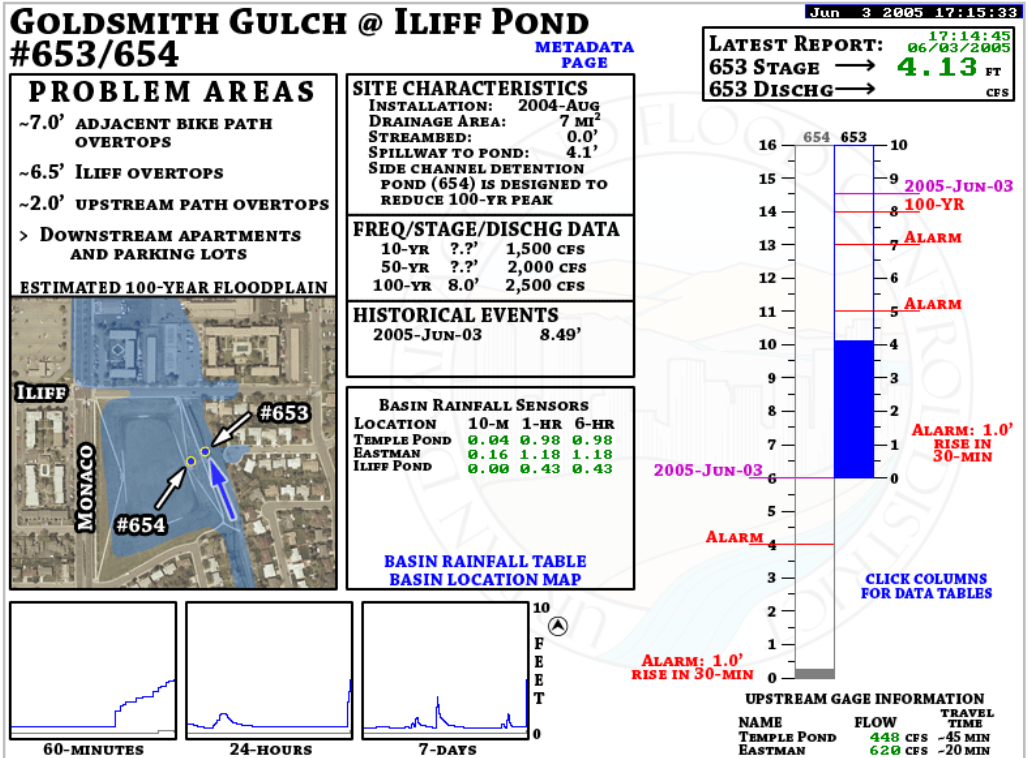
* New Record

ALERT Webserver Enhancements

By Chad A. Kudym, GIS Administrator, Information Services and Flood Warning Program

The Information Services and Flood Warning Program staff is routinely working on ways to improve access to ALERT data and create additional decision support tools. In 2006, the District's ALERT webserver was updated with new stream gage and weather station graphics for a select set of stations. The graphics include more data to help local governments make decisions about potential flood threats. This development will continue into 2007.

The new streamgage graphics (right), now include the following: problem areas, overview aerial map, site characteristics, frequency/stage/discharge information, historical events, basin rainfall data (including map and table links), adjustable-scale hydrographs (60-minute, 24-hour and 7-days), metadata page link, latest report data, staff gage illustration with labels (alarm settings, historical high water marks and frequency marks) and finally upstream and downstream gage flows (with estimated travel time). The overview aerial map illustrates the gage location and the extent of the 100-year

