URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

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# UDFCD 2013 ANNUAL SEMINAR PROGRAM

| START | END | LENGTH | Session No. | TOPIC (PRESENTER) |
|---|---|---|---|---|
| 7:45 AM | 8:30 AM | 0:45 | | Check-In / Continental Breakfast |
| 8:30 AM | 8:35 AM | 0:05 | | **Welcome & Opening Remarks**<br>Paul Hindman, Executive Director, UDFCD |
| 8:35 AM | 9:20 AM | 0:45 | Session 1 | **Floodplain Management: What's In Your Future?**<br>Bill DeGroot (UDFCD), Michael Gease (FEMA Region VIII), Jamie Prochno (CWCB) |
| 9:20 AM | 9:45 AM | 0:25 | Session 2 | **USDCM Volumes 1 & 2: An Update on the Update**<br>Holly Piza (UDFCD) |
| 9:45 AM | 10:00 AM | 0:15 | | Morning Break |
| 10:00 AM | 10:30 AM | 0:30 | Session 3 | **The New NOAA Atlas Rainfall Atlas: What's Changed?**<br>Shannon Tillack (Wright Water Engineers), Ben Urbonas (Urban Watersheds, LLC) |
| 10:30 AM | 10:55 AM | 0:25 | Session 4 | **No Moss Growing Here**<br>Shea Thomas (UDFCD), Kyle Hamilton (CH2M Hill) |
| 10:55 AM | 11:55 AM | 1:00 | Session 5 | **How We Violated the Clean Water Act, and How You Can Avoid Doing the Same**<br>David Bennetts (UDFCD), Richard Clark (EPA Region VIII), Kiel Downing (USACE), Mary Powell (ERO) |
| 11:55 AM | 12:55 PM | 1:00 | | Lunch |
| 12:55 PM | 1:20 PM | 0:25 | Session 6 | **Sculpted Concrete Drop Structure Design Criteria and Construction Guidance**<br>Chris Kroeger (Muller Engineering) |
| 1:20 PM | 1:50 PM | 0:30 | Session 7 | **Current Research and Software Development**<br>Ken MacKenzie (UDFCD), Amanullah Mommandi (CDOT), Derek Rapp (Peak Stormwater, LLC) |
| 1:50 PM | 2:20 PM | 0:30 | Session 8 | **Real-time Flash Flood Forecasting Using New Hydrologic Models**<br>Kevin Stewart (UDFCD), Baxter Vieux (Vieux, Inc.) |
| 2:20 PM | 2:35 PM | 0:15 | | Afternoon Break |
| 2:35 PM | 3:50 PM | 1:15 | Session 9 | **Things We Learned The Hard Way**<br>UDFCD Project Engineers Rich Borchardt, Barbara Chongtoua, Bryan Kohlenberg, Dave Skuodas |
| 3:50 PM | 4:10 PM | 0:20 | Session 10 | **UDFCD Friend of the District Award**<br>Paul Hindman (UDFCD), Jeff Shoemaker (Greenway Foundation) on behalf of Joe Shoemaker |
| 4:10 PM | 4:20 PM | 0:10 | | **Closing Remarks**<br>Paul Hindman, Executive Director, UDFCD |

Annual Urban Drainage and Flood Control District Seminar
April 2, 2013

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## SESSION 1

# Biggert-Waters 12 Flood Insurance Reform Act-Insurance Impacts and Benefits of NFIP Community Rating System Reforms

Michael K. Gease, CFM, Natural Hazards Program Specialist,
FEMA Region VIII

**ABSTRACT:**

Under the Biggert-Waters Flood Insurance Reform Act of 2012, flood insurance premiums under the National Flood Insurance Program (NFIP) will be phased in to full actuarial rates in order to make the NFIP more fundamentally sound and reflect the true risk of flood prone area construction. This will have dramatic implications for property owners, especially those who built in hazardous areas before NFIP flood maps were produced showing their flood risk, and those built in compliance with previous maps and now are impacted by new map changes.

In turn, under the NFIP's Community Rating System (CRS), voluntary community participation and increased CRS class improvement can offset higher flood insurance costs by implementing freeboard, foundation design, fill protection, natural area protection, and other mitigation strategies that reduce rates but more importantly decrease risk and improve community resiliency. New changes in the CRS Manual benefit Colorado communities.

In this presentation FEMA Region VIII Staff will briefly outline the impacts of BW-12 and the CRS reforms on flood risk and flood insurance.

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SESSION 1 (continued)

## Update on the State Rules and Regulations for Floodplains in Colorado

Jamie Prochno, National Flood Insurance Program Coordinator, Colorado Water Conservation Board

**ABSTRACT:**

The Colorado Water Conservation Board promulgated new Rules and Regulations for Floodplains in Colorado (Rules) that became effective January 14, 2011.

The Rules contain higher standards for floodplain management that will help reduce flood losses, improving public safety and property protection.

The major changes to the floodplain management regulations include the application of a 1 foot freeboard, mapping of ½ foot floodway, LOMR-F requirements and critical facilities protection.

Communities in Colorado have three years from the effective date of the Rules to adopt the regulations, which means that all communities will need to update their floodplain management regulations by January 14, 2014.

CWCB is providing outreach and technical assistance to help local officials meet this deadline. To assist communities in this process, the CWCB has developed a State Model Flood Damage Prevention Ordinance that contains all the requirements of the Rules and meets the National Flood Insurance Program standards.

This presentation will introduce participants to the changes in floodplain regulations and will provide information about updating ordinances and municipal codes.

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SESSION 2

# USDCM Volumes 1 and 2 Updates—Expanded guidance on Storage Facilities

Holly Piza, UDFCD

**ABSTRACT:**

Volumes 1 and 2 of the Urban Storm Drainage Criteria Manual (USDCM) were last updated in 2001. These volumes are currently undergoing another update in order to capture experience gained and incorporate relevant research conducted over the past decade. This presentation will highlight changes and expanded guidance in the Storage chapter including:

- ✓ Regional, subregional, and onsite Detention
- ✓ Full spectrum detention as the recommended approach
- ✓ Allowable vs. historic peak unit discharge
- ✓ Incorporating full spectrum detention into various water quality BMPs
- ✓ Sizing methods
- ✓ Drop box configurations
- ✓ Trash racks

The presentation will also include findings from a recent investigation of over 20 storage facilities throughout the UDFCD region.

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# SESSION 3

## The New NOAA Rainfall Atlas: What's Changed?

Shannon Tillack, P.E., Wright Water Engineers and
Ben Urbonas, Urban Watersheds, LLC

**ABSTRACT:**

National Oceanic and Atmospheric Administration's (NOAA) National Weather Service has issued a draft of *NOAA Atlas 14: Precipitation-Frequency Atlas of the United States, Volume 8 Version 1: Midwestern States*. This is an update to the 1973 *NOAA Atlas 2: Precipitation-Frequency Atlas of the Western United States, Volume III – Colorado* which the Urban Drainage and Flood Control District (UDFCD) used to create the rainfall depth-duration-frequency isopluvial maps presented in the Rainfall chapter of the *Urban Storm Drainage Criteria Manual* (USDCM).

