Flood Hazard News

An annual publication of the Urban Drainage and Flood Control District

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Inside this issue

Elmer's Twomile Greenways Project

Colorado Association of Stormwater and Floodplain Managers Grand Award Winner for 2010

By

Annie Noble, City of Boulder; Mike Galuzzi, WHPacific; Mark Post, Centennial Engineering; Dave Skuodas, UDFCD

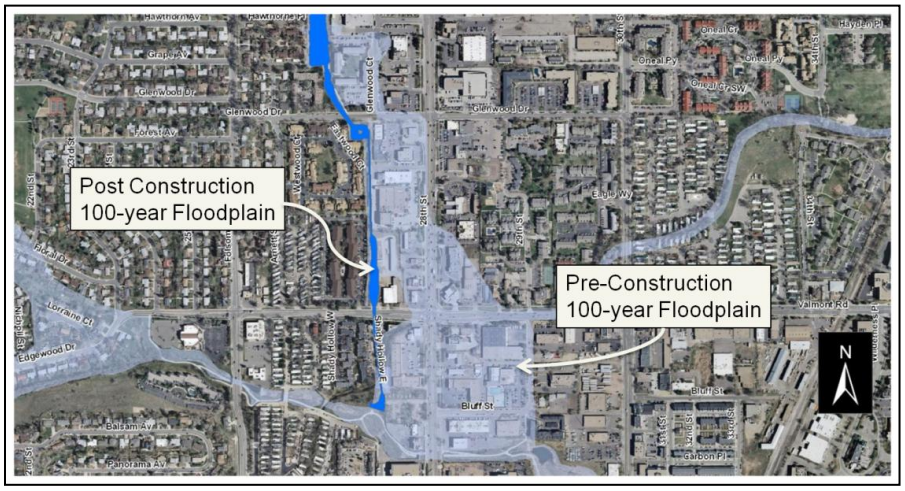
The Elmer's Twomile Greenways project is located in the north area of the City of Boulder between 26th and 28th Streets, in one of the most developed urban corridors of the City. Prior to construction of these improvements Elmer's Twomile Creek was an undersized small concrete trapezoidal channel with chain link and wooden fences on both sides. A local plumbing supply business used the one acre parcel to the east of the channel, and north of Valmont Road as a storage area for hundreds of used sinks, toilets, bathtubs and plumbing parts. South of Valmont Road, the channel passed behind a strip mall and flowed into the Boulder and White Rock Ditch, creating flooding problems along the ditch. The area adjacent to the channel was viewed as a no man's land and was a frequent dumping ground.

There was limited space to allow for an open channel that would contain the 100-year storm event. As a result, there were several dozen structures along Valmont Road and along 28th Street in the Elmer's Twomile Creek floodplain, with several of them located in the high hazard zone as well.

This project involved flood conveyance improvements and completion of a multi-use path connection from the confluence with Goose Creek upstream to Glenwood Drive, and included an improved crossing at Valmont Road and flow separation from the Boulder and White Rock Ditch. The total project length was approximately 2,100 feet. The project was a cooperative effort with funding and oversight provided by the City of Boulder, the Urban Drainage and Flood Control District and the Colorado Department of Transportation. The total project costs including design, property acquisition, construction, and the Letter of Map Revision was approximately $8.8 million. The Project was funded through the City of the Boulder's Flood ($2.87 million)

North of Valmont Road - Before

North of Valmont Road - After



and Greenways ($1 million) Capital Improvement Programs, with additional contributions from the Federal Transportation Improvement Program ($3.25million and the Urban Drainage and Flood Control District ($1.68 million).

Engineering and design was provided by the consultant team of Centennial Engineering and WHPacific, with construction by Concrete Works.

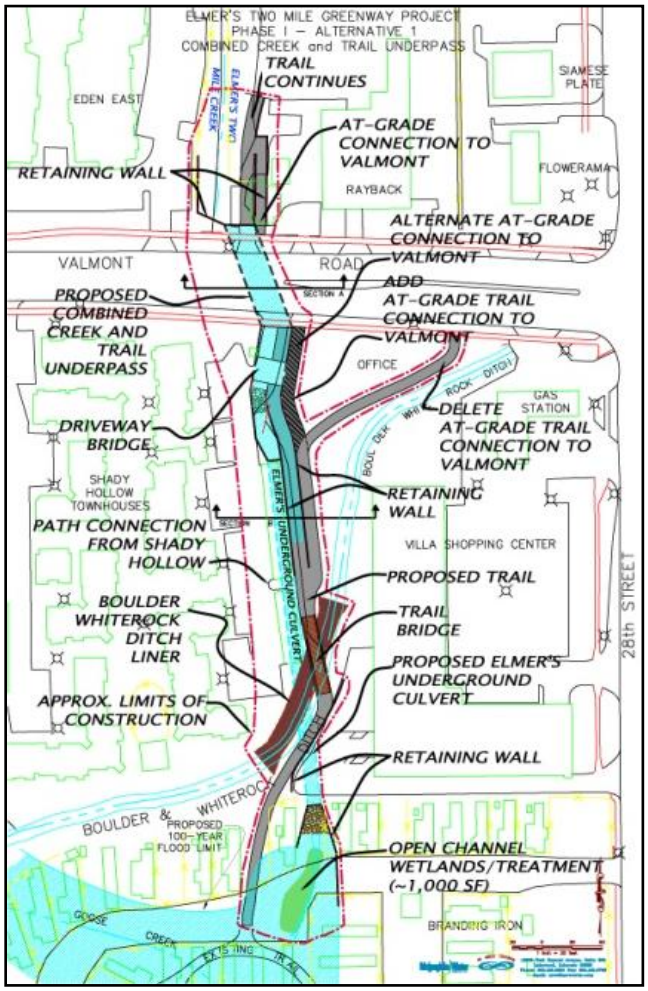
Description of Improvements

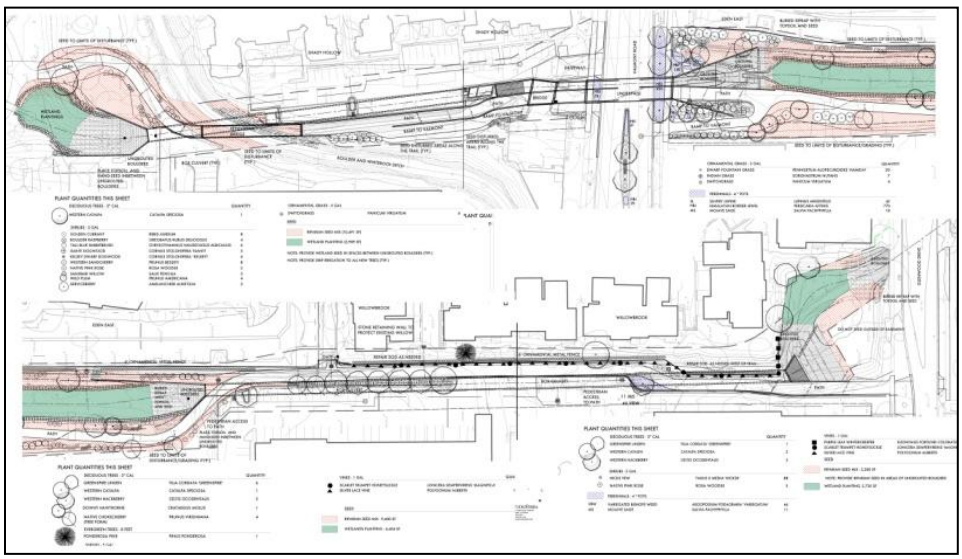
The conceptual design for the project was initiated in March 2004 with the first open house, as part of the City of Boulder's extensive Community and Environmental Assessment Process (CEAP). The CEAP evaluated three alternatives for the southern portion (Phase I) of the project and two alternatives for the northern section (Phase II). The chosen alternatives included a combined pedestrian and flood drainage underpass at Valmont Road, with a wider channel width north of Valmont Road.

Through the public input process, the plans for the northern portion of the project were changed to include an underground box culvert along the narrow corridor between the Willow Brook Condominiums and Tebo Plaza rather than an open channel. This modification was made to limit impacts on trees and reduce encroachment on the Willow Brook properties and parking spaces at Tebo Plaza, due to limited space for a conveyance channel. The at-grade connection from the Elmer's Twomile path south of Valmont was also modified to reduce impacts on trees along the Boulder and White Rock Ditch.

The project completed a ½ mile missing link in the multi-use path system between Glenwood Drive and Goose Creek, including a grade separated underpass at Valmont Road. The flood mitigation improvements removed numerous properties from the 100-year floodplain. South of Valmont Road, the flood mitigation improvements included 359 feet of 13'x5' box culvert between Valmont Road and the confluence of Goose Creek, which passes under the Shady Hollow parking lot. The box culvert crosses under the Boulder and White Rock Ditch and opens up into a 6,000 square foot pond and wetland area at the confluence with Goose Creek. North of Valmont Road there is a 10,000 sq. ft. pond and wetland area. Upstream of this wetland is a 643 linear foot section of 12'x6' box culvert which passes under the Tebo Plaza parking lot. At the north end of the project, at Glenwood Drive there is a third wetland area of approximately 3,000 square feet.

There was limited space to allow for an open channel that would contain the 100-year storm event. Several channel width options were evaluated prior to eliminating the open channel concept in favor of the underground box culvert. A wider, open channel (36 feet wide) would have required the removal of 50 parking spaces in Tebo Plaza and all of the mature trees east of Willow Brook Condominiums. The channel would have had retaining walls five to eight feet high on both sides, with the distance between the retaining wall on the west side of the channel and the Willow Brook Condominiums as close as 10 feet. By reducing the channel width to 30 feet and moving the channel closer to the Willow Brook Condominiums, the number of parking spaces

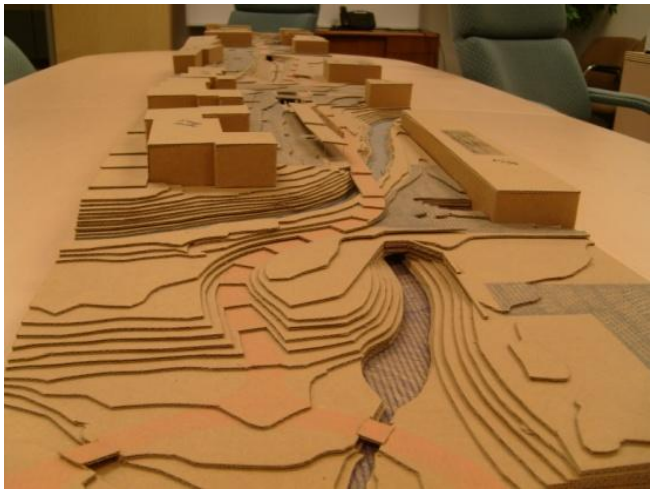




impacted would be reduced significantly, but the height of the retaining walls would increase and the distance between the retaining wall on the west side of the channel and the condominiums would be as close as four feet. In these areas, box culverts were installed in order to minimize impacts on adjacent properties.

Underpass structures were designed with minimum cover, which shortened lengths and maximized the natural lighting and openness. Where space was available, wetland pond areas were created to provide water quality, habitat and aesthetic enhancements. The project was also landscaped in such a way to provide privacy to adjacent property owners and enhance the user experience. While it is not the City's or the District's preference to utilize box culverts in lieu of an open channel, utilizing box culverts made it possible to minimize impacts on existing vegetation and established homes and businesses.

The multi-use path connection is located in a densely populated neighborhood, with three different condominium associations located adjacent to the project on the west side and the commercial strip along 28th Street on the east side of the project. This project also serves a significant population density to the north and south, providing access to commercial centers along 28th Street and connectivity to the Goose Creek and Boulder Creek multi-use path systems.



Conclusion

This multi-discipline, multi-objective project was a team effort, combining input from various City of Boulder departments including Flood Utilities, Transportation, Parks and Recreation, Water Quality and Environmental Services, Environmental Affairs, Planning and Open Space and Mountain Parks, in addition to the participation of the Urban Drainage and Flood Control District and the Colorado Department of Transportation. This project removed several dozen structures from the floodplain, separated flow from the Boulder and White Rock Ditch, improved the natural habitat of the stream corridor, connected a missing link in the City's multi-use trail system, and is an excellent example of balancing the needs of adjacent property owners with the difficult task of reclaiming a historic stream corridor in a heavily urbanized area.

Valmont Road Underpass

Confluence with Goose Creek

Hind' sight

By Paul A. Hindman

Timely Comment from the District's Executive Director

It's been an eventful year with some internal changes affecting the staff and the local governments. Mark Hunter retired (see article elsewhere in this issue) from his position as Manager of the Design, Construction, and Maintenance Program. That prompted some reorganization. Dave Bennetts took over as Manager and Laura Kroeger was promoted to Assistant Manager. We then hired Dave Skuodas as a Project Engineer. We then reorganized the program a bit by reassigning a few of the counties as follows:

- City and County of Denver and Douglas County-Barbara Chongtoua, Sr. Project Engineer assisted by Mike Sarmento, Sr. Construction Manager.
- City and County of Broomfield and Jefferson County-Bryan Kohlenberg, Sr. Project Engineer assisted by Darren Bradshaw, Construction Manager.
- Adams and Boulder Counties-David Skuodas, Project Engineer assisted by Joe Williams, Sr. Construction Manager.
- Arapahoe County, Richard Borchardt, Sr. Project Engineer assisted by Jeff Fisher, Sr. Construction Manager.
- South Platte River, Laura Kroeger, Assistant Manager assisted by Steve Materkowski, Sr. Construction Manager

These new assignments were done to distribute the work load more evenly. This is turn will allow us to better serve the local governments.

After hiring Dave, and making the reassignments, I reflected on the fact that the District has certain principles that it functions under and the new generation of staff may not know all of them, as well as why they exist. The answer of "well, we've always done it that way" doesn't hold much water with them, especially because we have hired some very bright and thoughtful people who search for answers instead of following the pack. To solve the problem, I started a series of "coffee chats" to relay institutional knowledge from the old guard to the new staff.

One of the principles in question that we discussed is the fact that the District does not own any property. This is vastly different from most, if not all, of the other flood control districts in the nation. Most districts own the drainageways, detention ponds, and other drainage facilities. Why not? It gives you better control of what happens on the property so you are able to make sure the facility functions as it was intended. Here are the main two reasons our district doesn't own things, 1) we do not have policing powers and 2) we firmly believe in local government control. To the first issue, unfortunately in drainageways a lot of unlawful activities occur. We have seen illegal dumping, fires, illegal gardening (yes cannabis), homeless encampments, and even dead bodies. With the local governments owning the property, it allows them to manage the situation with their police force without us as a middleman.

One of the most common unlawful activities is illegal dumping. When this occurs, our field inspectors working with the local agency are able to contact the local police department and have them issue a ticket, if it is warranted, to the person for dumping on public property. If we owned it we would have to file a civil complaint with the local agencies to instigate action being taken. Also, with the local agency being the property owner, they are able to react to their citizens in a manner that is consistent with the community's philosophy.

As to reason number two, it has always been our philosophy that our main "customers" are the local governments. With that in mind we always look to them to guide our activities. If a local government wants us to perform routine maintenance on a drainageway that is eligible, we will. If they want to maintain it themselves, we will back out of the picture. By not dictating to them what we will do, they are able to manage their community in a manner that their citizens desire. A good example of this is a drainageway that travels through a turf grassed greenbelt that gets a lot of public activity. The local government needs that area to have a more manicured look whereas our contracted crews are maintaining it from a flood control viewpoint. Our routine maintenance might only include mowing the grass and picking up the trash three times a year. We also would not maintain any irrigation systems because for flood control, non-irrigated grasses work just as well if not better for holding the soil in place as does an irrigated turf. Obviously this level of maintenance would not be adequate for what the citizens of the area require. With the local governments owning the property, they can initiate the level of maintenance required for a park like setting.

By transferring information to the "next generation," my hope is to have the District continue to function at a high level without becoming bogged down in bureaucracy. These "coffee chats" have been highly effective in accomplishing this task. I would highly recommend it for any organization.

Floodplain Management Program

Bill DeGroot, PE, Program Manager

Brochure wins award

The District's brochure "Preserving the Natural and Beneficial Values of Floodplains Adjacent to Development Projects" received the Association of State Floodplain Managers' James Lee Witt Local Award for Excellence. David Mallory and I accepted the award at ASFPM's annual conference in Oklahoma City.

We put the brochure together to show local governments and developers how to preserve the floodplain and use it as an asset to the development and the community, rather than following the common practice of essentially destroying the floodplain's natural and beneficial functions by channelization and fill.

We have been gathering feedback from users of the brochure and plan to make some revisions in the near future. We have also been talking with several organizations, including the ASFPM Foundation and the Natural Hazards Center about taking the concept to a national platform. We will let you know what happens in this regard.

LOMC delegation

We have been reviewing requests for Letters of Map Change (LOMC) for FEMA since July 1, 2001. We have had a pretty busy year again; and as was the case last year, most of the cases we have reviewed are for government funded projects. At the end of December we had 17 cases under review. Only three were private sector cases and two of those were requests for Letters of Map Revision for projects completed much earlier.

For about a year we have been acknowledging receipt of new cases by email to the applicant. In December we started sending additional data requests (316-AD letters) to the applicant by email as well. This will save the applicant at least a couple of days in the completion of the review of a LOMC request.