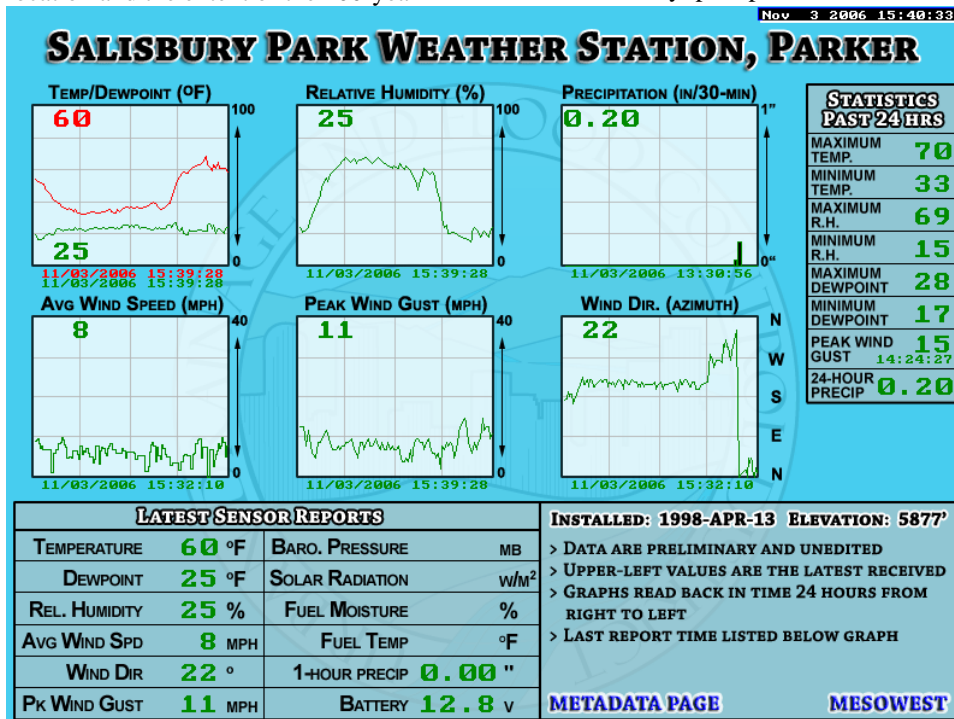


floodplain to help users assess the relative threat to life and property.

The new weather station graphics (below), display 24-hour trends for several sensors. The graphics include trend graphs for temperature, dewpoint, relative humidity, precipitation, wind

speed, peak wind gust, wind direction and barometric pressure (where available). The precipitation graph is a bar graph that displays a bar for each 30 minutes of accumulation. The graphics also include statistics for the past 24-hours and a section displaying the latest sensor reports. The date and time below each of the graphs displays the timestamp of the latest report to help users determine if the reports are recent. As with other graphics that users are familiar with, the weather station graphics include navigation features called "hotspots" that provide hyperlinks to a table of data reports for further data analysis.

Weather stations in the District ALERT network help provide information leading up to storm events. Often times the meteorologists in the Flash Flood Prediction Program provide specific criteria associated with the potential for storm development. Such criteria usually involve a temperature and dewpoint combination that will initiate convective activity. The weather station graphics will help users monitor surface conditions in their area in advance of storm development.



GIS Notes

By Chad A. Kudym, GIS Administrator, Information Services and Flood Warning Program

In 2006, the District completed a GIS master plan and started working towards several of the goals resulting from the plan. The main goal is to develop a GIS layer that includes all of the district drainageway centerlines, names, identification numbers and associated stationing using existing FHADs and Master Plans. The completion of this layer will provide a mapping context for many of the databases that are maintained by District staff. Without a mapping context it is often difficult to accurately relate adjacent projects from various District programs through time.

The Floodplain Management Program utilized GIS in 2006 to develop a new

method of informing residents of their flood risk (see article by Bruce Rindahl). The District worked with Leonard Rice Engineers to implement an internet mapping site for floodplains. The site includes a function to input an address and zoom to that area to view the best available floodplain information. The floodplain layer is a mosaic of DFIRMs, FHADs, LOMRs and other sources of mapping. A link to the floodplain mapping site can be found on the District's homepage.

District student interns continue to use GIS as a basis for their routine maintenance documents. The documents are made up of map pages

with aerial photography backgrounds and GIS layers representing debris limits, maintenance limits and other data to help contractors.

In 2006, the District invested in new computer hardware to centralize GIS software and associated data. The new hardware also automates data backup to protect the data. Centralized GIS processing will also help standardize data access for better sharing between District programs.

IT Infrastructure Improvements

By Chad A. Kudym, GIS Administrator, Information Services and Flood Warning Program

This past year brought significant changes for the District IT infrastructure. After researching hardware and configuration options, the District made a big step towards centralized data storage and protection in early 2006. The new infrastructure includes two central servers, a RAID disk array, tape backup and offsite storage and recovery. The new configuration protects our computer filing system and staff email archives while providing a platform for coordination between District programs.

Some staff members, such as Paul Hindman, used the upgrade as an excuse

to clean out their email archives and backlog (ok, so maybe it wasn't intentional). If you haven't seen an email from Paul in a while, you might want to resend your contact information.

The process wasn't as "seamless" as we had hoped. The upgrade wasn't cutting edge, but it provides a much safer repository for District data.

During 2006, District staff also worked towards developing an online digital library. The Design, Construction and Maintenance Program finished a project that included scanning all mylar as-built drawings into PDF format files. The

scanned as-builts combined with scanned reports and hydrology and hydraulics modeling files will eventually make up the contents of the District Digital Library.

The Digital Library will reside online to provide local governments, District consultants and residents access to materials that were previously only available in the District library or by contacting District staff to make a specific request. The Digital Library will help save time for both District staff and persons requesting information.

Ben Urbonas Receives a Lifetime Achievement Award

The Environment and Water Resources Institute of the American Society of Civil Engineers presented a Lifetime Achievement Award to Ben Urbonas of our staff at their annual meeting in Omaha in May, 2006.