Based on the point precipitation depths from precipitation stations within UDFCD boundaries, the 2-year and 100-year, 1-hour point precipitation depths in the new draft Atlas are lower when compared to the 1973 NOAA Atlas.

This presentation will provide an overview of how the current rainfall depth-duration-frequency figures in the Rainfall chapter were created using information from the 1973 NOAA Atlas and the differences in the point precipitation depths between the current Rainfall chapter of the USDCM and the new draft Atlas. The technical issues being raised by UDFCD to NOAA inquiring about the differences will also be described, as well as the implications the changes in the point precipitation depths could have on stormwater and floodplain management within UDFCD.

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## SESSION 4

# No Moss Growing Here

Shea Thomas, Master Planning Program
Kyle Hamilton, CH2M Hill

**ABSTRACT:**

What did UDFCD shake up over the last year? The Design, Construction, and Maintenance (DCM) Program will finally be implementing the long awaited revised specifications. Learn what changes have been made and how other agencies can also utilize the specifications. The Bid Tabulations Program has also been revamped to better link and to provide more consistent bid items. Kyle will be discussing the updates to both the specifications and Bid Tabs.

Master Planning is working on establishing a geodatabase for all of the improvements shown in existing master plans. With the assistance of Enginuity Engineering Solutions and Atkins Global, a GIS-based program called SWIFT has been developed to help populate the database. This software will also be used for future master planning and design project deliverables to automatically update the database at the end of a project. Shea will discuss the goals of the database and describe how the product can be used by the public.

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## SESSION 5

# How We Violated the Clean Water Act and How You Can Avoid Doing the Same

David Bennetts, UDFCD;
Kiel Downing, US Army Corps of Engineers;
Richard Clark, Environmental Protection Agency
Mary Powell, ERO Resources

**ABSTRACT:**

**During a sediment removal project last year, the District violated the Clean Water Act. This presentation will discuss the project involved, the violation, and our interactions with the US Army Corps of Engineers (USACE) and the Environmental Protection Agency (EPA) to successfully resolve the situation.**

### David Bennetts, UDFCD

During completion of a sediment removal project on Piney Creek last April, the District violated the terms of our 404 permit with USACE. The District has had two violations in its long history of doing projects in the nations waterways. The presentation will briefly discuss both of these violations as well as the differing approaches and results in working to resolve them.

### Kiel Downing, USACE

Presentation will provide a brief overview of the 404 permitting process, permits and requirements for doing sediment removals in drainageways, and explain USACE's interaction with EPA once an enforcement action begins.

### Richard Clark, EPA

Presentation will include a brief discussion on the relationship that EPA and USACE have in administering the Clean Water Act, Section 404 program requiring federal authorization for the discharge of dredged and fill materials into waters of the U.S. It will also include how EPA handles Section 404 enforcement actions on unauthorized discharges into waters of the U.S.

### Mary Powell, ERO Resources

Presentation will provide an outline of the new processes and procedures implemented by the District to avoid future violations on projects. Some guidance and general recommendations will be provided regarding the 404 permitting process.

**A question and answer session will follow the presentations, providing the opportunity to ask both USACE and EPA questions regarding permitting and enforcement actions.**

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SESSION 6

# Sculpted Concrete Drop Structure Design Criteria And Construction Guidance

Chris Kroeger, Project Manager/Muller Engineering Company

**ABSTRACT:**

Sculpted concrete drop structures have been used for stream grade control since the late 1990s in Denver metro area. Much has been learned about the design and construction of these structures and the District's updated Urban Storm Drainage Criteria Manual will soon include design criteria and guidance within the Hydraulic Structures chapter.

This presentation will provide an overview of the draft criteria and guidance that is being prepared. The discussion will include a brief description of what a sculpted concrete drop structure is and background on their use for grade control. Information will be provided on how the design criteria was developed, and design details will be discussed which should benefit both design engineers and review agencies alike. To achieve successful projects, it has been learned that the construction process itself may be as or more important than the design. The presentation will conclude with a discussion on construction guidance, finishing techniques, and insight on how the design of sculpted concrete drop structures might evolve over the next 10 years.

SESSION 7

# Internet-Based Flood Database for Colorado

Amanullah Mommandi, P.E.
Senior Hydraulic Engineer (Hydraulic Program Manager),
Colorado Department of Transportation

**ABSTRACT:**

The accuracy of flood-frequency estimates can be greatly improved when historical flood information is included with systematically collected flood data (Interagency Committee on Water Data, 1982). Although many reports contain flood information for streams in Colorado, there has historically been no centralized repository for this information, making it difficult to access flood data. Prior to the completion the Web-based flood database, much of the historical flood information for Colorado was stored in numerous published and unpublished reports and files in local, State, and Federal government agencies and the offices of engineering firms and universities.

Although considerable research has been conducted using historical flood information in flood-frequency analyses, this information is often underutilized because of the uniqueness of each site and a lack of knowledge of the site location. Having an easy-to-use, Web-based geodatabase of historical flood and paleoflood information with links to sources of flood data would allow engineers and water-resource managers to fully use these data to provide information on the largest floods and would lead to improved flood-frequency estimates of the largest floods in Colorado.

The U.S. Geological Survey (USGS), in cooperation with the Colorado Department of Transportation, created a Web-based geodatabase for information on floods from 1867 through 2011 and information on paleofloods occurring in the past 5,000 to 10,000 years. The geodatabase was created using Environmental Systems Research Institute (ESRI) ArcGIS JavaScript Application Programing Interface (JavaScript API) 3.2. Engineers, scientists, and water-resource managers will be able to use these data for floodplain regulation, dam-safety, infrastructure design, and other uses.

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SESSION 7 (continued)

# User Interface and File Management Improvements to the Colorado Urban Hydrograph Procedure (CUHP)

Derek Rapp, P.E., CFM, CPESC
President, Peak Stormwater Engineering, LLC

## ABSTRACT:

The Colorado Urban Hydrograph Procedure (CUHP) is an evolution of the Snyder unit hydrograph. It has been calibrated to the Colorado Front Range using data collected by the USGS beginning in 1969. Data from 30 sites, representing a full range of land uses in the Denver Metro Area, was used to develop empirical relationships between the input hyetograph and observed output flows. Since its conception in 1978, numerous modifications have been made to the CUHP program to adapt to changing computational requirements as well as to refine and expand its capabilities.

At the request of CUHP modelers and project reviewers, an effort began in 2012 to once again update CUHP. The goals of this update were to simplify the user interface, incorporate recent improvements to the Urban Storm Drainage Criteria Manual, provide compatibility with 64-bit operating systems, and to provide advanced file-management tools for large watershed studies.