DLOMC guidelines

We unveiled Digital Letter of Map Change (DLOMC) guidelines at the District seminar in April. So far we haven't had many submittals, which has been a bit of a disappointment. DLOMC's are voluntary, but we believe they will save both applicants and the District time and money, and we continue to encourage DLOMC submittals.

Floodplain delineation

We completed one digital flood hazard area delineation (DFHAD) study this year; for Willow Creek in Centennial, Lone Tree and Douglas County. Our DFHAD Guidelines have been undergoing some modifications, based on our experience with several on-going projects. New guidelines will be posted on our website in early 2011.

We have DFHADs underway for First Creek in Denver and Aurora; Upper East Toll Gate Creek in Aurora; Big Dry Creek in Adams County, Thornton and Westminster; Piney Creek in Centennial, Arapahoe County, Aurora and Douglas County; Littles Creek in Littleton and Centennial; Cottonwood Creek in Greenwood Village, Centennial, Arapahoe County, Douglas County and Lone Tree;, Second Creek above DIA in Aurora and Adams County, West Toll Gate Creek in Aurora, Centennial and Arapahoe County, and Lower East Toll Gate Creek in Aurora.

All of these studies will be compatible with FEMA's DFIRM specifications, and will be provided to FEMA for incorporation into the appropriate DFIRMs.

DFIRM projects

In 2009 we received four grants from FEMA FY2009 Risk MAP funds to update existing DFIRM's for the City and County of Broomfield, City and County of Denver, Douglas County and Jefferson County. All of those projects are still underway.

We completed the Arapahoe County DFIRM, which became effective on December 17, 2010.

The Boulder County DFIRM conversion project, which is being managed by the Colorado Water Conservation Board, is the only one left before all of the District's local governments are covered. It will probably be early 2012 before it becomes effective.

Left to right, Greg Main, ASFPM Chair, Bill DeGroot, David Mallory, Larry Larson, ASFPM Executive Director with James Lee Witt Award

New CWCB Rules

The Colorado Water Conservation Board (CWCB) adopted new state-wide floodplain rules and regulations that become effective mid-January, 2011. The three main changes are:

- One foot of freeboard for new structures in the 100-year floodplain.
- A floodway based on a maximum 0.5 foot rise in water surface elevation.
- Two feet of freeboard for "critical facilities" in the 100-year floodplain.

Our regulation already had the first two items above but we will have to add the critical facilities requirement. I refer you to the CWCB staff for specific implementation guidance. The regulations can be accessed at:

http://cwcb.state.co.us/Documents/FloodplainRulesRegsUpdate/CWCB_Adptd_FP_Rules_BasisPurp_%2011172010.pdf

We have always defined both the 0.5 and1.0 foot rise floodways in our FHAD studies. Once the dust settles we will be making a decision on discontinuing defining the 1.0 foot rise floodway. This decision will be made in consultation with our local government partners.

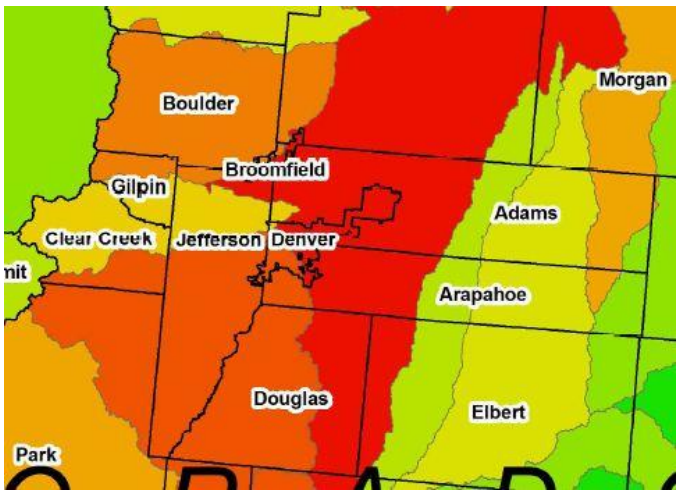
Maintenance Eligibility

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

Risk MAP update

FEMA continues to roll out new guidance and prototypes of new products. A few demonstration projects have been initiated around the country, but this fiscal year should see FEMA settle in on some full blown projects.

Our concern, as far as District participation in Risk MAP projects, has been FEMA's decision to perform their studies at a HUC-8 watershed level. Whenever a project "touches" a watershed, a database for the entire watershed has to be populated. The District is in parts of four HUC-8 watersheds, all of which extend well beyond our boundaries (see adjacent figure). For example, if we were to "touch" Clear Creek, which is in the District from the South Platte River through Golden, we would have to determine the wants and needs of the watershed all the way to the continental divide. We don't want to do that.



HUC-8 watersheds in the Denver Metro Area.

Another example is Adams County. Due to the distance it extends to the east it is in five HUC-8 watersheds. As it stands as I write this, if we were to apply for a grant to perform DFIRM maintenance for Adams County we would have to populate five HUC-8 watershed databases. We don't want to do that.

I'm hopeful that we will be able to work out some arrangement with FEMA and the CWCB to allow us to stay in the mix without ranging too far outside our borders.

Reinventing NFIP

FEMA has been working on a project to reinvent the NFIP in order to present their findings to Congress the next time reauthorization is on the table. As part of their outreach they held two listening sessions, one in Denver that David Mallory attended on our behalf. We also provided comments through FEMA's on-line comment process. It will be very interesting to see the outcome of this effort.

CRS Credits

We cooperated with the Colorado Water Conservation Board on the preparation, by French Wetmore, of a document detailing how local governments can get Cooperating Technical Partners credits for activities that the State and/or District already do. For example, credits are available to communities in the District for our annual Flood Hazard Information brochure mailing.

Since preparation of the document the CWCB has adopted the new rules noted earlier. The state-wide floodway based on the 0.5 foot rise should make additional points available for those communities that will be switching from less restrictive floodway criteria.

Gilbert White Forum

I was pleased to be invited to participate in the third Gilbert White Forum hosted by the ASFPM Foundation in March in Washington. Each participant was asked to prepare a short paper on one or more issues related to the topic "Managing Risk to Humans and to Floodplain Resources." We then attended a 1 ½ day meeting which included plenary and breakout sessions. It was a very intellectually stimulating experience. A final report on the meeting should be available soon.

Maintenance Eligibility Program

David Mallory, PE, CFM, Senior Project Engineer, Floodplain Management Program

The District has a longstanding commitment to national leadership in the areas of floodplain and stormwater management. I was honored to participate in that endeavor more prominently in 2010, as described in the Professional Activities column of this issue. I appreciate the opportunities and support provided by Paul and Bill to spread the word and engage in the national discussion. As indicated in Bill's column, there is a lot of activity on the national and state level as together we modernize floodplain management in America.

Maintenance Eligibility on GIS

The Maintenance Eligibility database has been converted to a GIS platform. It is currently an internal application which is a huge help to us in tracking development projects through the various stages of completion. We are in the process of providing this data through the District's web-based Electronic Data Management (EDM) application. We believe this data will be as useful to local governments and the private sector as it has been to us. We will be able to provide graphical representation of projects as they progress through the design approval, construction acceptance, and final certification steps in the Maintenance Eligibility Program.

Joanna has worked diligently to get all the past projects into the GIS system. She has also developed the protocol for project inclusion from this point forward. We are also able to interface FEMA's Nation Flood Hazard Layer (NFHL) into our GIS application, which is also very helpful.

The Projects

Large-scale private sector development projects were essentially non-existent in 2010. We did spend significant effort on several public sector projects:

RTD FasTracks West Corridor Project

We have worked with RTD on this project since the summer of 2004. RTD completed the design package release to the Denver Transit Construction Group JV (DTCG) for the guaranteed maximum price quote. Construct commenced in the spring of 2009. The Maintenance Eligibility Program Notes last year described some of the challenges we faced in constructing a project that did not have a completed design. Largely through the efforts of Joanna and Bruce Behrer with Muller Engineering Company (drainage design consultant) working with the staff of RTD and DTCG we made it through the 2009 construction session. Construction during 2010 has been much smoother. Current drainageway construction is focused on the Federal Boulevard drop structure in Denver and the Harlan Street channel reach in Lakewood. The Federal Boulevard drop is the largest of the six drop structures in the West Corridor construction package and is located immediately upstream of the Federal Boulevard bridge. The Harlan Street channel is a reach from the confluence of Dry Gulch and North Dry Gulch at Harlan Street and extending downstream 1200 feet.

Two adjacent DCM projects, the Richey Park detention improvements in Lakewood and the Oxbow Area (Lakewood Gulch upstream of Knox Court in Denver) are largely complete. The largest companion DCM project is of course the South Platte River and Lower Lakewood Gulch improvements which are addressed in the DCM column elsewhere in this issue. One of my "other duties as assigned" is to provide periodic aerial photography for the South Platte River Project and drainage-related work along the West Corridor Project. I can tell you from recent flights there is plenty of activity along the entire reach of the West Corridor from downtown Denver to the Jefferson County Government Center in Golden. Several folks from the Denver team have been able to accompany the helicopter flights for a unique prospective on these massive public works projects, including Denver Deputy Mayor Bill Vidal and City Engineer Lesley Thomas.

Completed Richey Park detention and water quality improvements. View is looking east with Carr Street in the background and 13th Avenue and the RTD West Corridor on the right. Photo date is October 29, 2010.

RTD FasTracks Eagle P3 Project

The next corridor project includes the East Corridor to DIA, the Gold Line to Arvada and Wheat Ridge and a starter segment of the Northwest Rail Corridor to Westminster. Eagle is an acronym for those corridors and P3 stands for public-private partnership. The Eagle P3 Project is a competitive concessionaire arrangement where the selected team, Denver Transit Partners (DTP) (Fluor, HDR, PBS&J, Parsons Brinckerhoff and others) will design, build, finance, operate and maintain the project with a long-term lease back to RTD.

Nearly complete Lakewood Gulch improvements at Knox Court. The Oxbow area is to the north of the West Corridor alignment. View is looking northeast and was taken August 4, 2010.

There are significant drainage and floodplain management issues throughout the corridors. For example, the proposed commuter rail alignment impacts every detention pond located along Pena Boulevard. We negotiated a Memorandum of Understanding (MOU) with RTD concerning the design approach as it affects Irondale Gulch, Blue Grama Draw and the West Fork of Second Creek. Challenges also exist throughout lower downtown Denver, First and Second Creek crossings, South Platte River crossings, Little Dry Creek at Federal Boulevard and Clear Creek at Federal Boulevard. Construction will be underway on the initial segments by this time next year.

Parker Jordan Centennial Open Space Project

This is an interesting stream restoration project along a blighted reach of Cherry Creek. The project limits are approximately Broncos Parkway to the 17-mile House property. The project sponsors are the Parker Jordan Metropolitan District (PJMD) and the City of Centennial. Both the District and SEMSWA are minor funding partners. The project design has to be carefully balanced between the needs of the adjacent property owner, existing residential development, environment restoration, floodplain management, open space goals and Cherry Creek basin water quality management goals. Did I miss anything? We participated in a number of robust discussions over the design concepts and correct balance. In the end, we believe the project approach is sound and will result in a successful recreation/open space and stream restoration effort. Our congratulations to the project sponsors and the consultant team lead by J3 Engineering Consultants.

In the Field

Joanna continues to do an outstanding job of observing the construction phase of projects that will ultimatly be eligible for District maintenance assistance. There are two ongoing construction projects of note. The first involves Westly Creek in and around the two flood control facilities located on the Lowry redevelopment site, Kelly Road Dam and Westerly Creek Dam. The East Lowry Open Space & Dog Park project entails removing a section of the Westerly Creek Dam outlet pipe and replacing it with an open channel, trails, landscaping and adjacent dog park. The work is located within the emergency spillway, so this means the USACE was a review agency along with the District and Denver. The companion project is the Lowry Wetlands Park project located within the flood pool of Kelly Road Dam. That project is just getting underway and includes channel and water quality improvements.

The other project of note is the Cottonwood Creek Stream Restoration Project, sponsored by SEMSWA. The design for this project was completed some time ago; however construction was delayed until this year. This is a stream restoration project that seeks to reverse some channelization efforts of the past. In addition to reestablishing overbanks and low flow meanders, the gradient is controlled with some very unique drop structures designed by Michelle Slovensky who was working as a sub-consultant to the project designer, Moser & Associates.

Lakewood Gulch work is progressing. This photo was taken on December 22, 2010 and includes the Federal Boulevard and Decatur bridges as well as the RTD light rail bridge. View is looking north.

One of the interesting developments this year and due to economic realities has been a heightened effort in qualifying projects for final maintenance eligibility acceptance and of course the release of performance securities. Joanna has gone through this drill for a dozen past projects located in a half dozen communities.

In the Office

Terri has spent a significant part of this year reviewing various DFHADs produced by District consultants and a number of floodplain studies prepared by the Town of Castle Rock that will be included in the Douglas County DFIRM maintenance project. See Bill's column elsewhere in this issue. FEMA has, through Map Mod and will continue with

the introduction of Risk MAP insisted on high quality data. After completing several DFIRM projects and working through the agreement checks we determined we had to revise our standards. The result was the publication of the DFHAD Guidelines. We now require our consultants to submit completed agreement checks with the project deliverables. More to the point, we are thoroughly checking the submittals in order to conform to current FEMA standards. That's where Terri comes in.

The time and effort required to work through this basic quality control check has been a drain on our resources. We are looking for ways to improve the quality of initial submittals. To that end we will reissue the DFHAD guidelines with updates based on our review experience this year.

Mark Hunter Retires After 29 Years

By Paul A. Hindman

As mentioned in last year's *Flood Hazard News*, Mark Hunter who managed the Design, Construction, and Maintenance Program retired in March of 2010 after 29 years of service with the District. Mark started with the District in 1981 as a Project Engineer with the original staff of the Maintenance Program. Within just a couple of years he was promoted to Chief of the Maintenance Program and held that position until 2006. Then in 2006, Mark was instrumental in facilitating the merging of the Maintenance Program with the Design and Construction Program. From 2006 to 2010, he co-managed that program with me and then with Dave Bennetts until his retirement.

Mark during his Hippie era!

Mark was the one who hired me into the District in 1985 for which I will be eternally grateful because it not only shaped my business career but also my personal life. Mark was a great boss and during his time as Manager he turned the Maintenance Program into a super efficient program of maintaining the network of drainageways within the Denver Metro area. The Program's reputation spread and to this day is regarded as one of the best of its kind in the nation, mainly due to Mark's handiwork.

Mark and friends after a Grand Canyon hike enjoying refreshments.

I have many fond memories of working with Mark but I also enjoyed some non-work related activates. This is code for the fun stuff in life. Here are a few pictures.

Mark and Frank Rosso along Goldsmith Gulch (back when people wore ties to work).

Mark at his retirement party with a cutout of former Executive Director Dave Lloyd.

Thanks Mark. You've been a great friend.

Information Services and Flood Warning Program Notes

Kevin Stewart, PE, Program Manager

This past year brought some exciting changes and new challenges to the District's Information Services and Flood Warning Program. After the departure of our GIS administrator in late 2009, the District was well-staged to take advantage of technologies put in place over the previous four years. With the addition of Julia Bailey to our staff, we quickly wrapped-up the first public release of an Internet mapping application (a.k.a. EDM) that makes finding useful District documents easier than ever. The EDM's floodplain map and routine maintenance tabs are other nice features to explore. If you haven't visited the District website lately, I encourage you to do so. As you browse keep in mind that this new e-Library resource is just beginning to evolve.

Our IT guru Derrick Schauer continues to build the foundation that supports all of our information services. The District website www.udfcd.org is Derrick's creation and he is always opening new doors for innovation. Internally, Derrick has the pulse of the staff as he keeps LAN communications and equipment in top working order.

Stephanie LaCrue is our engineering student intern from the Colorado School of Mines who worked most closely with Julia over the past year. She has been instrumental in assembling the District's flood history archive of local newspaper articles and other information sources; storm/flood videos; and streamflow data summaries from the ALERT System. Much of her work will soon be Internet accessible. Stephanie received her B.S. degree in Civil Engineering from Colorado School of Mines in May and was soon thereafter accepted into their graduate program. Congratulations Stephanie!

The biggest local news story of the year that affected the District's Flood Warning Program was the Fourmile Canyon Fire that started on Labor Day (Sept. 6) near Emerson Gulch, burned 6,200 acres over a 5-day period and destroyed 169 homes in the Gold Hill area of Boulder County. This event was Colorado's most costly wildfire to date with property damages exceeding $200 million. Major efforts are now underway to address mitigation measures; recovery plans; public information and education needs; and flood preparedness. Quantifying the increased flood risk and developing strategies on how to best warn the public and respond to the threat is high on the priority list. Areas both in and downstream of the burn area, including the City of Boulder, are of great concern. Debris flows and floods will pose serious threats for years to come.

This past flood season had an average number of threat days that mostly resulted in minor flooding in the District. While numerous heavy rainstorms were observed, the largest of these events skirted the District boundary. Read on for a description of the more notable events of 2010.

36 days with flood potential in 2010

April	21, 22	2
May	18, 26, 29	3
June	8, 9, 10, 11, 12, 13, 20, 21, 27	9
July	2, 4, 6, 7, 8, 14, 20, 21, 22, 27, 28, 29, 30, 31	14
August	1, 4, 6, 8, 9, 15, 16, 23	8

Red dates denote days when rainfall measured by automated gages exceeded alarm thresholds. Yellow highlighted dates indicate that heavy rainfall measurements only affected areas outside the District's main area of concern, i.e. Hayman Burn Area in Douglas and Jefferson Counties, and St. Vrain Creek in northern Boulder County. Blue boxes designate NWS flood watches that affected the District. No flash flood warnings were issued for the District in 2010.