He was one of three to receive this award from the 40,000 member organization. The other two recipients were William H. Espey and Daniel A. Okum. The inscription on the award reads: "In recognition for a life-long and eminent contribution to the environmental and water resources

engineering disciplines through practice, research, and public service."

The Board of Directors of the Urban Drainage and Flood Control District recognized the contributions Ben has made to the District and his profession, and congratulated him on receiving this award, and, in June, passed a resolution to that effect. Congratulations Ben!



Ben, describing how the boat chute at Confluence Park was designed and built.

CoCoRaHS: valuable precipitation data for the District

By Nolan Doesken, Colorado State Climatologist

Local residents, with precision rain gauges in their yards, are providing valuable assistance for District rainfall monitoring and flood warning activities. During 2006, over 400 volunteers from 8 counties in and around the Denver metro area submitted 85,000 individual rainfall reports. The largest one-day rainfall report from this region occurred on July 3 just east of Sedalia where 3.14" fell.

CoCoRaHS; the Community Collaborative Rain, Hail and Snow Network; is a "Citizen Science" project coordinated by the Colorado Climate Center at Colorado State University (CSU). The project originated in northern Colorado as the result of the devastating flash flood that hit Fort Collins in July 1997. The storm dropped over 10" of rain in 5 hours and over 14" in just over 24 hours in parts of Fort Collins. This was the most rain ever documented within an urbanized area in Colorado. Meanwhile, just a few miles away, less than 1" of rain was reported. Since that time hundreds of volunteers have been recruited by CSU climatologists to help track and report storms.

The network of northern Colorado volunteers expanded into the Denver area in 2002. Since that time, the District has provided annual support to increase volunteer participation in CoCoRaHS and improve data quality and availability for the Denver area. Since 2002, nearly 1000 volunteers have joined the CoCoRaHS effort in the Denver area. Some participate for a few months while others have stuck with the project since the beginning. More volunteers are needed each year to maintain a high-definition rainfall observing network. In 2006, 49 new volunteers joined the CoCoRaHS team in the Denver area. Statewide, a total of 3,600 volunteers have participated since the project first started in 1998.

Summary of 2006 precipitation

This year got off to a dry start with much below average precipitation over much of Colorado during April, May and June. But as July began, weather

County	Max 1-day rainfall	Date	Location
Adams	1.35"	7/ 9/2006	Northglenn 4 NNE
Arapahoe	2.25"	8/ 2/2006	Foxfield 3 E
Boulder	1.64"	6/25/2006	Boulder 1 NW
Broomfield	1.08"	8/14/2006	Superior 3 E
Denver	1.97"	8/20/2006	Denver 3 NW
Douglas	3.14"	7/ 4/2006	Sedalia 2 E
Jefferson	1.70"	8/ 4/2006	Ralston Buttes
Nearby Counties:			
Clear Creek	1.77"	8/20/2006	Idaho Springs 2 WSW
Elbert	1.85"	8/27/2006	Elizabeth 10 NNE
Gilpin	1.37"	7/ 9/2006	Rollinsville

patterns changed and several significant storms were reported, particularly over the southern and eastern portions of the Denver metro area. The fall was cool with a few storms. One of the larger precipitation events of the year occurred on October 26th with several inches of very wet snow over the entire metro area.

Rainfall Extremes for 2006

As is almost always the case, heavy rains were spotty and localized during 2006. Compared to some years, large events were relatively infrequent and not excessive. Still there were several very significant heavy rain events.

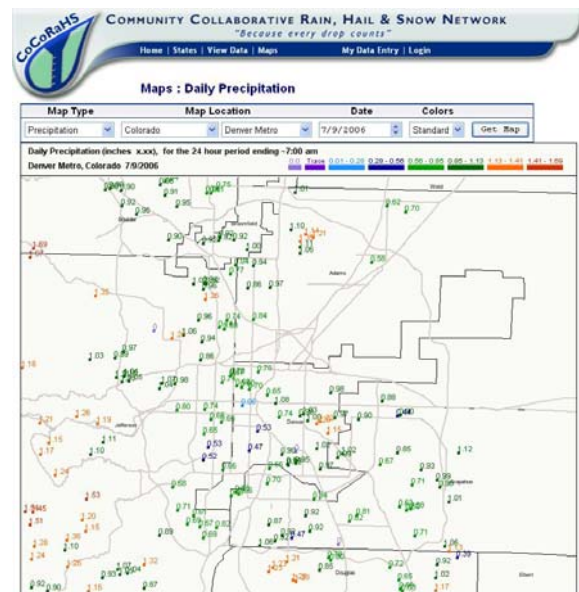
The table above shows the greatest one-day rainfall from CoCoRaHS observers in each county in or near the District area during 2006. Precipitation totals are for the 24-hour period ending at 7AM of the date shown.