The user interface was simplified by reducing the number of worksheets in the Excel workbook and consolidating the user-input cells. Several tools were added including: the option to choose the input units for length and area (feet vs. miles, acres vs. square miles, etc.); a reasonableness check on user-inputs prior to running the model; and a check for consistency between the user-entered SWMM nodes and the EPA SWMM interface file. Also, the new CUHP workbook runs as a standalone Excel workbook and does not require separate code files. This allows anyone with Excel to open and run the model without having to download and install the program first.

The new CUHP also includes an advanced file management tab for engineers engaged in large watershed studies. This tool allows the user to setup a single CUHP input file that can produce several output files for different scenarios with the click of a single button. The different scenarios can include various combinations of land use (existing vs. future) and rainfall distributions (different return periods and area corrections). This presentation will highlight the major changes in the new CUHP software which will be released in mid-2013.

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## SESSION 8

# Real-Time Flash Flood Forecasting Using New Hydrologic Models

Kevin Stewart, Manager/UDFCD Information Services & Flood Warning Program
Baxter Vieux, Professor/University of Oklahoma, Dept. of Civil Engineering
and Principal/Vieux & Associates, Norman, OK

**ABSTRACT:**
Can anyone realistically and accurately predict a specific flash flood's impact before heavy rainfall occurs? Many would like to believe that such predictions are possible, but few are willing to risk saying that they can do so lest they be judged misguided or worse. If your leaning is toward the negative side, we only ask that you willingly suspend your belief for the next 30 minutes while we will attempt to show how the 2010 Fourmile Canyon wildfire in Boulder County provided a unique opportunity to push the limits of this dream.

It is well-accepted that hydrologic conditions after a severe wildfire increase the flood threat downstream for some period of time. In the case of the Fourmile Burn Area (FMBA) this includes areas along Gold Run, Fourmile Creek, Fourmile Canyon Creek and Boulder Creek through the mountains of Boulder County and the City of Boulder. After the wildfire a new flood forecasting system was put into place by UDFCD composed of a physics-based distributed hydrologic model, V*flo*, with rainfall inputs derived from a combination of radar and real-time gauge measurements called gauge-adjusted radar rainfall (GARR). The modeling approach integrates diverse information on the land surface with rainfall input from the GARR product to simulate the hydrologic effects of the FMBA wildfire. Predictive hydrologic information in real-time was used to generate flood threat alerts based on discharge thresholds at critical locations in and downstream of the FMBA. Due to the short hydraulic response of this mountainous watershed, any increase in forecast lead-time would be useful for taking protective actions.

Continuous simulation of flood potentials took place from May through August of 2011 and again in 2012. After the first significant runoff event on July 13, 2011, V*flo* was adjusted to more accurately reflect the observed runoff characteristics from the FMBA. The model was initially deployed without calibration using physically realistic model parameters and assuming zero infiltration in the burn area. After the first significant runoff event on July 13 2011, the assumed infiltration rates were increased slightly, but after two more events in 2012, additional adjustment to parameters was deemed unnecessary. In 2012, initial tests revealed the potential benefit of adding radar-based quantitative precipitation forecasts (QPF) for real-time operations. QPF is obtained by projecting the movement of storm cells over the target watershed using prior radar scans. Through reanalysis of three events, a significant increase in lead-time was possible through addition of QPF, but depends on individual storm formation and movement over the burn area. Even in fast-response watersheds where minutes count, critical lead time could be gained by adding QPF. This presentation will demonstrate the applicability of the modeling approach and the potential benefits of adding QPF to extend warning lead-times.

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# SESSION 9

# Things We Learned the Hard Way

Barbara Chongtoua, Rich Borchardt, Bryan Kohlenberg, and Dave Skuodas
Senior Project Engineers / Design, Construction, and Maintenance Program

## ABSTRACT:

**The project engineers in the Design, Construction, and Maintenance Program will be sharing some lessons they learned the hard way, including successes and failures. The four specific topics that will be covered are described below:**

**Barb Chongtoua: Vegetated Hydraulic Systems – What we have GROWN to Know…is that we are Young in Our Understanding.** We acknowledge that vegetation is important to the hydraulic stability of drainageways, but we need to do more to attain its full potential by deliberately designing systems that incorporate vegetation as a functioning element. Many questions and precautions will be raised such as "how can vegetated hydraulic systems" be designed using proven scientific methods. Is it sustainable especially since Colorado is in the arid west? Is it cost effective when considering the life cycle of construction, operation, maintenance, and rehabilitation? Our contemplation begins with reviewing project experiences, assessing project performances, and most importantly, learning from the "lessons".

**Dave Skuodas: Our Dealings with *Cynomys ludovicianus*.** We partnered with the City of Thornton on a stream restoration project along Grange Hall Creek, in a designated prairie dog habitat area. This talk will focus on issues related to prairie dog management, including how they were "scooched" out of the work area prior to construction, how they were segregated during construction, and the efforts to keep them away from the newly planted trees and shrubs. Three different types of fence were installed, select fumigation was used, and the aforementioned "scooching" was attempted in an effort to manage the prairie dogs. The cost and effectiveness of these strategies will be discussed, along with how our 404 permit has been affected.

**Rich Borchardt: Close Encounters of the *Fence* Kind.** There are many barriers to getting a drainage project from concept to completion. One of the more pesky and frequent obstacles we face on projects is fencing. Most floodplain regulations don't allow permanent fencing and the development codes require fence permits to be obtained for construction. Is the problem solved or not? Often times whether a fence remains or removed is the decision point on whether the needed property and permission is obtained to do a drainage project. The path forward may require more than citing floodplain regulations and development requirements; an analysis of the benefits of the drainage project versus the risk of the fence usually helps in the decision process.

**Bryan Kohlenberg: Beware!! Low Flow Crossings Ahead!** One obstacle we face during channel improvement projects is the existence of private low-flow crossings of small drainageways in older neighborhoods. Property owners typically ask for these crossings to remain or to be improved to fit the proposed channel design, regardless if they meet local floodplain regulations. In many cases these crossings are considered just as necessary to the homeowner as a fence. We will examine a recent project on Lakewood Gulch and offer suggestions to consider for handling the tough decisions that need to be addressed.

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SESSION 10

# William Joseph "Joe" Shoemaker (1924 – 2012)
# A True Friend to the Urban Drainage and Flood Control District

Friend of UDFCD Award accepted by Jeff Shoemaker, Executive Director
The Greenway Foundation

**ABSTRACT:**

Joe Shoemaker served as Chief of Staff for former Denver Mayor Batterton, Manager of Public Works for the City of Denver, and served in the Colorado Legislature as a state senator from 1962 to 1976 including several terms as Chairman of the Joint Budget Committee. He practiced law with Robert S. Wham for 40 years. He founded the Greenway Foundation and the Foundation for Colorado State Parks as well as started and directed the Colorado County Officials and Employees Retirement Association (CCOERA).