New Addition to District Staff

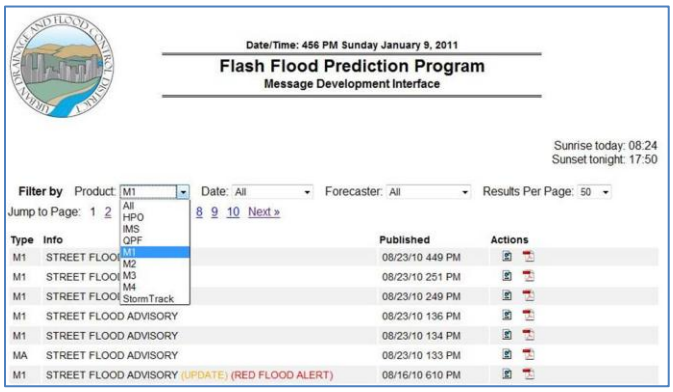
Julia Bailey joined the District as our first Information Services Engineer in February of 2010. Julia graduated from the Colorado School of Mines in 2009 with a B.S. degree in Metallurgy and Materials Engineering. Since 2005 she worked part-time for the District's Design, Construction and Maintenance Program as an engineering student intern. During those four years Julia gained considerable skill working with GIS projects and database applications. Her handiwork is clearly evident in the article describing the District's public release of the Electronic Data Management (EDM) internet application. She has certainly made herself a valuable and welcomed staff addition.

Early Flood Prediction and Notification Services

The hydro-meteorological support team of Genesis Weather Solutions and Skyview Weather provided local governments with heavy precipitation forecasts and flood threat notifications for the fourth consecutive year. Project manager and chief meteorologist Bryan Rappolt completed his 17th year of service to the F2P2. Bryan's support team was comprised of Skyview Weather's Tim Tonge and Brad Simmons as lead forecasters joined by Chris Anderson and Daryl Brynda providing valued technical support. This District program was established after the deadly 1976 Big Thompson Canyon flash flood and has served the Denver/Boulder metropolitan area for the past 32 years.

The F2P2 operates from April 15 through September 15. The forecast services focus primarily on heavy rain and flash flood threats over an approximate 3,000 square mile area encompassing the District and drainage areas upstream. During the snowmelt runoff season, late spring to early summer, mountain streams typically overflow their banks. Although the program's prediction services are less oriented to this type of flooding, corresponding flood information is disseminated to affected local governments when warranted. Program meteorologists also relay information concerning reservoir releases made by the Tri-Lakes Office of the U.S. Army Corps of Engineers from Chatfield, Cherry Creek and Bear Creek dams. The F2P2 works in close partnership with the National Weather Service Forecast Office in Boulder.

An external evaluation of the F2P2 was conducted by Judy Peratt of JP Consulting for the fourth consecutive year. The purpose of this activity is to gain a better understanding about how well the program is working from a local government perspective and to obtain suggestions on how to improve future services. Judy also assisted GWS/Skyview with a new training initiative for dispatchers and other local officials involved with the F2P2. The feedback from this first attempt has been extremely positive and a repeat performance is currently being planned. This may become a regular pre-flood season activity.



Anyone interested in looking back at products and services rendered by the F2P2 should visit f2p2.udfcd.org. Daily heavy precipitation outlooks, quantitative precipitation forecasts, messages specific to local governments, message status reports, and storm tracks can be easily sorted and downloaded. Storm summary maps for the past four flood seasons are also available at this website.

CoCoRaHS Update

The Community Collaborative Rain, Hail and Snow network is operated by the Colorado Climate Center at Colorado State University in Fort Collins. This nationwide network has become a popular source of precipitation data for many users that represent the public, private and academic sectors of the weather and climate enterprise. The District has been a sponsor of CoCoRaHS since 2001 and routinely makes use of this valuable data source including innovative ways of displaying the data (www.udfcd.org/FWP/LDAD/gmap.html). CoCoRaHS is a community-based initiative that would not possible without help from people like you. Consider becoming a CoCoRaHS volunteer or sponsor today by visiting www.cocorahs.org.

EMWIN-Denver Update

The Emergency Managers Weather Information Network continues to provide timely weather warnings and advisories to 22 counties in NE Colorado. The EMWIN-Denver steering committee meets quarterly to review operations, address issues and recommend system enhancements. In 2010 the rebroadcast portion of the network was discontinued due to the difficultly of maintaining the VHF and UHF radio equipment. Also, the multi-path Internet delivery has proven to be highly reliable making the need for redundant radio broadcasts much less critical. Next steps include finalizing the cost sharing arrangements for long-term maintenance and implementing the EAS (Emergency Alert System) activation request procedure for local governments. For more information about EMWIN-Denver visit emwin.udfcd.org.

ALERT System News

The District's ALERT system currently collects data from 217 stations including 8 radio repeaters, 188 rain gages, 96 stream gages and 24 weather stations. Only a few changes to the automated gaging network occurred in 2010. A stream gage was added to the East Plum Creek at Colorado Highway 105 station in southern Douglas County and the nearby Dakan Road rain gage (pictured) near West Plum Creek was upgraded to a repeater site to relay data from the more remote Highway 105 station. In Boulder County new ALERT streamflow monitoring equipment was installed at Barker Dam to measure reservoir levels and downstream releases. In Aurora the Sable Ditch rain/stage gage was moved a short distance upstream from the concrete channel at E. 18th Ave. to a recently completed stormwater detention facility downstream of E. Colfax Ave.

OneRain of Longmont and Water & Earth Technologies (WET) of Fort Collins provided preventative maintenance and repair services for 2010. Automated daily/weekly monitoring reports by OneRain were used to determine which stations required special service calls and to monitor the overall health of the ALERT system. Detailed monthly reports by WET helped assess the overall system performance by focusing on decoded ALERT messages received by the District's base station. Lost reports, unknown decoded sensor ID's and data transmission rates were analyzed. WET's monthly rainfall intensity analysis is used by the District to assess how often "infrequent" rain events occur within the approximate 3,000 square mile area monitored by the network. The District base station decoded over 4-million ALERT messages in 2010 with the peak hourly rate of 1,638 reports occurring on July 30 between 7 and 8 pm. That's a lot of data!

The ALERT2™ 4800 baud protocol implementation continues to show much promise. Although the hydro events of 2010 failed to push the limits of the 300 baud legacy protocol, monthly reports by WET consistently revealed improved performance using the new protocol. The District is clearly one step closer to replacement of the 40-year-old technology.

Leonard Rice Engineers (LRE) continued their support of the real-time hydrologic models for Boulder Creek in Boulder County; Lena Gulch in Jefferson County; and Harvard Gulch and Goldsmith Gulch in Denver, and upper Cherry Creek in Douglas County. These models activate automatically when corresponding flood threat notifications are issued. With the FMC Fire having impacted the Fourmile Creek watershed so severely, the Boulder Creek model needs revision. Before the fire, 1 to 2-inch rainfalls caused very little runoff. Now many experts believe that dangerous flooding will occur from rainstorms producing less than one inch. LRE has been asked to quantify the increased threat by making appropriate adjustments to the model.

For more information about the District's F2P2 and ALERT System operations, read the detailed reports at: www.udfcd.org/FWP/ALERT_Reports/ and www.udfcd.org/FWP/F2P2_Reports/.

2010 Flood Season Recap

Heavy rainfall caused the ALERT system to set off alarms on only 17 days in 2010 compared to 32 days the previous year. The specific alarm dates are shown in the table on the first page of this newsletter article. On half of those days, rainfall amounts exceeded 1-inch in 1-hour or less (6/11; 7/4, 6, 8, 20, 30 &31; and 8/1&4). For all other intense rainfall dates the alarms resulted from one-half inch falling in a very short 10-minute time period. That small but intense rainfall amount equates to a 3-inch per hour intensity and is certain to at least cause some impressive street flooding.

The following briefly describes some of 2010's more notable events:

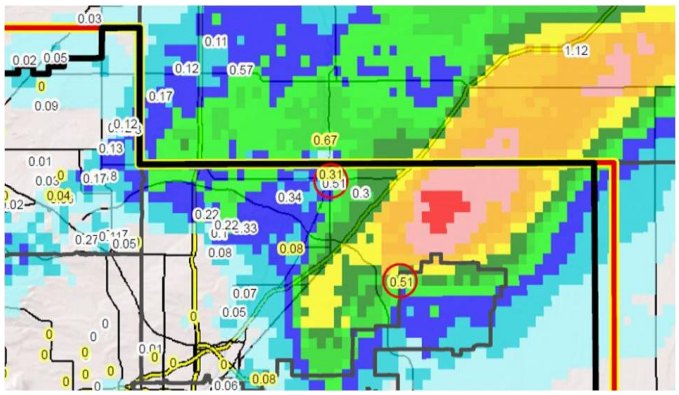
Wednesday-Friday, April 21-23

The 2010 flood season got off to an interesting start when a system of strong thunderstorms arrived Wednesday afternoon producing large hail and heavy rainfall. The stormy period lasted about 48 hours, changing over to a widespread rain/snow storm with precipitation totals exceeding two inches at many locations and prompting the NWS at 4:38 pm on Friday to issue a flood warning for the South Platte River from Henderson to Fort Lupton. Runoff from the storms caused annual flood peaks at 29 ALERT gages affecting Ralston Creek in Arvada, Lena Gulch in Lakewood, Little Dry Creek in Adams County, Kelly Road Dam on Westerly Creek in Denver, Toll Gate Creek in Aurora, Sand Creek, Cherry Creek through Denver, Bear Creek, the South Platte River, and a number of other District streams. While no serious damages occurred, it is safe to conclude that this was the largest widespread flooding event of the 2010 flood season.

South Platte River at Confluence Park in Denver--April 23, 2010

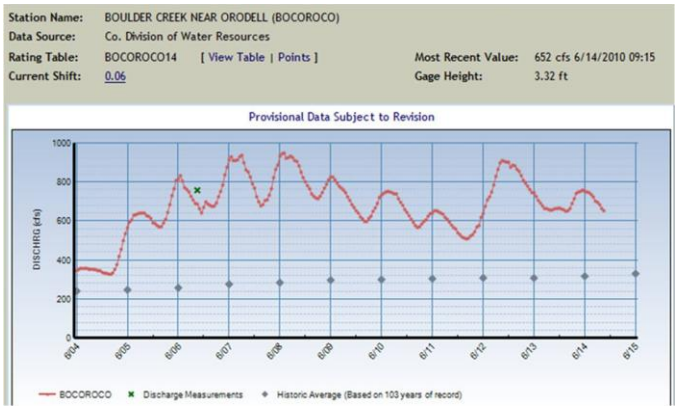
Wednesday, May 26

Multiple severe thunderstorms brought copious amounts of large hail, strong winds and tornados to Adams and Weld County north of DIA. Radar-estimates of precipitation totaled an impressive 4.65 inches but no rain gages were close enough to verify this amount (see ALERT and CoCoRaHS maximums of 0.51" circled in following figure). Hail tends to cause overestimates of rainfall from Radar data. It is interesting to note that a similar storm the previous week (May 18) targeted nearly the exact same area. Property damage estimates from the hail was approximately $70 million. No significant flood damage was reported.



Tuesday, June 8

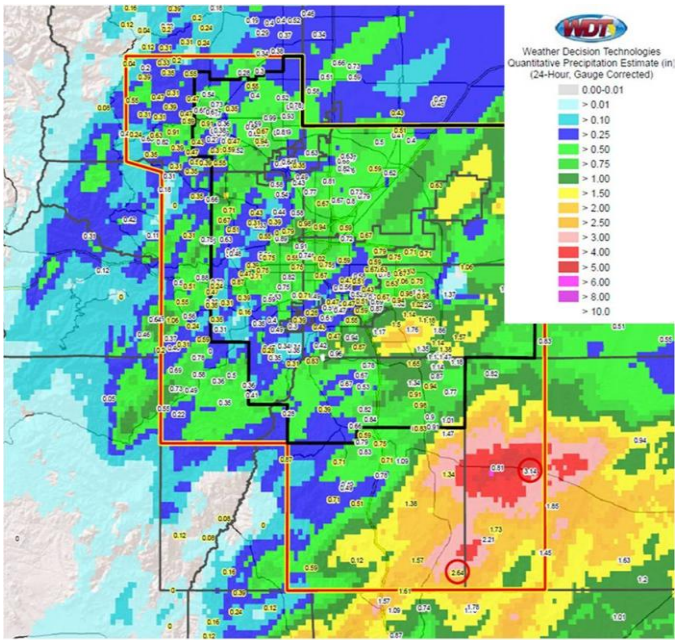
High snowmelt runoff rates are common in mountain streams at this time of year. What is not common is the issuance of a flash flood watch for snowmelt runoff without any threat of heavy rainfall, but that's precisely what happened on this particular day. The circumstance that led to this decision by the NWS was the partial failure of a private road crossing of Boulder Creek at the Red Lion Inn in the canyon west of Boulder. The main concern was for areas immediately downstream in the event that runoff waters would pile-up and release suddenly. Fortunately, nothing serious developed. Peak flows on Boulder Creek were approaching 1,000 cfs when the runoff waters did an end-around leaving the culverts in place with the road crossing impassable. For five consecutive days following for Red Lion incident (June 9-13), a heavy rain threat did exist for the region prompting the NWS to issue subsequent flash flood watches for the 12th and 13th. From June 11-13, the rainfall totals in the Boulder Creek watershed upstream of Boulder ranged from 2 to 3 inches but the intensities were quite low and the resulting runoff well-behaved.



Hydrograph plot for Boulder Creek near Orodell for 2010 peak snowmelt runoff period. June 12 peak caused by rainfall.
http://www.dwr.state.co.us/SurfaceWater/data/division.aspx?div=1

Sunday, July 4

Independence Day seems to be a recurring favorite for thunderstorms competing with fireworks. This year an upper level storm system brought unseasonably cool and very wet weather to the region. Multiple thunderstorms produced heavy rainfall across the entire District with the highest rainfall amounts observed in the Cities of Aurora, Centennial and Parker. Rainfall amounts produced by each storm ranged from ½ to 2½ inches. The Sulphur Gulch stream gage at Parker recorded its annual peak at 11:43 pm. Southeast of the District in Elbert County, radar rainfall estimates totaled 6.1" for the 24-hour period. Now that's wet!



Storm summary map showing 24-hour rainfall totals for July 4, 2010 from the ALERT System (yellow background), CoCoRaHS (white background) and gauge corrected Radar estimates ending at 7AM the following day.

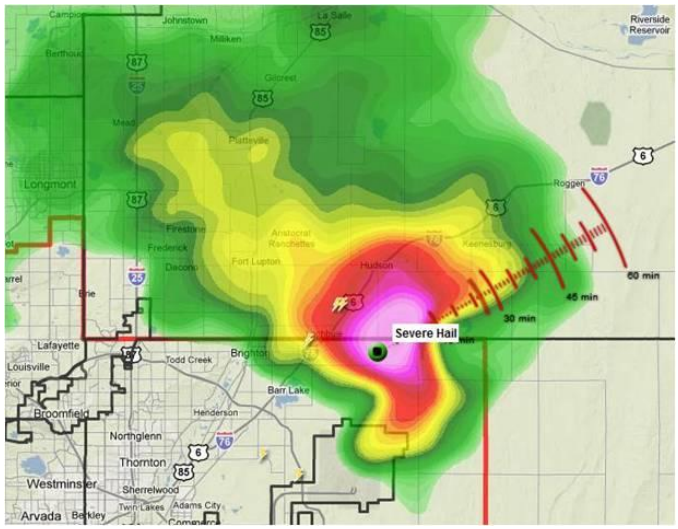
Tuesday, July 6

The storm activity in the District on this day was rather unremarkable, but nearby a couple of storms are worth honorable mention. In Boulder County north of the District, an ALERT rain gage south of Lyons in the Red Hill Gulch basin measured the year's most intense 10-minute rainfall of 5.4 in/hr during a 10 pm storm that lasted only 17 minutes. Earlier that same evening the NWS issued a flash flood warning at 7:27 pm for another intense storm that dropped 2 to 3 inches east and southeast of the District in northern Elbert and central Arapahoe and Adams Counties.

Wednesday, July 28

A very impressive severe thunderstorm in the Nederland area west of Boulder dropped over 8 inches of pea-to-marble-sized hail near the Eldora ski area with radar-estimated rainfall totaling 2-4 inches and prompting the NWS at 3:55 pm to issue its second flash flood warning of the year for Boulder County. Runoff from this storm caused streams to overflow their banks and wash over bridges and roadways, flooding streets in Nederland and causing car accidents. Roads were closed until they could be reopened by snowplows. Like the July 6 storm, the District was not impacted by this event.

Dan Barber with the Boulder Office of Emergency Management was highly complementary of District services provided prior to and during this storm, with the earliest notification of a potential threat being the 9:32 am heavy precipitation outlook that indicated a high potential for flooding later in the day. This early forecast also noted that should a strong thunderstorm become nearly stationary it could result in up to 2.5" in 60-75 minutes. As the situation developed later that afternoon, Mr. Barber was able to monitor a custom radar display developed for the District and later commented that: *"…I was able to anticipate and react to your radar and what I was seeing before NWS issued a flood warning."* The following image shows an example of the Google Map-based custom radar application used by Mr. Barber. Users may also select other information to display such as GIS layers (e.g. floodplains, burn areas, etc.) and real-time ALERT data.