When averaged over the entire Denver metro area, the wettest day of the year (using 24-hour CoCoRaHS precipitation totals ending at 7 AM each morning) was July 9 with a regional average of nearly 1-inch. That was a gentle, soaking

rain with only modest urban runoff.

More volunteers needed

More CoCoRaHS volunteers are still needed. Storms that produce high-intensity rainfall are often quite localized, and an ideal network would consist of at least one rain gauge per square mile over the entire Denver metro area and tributary watersheds. If you would like to help track our fascinating and highly variable storms, visit the CoCoRaHS website at www.cocorahs.org and click the "Join CoCoRaHS" button. Volunteer coordinators throughout the Denver area are ready to help get you set up!



Daily precipitation map. For a readable version go to www.CoCoRaHS.org

South Platte River Notes

By Bryan Kohlenberg, P.E., Senior Project Engineer

In 2006 the South Platte River Program officially joined forces with the District's Design and Construction Program and the Maintenance Program. The newly formed mega program, aptly named the Design, Construction and Maintenance Program, now consists of a project engineer, a construction manager, and a student intern assigned to each county and the 41 miles of the South Platte River.

We continue to work with the cities, counties, special districts, utility owners, and property owners along the South Platte River to help preserve the corridor, improve conditions and habitat of the river, and assist with the maintenance of this valuable natural resource downstream of Chatfield Reservoir.

Capital Projects

Globeville Project

The final construction phase of Denver's project to remove approximately 200 acres of highly urbanized lands in north Denver from the 100-year floodplain continues. Lawrence Construction is the general contractor. Under an agreement with the District, Love and Associates and their sub-consultant team are providing construction management services for Denver. Construction is expected to be complete in the spring of 2008.

Zuni/Sun Valley Reach Project

This year, Denver and the District selected Matrix Design Group, Inc. to provide final engineering design of this channel improvement/environmental enhancement project between 8th Avenue and Lower Colfax Avenue. The design team is now actively pursuing project real estate and utility relocation needs along this reach of the South Platte River. Construction is expected to begin in early 2008.

Maintenance Activities

Routine Maintenance

In 2006, South Platte River routine maintenance efforts included:

- 198 river miles (equivalent) of trash and debris pickup and removal
- 3.6 acres of string-trim mowing at access ramps and rest areas
- 79 miles (equivalent) of recreation/maintenance trail edge mowing
- 9.1 miles of tree pruning and trimming along the trail
- Removal of dead trees and other large items from the river
- Participation in annual NIMBY ("Not In My Backyard") FEST volunteer trash cleanup event

This year over \$210,000 was spent to perform these services along the 41 miles of river between C-470 and the Adams/Weld County Line. Colorado Total Maintenance (CTM), Inc. was selected again to perform these services. The routine maintenance also included efforts to re-vegetate various areas along the South Platte River. These efforts included reseeding, with native grasses, as well as the installation of various native trees and shrubs.

The complete South Platte River routine maintenance contract documents, including scalable aerial photos of the 41-mile river corridor are downloadable from our web site (www.udfcd.org).

Noxious Weed Management

We continue to be aggressive in controlling many varieties of invasive vegetation, including both noxious weeds and trees, along the river. Local governments consistently ask for our assistance in removing weeds such as Purple Loosestrife, Thistle, and Knapweed.

We have also removed Tamarisk (a.k.a. salt cedar), Russian Olive, and Chinese/Siberian Elms by cutting, and selective and careful application of herbicides, when needed. Removal is followed by the planting of native Plains Cottonwood, Sandbar Willow, shrubs and various native dry land grasses.



Before and After (prior to revegetation) of West Bank at Adams County South Platte Fishing Lakes

The Northeast Colorado Tamarisk Task Force (NoCoTTF) has been a great resource for effective Tamarisk control measures. For more information about the NoCoTTF, contact Kelly Uhing, Adams County Weed Specialist, at (303) 637-8115 or KUhing@co.adams.co.us.

Restoration Maintenance

In 2006, the following restoration maintenance projects were completed:

- Restoration and stabilization of 1100 feet of highly erosive west riverbank near 164th Avenue extended in Brighton.
- Lowered and restored west riverbank at the new Adams County South Platte Fishing Lakes & Open Space just north of 104th Avenue.
- Buried and vegetated over 2000 feet of exposed riprap bank in Thornton. Excess excavation from the above project was hauled and placed at this location.
- Repaired two failing bank revetments within the Army Corps of Engineer's channelized reach between Coal Mine Road and Hampden Avenue. More specifically, along the east bank adjacent to the Englewood Golf Course and 1200 feet upstream of Oxford Avenue.
- Repaired a damaged boat chute below Union Avenue with grouted boulders.
- Constructed 1000 feet of east

riverbank restoration/stabilization adjacent to the new Ken Mitchell Lakes facility currently being constructed by the City of Brighton. This project was in response to on-going lateral river migration that threatened to bypass the Brighton Ditch diversion structure.