In addition to drafting the legislation that created the Urban Drainage and Flood Control District, he led the controversial effort in 1972 to create the Auraria Higher Education Campus and was appointed by Mayor Bill McNichols to chair the Platte River Development Committee in 1974, which later became the Greenway Foundation.

State Senator Joe Shoemaker became involved with the Five County Engineer's Council (later renamed the Metropolitan Urban Drainage Advisory Committee of the Denver Regional Council of Governments) in 1967. In 1968 an article by Shoemaker entitled "An Engineering-Legal Solution to Urban Drainage Problems" which appeared in the Denver Law Journal became the framework for the formation of the Urban Drainage and Flood Control District.

The Advisory Committee decided to pursue legislation in 1969 which would create UDFCD. Senator Shoemaker introduced the legislation in the Senate (Representative Ted Bryant introduced the legislation in the House), and it passed. Governor Love signed the bill and UDFCD was created.

Joe was a visionary who stood on the banks of the South Platte River, when there was not a single park or trail, when the river was so polluted that it was toxic to touch, when no one else thought the river had a chance of survival and said, "We can do better." We did better, and we owe a great debt of gratitude to Joe Shoemaker.

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# NOTES:

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# *See You Next Year!*

Annual Urban Drainage and Flood Control District Seminar
April 2, 2013

# Floodplain Management: What's in your future?

2013 UDFCD Annual Seminar

April 2, 2013

- Floodplain Management Program Update
- Michael K. Gease, CFM, Natural Hazards Program Specialist, FEMA Region VIII
  - Biggert-Waters 12 Flood Insurance Reform Act-Insurance Impacts and the Benefits of NFIP Community Rating System Reforms
- Jamie Prochno, National Flood Insurance Program Coordinator at the CWCB
  - Update on the State Rules and Regulations for Floodplains in Colorado

# Agenda

- The December, 2012 issue of *Flood Hazard News* is now available on our website homepage

# Flood Hazard News

An annual publication of the Urban Drainage and Flood Control District

Vol. 42, No. 1 December, 2012

**Inside this issue**

Paul's Column

Master Planning Program

Floodplain Management Program

Maintenance Eligibility Program

Information Services and Flood Warning Program

Design Construction and Maintenance Program

Stormwater Quality and Permitting Activities

How to Discuss the Probability of Flooding with a Lay Person

Parker Jordan Centennial Open Space

InterMountain Alliance

Rainwater Harvesting project

Professional Activities of District Staff

## South Platte River and Lower Lakewood Gulch Improvement Project

By

Bryan W. Kohlenberg, Senior Project Engineer

**Introduction**

In the late afternoon of June 16, 1965, more than 14 inches of rain fell near Larkspur, Colorado, on a tributary to the South Platte River upstream of present day Chatfield Reservoir. Later that night, flood waters deposited mud and debris that devastated roughly ten square miles of houses, mobile home parks, shopping centers, factories and hotels. Total damage was estimated at well over $500 million in the basin. Some accounts reported up to twenty-eight people lost their lives during the flood. In Denver, flood waters overtopped river banks, split away from the channel and flowed through much of the Central Platte Valley and caused approximately $350 million damage (1965 dollars).

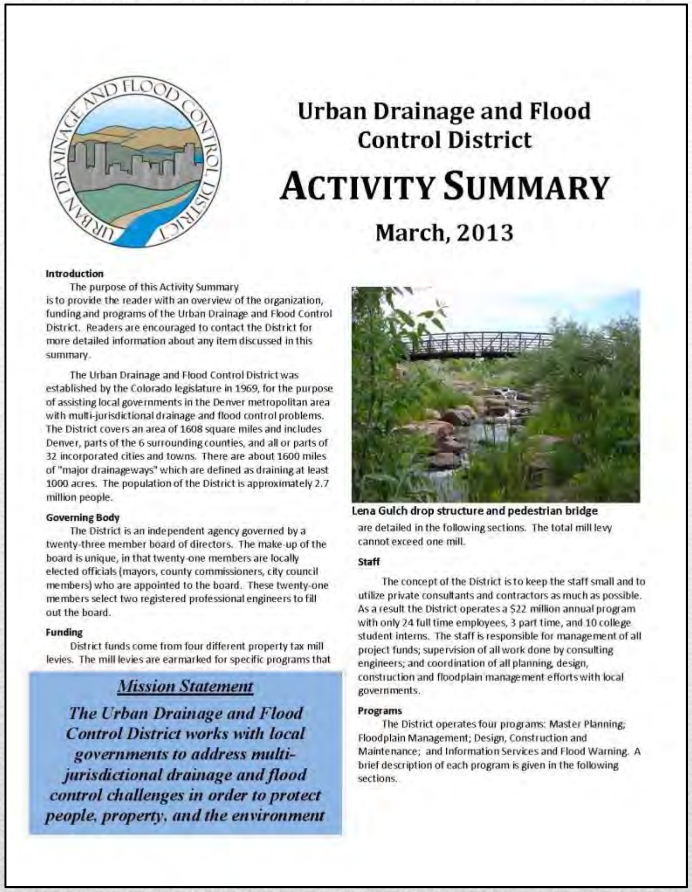
Since that emergency, the Army Corps of Engineers (Corps) built Chatfield Dam in 1973 to help reduce the risk of flooding in the Denver Metro area. Unfortunately, due to the many tributaries that join the South Platte downstream of Chatfield, the newly determined 100-year discharge still exceeded the river channel capacity at several locations in the City & County of Denver (Denver). As a result, Denver and the Urban Drainage & Flood Control District(UDFCD), formed in 1969 as a direct result of the 1965 flood, have proactively worked together to reduce the threat of flooding along the South Platte River in Denver since the early 1980's.

Only forty seven years after the '65 flood (short in geologic time), the third and final phase of a much larger Upper Central Platte Valley channel improvement project from Speer Boulevard upstream to 8th Avenue, initially envisioned in the 1985 *South Platte River Major Drainageway Plan*, is now complete. This phase, cleverly titled "South Platte River and Lower Lakewood Gulch Improvement Project" is located just south of Colfax Avenue, upstream to 8th Avenue. The major goal of this project was to reduce the extensive overbank 100-year floodplain just east of the river. This large floodplain was a result of lack of channel capacity caused by limited right-of-way, shallow depth utility crossings, and a large inflatable dam used to divert cooling water to Xcel Energy's Zuni Power Plant.

The confluence of the South Platte River and Lakewood Gulch.