Screen capture from June 11, 2010 showing WDT iMap™ Radar image with lightning strikes, storm attributes and projected storm track.

Friday, July 30

After two days of nearby flash flood warnings for Nederland (July 28) and the Hayman Fire Burn Area (July 29),

this Friday kicked off a 3-day weekend of NWS flash flood watches, typical for Colorado's monsoon season. While the storm activity this day did not culminate in any flash flood warnings or serious flooding in the District, a number of intense rainstorms produced amounts ranging from 1.8 to 2.4 inches over eastern and southern portions of the District's forecast area. The ALERT system measured 10-minute rainfall rates exceeded 3 in/hr at DIA and in Arapahoe and Douglas Counties. Eight rain gages also measured 1-hour totals exceeding one-inch followed by 8 stream gages recording annual peaks between 6:30 pm and midnight.

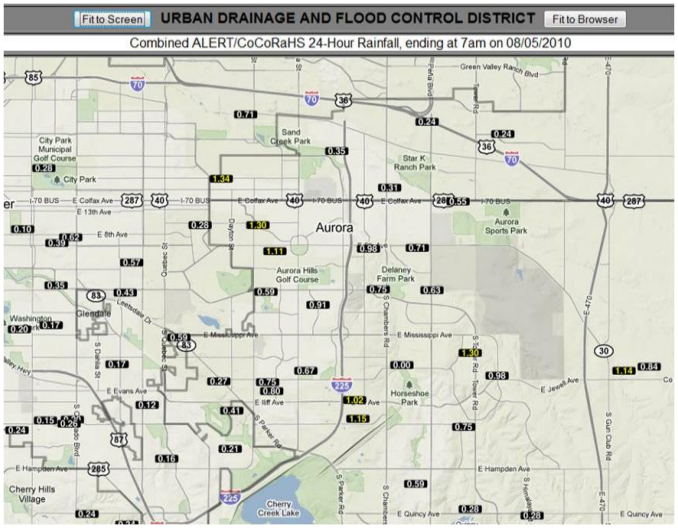
One storm near Castle Rock in Douglas County caused East Plum Creek at Haskins Gulch to rise 4.8 feet between 7 and 9:30 pm according to USGS records. The peak flow was estimated at just over 1,000 cfs. This is the largest event measured by this USGS gaging station since it was established in 1999. The largest known flood at this location occurred in June of 1965.

Sunday, August 1

This final District flash flood watch day of 2010 produced the ALERT System's largest 1-hour rainfall measurement for the year (1.93") in the Hayman Burn Area resulting in another flash flood warning for that area. North Boulder County rain gages in the St. Vrain Creek watershed also measured one-hour amounts exceeding an inch. Third Creek at DIA recorded its annual peak at 3:36 pm. While this day certainly produced the greatest 1-hour rain gage measurement of the year, a number of other days likely produced significantly larger events. As seen in the past, big storms have an interesting way of missing rain gages.

Wednesday, August 4

This day marked Hayman's third and final flash flood warning of 2010. Heavy rains elsewhere impacted Westerly Creek in Aurora and Denver, and Toll Gate Creek in Aurora. Annual flood peaks were recorded by 7 ALERT gages in these two drainage basins. Both streams are tributaries of Sand Creek. While rainfall totals only approached 1.4 inches in this area, four stations measured 10-minute rain intensities between 3 and 4 inches/hour. That's intense!



Monday, August 16

Although this was not the final flood threat day of 2010, it did mark the second most intense downpour measurement of the year—4.96" in 10 minutes at 5:47 pm, Station No. 4840 (South Boulder Creek at South Boulder Ditch) near CU-Boulder's South Campus site. Heavy rainfall was also observed in the upper Cherry Creek and Plum Creek basins in southern Douglas County.

Concerning heavy rainfall at Hayman and other burn areas

Past issues of *Flood Hazard News* documented many storms and flash flood warnings that affected the Hayman Burn Area in Douglas, Jefferson, Park and Teller Counties since the 2002 fire. Hayman was Colorado's largest ever wildfire having burned over 138,000 acres. Prior to 2002, Buffalo Creek in Jefferson County (12,000-acre burn area) was a notorious target for heavy rainfall resulting in very costly and deadly floods following the May 1996 fire. In 2011 and for some time period beyond the greatest concern for dangerous flooding on Colorado's Front Range will likely be the Fourmile Canyon (FMC) Burn Area west of Boulder. This burn area is half the size of Buffalo Creek but the watershed slopes are twice as steep. Debris and mudflows will soon become a recurring problem and the potential for dangerous and destructive floods is also very high. The current condition of the watershed resembles the conditions at the turn of the prior century when the area surrounding Gold Hill was heavily mined and cleared of timber.

The 1894 flood was Boulder's largest known flood. It washed away buildings, bridges and long sections of roads and railroads. The estimated peak discharge on Boulder Creek through Boulder was 12,000 cfs, equaling the 100-year (1% annual chance) flood. According to the USGS, the flood on Buffalo Creek that occurred just two months after the fire produced at peak discharge of 14,000 cfs of which 7,000 cfs came from a small tributary named Sand Draw that drains just over 1,000 acres. According to Bob Jarrett with the USGS, paleoflood studies show that Fourmile Creek was the primary source of the 1894 flood with little evidence of high flows from Boulder Creek upstream of the confluence.

Scientists and meteorologists who have studied wildfire impacts have observed that larger more intense rains appear to occur more frequently over burn areas compared to the adjacent healthy forest. This may just be a coincidence or just plain luck, but in the case of Hayman and Buffalo Creek this phenomenon is well document. One locally well-known meteorologist, John Henz, has called this a "chimney effect" and he believes it occurs because the exposed ground lacks shade formerly provided by the forest. The solar-heated soils cause a column of warm air to rise above the burn area, thus creating a rich environment for storm development and intensification. While the jury is still out on this issue, it is one plausible theory to consider and if true, the increased flood potential from the FMC-BA may be far worse than some engineers and hydrologists currently believe.

As empirical evidence in support of the chimney theory—in 2010 Hayman residents experienced three days reacting to NWS flash flood warnings (7/29, 8/1,4) and eight more days when heavy rainfall exceeded ALERT alarm thresholds (6/11,12,27 and 7/20,22,30,31 and 8/23). With experts telling us that as little as 1/4-inch of rain in one hour will cause large debris flows in the FMC-BA, we predict that flood warnings for this area will soon become commonplace.

Extreme Rainfall Not Required

How likely are flood-producing rainstorms really? Three years ago a small magnitude flood on Lakewood Gulch in Denver claimed the life of a child. It was this tragic event that prompted me to begin writing about what we have learned about rain frequency and flood frequency from more than 20 years of measuring rainfall and streamflow. In 2009 after the busiest year of flood threats in 30 years, the question of extreme rainfall and floods was revisited and suggestions were made concerning how subject matter experts might better communicate truths about floods. This year the FMC Fire in Boulder County created yet another opportunity to take a much closer look at flood risk with respect to alleged "infrequent" rainstorms.

Rather than ramble on trying to prove my case beyond reasonable doubt, I have simply chosen to present the following opinions and supporting evidence to challenge you, the reader, to refute these conclusions:

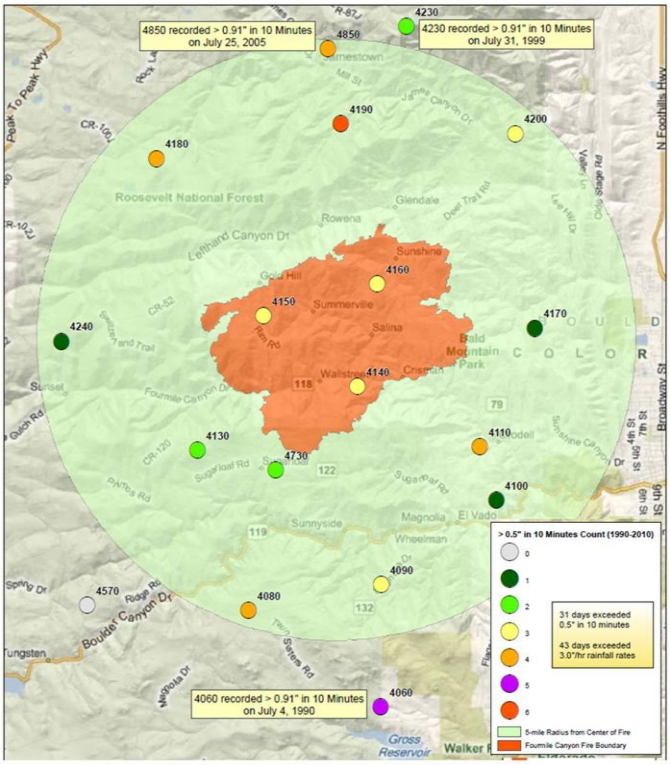
1. Big floods happen (support: many historic flood accounts for the region dating back to the 1860's)
2. Big rains happen often (read 2007 & 2009 issues of *Flood Hazard News* and preceding text)
3. Big rains do not always cause big floods (see past 20+ issues of *Flood Hazard News*)
4. Rainfall of a given magnitude, normally expressed as annual probability of occurrence or return period, never causes a like-magnitude flood on the receiving stream (support: have neither witnessed nor read an account of a flood with these characteristics).
5. Small floods can be deadly (e.g. Lakewood Gulch 2007)
6. Big floods occur in dry years (e.g. Big Thompson 1976 and Cherry Creek at Denver 2008)
7. Small rains can cause big floods (e.g. Hayman, Buffalo Cr)

Point No. 7 concerns everyone involved with the FMC-BA projects as well as the people who live in or travel through the high risk areas. One urgent question currently being asked is: How much rain will it take to seriously threaten lives and properties? For areas in and immediately downstream of the BA the answer seems fairly simple…it will not take much, possibly at little as ¼-inch in one hour, and such events are highly likely. For the City of Boulder the answer is more difficult and steps are currently being taken to make some reasonable educated guesses. Until then we should trust what we have learned from Hayman and Buffalo Creek.

The following table and figure provide a revealing historical look at rainfall measured within a 5-mile radius of the center of the FMA-BA over the past 21-years. Hopefully this data will help interested parties comprehend the likelihood of experiencing relatively small rainfalls. I wonder what flow rate the half-inch storm will produce? Time will certainly answer this question. Remember that a foot of rain fell nearby in 1976 (Big Thompson) and again in 1997 (Ft. Collins).

Number of 30-Minute Duration Storms Exceeding:

	0.25"	0.5"	0.75"	1.0"	1.25"	1.5"
1990	18	14	3	2	1	0
1991	25	9	3	2	1	0
1992	18	2	0	0	0	0
1993	20	4	0	0	0	0
1994	27	8	1	0	0	0
1995	22	4	0	0	0	0
1996	23	8	2	0	0	0
1997	27	9	1	0	0	0
1998	22	9	3	1	0	0
1999	35	16	5	3	0	0
2000	12	2	0	0	0	0
2001	27	7	2	0	0	0
2002	13	3	1	0	0	0
2003	16	6	3	1	1	1
2004	13	8	0	0	0	0
2005	9	3	1	1	1	0
2006	2	1	1	1	0	0
2007	9	4	2	2	0	0
2008	1	0	0	0	0	0
2009	5	0	0	0	0	0
2010	5	2	0	0	0	0
TOTALS:	**349**	**119**	**28**	**13**	**4**	**1**



Let's prepare for the worst and hope that it does not happen.

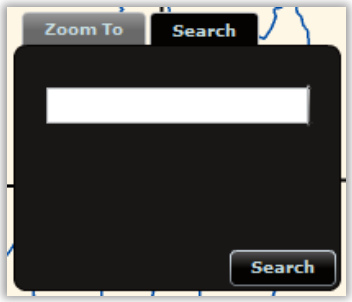
Public Release of the Electronic Data Management Application

Julia Bailey, Information Services Engineer, Information Services and Flood Warning Program

The District's Electronic Data Management (EDM) web map application developed by GIS Workshop Inc. (GISW) was launched for public use in April of 2010. Since then, the District has received typically positive feedback from users on the functionality and increased availability of District reports and data. The map application consists of three tabs (Document Search, Floodplain, and Routine Maintenance). Each tab can display three views (Map, Aerial, and Terrain) and multiple scales similar to a Google map. Users can use the Zoom-To tool to navigate the map by entering an address, intersection, stream, confluence, stream crossing, or section/township/range.

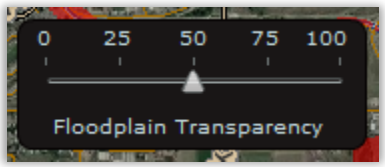
Buttons that control the map view.

The Document Search tab features an additional text search option in the upper right. This option allows users to search District report documents and index information such as name, author, sponsor, drainageway, year, and document type. When hovering over a particular map feature, the feature will become highlighted and a popup displays the feature name. Users may also search for documents by clicking on a highlighted basin or stream. The search results are displayed in a list with sort and filter capabilities. Reports can be opened in a browser window by double clicking on a report title. It is also possible to open reports directly from the map by clicking on a highlighted point feature.



Text search window is available by clicking the Search tab.

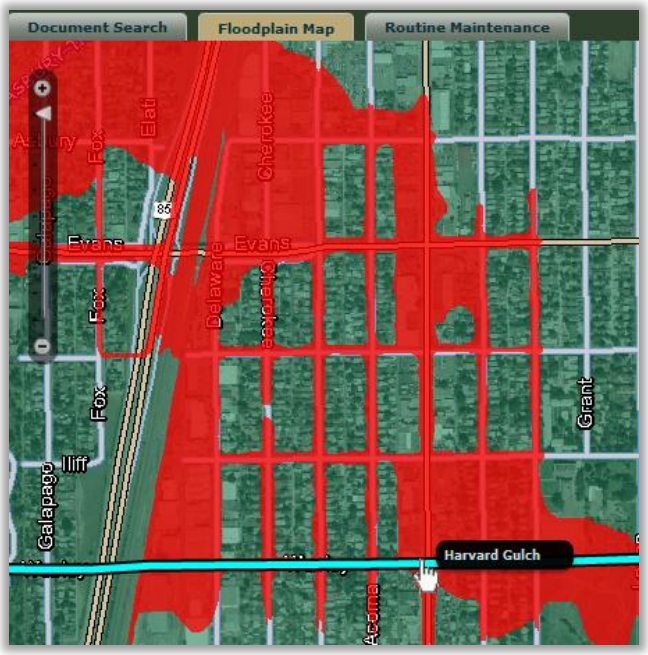
The Floodplain tab shows the District's consolidated floodplain layer. The floodplain boundaries are approximate and should not be used for official floodplain determinations. A slider bar at the top right allows the user to control the layer transparency.



The Routine Maintenance tab is a simple viewer for work item limits of debris removal, weed control, and natural areas. Similar to the Routine Maintenance tab, a Maintenance Eligibility tab viewer has been developed and will be available for public use in the coming months.

In parallel with EDM development, GISW built a web based data entry form. The webpage grants direct access to the MySQL database driving the application. District staff utilizes the web access of the database to upload reports and manage attributes. The District administers unique value tables in the database through phpMyAdmin.

The next phase of development includes a professional graphic redesign of the web map application, additional organization features of the MySQL entry form and expansion of interface functionality. By March of 2011, the District anticipates that the EDM will replace the existing SVG floodplain map referenced in the annually distributed flood hazard information brochures.



The District's consolidated floodplain layer at Harvard Gulch.

The FEMA National Flood Hazard Layer (NFHL) web map service is a new enhancement feature being added to the Floodplain tab. Where NFHL data does not exist, users will still be able to see the District's consolidated floodplain layer. Transparency of the floodplain layers will be controlled through the slider bar. A legend will also be added for easy determination of the floodplain information source.

One significant improvement to get excited about is that GISW will replace the ESRI geocode service in the address tool with the Google geocode API. This change will mean that the EDM Zoom-To address and intersection feature will locate the same result as Google maps.

The District encourages user comments and feedback on the EDM application.

Master Planning Program

Ken MacKenzie, Program Manager and Shea Thomas, Senior Project Engineer

Master Planning Projects

We completed six planning projects in 2010 with sixteen additional projects under way; and we hope to begin four new planning projects in 2010.

To date, UDFCD has completed a total of 81 major drainageway planning (MDP) studies, 87 outfall system planning (OSP) studies, and 80 flood hazard area delineation (FHAD) studies, including many updates of studies completed in the past.

We have recently completed a new tool used for estimating cost estimates in master plans in a more consistent manner. The workbook, called UD-MPCost, is available on the website for downloading.

A new master plan product, which we're calling an EPlan, is in the works. The EPlan is an electronic master plan. It includes all of the information found in a traditional master plan but presents it in a pdf format that is more user-friendly than the 11x17 plan-and-profile sheets from the past. We are putting the finishing touches on the EPlan Guidelines and new checklists, which will both be available on the website soon.