- Replaced severely cracked or heaved concrete recreation/maintenance trail sections in Denver.

Several restoration maintenance projects that are planned for construction next year include:

- Repair of several riverbank stabilization and wildlife habitat rehabilitation structures within South Platte Park in Littleton.
- Repair or replace badly deteriorated wooden retaining walls and wooden bridges along the South Platte River trail within Denver.
- Construction of at least two bank stabilization/restoration projects adjacent to existing sand and gravel mines in Adams County.

Cooperative Projects

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. The District can participate financially up to 75 percent of the total project cost. To date over 740 acres of such easements have been dedicated,

resulting in over 35 bank stabilization and/or river grade control and riparian revegetation projects since 1987.

Three new cooperative projects were completed this year:

- McIntosh Farm Coop - West bank of the river south of 120th Avenue. Left Hand Excavating installed buried riprap along the bank in order to help protect the adjacent dairy farm operations. Thirty-one acres of riparian area were dedicated to the District.
- Stagecoach Stop Pit Coop - Naranjo Civil Constructors completed 700 feet of east riverbank restoration/stabilization on property owned by LaFarge Inc. north of 124th Avenue. Six acres of riparian area were dedicated to the District.
- Worthing Pit Coop - Left Hand Excavating completed over 1400 feet of east riverbank restoration/stabilization on property owned by Henderson Aggregates Inc. (Albert Frei and Sons) just south of 132nd Avenue. Forty-four acres of riparian area were dedicated to the District.

Next year we hope to have the following cooperative projects under construction:

- Hazeltine Reservoir Coop - East riverbank restoration/stabilization adjacent to a sand and gravel mine just north of 104th Avenue on property owned by Aggregate Industries.
- Lindgren Property Coop - East riverbank restoration/stabilization on property owned by the Lindgren family just north of 124th Avenue.
- Brighton Mine Coop - West riverbank restoration/stabilization adjacent to a sand and gravel mine north of E-470 on property owned by Aggregate Industries.



Boat Chute Repair Below Union Ave

Web-based Floodplain Mapping an Inaugural Success

By Bruce Rindahl, Leonard Rice Engineers

Each year UDFCD sends approximately 24,000 flyers to addresses within the District that are located in or near identified flood hazard areas. In the past these flyers included maps prepared by manually transposing 100-year floodplain delineations from the original studies onto USGS topographic maps. The map scales were typically 1:24000 and were quite outdated in fast growing sections of the District. Sixty-seven hazard-specific flyers were produced,

In late 2005, a major change to the SVG floodplain interface was undertaken based on existing work developed at carto.net. The existing floodplain interface was updated to permit GIS data to be stored in a free central database and the interface code to be stored on a central server. This allowed the entire interface to be stored on one central server where updates could be easily maintained.

The SVG interface also utilized other

raster data sources such as Microsoft Terraserver for color aerial photography to minimize the load on the host server. The user could specify either a USGS topographic map or a high-resolution color photo for the map background and zoom to a much greater level of detail than was possible in the previous paper maps or fixed raster images.

A feature of the new SVG interface was the ability to specify an address and zoom to the location requested by the user. This is accomplished by sending an Internet request to Yahoo! Maps which then returns a latitude/longitude from their mapping server. The web display will then recenter the map to the address requested and zoom automatically to detailed scale. Users can then “turn on” the floodplain layer (and other map controls) to show their property location and nearby floodplain. Figure 2 shows an example display for the Denver address 2000 Clay St.

New color flyers were created to explain the use of the new SVG interface. The original 67 flyers were reduced to 50 hazard-specific flyers. A link was added to the District’s homepage giving users easy access to the floodplain mapping interface with instructions on its use.