# Recent publications

- The March, 2013 update of our *Activity Summary* is now available on our website homepage



**Urban Drainage and Flood Control District**

**ACTIVITY SUMMARY**

**March, 2013**

**Introduction**

The purpose of this Activity Summary is to provide the reader with an overview of the organization, funding and programs of the Urban Drainage and Flood Control District. Readers are encouraged to contact the District for more detailed information about any item discussed in this summary.

The Urban Drainage and Flood Control District was established by the Colorado legislature in 1969, for the purpose of assisting local governments in the Denver metropolitan area with multi-jurisdictional drainage and flood control problems. The District covers an area of 1608 square miles and includes Denver, parts of the 6 surrounding counties, and all or parts of 32 incorporated cities and towns. There are about 1600 miles of "major drainageways" which are defined as draining at least 1000 acres. The population of the District is approximately 2.7 million people.

**Governing Body**

The District is an independent agency governed by a twenty-three member board of directors. The make-up of the board is unique, in that twenty-one members are locally elected officials (mayors, county commissioners, city council members) who are appointed to the board. These twenty-one members select two registered professional engineers to fill out the board.

**Funding**

District funds come from four different property tax mill levies. The mill levies are earmarked for specific programs that are detailed in the following sections. The total mill levy cannot exceed one mill.

***Mission Statement***

***The Urban Drainage and Flood Control District works with local governments to address multi-jurisdictional drainage and flood control challenges in order to protect people, property, and the environment***

**Lena Gulch drop structure and pedestrian bridge**

**Staff**

The concept of the District is to keep the staff small and to utilize private consultants and contractors as much as possible. As a result the District operates a $22 million annual program with only 24 full time employees, 3 part time, and 10 college student interns. The staff is responsible for management of all project funds; supervision of all work done by consulting engineers; and coordination of all planning, design, construction and floodplain management efforts with local governments.

**Programs**

The District operates four programs: Master Planning; Floodplain Management; Design, Construction and Maintenance; and Information Services and Flood Warning. A brief description of each program is given in the following sections.

# Recent publications


# LOMC database

- **City and County of Broomfield**
  - Projected effective date:  10/2/13
- **City and County of Denver**
  - Projected effective date:  11/20/13
- **Jefferson County**
  - Projected effective date:  12/13
- **Douglas County**
  - Projected Preliminary Map date: Summer


# Status of DFIRM updates

- April 1, 2012 to March 31, 2013:  46 cases opened
- Baker is helping us through a grant funding problem
- Most of these cases were for public sector projects
  - UDFCD and local partners
  - RTD FasTracks projects
  - SEMSWA
  - Boulder, Westminster, Arapahoe County, others

# Status of LOMC reviews

# Other program areas

- Referrals from local governments for zoning, platting, drainage studies, etc. are way up
- Maintenance Eligibility Program activity is way up
  - Referrals of construction drawings are increasing
  - West Corridor drainage projects completed
  - Eagle P3 design approvals completed and construction in progress
- We completed four Flood Hazard Area Delineation studies in 2012, and have 10 underway

# Final Thought

## Don't use riprap rundowns!

NFIP/CRS

# Introduction to the NFIP's

# COMMUNITY RATING SYSTEM

**(CRS)**

# CRS Purpose

- Rewards Communities for pro-active local floodplain management programs with lower flood insurance premiums
- Similar to Fire Rating and Building Code Enforcement Rating
- Implemented by Insurance Services Office, Inc. (ISO)

# CRS Goals

- Reduce Flood Damage to Insurable Property
- Strengthen and Support the Insurance Aspects of the NFIP
- Encourage a Comprehensive Approach to Floodplain Management

# The CRS Discount for NFIP Insurance

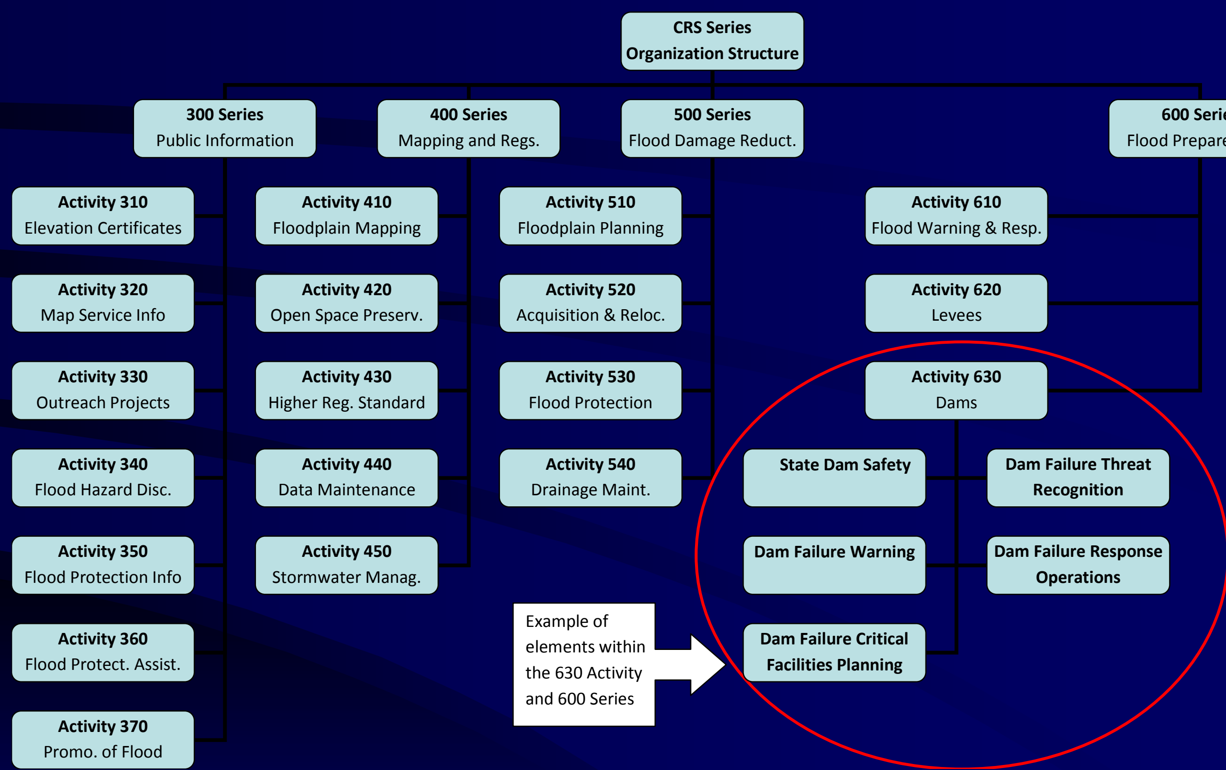
- CRS Class Improvement for Each 500 CRS Points
- 5% Linear Discount per Class for SFHA Policies
- 5% Discount for Policies Outside the SFHA (10% for Classes 1-6)