STATUS OF PLANNING PROJECTS

Project	Sponsors	Consultant	Status
Baranmor Ditch OSP	**Aurora**	**Olsson**	**Completed in 2010**
Big Dry Creek MDP & FHAD	Adams, Thornton, Westminster	Wright Water	50% Complete
Cherry Creek Stabilization Plan	Joint MP-DC&M Programs	Matrix	75% Complete
Cottonwood Creek (Lower) OSP Update	**SEMSWA, Douglas**	**Muller**	**Completed in 2010**
East Toll Gate Creek (Upper) MDP and FHAD	Aurora, SEMSWA	J3	90% Complete
East Toll Gate Creek (Lower) MDP and FHAD	Aurora, Buckley	None Yet	2% Complete
First Creek (Upper) MDP & FHAD	**Aurora, Denver**	**Moser**	**Completed in 2010**
Irondale Gulch OSP	Commerce City	Moser	55% Complete
Lafayette / Louisville Boundary OSP	Lafayette, Louisville	McLaughlin	70% Complete
Little's Creek MDP and FHAD	SEMSWA	AMEC	30% Complete
Lone Tree, Windmill, & Dove Creek MDP & FHAD	**Douglas, SEMSWA**	**Icon**	**Completed in 2010**
Louisville Criteria Manual Update	Louisville	WHPacific	5% Complete
Marston Lake North Drainageway MDP Update	Denver, Denver Water, Lakewood, Jefferson	None Yet	2% Complete
North Dry Gulch OSP	Lakewood	Muller	30% Complete
Park Hill (Lower) Drainage OSP	Denver, Denver Water	Enginuity	60% Complete
Pine Gulch Dam Analysis & OSP Update	Parker, Douglas County	URS	65% Complete
Piney Creek OSP & FHAD	SEMSWA, Aurora, Douglas	WRC	50% Complete
Second Creek MDP & FHAD	Aurora	Olsson/Matrix	40% Complete
South Boulder Creek Flood Mitigation Study	City of Boulder	CH2M Hill	65% Complete
West Toll Gate Creek MDP & FHAD	Aurora, SEMSWA	Michael Baker	5% Complete
Westerly Creek (Lower) MDP	**Aurora, Denver**	**Kiowa**	**Completed in 2010**
Willow Creek, Little Dry Cr & Greenwood Gulch OSP	**Douglas, Greenwood Village, Lone Tree, SEMSWA, SSPRD**	**CH2M Hill**	**Completed in 2010**

MDP = Major Drainageway Plan, OSP = Outfall Systems Plan, FHAD = Flood Hazard Area Delineation

Urban Storm Drainage Criteria Manual

The major rewrite of the *Urban Storm Drainage Criteria Manual Volume 3: Best Management Practices* that began in August 2008 was completed in November. This manual is considered by many as the standard by which other stormwater quality manuals are measured, and is one of the most respected stormwater management criteria manuals nationally and around the world. All three volumes of the *Urban Storm Drainage Criteria Manual* (USDCM) are available in pdf format on our web page (www.udfcd.org) for download. We encourage you to check the website frequently for the latest updates.

UDFCD Computational Tools and USDCM Support Group

You too can be a member of the UDFCD cyber-community by subscribing to this internet discussion group at: http://groups.google.com/group/UDFCD-support. Ask a question about the criteria manual, software, or spreadsheets and hear what we and other users have to say. We post messages to this group whenever a new version of the spreadsheets, software or manual is posted so this is a great way to be alerted to new releases on our website.

UDFCD Software

You may download the UDFCD unit hydrograph program *Colorado Urban Hydrograph Procedure (CUHP),* and other free software, including *UDSEWER* that includes a profile plotter, and many other free design aid workbooks from our website at www.udfcd.org. To download the CUHP companion EPA SWMM program, we have placed a hyperlink from our software site to the EPA website.

UDFCD Annual Seminar

At our 2010 annual seminar we had 311 registrants, the largest attendance ever. The proceedings are available at: http://www.udfcd.org/resources/conferences.htm.

On April 25, 2011 we will have our next annual seminar. This one-day program will be at the Stapleton Doubletree Hotel, and registration will be $60. Please mark your calendar and join us to find out what is going on regionally and nationally in drainage, stormwater quality, and floodplain management.

A full house at the 2010 District seminar.

The District now has a Facebook page! Follow us for information of upcoming events, useful tips or information for designers, policy reminders or explanations for local governments, public service announcements, training opportunities, etc.

Check us out at:
http://www.facebook.com/pages/Urban-Drainage-and-Flood-Control-District/178014312224296

Caley Drive Bridge Completed

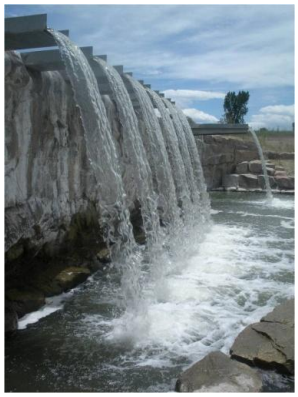
The Caley Drive bridge project replaced an inadequate crossing of Piney Creek that was the only access to a subdivision in Centennial. District partners were Centennial and the Southeast Metro Stormwater Authority.

Caley Drive bridge over Piney Creek.

Executive Director Paul Hindman, left, participates in ribbon cutting ceremonies at the completion of the project.

Cherry Creek Drop Number 27 Receives CASFM Honor Award

By Barbara Chongtoua, Senior Project Engineer, Design, Construction and Maintenance Program



The Cherry Creek Drop Number 27 Project is located within the John F. Kennedy Golf Course off of Havana Street in the City and County of Denver (City). Although the project area has a beautiful golf course as its back drop today, in 1935, the area served a very different purpose as the site of the Kenwood Dam. The Kenwood Dam was constructed to provide flood protection for the City subsequent to a disastrous flood. In 1944, the Kenwood Dam was decommissioned to accommodate the construction of the Cherry Creek Reservoir. Remnants of the Kenwood Dam still exist today which have been incorporated as elements of the improved drop structure.

Concerned with the structural integrity of the existing drop structure and stability of Cherry Creek, the City and the District initiated a project to rehabilitate the area. The goals

of the project were simple: preserve the heritage of the project area, arrest erosion at the existing drop structure, and stabilize the reach of Cherry Creek downstream and upstream. The design, however, was challenging since this drop structure is one of the tallest along Cherry Creek at 18 feet in height.

Using the Kenwood Dam end sill as the crest and the face for the Drop Structure, the project was a success, earning the CASFM 2010 Honor Award for Outstanding Achievement. Cherry Creek Drop Structure 27 recreates a natural waterfall using recycled materials and faux rock panels, operates as an effective energy dissipater stabilizing the creek corridor, and enhances the existing the surrounding environment.

CHERRY CREEK DROP #27

building the vision

District Releases New Stormwater Quality Design Criteria

Holly Piza, Senior Project Engineer, Master Planning Program

Note: This was previously published by Colorado NPS Connection, Fall 2010.

The Urban Drainage and Flood Control District (UDFCD) recently finalized a major update to the Urban Storm Drainage Criteria Manual (USDCM) Volume 3. The manual is designed to provide guidance in selecting, designing, maintaining, and implementing best management practices (BMPs) to minimize water quality and quantity impacts from stormwater runoff. The update emphasizes the holistic Four Step Process (see inset) for reducing the impacts of urban runoff.

The manual has been updated and expanded several times since it was first published in 1992 as our understanding of urban hydrology and BMP performance expanded, and as the design of various BMPs has been refined. Noteworthy additions and revisions of the update include:

- Increased emphasis on runoff reduction, which is Step 1 of the Four Step Process. The updated manual provides guidance for quantifying volume reduction when MDCIA and other LID measures are implemented. This provides the user with potential "sizing credits" for downstream stormwater facilities.
- Substantial revision to design criteria for several BMPs as well as inclusion of BMPs not previously in the manual. Green roofs and underground BMPs were added. Although UDFCD continues to strongly recommend treatment of runoff above ground, it also recognizes the need to provide guidance related to underground BMPs when surface treatment is not practicable.
- Revision and expansion of the Construction BMPs chapter.
- Addition of supplemental guidance to promote more effective implementation of BMPs. While the manual remains focused on engineering design criteria, UDFCD also recognizes that it is helpful for designers to be aware of why certain criteria have been developed, how various practices can best be implemented on a site, opportunities to consider, and common problems to avoid.
- New Excel™ workbooks to assist in BMP selection based on site specific conditions, BMP design including integration of the excess urban runoff volume for use with full spectrum detention, and BMP performance expectations and life cycle costs.

The manual update is available at www.udfcd.org.

The Four Step Process for Stormwater Quality Management

Step 1Employ Runoff Reduction Practices: To reduce runoff peaks and volumes and pollutant loads from urbanizing areas, implement Low Impact Development (LID) strategies, including measures to "minimize directly connected impervious areas" (MDCIA). These practices reduce unnecessary impervious areas and route runoff from impervious surfaces over permeable areas to slow runoff and promote onsite storage and infiltration.

Step 2 Implement BMPs that Provide a Water Quality Capture Volume (WQCV) with slow release: After runoff has been reduced, the remaining runoff must be treated through capture and slow release of the WQCV.

Step 3 Stabilize Drainageways: During and following urban development, natural drainageways are often subject to bed and bank erosion due to increases in the frequency, rate, and volume of runoff. Although Steps 1 and 2 help to minimize these effects, some degree of drainageway stabilization is required.

Step 4 Implement Site Specific and Other Source Control BMPs: Frequently, site-specific needs or operations require source control BMPs. This refers to implementation of both structural and procedural BMPs.

The Volume 3 update includes design guidance for BMPs not previously included in the manual. This includes design and maintenance considerations for green roofs such as this one located at the Denver Botanic Gardens.

Stormwater Quality & Permitting Support Activities

Holly Piza, Senior Project Engineer and Ken MacKenzie, Manager, Master Planning Program

UDFCD continued to be active in the stormwater quality arena in 2010, with commitments to the following organizations and activities:

Best Management Practices (BMP) Advancements:

UDFCD completed a rewrite of Volume 3 of the Urban Storm Drainage Criteria Manual (USDCM). The document available at www.udfcd.org, includes updated design criteria and maintenance recommendations, new guidance on quantifying volume reduction, and has a new format designed to improve readability of the manual.

UDFCD BMP Monitoring Program:

The UDFCD BMP monitoring program continued in 2010 with sites collecting between 12 and 28 rain events. We monitored a side-by-side porous asphalt and permeable interlocking concrete pavement test site at the Denver wastewater building, pervious concrete and a sand filter at the Lakewood Maintenance facility, and an Extended Detention Pond (EDB) in Grant Ranch. Both flow and pollutant data will be formatted for submittal to the International BMP Database.

New Discoveries:

With the addition of green roofs to Volume 3 of the USDCM, we have added a new test site at Denver Botanic Gardens. A sampling vault was constructed as part of the new Mordecai Children's Garden; a green roof constructed on the Denver Botanic Garden's parking structure. UDFCD will monitor runoff reduction as well as water quality of the runoff.

Colorado MS4 Stormwater Group:

The District continued to host quarterly luncheon meetings to discuss stormwater issues in 2009. These meetings are open to all Colorado communities affected by the Clean Water Act, which requires permits for municipal separate storm sewer system (MS4) discharges. The meetings serve as a forum to exchange ideas and experiences and to meet face-to-face with the Colorado Department of Public Health and Environment regulators.

New Software:

In August we released BMP-REALCOST, a stormwater best management practice life cycle cost assessment and effectiveness model. This software was developed by Chris Olson and Dr. Larry Roesner at Colorado State University under contract with UDFCD. Technical review and oversight was provided by the Urban Watersheds Research Institute, a Colorado non-profit organization which also helped fund the research and development of the software. Additional funding was provided by the Colorado Stormwater Council. BMP-REALCOST is available for download at www.udfcd.org.

District Receives Financial Reporting Certificate

For the twenty-first year in a row the District has received a *Certificate of Achievement for Excellence in Financial Reporting* from the Government Finance Officers Association of the United States and Canada

The certificate is presented to government units whose comprehensive annual financial reports achieve the highest standards in government accounting and financial reporting. The award was presented to the District at its March Board of Directors meeting by District auditor Dean Johnson, Johnson, Holscher & Co., P.C.

Congratulations to Frank Dobbins, Manager of Finance and Accounting, and assistant Darla Reeves for continuing this string of awards.

From left, Paul Hindman, Darla Reeves, Dean Johnson and Board Chairman Nancy McNally

Design, Construction & Maintenance Program

Dave Bennetts, PE, CFM, Program Manager and Laura Kroeger, PE, Assistant Program Manager

Staff Changes

In the last year, the Design, Construction, and Maintenance (DCM) program has had several staff changes. Mark Hunter, our long time manager, retired after 29 years at the District. This created the opportunity for some movement of staff within the program. As a result of an internal selection process; David was selected to become the new Program Manager, and Laura was selected to become the new Assistant Program Manager. Both are excited to be in new roles and looking forward to implementing changes to the program.

Cindy Thrush had left the District at the end of 2009 which created an opening for a project engineer position. The program welcomed David Skuodas as their new project engineer in May. With Laura moving to the assistant manager role the program was still one project engineer short from the previous year. It was decided to keep the smaller staff, and by shifting duties and areas of responsibility the work load would hopefully balance out. For more information about the new areas of responsibility, a revised organizational chart is available on our website (www.udfcd.org). Look for next year's program report to see how the decision panned out…

Program Changes

Once the decision was made to keep a smaller staff it was essential to make administrative changes that would help the program run more efficiently. The changes made in the program were in line with overall District changes, such as going paperless and developing an integrated team approach with the administrative staff.

Going paperless is a challenge from a filing, records management and project management standpoint. A standardized project electronic filing system has been established and is being linked to a Projects Layer on the District's Electronic Data Management (In-House EDM) which utilizes GIS. The Projects Layer is a shape file of project limits with a project management attribute table. Once a project is complete the Project Layer will feed into the Public EDM system available through the website.

Other In-House EDM tools being developed are the Routine Maintenance Layer, Dam Layer and Pond Layer. The Routine Maintenance Layer will link work schedules and inspection reports with routine work items. The Dam Layer will pull together all the information on dams to one location that is easy to access. Information in this layer includes the Emergency Preparedness Plans, Design Reports and Inundation Maps. The Pond Layer will assist in tracking the frequency, volume and cost of sediment removals; as well as provide a central location to store the Maintenance Plans.

The integrated team approach of having a project engineer/construction manager/ administrative staff/intern team has worked well for the program. The administrative staff has taken on more responsibilities with the engineering selection process, public bidding process and closing out construction projects. This has freed up needed time for the project engineers to spend on managing projects.

Research Update

In 2009, the DCM program created a research line item in our budget. The intent is to use the funds to provide documentation of new concepts or construction techniques that are being considered and evaluated. The ultimate goal is to provide regular updates, monitor results, and post the information on our website in the form of case studies. The District is continually trying new design and construction techniques but has not had a platform to share this information. The case studies will document the background/history, outline the idea, follow a project where the idea was implemented, and record/monitor the results. With the case studies being available on our website, the public, engineers, contractors and agencies can access this information so the information can be freely shared and utilized.

The first case study of Void Filled Riprap and Riffle Drops has been completed, and will be posted on our website soon. Other case studies in the development phase include; Hybrid (vegetated) Drop Structures, Log Drop Structures, Glass Fiber Reinforced Concrete (GFRC) Panels in Drop Structures, Floating Vegetated Islands in ponds, and various outlet structure configurations. The District is interested in feedback and hearing others' experiences related to the case studies posted. The website will include a comment section that will be monitored.

There is a potential that a few of these case studies may lead to revised or new criteria to be included in District Criteria Manual updates. An example is the sculpted concrete drop structures. Currently there is no design criteria available for designing this type of drop structure, even though dozens have been constructed within the District. The draft sculpted drop structure criteria will be posted on our website and the District will be looking for input and comments.

CIP and Work Plan

The DCM program is funded by three different legislative authorizations; the Construction Fund, the Maintenance Fund, and the South Platte River Fund. Each year the District prepares a work plan for each of the funds. The 5-year Capital Improvement Plan (CIP) lists capital construction projects by county for the Construction and South Platte

River funds. The CIP shows the District's financial participation, which will be matched by the participating local governments, for a 5 year window of time. This allows both the District and local government partners to plan funding levels into the future.

The Maintenance Work Plan lists projects for the Maintenance and South Platte River funds. Work is listed by county, category of work, the local government where the work is located, project location, description of work, and the estimated cost. Maintenance work is funded entirely by the District. Both the 5-year CIP and Maintenenace Work Plan are developed based on prioritized project requests from local governments. Copies of both of these plans are available on the District's website.

Routine Maintenance

Routine maintenance provides the basic level of care along the major drainageways within the District. Services typically provided have included mowing, trash and debris removal, weed control, and tree thinning. As part of the District's efforts to provide sustainable services, changes were made to how the routine maintenance is done. For example the mowing effort was refocused on reducing the mowing frequency. Less frequency combined with an aggressive noxious weed control program can maintain healthy vegetation with fewer site visits. In addition if more suitable vegetation is selected, like low mature plant height, this will reduce maintenance needs even further.

The success of this reduced maintenance approach depends on how the public views the changes. With fewer site visits the perception could be that the drainageways are not receiving maintenance that they need, or traditionally received. With that in mind, the District is in the process of developing an education brochure that will discuss the revised approach and the reasoning behind it. It will also address the benefits of a natural drainageway such has habitat and water quality benefits, as well as aesthetics. Once this information is developed, it will be available on the website to help educate the public on the efforts to provide a more sustainable routine maintenance program.

The District is currently maintaining over 300 drainageways and has spent $1,108,000 in 2010 for Routine Maintenance. Private contractors are hired each year to perform the maintenance on a unit price basis. The District's website has maps of the routine work broken down by county, major drainageway and reach.