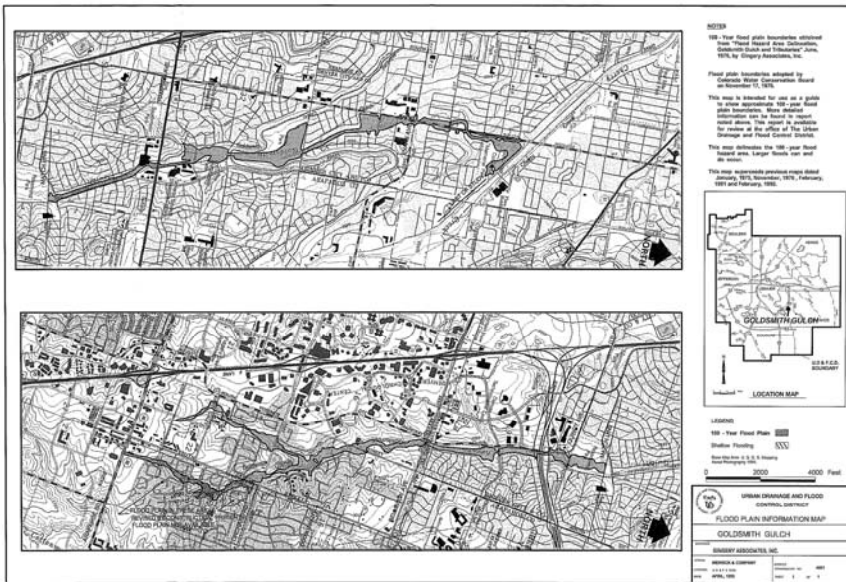


Figure 1. Typical flood hazard information brochure map prior to 2006

one for each major drainageway in the District. Figure 1 shows an example of a typical flood hazard information map used prior to 2006.

In 2004, the District began developing web-based applications for flood warning and floodplain displays using Scalable Vector Graphics (SVG). SVG allows vector line drawings in a web display that can rescale automatically without loss of image quality. Those applications, while successful for in-house use, were judged unsuitable for widespread public use mainly because all files had to first be downloaded to the client machine before executing the displays. As these applications evolved, maintenance became more difficult to manage. Any changes to the GIS information or updates to the display code required a new download of the user interface.

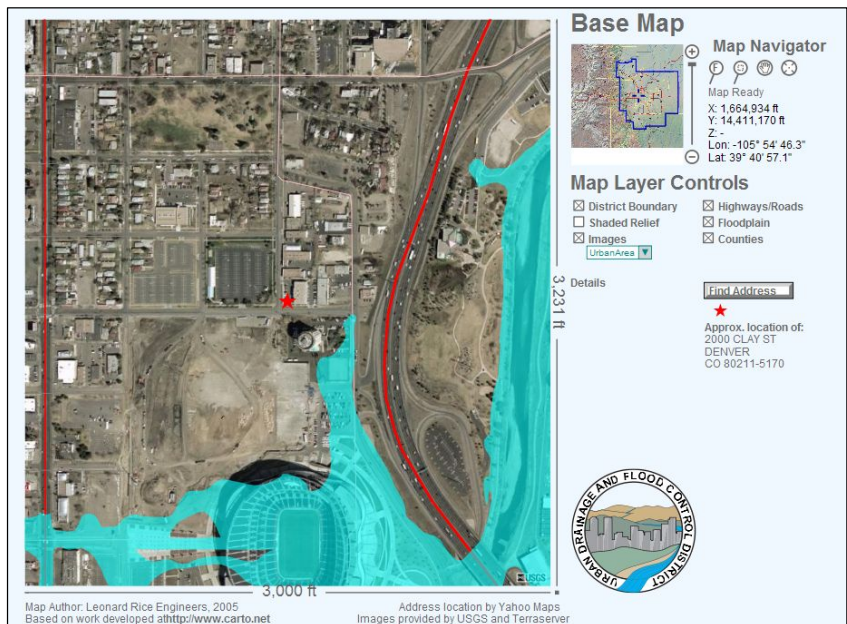


Figure 2. Example SVG floodplain map display

The flyers were mailed to the public on May 12 and a program was developed to analyze the webserver logs to track the number of floodplain queries from the new interface. In order to assure a reasonable use estimate or count, the log files were searched for specific address location queries. Multiple requests for the same address were eliminated to obtain a more meaningful estimate of the number of floodplain requests. These requests were then plotted to show the number of requests per day. Figure 3 shows the floodplain requests for the period May – November 2006.

In addition to the web access logs, District front office staff responded to phone calls from the public requesting that floodplain maps be sent to them by either mail or email. These calls were logged and tracked along with the web requests. In total, it was estimated that 868 map requests were made to the webserver and only 64 requests required manual handling. This means just fewer than 4% of the flyers sent out resulted in requests for additional information. While this number seems low, it was not surprising considering the direct mail method of contacting homeowners and tenants. The pleasant surprise was that only 7% of the requests required personal assistance from District staff while the other 93% was accomplished via the SVG interface.