# CRS Activities

- 300 Series - Public Information
- 400 Series - Mapping and Regulations
- 500 Series - Flood Damage Reduction
- 600 Series – Flood Preparedness

# Activity 430 - Higher Regulatory Standards

- Freeboard
- Foundation Credit
- Cumulative Substantial Improvements
- Lower Substantial Improvements
- Protection for Critical Facilities
- Protection of Storage Capacity
- Natural & Beneficial Functions
- Enclosure Limits
- Other Higher Standards
- Building Code & Staffing



CRS Series
Organization Structure
300 Series
Public Information
400 Series
Mapping and Regs.
500 Series
Flood Damage Reduct.
600 Series
Flood Preparedness
Activity 310
Elevation Certificates
Activity 320
Map Service Info
Activity 330
Outreach Projects
Activity 340
Flood Hazard Disc.
Activity 350
Flood Protection Info
Activity 360
Flood Protect. Assist.
Activity 370
Promo. of Flood
Activity 410
Floodplain Mapping
Activity 420
Open Space Preserv.
Activity 430
Higher Reg. Standard
Activity 440
Data Maintenance
Activity 450
Stormwater Manag.
Activity 510
Floodplain Planning
Activity 520
Acquisition & Reloc.
Activity 530
Flood Protection
Activity 540
Drainage Maint.
Activity 610
Flood Warning & Resp.
Activity 620
Levees
Activity 630
Dams
State Dam Safety
Dam Failure Threat Recognition
Dam Failure Warning
Dam Failure Response Operations
Dam Failure Critical Facilities Planning
Example of elements within the 630 Activity and 600 Series

## COMMUNITY RATING SYSTEM US and COLORADO

- Class 1 (45%) (Roseville, CA)
- Class 2 (40%) (Tulsa, OK)
- Class 3 (35%) (none)
- Class 4 (30%) (Ft. Collins-tops in CO)
- Class 5 (25%) (Arvada; Boulder-new!)
- Class 6 (20%) (Jefferson Co.)
- Class 7 (15%) (Littleton)
- Class 8 (10%) (Denver, Douglas Co.)
- Class 9 ( 5%) (Morrison)
- More than 1200 communities nationally (46 in CO; 24 within Adams, Arapahoe, Boulder, Broomfield, Denver, and Douglas Counties)
- Represents **65-70% policies in force**
- Annual **savings** to policyholders in Colorado **>$1.45M; within UDFCD communities the savings is 1.2M!**)

# New 2012 CRS Manual

- Changes support community resiliency
- Emphasis on Open Space Preservation
- Protecting Natural Floodplain Functions
- More attention to restrictions on fill
- Human/Life Safety
- Master Planning
- Promoting Flood Insurance (New 370)- Think Flood Insurance as Mitigation!

# 2012 CRS Manual

www.crs2012.org

- Summary of Changes and download the new Manual (no longer in print)

- Technical Assistance From ISO
- Kerry Redente #719-942-4092

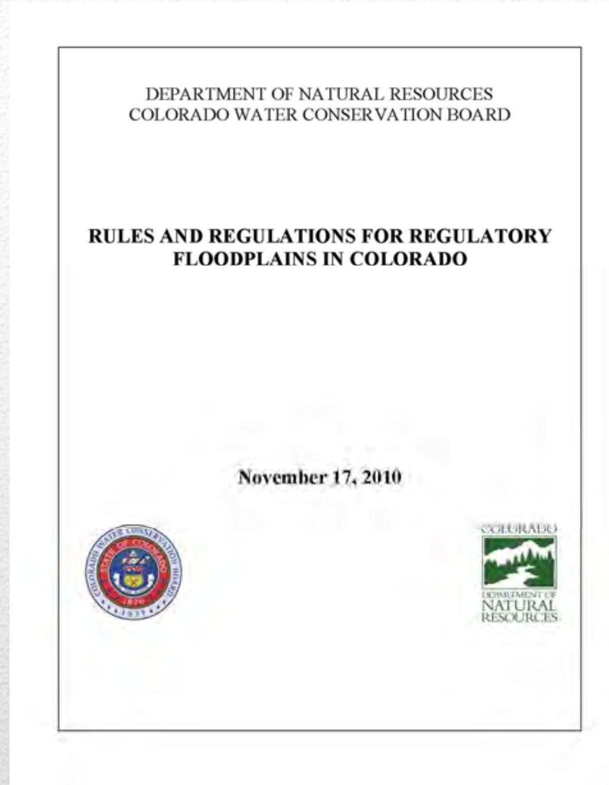
# Update on the State Rules and Regulations for Floodplains in Colorado

2013 UDFCD Annual Seminar

April 2, 2013

# Revised Rules and Regulations for Floodplains in Colorado

- Minimum effective standards for Colorado
- Effective date January 14, 2011, communities have 3 years from that date to update local regulations


DEPARTMENT OF NATURAL RESOURCES
COLORADO WATER CONSERVATION BOARD

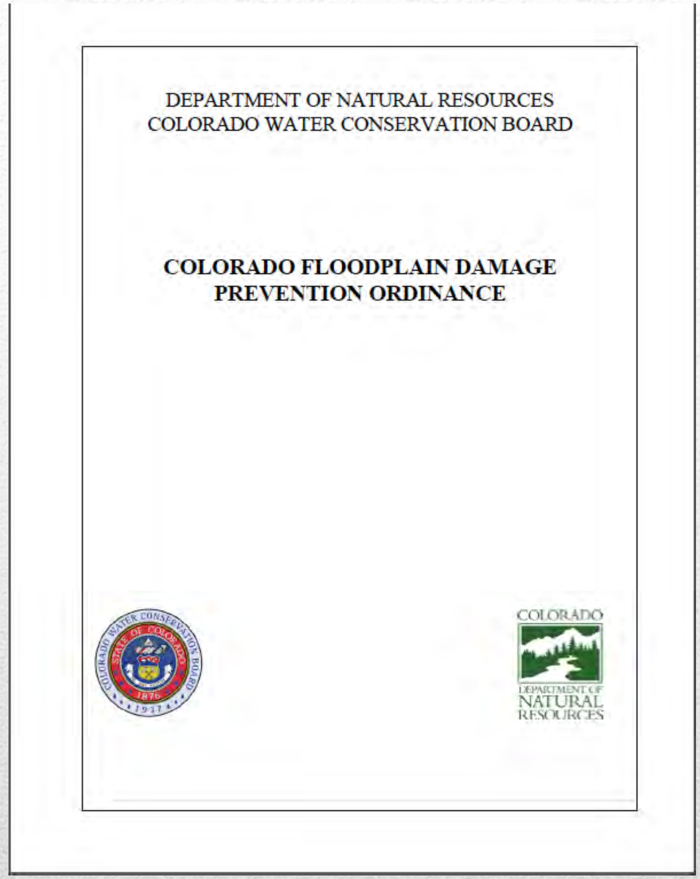
**RULES AND REGULATIONS FOR REGULATORY FLOODPLAINS IN COLORADO**

**November 17, 2010**

| Standard | Colorado Rules | NFIP Minimums |
|---|---|---|
| Freeboard | 1 foot | No freeboard required |
| Floodway | ½ foot surcharge | 1 foot surcharge |
| Critical Facilities | 2 foot freeboard | No specific standards |
| LOMR-F areas | New structures must have freeboard above previous BFE | Area is removed from SFHA and no standards apply |