Restoration Maintenance

Restoration work is site specific construction work to repair isolated drainageway problems, and is the majority of the activity in the maintenance program. This work often eliminates the need for more costly work later. Types of restoration activities include detention pond mucking, local erosion repair and bank protection, drop structure repair, and local channel grading, stabilization, and revegetation. All of this work is accomplished using private contractors either through a public bidding process or a pre-qualified contractor selection process. In 2010, the District completed $9,389,700 of restoration work.

Capital Construction Projects

CIP projects involve the design and construction of master planned projects. Generally, the District coordinates final designs prepared by consulting engineers. The local governments are involved in all aspects of the design process, and usually acquire any necessary ROW. Projects are publically bid for construction. In 2010 the District encumbered approximately $11,038,700 for construction projects. Below is a brief outline of a few capital and maintenance projects that have been recently completed:

Adams County

In the fall of 2010 the City of Thornton and the District completed maintenance improvements along **Grange Hall Creek** from the 108th Avenue culvert to 200 feet downstream. Grange Hall Creek and its tributaries flow east through portions of the City of Northglenn and the City of Thornton, before draining into the South Platte River north of 104th Avenue. As can be seen in the "before" photos below, the area downstream of the culvert outlet had become significantly down cut with eroding side slopes up to 15 feet tall and exposed utilities. Nearby schools make this a high traffic pedestrian area, and the vertical banks posed a safety risk to trail users. The improvements included the installation of a grouted boulder drop structure at the culvert outlet, the extension of an adjacent storm outfall, laying back eroded side slopes, and the installation of wrapped soil lifts. Wrapped soil lifts were used to save a stand of existing trees in a confined area of the channel. The wrapped soil lifts were planted with willow stakes harvested from an adjacent



Grange Hall Creek, before, left and middle; after, right

stand of willows, upland shrubs, and cottonwood poles.

In the winter of 2010 the City of Westminster, Adams County, and the District advertised the bid for construction of the **Shaw Heights Tributary Drainage Improvements**. The Shaw Heights project will provide much needed improvements to the existing storm sewer system in an older residential neighborhood. Runoff from an area of approximately 270 acres would drain down Shaw Boulevard to a sump located in a "T" intersection at Circle Drive where a single Type R Inlet would capture runoff and convey it in a 24-inch storm sewer pipe to the Allen Ditch. A single family residence at this intersection has experienced frequent flooding as the inlet has been overwhelmed by runoff and occasionally has clogged due to sediment loading from an upstream agricultural area.

This project will install a special 45-foot long open throat inlet that will capture the 10-year storm and convey it to a new storm sewer along Circle Drive. An overflow will be constructed to convey runoff in excess of the 10-year storm from the inlet to the Allen Ditch. The new storm sewer along Circle Drive will drain to an enlarged storm sewer system along Wagner Drive that will replace an older undersized system. The Wagner Drive storm sewer outfall flows into the detention pond at Rotary Park, which was built in 1990 as a previous District project. Improvements will be made to the Allen Ditch to provide a controlled spill location so that single family residences along the ditch can be protected from storm runoff intercepted and conveyed by the ditch. This project will begin construction in January 2011.

Arapahoe County

The District and Aurora Water (Aurora) completed the capital project on **Sable Ditch Detention Pond** on the northeast corner of Colfax Avenue and Jasper Street. The project is located in Adams County, but was coordinated through the Arapahoe County program. The project provides regional detention which reduces peak flood flows; and water quality for the Sable Ditch, a tributary to Toll Gate Creek. A Letter of Map Revision (LOMR) is currently in progress. The completed project removes 87 structures from the floodplain. The project is the first full spectrum detention pond built by the District. The project included inlet improvements and a second concrete box culvert crossing of Colfax Avenue. A unique challenge was dealing with the "hidden treasures" found during construction. The site that had been redeveloped several times from a farm house to hotel, which led to such interesting finds as old fuel oil tanks, abandoned wells, rubble containing asbestos, and several tons of buried broken up asphalt. The District's ALERT gaging station was moved upstream from 17th Avenue to the newly constructed pond to help monitor the performance of the pond.

Above, Sable Detention Pond site looking south after construction.

Before, East Tributary of Willow Creek looking west

After, East Tributary of Willow Creek looking same view

The District and Southeast Metro Stormwater Authority (SEMSWA) have completed the construction on a maintenance project for **East Tributary of Willow Creek,** located southwest of Dry Creek Road and Quebec Street. The drainage improvements protect the park from bank erosion and channel degradation. The project called for the

installation of a turf reinforcement mat, soil riprap check structures, and a soil riprap plunge pool. This project studies and evaluates the performance of a softer approach to channel stabilization. This softer approach allowed for the wetlands along the channel to blend into the adjacent turf areas of the green belt area.

Boulder County

In the spring of 2010 Boulder County and the District completed maintenance improvements along **Rock Creek at the Zaharias Open Space**. Construction of a high power overhead utility line and cow grazing activities had impacted a section of Rock Creek, resulting in a severely incised channel with 5- to 8-foot tall eroded vertical banks. Based on field observation and review of historical aerial photographs, it appeared that the alignment of the channel had moved significantly from its historic course, which contributed to the bank and bed erosion. If left alone, the channel would continue to erode and cut a deep channel upstream further degrading more reaches of Rock Creek. The purpose of the project was to repair the stream bank and bottom erosion and restore aquatic and riparian habitat to Rock Creek.

Because it appears that Rock Creek through the Zaharias Open Space will not be subjected to increased urban runoff flows from any upstream development, a unique natural approach to the channel design was utilized rather than hardened grade control structures. Restoration objectives included reconnecting the channel to the floodplain to restore hydraulic and habitat functions, provide channel stability, minimize cut and fill, and enhance riparian vegetation for habitat and erosion control.

The natural channel design approach utilizes data collected from a stable and high quality "reference reach" within the same stream system to develop the design criteria for the section of channel to be restored. There was an excellent reference reach located just downstream of the proposed stream restoration project reach. The data collected from the reference reach primarily identifies the physical character of the stream including the width and depth dimensions, sinuosity pattern, channel bed profile and channel bed material (size and type of soil/rocks). During the data collection phase, cross section dimensions were obtained at several riffle and pool sections, which helps identify the vertical stability parameters. The channel bank full profile was measured to ascertain lateral stability. Bed material from the stream channel was collected and evaluated to determine the bed material size-frequency distribution. Observations of the existing vegetation communities were recorded for re-vegetation recommendations and to maintain thriving wildlife habitat.

In addition to utilizing reference reach data, the study of historic aerial photographs from the 1940's, and observation of onsite physical features, were used to determine the new restored horizontal channel alignment. The existing eroded channel was filled in, and a new smaller bank full size channel was created in the approximate location of the historic channel. To help create a stable channel profile, the longitudinal slope of the creek was flattened by making the creek longer through creating meanders in the channel, similar in sinuosity to those found in the reference reach. In addition, pool and riffle sections were constructed along the channel bed and lined with the native cobble to help provide channel stability and create more natural aquatic habitat. The newly created channel will be vulnerable to erosion until the vegetation becomes fully established, so several protection measures were installed. These include two rock cross vane structures, and 10 buried log vane structures that were placed within the bed of the channel and are hardly visible. The grading design for the new channel, the over bank areas, and the upland areas minimized the cut and fill requirements and the impact to existing vegetation communities, and have helped reconnect natural floodplain functions.

In the Town of Erie a drop structure upstream of **Pond 1043** was repaired. The original structure was installed without a proper cutoff wall, and runoff was flowing underneath the crest of the structure and day lighting in the stilling basin. The crest was exposed and grout was pumped into the void underneath the structure, and a proper cutoff wall was added.

Left, Rock Creek before construction. Middle, aerial view during construction. Right, after construction.

Denver County

The District and the City and County of Denver have been working together, for the last twenty years, to rehabilitate **West Harvard Gulch**. In the summer of 2010, the District and Denver achieved an important milestone with the construction of drainage improvements along West Harvard Gulch upstream of Zuni Street. With these improvements, the entire length of West Harvard Gulch in Denver, except for the reach from the confluence of the South Platte River to the Burlington Northern Railroad Tracks, has been stabilized. Improvements for the remaining reach of the gulch are scheduled for construction in the fall of 2011.

ICON Engineering, under contract with the District, designed the improvements for the section of West Harvard Gulch upstream of Zuni Street for a distance of about 500 feet. The existing channel was subjected to severe head cutting and bank erosion especially in the lower reach near the Zuni Street culvert. The erosion had resulted in steep vertical banks and in many areas had exposed roots of adjacent trees as well as a Denver irrigation water line that crossed the gulch.

A trail parallels the gulch on the north and a park is nested along the southern bank. Both the trail and park serve the adjoining residential neighborhood for the purposes of recreation and transportation. With the eroding and nearly vertical channel banks, safety was a priority concern especially since the playground was in close proximity to the unstable channel banks.

Rehabilitation of the channel entailed constructing four small grouted boulder drop structures to raise the eroded channel bottom back to its previous elevation and to stabilize the longitudinal slope to approximately 0.50%. The project also enhanced the Zuni Culvert entrance, fashioned a shallow channel cross section and provided natural erosion protection using soil lifts and plantings where possible. Construction started in the summer of 2010 by L&M Enterprises and was completed by the fall. Thank you to Denver Parks and Recreation and Denver Wastewater for their contribution to the project.

Two projects on West Harvard Gulch before, top, and after, above.

Douglas County

Timbers Creek, located at approximately Fox Sparrow Road and Bayou Gulch Road in Douglas County, was experiencing channel bed and bank erosion. The ephemeral creek tucked between homes in a residential community naturally forested with Ponderosa Pine trees provides a beautiful backdrop for the neighborhood. Degradation, however, of the channel bed had undermined the banks, and with loss of the channel banks, the creek was becoming a liability threatening an existing maintenance trail and the native shrubs and pine trees. CH2M Hill was contracted to assist the District and Douglas County with the design of an improvement plan that would arrest the existing instability while maintaining the natural character of the corridor.

A system of sculpted concrete and timber drop structures and soil riprap bank protection was proposed to mitigate the erosion along the channel bed and bank, respectively. Unlike sculpted concrete drop structures and soil riprap, which have been widely designed and installed by the District, timber drop structures was a new technology. Kyle Hamilton and Mark Glidden with CH2M Hill devised the drop structure layout and details working alongside Laura Kroeger and Brad Robenstein, with Douglas County. The challenge during design was deriving a practical and constructible way of connecting the timber logs with the anchoring system and the steel sheet pile cutoff wall.

Timber drop structures immediately after construction.

With design finalized, Naranjo Civil Constructors and Jeff Fisher took over the project and employed the design vision. Fortunately the timber log drop details held together during construction and the challenge during construction was in aligning the channel between all the trees that were to be saved. During design it was also decided to try a new material for the cutoff walls on the sculpted drop structures, vinyl sheet pile. The gage of the sheet pile was selected based on the soils type and length to be driven. That resulted in the smallest gage of vinyl, but what was discovered in the field during installation was it was very difficult to work because it was very flimsy. A stiffer gage vinyl should be selected in the future.

The project was constructed during the summer of 2010 with completion achieved in the fall. Thank you to Douglas for their collaboration on the project.

Jefferson County

The **Lakewood Gulch Channel Stabilization Project** was initiated by the City of Lakewood and the District to stabilize a dangerous, badly eroded channel. The project is located between Dudley Street and Carr Street just north of West 7th Avenue. Within the project reach, Lakewood Gulch flows from west to east through a residential development.

The stabilization improvements were needed to protect/preserve adjacent residential properties as well as maintain the current flood capacity of the channel. This project provides a safer drainage corridor and the newly acquired permanent easements will provide access for future maintenance operations.

Before and after on Lakewood Gulch.

Prior to construction, the Lakewood Gulch channel had experienced severe erosion within the project reach. This erosion produced 5 to 10-foot vertical banks that encroached into backyards, threatening damage to houses, fences, sheds, and landscaping and creating unsafe fall hazards. Evidence of past makeshift channel stabilization measures was evident, such as buried rock, concrete rubble, and wood and chain link retaining walls built by property owners in an attempt to protect their properties from further damage and loss of land. Muller Engineering Company and ERO Resources were hired by the District to design and permit the improvements.

Because of tight space restrictions that exist within most of the project area (i.e., structures, retaining walls, and landscaped backyards), encroachment onto residential lots had to be minimized. However, several adjacent houses are in very close proximity to the Lakewood Gulch floodplain. As such, project improvements needed to find a balance between preserving the backyards of impacted properties and maintaining the pre-project flood capacity of the channel.

In order to accomplish this, the existing channel bottom was widened to 12.5 feet and stacked grouted boulder walls ranging in height from 2.5 to 7.5 feet were constructed to stabilize the existing steep banks. The stacked boulder walls were utilized to make use of natural materials, while providing aesthetic, structurally sound retaining walls.

The improvements consist of over 500 feet of stacked grouted boulder walls on each bank, four 2-foot high grouted boulder grade control structures, two storm sewer outfall modifications, and upland and wetland restoration of the project site. Design of the project was completed in August of 2009. Construction of the improvements started in October of 2009 and the project was successfully completed in February of 2010, by Left Hand Excavating.

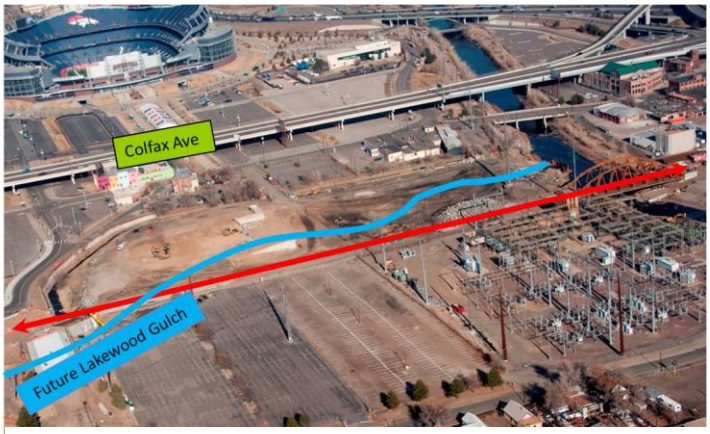
South Platte River

Construction continues on the **South Platte River Zuni/Sun Valley Reach and Lower Lakewood Gulch Reconstruction Project** between Colfax Avenue, 8th Avenue and Decatur Street in Denver. This challenging construction project, designed by Matrix Design Group Inc. (MDG) and awarded to Lawrence Construction Company in 2009, involves channel lowering/widening along the South Platte and complete reconstruction of Lower Lakewood Gulch from just upstream of Decatur Street to the river confluence. MDG is also providing construction management services for Denver and the District. Currently the construction is close to 45 percent complete with final completion expected in the spring of 2012 at an estimated cost of approximately $18 million.

Most of the construction in 2010 has occurred along the South Platte. The majority of the work consisted of constructing concrete caisson retaining walls, to be faced with decorative pre-cast concrete panels, along both banks downstream of 13th Avenue. These walls were required to contain the 100-year flow through a very tight reach between the Zuni Power Plant on the east bank and the electrical substation on the west bank. Shorter walls were also required for the new river trail underpass ramps at 13th Avenue.

Other major work along the river to date has been the construction of the soil riprap bank stabilization along the west bank. This work required diverting the river flow to the east side and pumping groundwater down to install the riprap toe. Lawrence Construction chose to install over 2500 feet of temporary sheet pile along the river to accomplish this. This sheet pile serves a double duty as it helps minimize groundwater intrusion into the work area. This “steel silt fence” (so nicknamed by Bill Lawrence) appears have been the saving grace on a sand-bed river this large, although there must be a shortage of sheet piling in the Denver area now. While the river has been diverted to the east side, other items such as a new grouted boulder diversion structure, a 54-inch water line lowering, several storm sewer outlet rundowns and sculpted concrete river jetty’s are being constructed either in whole or in portions until the river is flipped back to the west side and the east side can be completed.

Recently, the Lower Lakewood Gulch Reach has been given the green light due to the long awaited demolition of Denver’s Decatur Street facility in December. Removal of the building was necessary to relocate and reconstruct the severely undersized existing channel to 100-year capacity, thus removing land, buildings and the future RTD West Corridor light rail tracks from the 100-year floodplain. Presently the contractor is excavating for the new channel while constructing a large grouted boulder rundown into the South Platte. More information concerning this project can be found on Denver’s website at **www.denvergov.org**



Lower Lakewood Gulch at South Platte River after Decatur Facility Demolition. The future RTD West Corridor Light Rail is in red.

In 2010 several restoration maintenance projects were completed along the South Platte River. One such project was the extension of a 2009 bank restoration/stabilization project adjacent to South Adams County Water and Sanitation District's Williams Monaco Wastewater Treatment Plant at about the 98th Avenue extended. Originally constructed in the 1950's, the plant has undergone a series of expansions and upgrades. Unfortunately these expansions have been increasingly threatened by potential lateral movement of the river and the destabilization of the river bank over many years. Therefore, approximately 1000 feet of 3:1 sloped soil riprap revetment, vegetated with native grasses, trees and shrubs was installed within a flowage and maintenance access easement dedicated by the sanitation district. Revegetation maintenance efforts are ongoing.