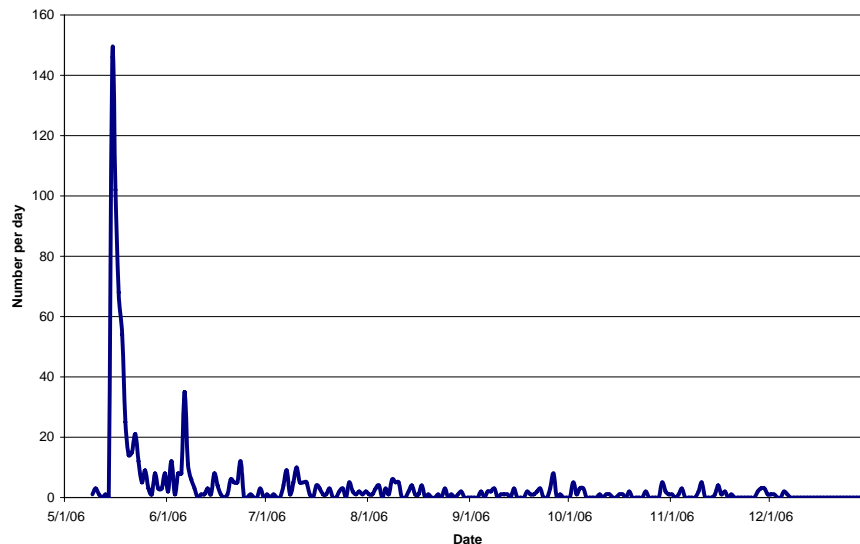


Figure 3. Daily floodplain map requests for 2006

During the course of the summer of 2006, three updates to the underlying GIS data layers were performed. The first was a replacement of the highways and roads coverage. A new coverage was obtained from the Colorado Department of Transportation (CDOT), which was not only statewide but included all street names in the attribute table. This allowed the user to mouse over a street and confirm the name of the street or highway from the interface. In addition, two updates to the floodplain layer were performed as new GIS information became available. These new coverages were

imported into a new table in the central database and tested. When the results were verified, the main SVG file was simply updated to point to the new data. This would not have been possible with the 2004 version.

The new SVG interface developed for the District allowed a highly detailed, interactive floodplain hazard mapping interface. This level of detail and interaction was possible via the ability of SVG to integrate raster and vector data in one display.

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- Geanesia Hinton, Receptionist

FLOOD HAZARD NEWS

- Bill DeGroot, Editor

2006 Professional Activities of District Staff

Dave Lloyd, Executive Director

- *Chairman, Board of Advisors, Urban Watersheds Research Institute
- *Attended National Association of Flood and Stormwater Management Agencies (NAFSMA) 2006 annual meeting in San Antonio, TX in September.
- *Attended Colorado Association of Stormwater and Floodplain Managers (CASFM) 2006 annual meeting in Glenwood Springs in September
- *Elected to Governing Board, Colorado County Officials and Employees Retirement Association (CCOERA) for a four-year term.
- *Member of Douglas County Stormwater Working Group.
- *Member of American Public Works Association (APWA) and CASFM

Bill DeGroot, Manager, Floodplain Management Program

- *Treasurer of the Board of Directors and Chair of the Floodplain Management Committee of the National Association of Flood and Stormwater Management Agencies (NAFSMA).
- *Attended NAFSMA's annual meeting in San Antonio, TX in September. Chaired the Floodplain Management Committee meeting, and gave a progress report to a plenary session.
- *Attended the Association of State Floodplain Managers annual conference in Albuquerque, NM in June.
- *Attended the annual meeting of the Colorado Association of Stormwater and Floodplain Managers in Glenwood Springs in September.
- *Organized "A Day at the District" CTP mentoring project sponsored by NAFSMA and partially funded by FEMA.
- *Gave a talk on DFIRM maintenance at FEMA's Tri-Region Workshop in Denver in April.
- *Member of Association of State Floodplain Managers (ASFPM), American Society of Civil Engineers (ASCE), and Colorado Association of Stormwater and Floodplain Managers (CASFM).

Kevin Stewart, Manager, Information Services and Flood Warning Program

- *President of the National Hydrologic Warning Council (NHWC)
- *Member of the U.S. Department of the Interior's Advisory Committee on Water Information, Subcommittee on Hydrology
- *Steering Committee Member of the American Meteorological Society (AMS) Commission on the Weather and Climate Enterprise
- *Co-Chair of the EMWIN-Denver Steering Committee
- *Member of ASCE, APWA, ASFPM, CASFM and the Colorado Emergency Managers Association
- *Attended AMS Annual Meeting and Users Conference in Atlanta, GA in January
- *Invited speaker at NOAA/WMO/USAID International Flash Flood Forecasting Workshop in San José, Costa Rica in March
- *Speaker at 21st ALERT Users Group Conference in Yosemite, CA in April
- *Represented NHWC at meeting with The Weather Coalition in Washington, DC in June
- *Speaker at Annual CASFM Conference in Glenwood Springs in September
- *Speaker at 16th Southwestern Association of ALERT Systems Conference in Overland Park, KS in October
- *Invited speaker at the ICIMOD (International Centre for Integrated Mountain Development) Consultation Workshop on 'Capacity Building for Flash Flood Management and Sustainable Development in the Himalayas' in Kathmandu, Nepal in December