# Colorado Rules vs NFIP Minimum Requirements

- Provides a template for local regulations
- Integrates State and NFIP standards
- Updates minimum requirements and definitions



DEPARTMENT OF NATURAL RESOURCES
COLORADO WATER CONSERVATION BOARD

**COLORADO FLOODPLAIN DAMAGE PREVENTION ORDINANCE**

COLORADO DEPARTMENT OF NATURAL RESOURCES

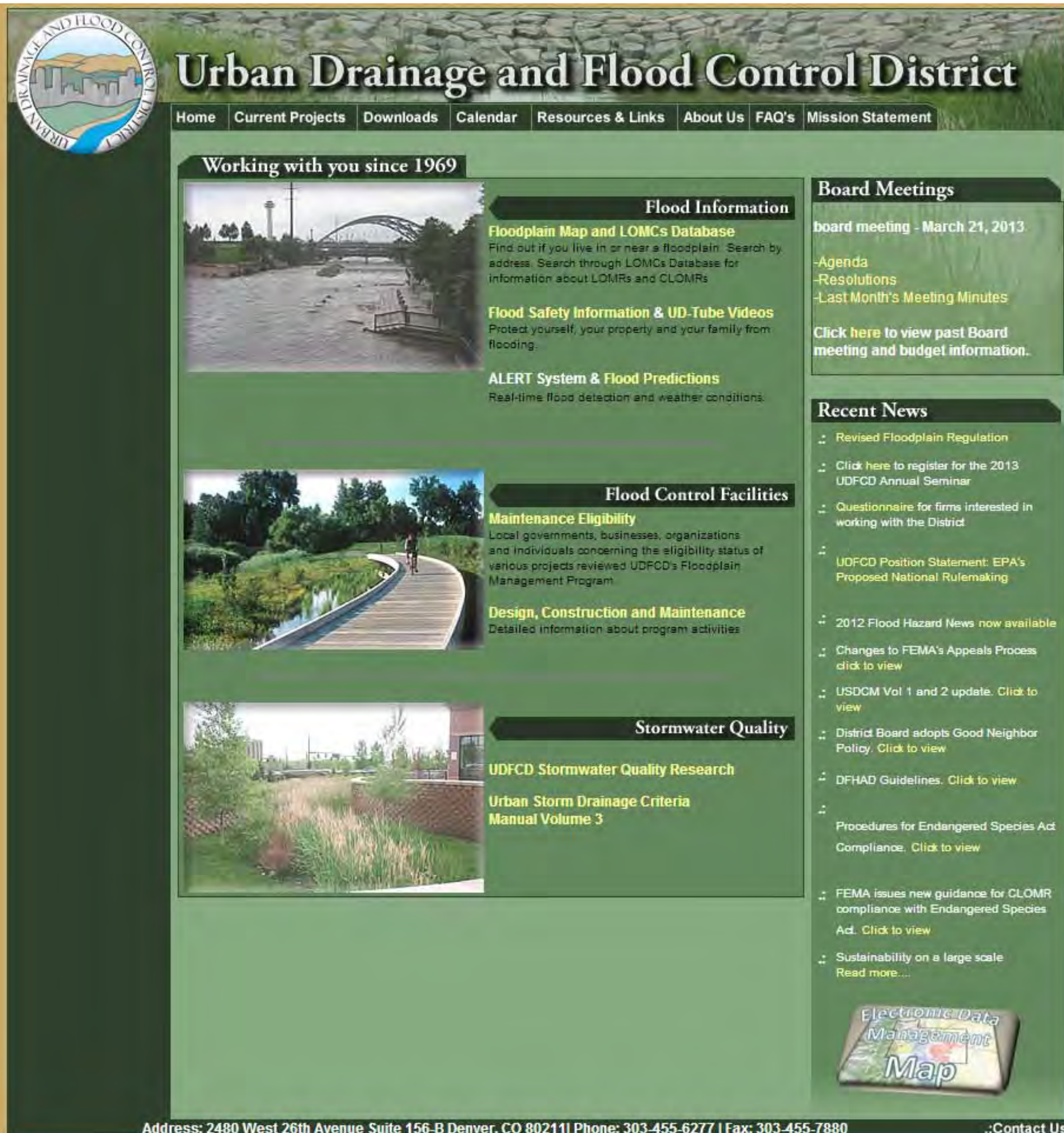
# Overview of the Colorado Model Ordinance

# More information

- www.cwcb.state.co.us
  - Rules and Regulations for Regulatory Floodplains in Colorado, dated November 17, 2010
  - Colorado Floodplain Damage Prevention Ordinance
- Technical Guidance Document, dated September 12, 2011

# Expanded Guidance on Storage Facilities

USDCM Volumes 1 and 2 Updates




## https://sites.google.com/a/udfcd.org/udfcd-criteria-manual/

- Full spectrum detention as the recommended approach
  - Full Spectrum Detention 101
  - Allowable vs. pre-development discharge
  - Drop box considerations
  - Sizing methods
- Recent Findings

# Agenda

Policy Chapter:

*Every urban area has an initial and major drainage system, whether or not they are actually planned and designed.*