The following DCM staff members contributed to this column: Bryan Kohlenberg, P.E., Senior Project Engineer; David Skuodas, P.E., CFM, LEED AP, Project Engineer; Richard Borchardt, P.E., CFM, Senior Project Engineer; Barbara Chongtoua, P.E., CFM, Senior Project Engineer

Former District Executive Director honored by NAFSMA

The National Association of Flood and Stormwater Management Agencies (NAFSMA) has named a new award in honor of former District Executive Director Scott Tucker. It is called the "L. Scott Tucker Award for Member Service to the Organization." Scott was a founding member of NAFSMA, and served as the District's representative to NAFSMA from 1977-2004, and served two terms as NAFSMA's President, Vice President, Secretary and Treasurer.

The first recipient of the award was Andre McDonald, President of Fort Bend County Levee Improvement District # 2 and President of Fort Bend County Flood Management Association. He chairs the Levee Issues subcommittee of the Flood Management Committee.

Scott Tucker (L), and Jim Fiedler, President of NAFSMA (R), with award winner Andre McDonald.

David Skuodas Joins District

As noted above, David Skuodas joined the District as a Project Engineer in the Design, Construction, and Maintenance Program in May of 2010. He will be the District's Project Engineer in charge of all projects in Adams and Boulder Counties. Dave holds a B.S. degree in Civil Engineering from the University of Florida; is a Certified Floodplain Manager, is a LEED Accredited Professional, and a licensed Professional Engineer in Colorado. His previous engineering experience includes work at Olsson Associates in Lakewood, Colorado, EA Engineering in Lincoln, Nebraska, and Kaw Valley Engineering in Lenexa, Kansas. Please join me in welcoming another Dave to the District.

Mark Hunter honored by ICEA

Mark Hunter, former Manager of the Design, Construction and Maintenance Program received the Sustained Contributor Award from the International Erosion Control Association (IECA). The award is defined as honorable recognition to an esteemed member who has made outstanding contributions to improve the erosion and sediment control community over a sustained period of time. The Sustained Contributor category includes members who have demonstrated leadership by example through a significant and long-term contribution to the erosion and sediment control industry and to IECA through education, government involvement, research or the development of technology. The Honoree must be a member of IECA for a minimum of 10 years.

Investigation of Hydraulic Efficiency of Street Inlets Common to UDFCD Region

By Ken MacKenzie, UDFCD and James C.Y. Guo, University of Colorado

When we updated the *Urban Storm Drainage Criteria Manual* (USDCM) in 2001, we also created a series of Visual Basic© driven spreadsheet workbook design tools, including the workbook *UD-Inlet.xls*. During the process of creating this workbook, we realized that the nationally accepted method of determining inlet capacity as described in the FHWA Hydraulic Engineering Circular No. 22 (HEC-22), was inadequate to describe the specific hydraulic characteristics of the most commonly used inlets in the UDFCD region. In 2006, we commissioned a study to investigate the hydraulic efficiencies of the CDOT Type 13 and Denver No. 16 grated inlets in valley and combination configuration, and the CDOT Type R curb opening inlets for street and roadway drainage (see Figure 1).

The study was completed at the Colorado State University (CSU) hydraulic laboratory, where a 1/3 scale model, Figure 2, was constructed to study the hydraulics of these inlets. The project was financially supported by the Urban Drainage and Flood Control District, the Colorado Department of Transportation, Denver, Adams County, Arapahoe County, Arvada, Douglas County, Jefferson County, Boulder, Golden, Lafayette, Lakewood, Littleton, and Lone Tree.

It was concluded that the USDCM design procedures and formulas provide a generally appropriate foundation to represent the hydraulic performance of these three inlets. The focus, therefore, was on adjusting the specific design parameters used in the empirical formulas to better agree with the laboratory data.

Testing was performed from January 2007 through November 2008. A total of 318 tests were conducted in two basic street drainage conditions: a sump condition, in which all of the street flow was captured by the inlets, and an on-grade condition, in which only a portion of the total street flow was captured and the rest of the flow bypassed the inlets.

Inlets on Grades

For a grated street inlet on a longitudinal grade, stormwater available for capture can be divided into frontal (or gutter) flow that is carried within the inlet width, and side flow that is outside the inlet width and spreads into the traffic lanes. Generally speaking, most of the frontal flow will be intercepted by the inlet and most of the side flow will not. The ratio of intercepted frontal flow to total frontal flow is approximated by the equation:

$$R_f = 1.0 - 0.09(V - V_o) \qquad (1)$$

Where R_f is the ratio of intercepted frontal flow to total frontal flow, V is the mean gutter flow velocity, and V_o is the splash-over velocity, i.e., the minimum velocity where some of the flow begins to jump or splash over the entire length of the inlet. V_o is a function of the grate length and the hydraulic characteristics of the openings, e.g., the Denver No. 16 grate has a higher splash-over velocity due to its directional cast vanes, than that of the CDOT Type 13. The splash-over velocity can be estimated as:

$$V_o = \alpha + \beta L_e - \gamma L^2{}_e + \eta L^3{}_e \qquad (2)$$

where L_e = effective grate length in feet. New values for coefficients, α, β, γ, and η were developed by applying multiple regression analyses to the data collected during the on-grade grate tests. It was found that the HEC-22 method

Left to right : CDOT Type 13 grated inlet in combination configuration, Denver No. 16 grated inlet in combination configuration, CDOT Type R curb opening inlet

Figure 1. Street inlets common to the UDFCD region

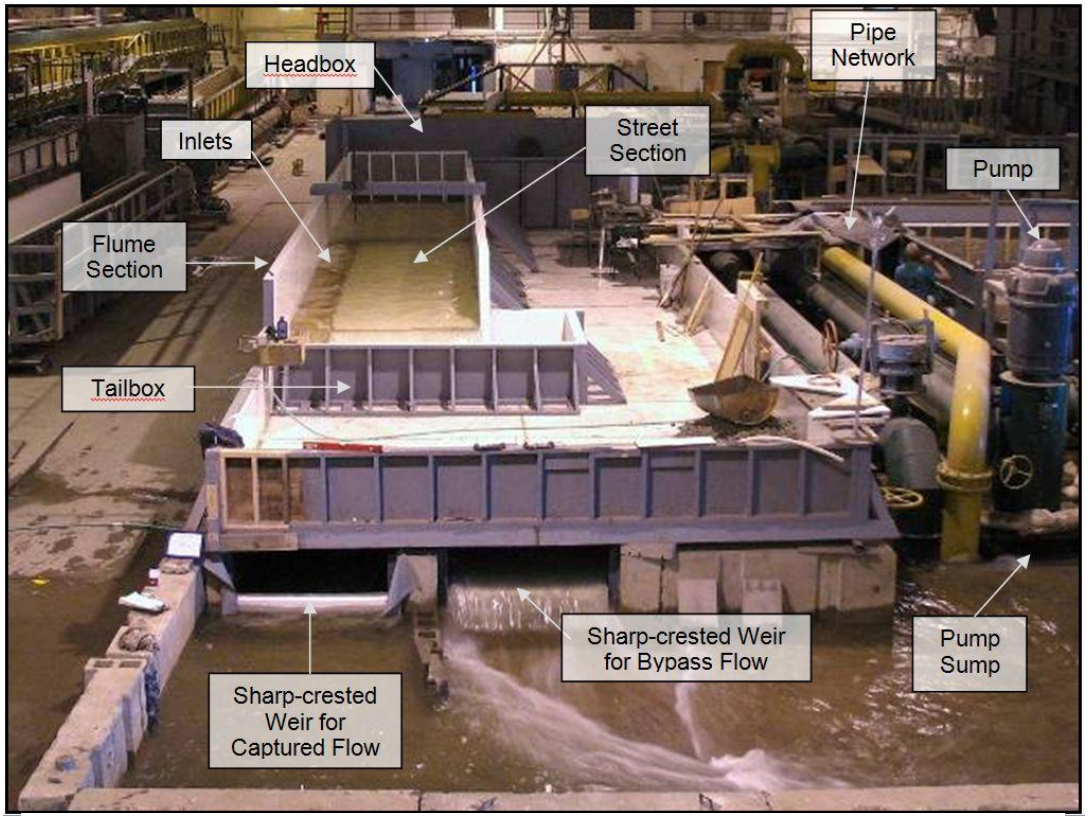


Figure 2. Laboratory layout of modeled street, sidewalk, curb, gutter, and inlets.

tends to over-predict the efficiency of the Type 13 and No. 16 grates, sometimes by quite a bit. Figures 3 and 4 demonstrate good agreement between the observed and predicted hydraulic efficiency using the above design procedure.

For the CDOT Type R curb opening inlet on a continuous grade, the required opening length, L_T, for complete interception of the design storm runoff, Q_s, on the street is computed by:

$$L_T = NQ_S{}^a S_L^b \left(\frac{1}{nS_e}\right)^c \qquad (3)$$

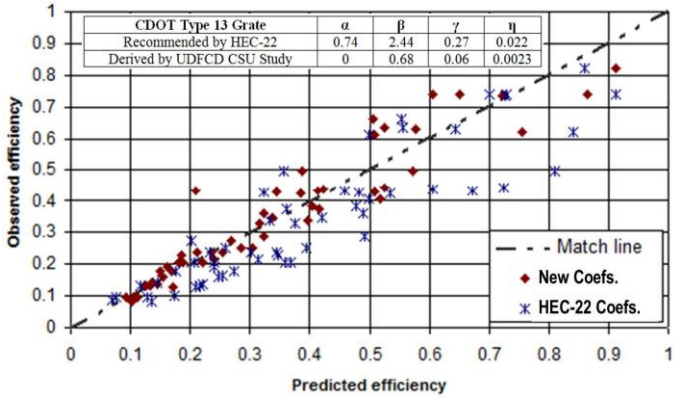


Figure 3. Predicted vs. observed efficiency for Type 13 combination inlet.

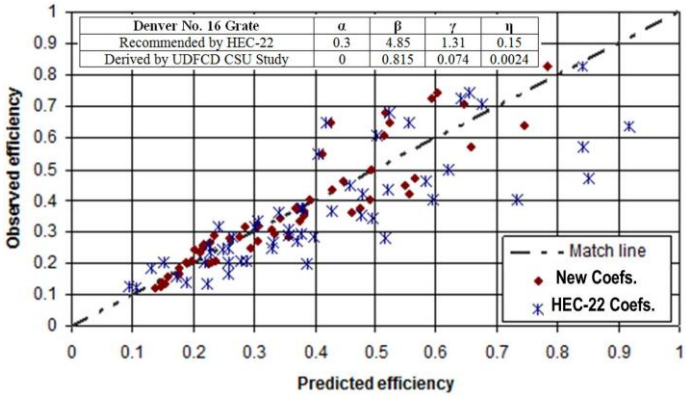


Figure 4. Predicted vs. observed efficiency for Type 16 combination inlet

In which L_T is the required length for a 100% runoff interception, N is a reduction factor, S_L = street longitudinal slope, n = Manning's roughness, and S_e = equivalent transverse street slope. The analysis of the laboratory data collected in this study led to a new set of coefficients for Equation 3. For the Type R inlet, the HEC-22 method was modified with newly derived coefficients. The comparison between observed and predicted hydraulic efficiency is presented in Figure 5.

Grated Inlets in Sumps

The flow through a sump inlet varies with respect to depth and continuously changes from weir flow at shallow depths, mixed flow at intermediate depths, and orifice flow at greater depths. The classic formulas for weir and orifice flows were modified with weir length or area opening ratios as:

$$Q_w = N_w C_w (2W_g + L_e) D^{3/2} \qquad (4)$$

$$Q_o = N_o C_o W_g L_e \sqrt{2gD} \qquad (5)$$

where Q_w = weir flow in cfs, Q_o = orifice flow in cfs, W_g = grate width in feet, L_e = effective grate length in feet, D = water depth in feet at gutter flow line outside of any local depression, N_w = weir length grate reduction factor, N_o = orifice area grate reduction factor, C_w = weir discharge coefficient, and C_o = orifice discharge coefficient. The transient process between weir and orifice flows is termed

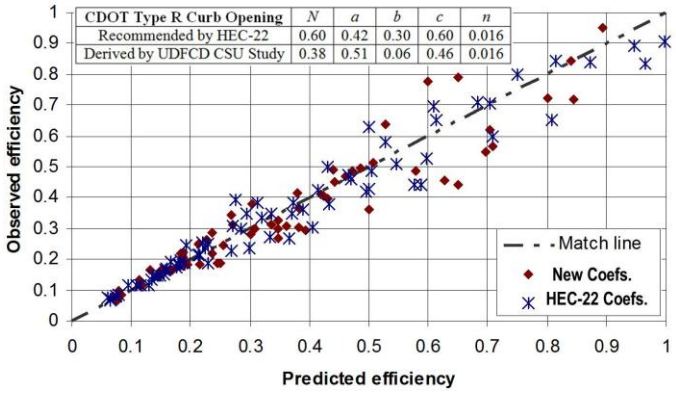


Figure 5. Predicted vs. observed efficiency for Type R inlets

mixed flow that is modeled as:

$$Q_m = C_m\sqrt{Q_w Q_o} \qquad (6)$$

where Q_m = mixed flow in cfs and C_m = mixed flow coefficient. In practice, for the given water depth, it is suggested that the interception capacity for the in-sump grate be the smallest among the weir, orifice, and mixed flows as:

$$Q_i = \min(Q_w, Q_m, Q_o) \qquad (7)$$

The recommended coefficients, C_w, C_m, and C_o are listed in Table 1.

Inlet Type	N_w	C_w	N_o	C_o	C_m
CDOT Type 13 Grate	0.55	2.73	0.44	0.57	0.97
Denver No. 16 Grate	0.62	2.38	0.32	0.61	0.97
Type 13 / No. 16 Combination Curb Opening	1.0	2.59	1.0	0.67	0.90
CDOT Type R Curb Opening	1.0	3.55	1.0	0.67	0.73

***Table 1:** Coefficients for various inlets in sumps.*

Curb Opening Inlets in Sumps

Like a grated inlet, a curb opening inlet operates under weir, orifice, or mixed flow. The capacity of a CDOT Type R Inlet is estimated based on its curb opening geometry as:

$$Q_w = C_w N_w L_e D^{3/2} \qquad (8)$$

$$Q_o = C_o N_o (L_e H_c)\sqrt{2g(D - 0.5H_c)} \qquad (9)$$

where H_c = height of the curb opening throat. Equations 6 and 7 also apply to curb opening inlets. The HEC-22 procedure was found to overestimate the capacity of a curb opening inlet under shallow depth, and underestimates capacity when water depth exceeds 0.8 feet. The new equations and coefficients agree well with the observed data for depths greater than 0.8 feet, as shown in Figure 6.

Combination Inlets in Sumps

Because the vault for a Type 13 or No. 16 combination inlet lies under the grate, any water entering the curb opening is forced through a narrow horizontal opening that exists under the curb head and in the plane of the grate. Therefore the capacity of a 3-ft curb opening associated with a Type 13 or No. 16 combination inlet is estimated based on this horizontal throat opening geometry as:

$$Q_w = C_w N_w L_e D^{3/2} \qquad (10)$$

$$Q_o = C_o N_o (0.44L_e)\sqrt{2gD} \qquad (11)$$

where $0.44L_e$ represents the horizontal orifice area (in ft^2) for Type 13 and No. 16 inlets. Equations 6 and 7 apply to curb openings associated with combination inlets as well.

Until now, estimation of the hydraulics of combination inlets has been unclear, even though thousands of combination inlets have been installed in the UDFCD region over time. In this study, a new approach was formulated to model the interception capacity of a combination inlet. It is suggested that a reduction factor tied to the geometric mean of the grate and curb opening capacities be applied to the algebraic sum of the total interception as:

$$Q_t = Q_g + Q_c - K\sqrt{Q_g Q_c} \qquad (12)$$

where Q_t = interception capacity for combination inlet, Q_g = interception for grate, Q_c = interception for curb opening, and K = reduction factor. The least square method was set up to minimize the squared errors using the reduction factor, K. It was found that K = 0.37 for the CDOT Type 13 combination inlet, and K = 0.21 for the Denver No. 16 combination inlet. A higher reduction factor implies higher interference between the grate and the curb opening. The HEC-22 procedure assumes that the grate and curb opening function independently, resulting in a consistent overestimation of the capacity of a combination inlet. K is a lumped, average parameter representing the range of observed water depths in the laboratory. During the model tests, it was observed that when the grate surface area is subject to shallow water, the curb opening intercepted the flow only at its two corners,

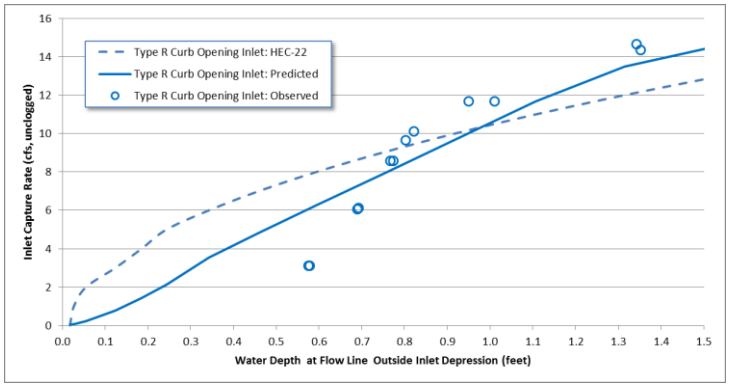


Figure 6. Flow capacity vs. depth for Type R inlets in sumps

and did not behave as a side weir by collecting flow along its full length. Under deep water, vortex circulation dominates the flow pattern. As a result, the central portion of the curb opening more actively draws water into the inlet box. Equation 12 best represents the range of the observed data, as indicated in Figure 7.