Ben Urbonas, Manager, Master Planning Program

- *Gave a talk at the District's April 28th seminar on updates to the *Urban Storm Drainage Criteria Manual*.
- *Continues to serve on the Board of Directors of the Cherry Creek Basin Water Quality Authority.
- *Continues to serve on the Water Environment Research Foundation's (WERF) Research Council.
- *Continues to serve as Chairman on two of WERF's Project Steering Committees for research projects on *Quantification of Solids in Stormwater* and the development of the *International BMP Database*.
- *Continues to serve a Co-chair of WERF's Project Steering Committee for research project on *Impacts of Urbanization on Receiving Waters*.
- *Taught at a training workshop in February and July on *EPA's SWMM 5.0 Software and CUHP Interface* and was the lead instructor at a workshop on *BMP Selection and Design* in August.
- *Continues to serve on the Program Advisory Committee for the Civil Engineering Department of Colorado State University.
- *Attended the National Association of Flood and Stormwater Management Agencies (NAFSMA) annual meeting and participated in its Stormwater Committee meetings in San Antonio, Texas.
- *Attended the EWRI's World Environment and Water Congress 2006 in May where he received the *Lifetime Achievement Award*.
- *Participated in a satellite and web broadcast put on by *CTE National Broadcast Series* (Center for Transportation and the Environment, Raleigh, NC) in November

Paul Hindman, Manager, Design and Construction & Maintenance Program

- *Co-Chair of Cherry Creek Stewardship Partners Annual Conference
- *Chair of the 2011 Denver Site Committee for the American Public Works Association (APWA) International Public Works Congress and Exposition.
- *Chapter Delegate, APWA Colorado Chapter

Cindy Thrush, Senior Project Engineer, Design, Construction & Maintenance Program

- *Co-authored and co-presented with CH2M Hill, on "Optimizing the Performance of Water Quality Facilities with Effective Maintenance, Innovative Design, and Efficient Construction Practices" at the July 2006 StormCon Conference in Denver.
- *Member of American Society of Civil Engineers (ASCE), Society of Woman Engineers (SWE), and Colorado Association of Stormwater and Floodplain Managers (CASFM).

Bryan Kohlenberg, Senior Project Engineer, South Platte River – Design, Construction & Maintenance Program

- *Instructor at Urban Watersheds Research Institute training workshop on "Stream Stability and Bridge Scour Using FHWA BRISTAR Computer Model," in Aurora, CO in June, 2006.
- *Continued as NSPE's scoring coordinator for the Jefferson Chapter and Colorado State MATHCOUNTS competitions for 7th and 8th graders.

Mark Hunter, Manager, Design, Construction & Maintenance Program

- *Member of Board of Directors and on the Operations Committee of the Metro Wastewater Reclamation District.
- *Member of Board of Directors of the International Erosion Control Association.
- *Co-Chairman of the IECA Foundation Committee.
- *Member of IECA Stream Restoration Technology Section.
- *Member of IECA Awards Committee.
- *Committee member for the Mountain States Chapter of IECA.

David Mallory, Senior Project Engineer, Floodplain Management Program

- *Presented "Maintenance Eligibility Update" at the UDFCD April Workshop.
- *Co-presented with Dave Bennetts "Sculpted Concrete Drop Structures" at the 17th Annual CASFM Conference.
- *Serves on CASFM's Board of Directors as Treasurer.
- *Member of CASFM and ASFPM.

David Bennetts, Senior Project Engineer, Design, Construction & Maintenance Program

- *Program Chair for the 17th Annual CASFM Conference in Glenwood Springs in September
- *Co-presented with David Mallory "Sculpted Concrete Drop Structures" at the 2006 CASFM Conference in Glenwood Springs in September
- *Presented a paper entitled "30 Years of UDFCD Stormwater Projects" at 2006 StormCon Conference in Denver in July
- *Council Member, CU Denver Engineering Leadership Council
- *Committee Member, Urban Infrastructure Committee, CU Denver
- *Member of ASCE, APWA, and CASFM

Ken MacKenzie, Senior Project Engineer, Master Planning Program

- *Presented "Effects of Rainage Density on Runoff Simulation Modeling", and "Massey Draw Stream *Improvement Project" at the CASFM Conference in Glenwood Springs in September.
- *Served on ASCE's Urban Water Resources Research Council.
- *Served on the Metropolitan State College of Denver Engineering Technology Advisory Board.
- *Served on the Board of Directors of the Urban Watershed Research Institute.
- *Taught courses on flood detention design, open channel design, and street, inlet, and storm sewer design.
- *Member of ASCE and CASFM.

Mike Sarmento, Senior Construction Manager, Design, Construction & Maintenance Program

- *Received a certificate of completion in Construction Management from Colorado State University

Steve Materkowski, Senior Construction Manager, Design, Construction & Maintenance Program

- *Completed "Introduction to Floodplain Management" CU Denver, Continuing Education Program.
- *Completed Training "AutoCAD Civil 3-D 2007".
- *Attended 2006 APWA Inspectors Conference, Denver, CO.