Conclusions and Recommendations

As illustrated in the *USDCM* (2001), the current methods in determining the inlet efficiency for the CDOT Type 13, Denver No. 16, and CDOT Type R inlets had not previously been sufficiently verified. A physical model is sometimes the best way to duplicate complex physical conditions that are encountered in the field, and this is what we reproduced in the laboratory. The data collected and analyzed provided considerable insight to understand the performance of these commonly used inlets under varying hydraulic conditions.

In this study, it was found that HEC-22 agreement with observed test data was generally poor with a hydraulic

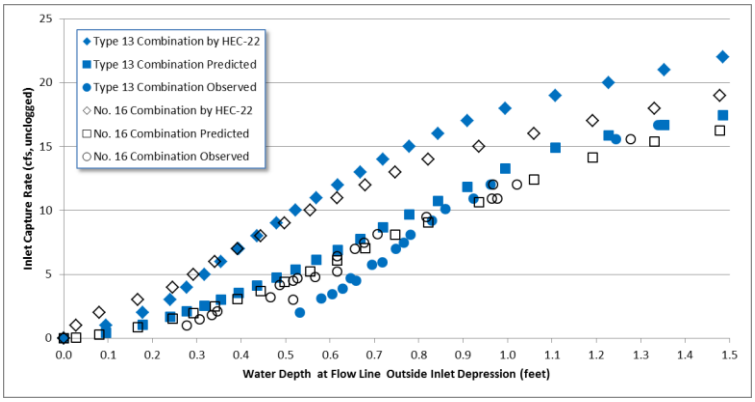


Figure 7. Flow capacity vs. depth for combination inlets in sumps

efficiency over-predicted by an average of 20% for the Type 13 and 16 combination inlets and under-predicted by an average of 7% for the Type R inlet. Methods given in the *USDCM* (2001) will be improved as part of the 2012 update for the on-grade condition by implementing the new splash-over velocity coefficients for the Type 13 and No. 16 grates. Similarly, the existing HEC-22 formula for Type R inlet will be improved by the regression analysis using the observed data. The form of the original equation was preserved, and the overall fit to the observed efficiency data was improved considerably with efficiency errors averaging 3.8%.

All cases investigated in the laboratory were conducted under no clogging condition. As recommended, a decay-based clogging factor is applied to the grate area when the grate operates as an orifice or to the wetted perimeter when the grate operates as a weir (Guo 2000, 2006). The clogging decay coefficients are 0.5 for grated inlets and 0.25 for curb opening inlets.

Lastly, the relevance of uniform flow in the model was examined by repeating the analysis with the observed test data adjusted to conditions of uniform flow. An average difference in hydraulic efficiency is approximately 3%, for all inlets under uniform or non-uniform flow conditions in the model. As a result, it is concluded that the impact of the uniformity of the street flow immediately upstream of the inlet is negligible.

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2010 Professional Activities of District Staff

Paul Hindman, Executive Director

*Co-Chair of Cherry Creek Stewardship Partners annual "Run for the Watershed"
*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
*Member, APWA National Water Resource Committee
*Planned and facilitated "Poker Night", 2011 Congress fund raiser, APWA Colorado Chapter Spring Conference, Grand Junction, Colorado
*Presented "Watershed Permitting, Coming to your Hometown" at the 2010 APWA Congress and Equipment Show, Boston, MA
*Participated in panel discussion titled, "Diversity and Succession Planning" at the 2010 APWA Congress and Equipment Show, Boston, MA

Bill DeGroot, Manager, Floodplain Management Program

*Board Member of the National Association of Flood and Stormwater Management Agencies (NAFSMA).
*Attended the ASFPM annual conference in Oklahoma City in May.
*Attended the CASFM Annual Conference in Snowmass Colorado in September.
*Attended NAFSMA's annual meeting in San Diego in August.
*Invited participant at ASFPM Gilbert White National Flood Policy Forum in Washington, DC in March
*Represented NAFSMA as a member of FEMA's Operating Partners Focus Group, which meets quarterly with representatives from FEMA, their Risk MAP contractors, NAFSMA and ASFPM to discuss Risk MAP and other mapping issues.
*Represented NAFSMA as a member of the Intergovernmental Flood Risk Management Committee (IFRMC), meeting quarterly with NAFSMA, ASFPM, FEMA and the Corps of Engineers.
*Participated in two panel discussions at the Natural Hazards Conference in Broomfield in July. Panel topics were "Design through decay and Beyond: Infrastructure Life Cycle Responsibilities" and "Motivating Local Governments to Reduce Hazards Risks."
*Presented our Good Examples brochure to an ISO/FEMA CRS Coordination Meeting in July in Denver.
*Co-presented *"Digital LOMC Submittals"* at the District's annual seminar in April.
*Presented testimony on behalf of CASFM at the CWCB Floodplain Rules hearing in November.
*Attended the FEMA Region VIII CTP Risk MAP conference in Lakewood in December.
*Member of Association of State Floodplain Managers (ASFPM), American Society of Civil Engineers (ASCE), Colorado Association of Stormwater and Floodplain Managers (CASFM) and National Hazard Mitigation Association (NHMA)..

Kevin Stewart, Manager, Information Services and Flood Warning Program

*National Hydrologic Warning Council (NHWC) President
*Advisory Committee on Water Information (ACWI) and Subcommittee on Hydrology for U.S. Department of the Interior
*American Meteorological Society (AMS) Steering Committee on the Weather and Climate Enterprise
*National Coordinating Committee for WERA 1012: "Managing and Utilizing Precipitation Observations from Volunteer Networks" authorized by the Western Association of Agricultural Experiment Station Directors and Sustainability/Funding Subcommittee
*Member: ASCE, ASFPM, CASFM, AMS and Colorado Emergency Management Association
*Invited participant at ASFPM Gilbert White National Flood Policy Forum in Washington, DC in March
*Invited speaker at Rocky Mountain Chinese Society of Science and Engineering Conference in Aurora, CO in April
*Keynote speaker at ALERT Users Group 23rd Flood Warning Systems Training Conference and Exposition in Palm Springs, CA in May
*Attended AMS Summer Meeting at Penn State University in State College, PA in August
*Attended Hurricane Ike Lessons Learned/Next Steps Conference at Rice University SSPEED Center in Houston, TX in September
*Plenary session speaker at National Flood Workshop in Houston, TX in October
*Participant at NHWC Texas Hydrological and Dam Safety Monitoring Best Practices Workshop in Conroe, TX in November

Ken MacKenzie, Manager, Master Planning Program

*Co-instructor for flood channel design training course on in February.
*Co-presented "*A Greener Rain Garden and a Better Permeable Pavement Section*" at the 2010 International Low Impact Development Conference in April.
*Keynote speaker at the 2010 US-Taiwan Urban Flood Mitigation and Floodplain Management Conference sponsored by the Rocky Mountain Chinese Society of Science and Engineering in April.

*Moderator of the UDFCD Annual Seminar in April; presented "*Street Inlets – Results of Our Research*".
*Served on the Urban Water Resources Research Council of the ASCE Environmental & Water Resources Institute.
*Presented "*Stormwater Quality Best Management Practices: What They Are, How They Work, and What Happens When They Go Wrong*" at the Colorado Environmental Health Association (CEHA) Annual Education Conference & Exhibition in September.
*Co-instructor for stormwater best management practices training course in September.
*Presented "Quantifying Stormwater Volume Reduction Benefits of Permeable Pavements" at the NAPA Paving Greener Conference in November.
*Served on the board of directors of the Urban Watershed Research Institute (UWRI).
*Served on Water & Environment Research Foundation (WERF) committee creating a model to link stormwater BMP systems performance to receiving stream protection.
*Served on the NAFSMA Stormwater Committee.
*Served on the CASFM Outreach Committee.
*Member of ASCE, ASFPM, CASFM, & NAFSMA.
*Co-authored "Design of Street Sump Inlets" technical paper in ASCE Journal of Hydraulic Engineering.

David Bennetts, Manager, Design, Construction & Maintenance Program
*Co-Presented "Highlights of the Design, Construction, and Maintenance Program" at UDFCD's Annual Seminar in April in Denver
*Attended CML's Annual Legislative Workshop in February in Denver
*Presentation to Taiwan Delegation in April at District
*Attended ASFPM's Annual Conference in May in Oklahoma City
*Attended APWA's Annual Conference in August in Boston
*Presented at CASFM's Annual Conference in September in Snowmass
*Panelist at Colorado Watershed Assembly in October in Vail
*Council Member, CU Denver Engineering Leadership Council
*Serve as Vice Chair, CASFM Board of Directors
*Member of ASCE, APWA, ASFPM, and CASFM

Laura A. Kroeger, Assistant Manager, Design, Construction & Maintenance Program
*Colorado Chapter APWA At-Large Board Member
*Colorado Chapter APWA Education Chair
*National APWA Co-Chair of Bridging Generations Sub Committee to Diversity Committee
*National APWA Membership Committee Member
*National APWA By-Laws Committee Member
*Panel Speaker at APWA Congress on Diversity and Secession Planning
*Panel Speaker at APWA Congress on Membership
*Mentor for the Emerging Leaders Academy
*CASFM Co-Presenter on Sculpted Drop Structures

Bryan Kohlenberg, Senior Project Engineer, Design, Construction & Maintenance Program
*Continued as National Society of Professional Engineers' (NSPE) scoring coordinator for the Jefferson County, North Metro and Colorado State MATHCOUNTS competitions for 6^{th}, 7^{th} and 8^{th} graders.
*Member of American Society of Civil Engineers (ASCE), Colorado Association of Stormwater and Floodplain Managers (CASFM) and American Public Works Association (APWA).
*Presented at Taiwan Water Resources Agency Symposium at UDFCD, April 23.
*Presented and co-led tour of South Platte River - Zuni/Sun Valley Reach Project for CASFM Metro Social, October 28.
*Co-presented the South Platte River - Zuni/Sun Valley Reach Project at 2010 National League of Cities - Congress of Cities and Exposition - River Vision Implementation Plan Mobile Workshop, December 2 and 3.

David Mallory, Senior Project Engineer, Floodplain Management Program
**Chair of the Colorado Association of Stormwater and Floodplain Managers (CASFM).
*Co-chair of the Floodplain Management Committee of the National Association of Flood and Stormwater Management Agencies (NAFSMA).
*Additional Memberships in the Association of State Floodplain Managers (ASFPM), American Public Works Association (APWA), and the National Hazard Mitigation Association (NHMA).
*Participated in the National Floodplain Function Alliance initiative.
*Participated in preparation of the ASFPM White Paper on Non-Levee Embankments.

*Presented *"Communicating Floodplain Preservation Values in Land Use Decisions"* at the FEMA Region VIII Hazard Mitigation Conference in February.
*Co-presented the *"Negations for Floodplain Managers"* workshop at the Georgia Association of Floodplain Management Annual Conference held at Lake Lanier in March.
*Attended the NAFSMA mentoring workshop *"Two Days in the Arid Southwest"* hosted at the Flood Control District of Maricopa County in Phoenix in April.
*Co-presented *"Digital LOMC Submittals"* at the District's annual seminar in April.
*Attended the Federal Interagency Floodplain Management Taskforce listening session in Washington DC, representing NAFSMA in May.
*Co-presented the *"Negations for Floodplain Managers"* workshop at the ASFPM Annual Conference in Oklahoma City in May.
*Presented *"Sustainable Floodplain Management"* at the APWA Sustainability Conference in Minneapolis in June.
*Presented *"Communicating Floodplain Preservation Values in Land Use Decisions"* at the CML annual conference in Breckenridge in June.
*Attended the Natural Hazards Annual Workshop in Broomfield in July.
*Attended the NAFSMA Annual Meeting held in San Diego in August.
*Chaired the CASFM Annual Conference held in Snowmass in September.
*Presented testimony on behalf of CASFM at the CWCB Floodplain Rules hearing in November.
Attended the FEMA Region VIII CTP Risk MAP conference in Lakewood in December.
Attended the NFIP Reform Listening Session held at the Denver Federal Center in December.
Participated in a panel discussion on behalf of NAFSMA at the FEMA Risk Analysis Division Conference held in Chicago in December.

Rich Borchardt, Senior Project Engineer, Design, Construction & Maintenance Program
*Attended 2010 District Annual Seminar in April in Denver
*Attended UWRI class on Hydraulic Design of Channels
*Attended 2010 APWA National Congress in August in Boston
*Presented at CASFM's Annual Conference in September in Snowmass
*Served as Water Resource Committee Chair for APWA Colorado Chapter

Shea Thomas, Senior Project Engineer, Master Planning Program
*Presented "*UDFCD Stormwater BMP Monitoring Program*" at the 2010 National Monitoring Conference in Denver in April.
*Presented "Effectiveness of Regional Detention on Flood Control and Water Quality" at the annual UDFCD seminar in Aurora in April.
*Presented "*Low Impact Development*" for the USGBC in June.
*Presented "*Full Spectrum Detention*" at StormCon in San Antonio in August.
*Served as the Treasurer, Scholarship Committee Chair and Conference Program Chair for CASFM.
*Served on the Stormwater and Floodplain Committees for NAFSMA.
*Member of CASFM.

Barbara Chongtoua, Senior Project Engineer, Design, Construction and Maintenance Program
*Author and presenter of the "Exploring Hybrid Drop Structures in Urban Drainageways" paper for ASCE World Environmental and Water Resources Congress 2010 in Providence, Rhode Island.
*Member of ASCE Urban Water Resources Research Council and National Safety Standards for Storm Water Facilities Sub-committee
*Workshop panelist at APWA 2010 Congress in Boston, Massachusetts.
*Presenter at CASFM 2010 in Snowmass, Colorado.
*Member of ASCE, APWA, Chi Epsilon, and CASFM.

Holly Piza, Senior Project Engineer, Master Planning Program
*Presented *Low Impact Design* for a USGBC meeting as well as the CML conference in June.
*Presented *Post Construction BMPs* at the UDFCD annual seminar in April.
*Presented *Permeable Pavements* at the Colorado Open Space Alliance (COSA) Conference in September.
*Presented *A Greener Rain Garden and a better Permeable Pavement* at the ASCE International LID conference in April and at StormCon in August.
*Presented *The New USDCM Volume 3* at the annual CASFM conference in September.
*Presented *Quantifying Volume Reduction* at the ASCE TDI Green Streets Conference in November. The presentation was part of the EPA workshop.

*Authored Urban Drainage and Flood Control District Releases New Stormwater Quality Design Criteria for the Fall 2010 issue of the Colorado NPS Connection.
*Served as the CASFM Water Quality Co-Chair.
*Served as UDFCD liaison to the Colorado Stormwater Council.
*Member of ASCE and CASFM.

Dave Skoudas, Project Engineer, Design, Construction & Maintenance Program
*Co-Chair of the ASCE Water Resources/Environmental Sciences Technical Group
*Member of ASCE, CASFM, and ASFPM
*Attended the Annual CASFM Conference in Snowmass
*Organized and Attended a Tour of the CSU Hydraulics Lab for ASCE
*Became Certified as an ASFPM Certified Floodplain Manager
*Attended a Flood Insurance Rate Map Revision Seminar
*Attended a BMP's in Drainageways Seminar
*Attended PSMJ Project Management Training for Public Works Officials
*Coordinated a Senior Design Project for CU-Denver Senior Design Class
*Participated in the Adams County Stormwater Advisory Committee

Julia Bailey, Information Services Engineer, Information Services and Flood Warning Program
*Attended DRCOG Denver Regional Data Consortium Annual Data Summit in January.
*Attended the ESRI Annual International Users Conference in San Diego, CA in July.
*Drainage Subcommittee member for DRCOG Denver Regional Data Consortium.
*Steering Committee member for EMWIN-Denver (Emergency Managers Weather Information Network).
*Member of GITA (Geospatial Information & Technology Association).

Mike Sarmento, Senior Construction Manager, Design, Construction & Maintenance Program
*Co-presented at District's Annual Seminar in April in Denver
*Attended the CARMA Spring Conference in Grand Junction, CO

Steve Materkowski, Senior Construction Manager, Design, Construction & Maintenance Program
*Passed national exam for certification as a Certified Professional in Erosion and Sediment Control
*Completed CDOT Erosion Control BMP Academy
*Completed HEC-RAS Course – UWRI
*HAZWOPER Re-certification
*Volunteer – Colorado Construction Career Days

Joe Williams, Senior Construction Manager, Design, Construction & Maintenance Program
*Attended APWA Construction Inspection Conference in February
*Volunteered for the 2010 Colorado Construction Career Days event
*Attended a Structural Best Management Practices Selection, Design and Economics short course presented by Urban Watersheds Research Institute

Jeff Fisher Senior Construction Manager, Design, Construction & Maintenance Program
*Presenter at UDFCD Annual Seminar in April in Denver
*Co-Presenter at CASFM Annual Conference in September in Snowmass
*Volunteer at APWA Construction Career Days

Darren Bradshaw, Construction Manager, Jefferson and Broomfield County – Design, Construction & Maintenance Program
*Continued membership in Association of State Floodplain Managers (ASFPM)
*Continued membership in American Public Works Association (APWA)
*Continued certification for the ASFPM Certified Floodplain Manager (CFM)
*Attended the UDFCD annual Stormwater & Floodplain Management Seminar in April