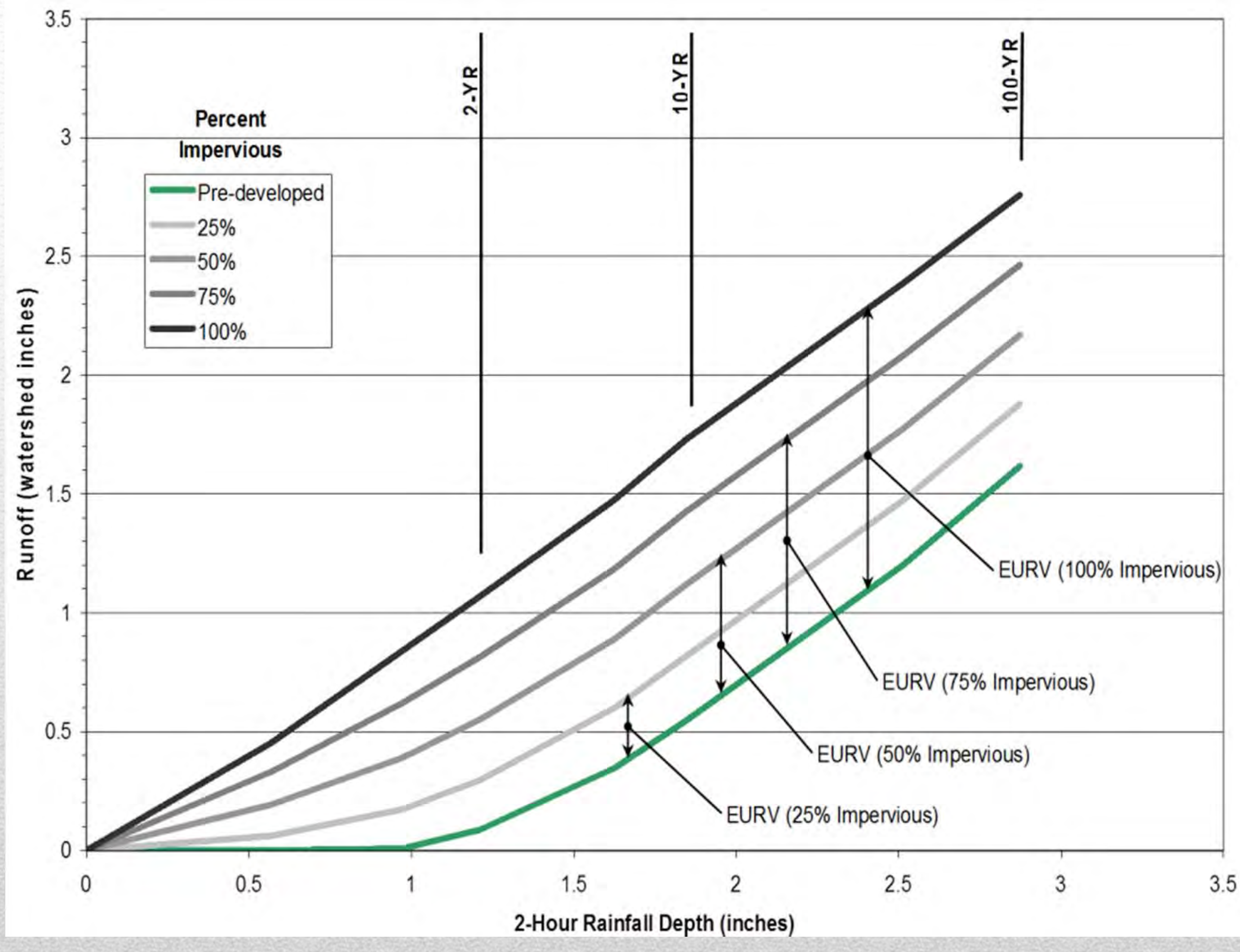
# Full Spectrum Detention as the Recommended Approach

- Addresses the flows responsible for carrying the most bed load

- Better resembles pre-development conditions over an entire watershed, even with multiple independent detention facilities

# Full Spectrum Detention - Advantages

- Excess Urban Runoff Volume (EURV)
- Full spectrum detention (includes 100-year)




# Excess Urban Runoff Volume (EURV)

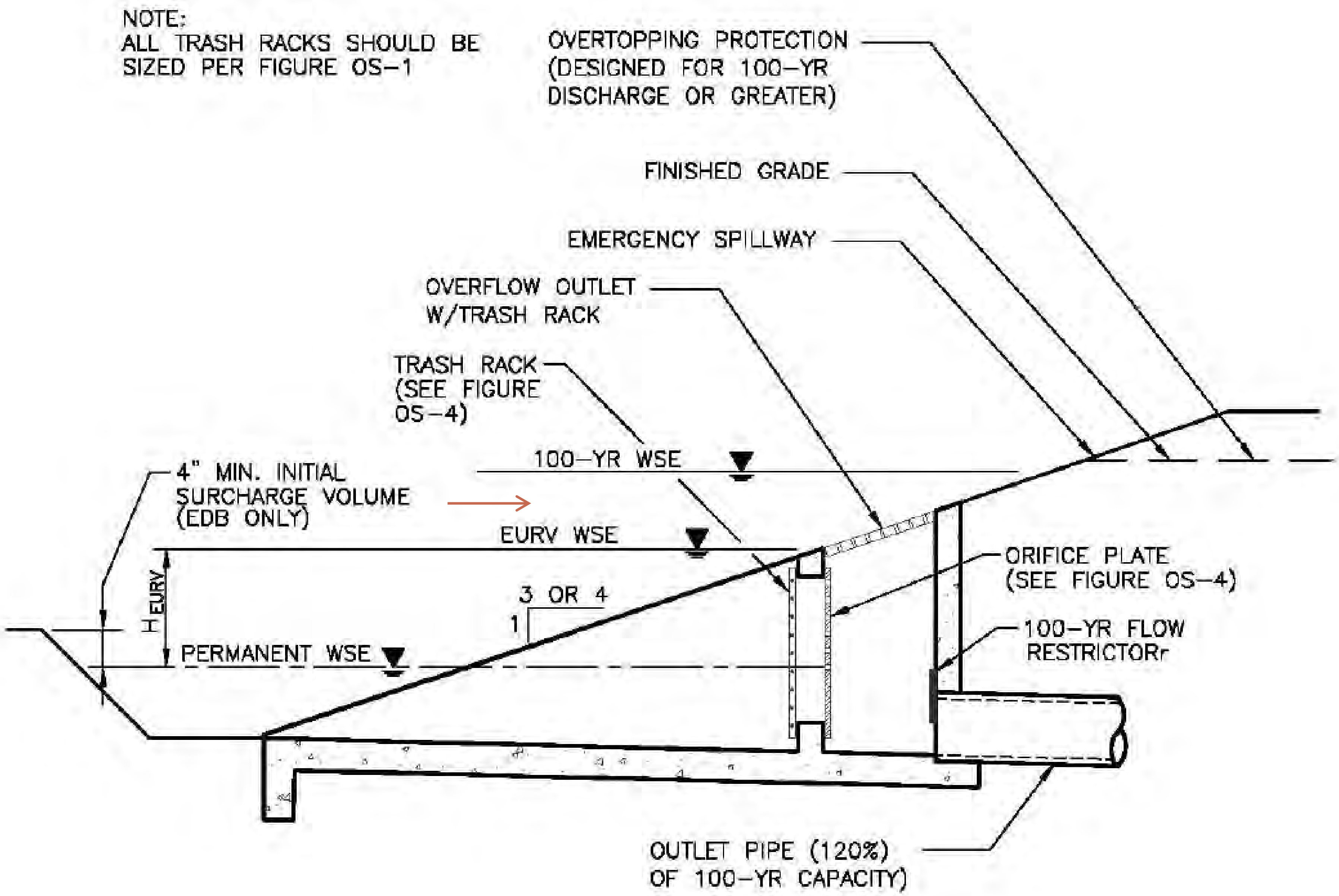
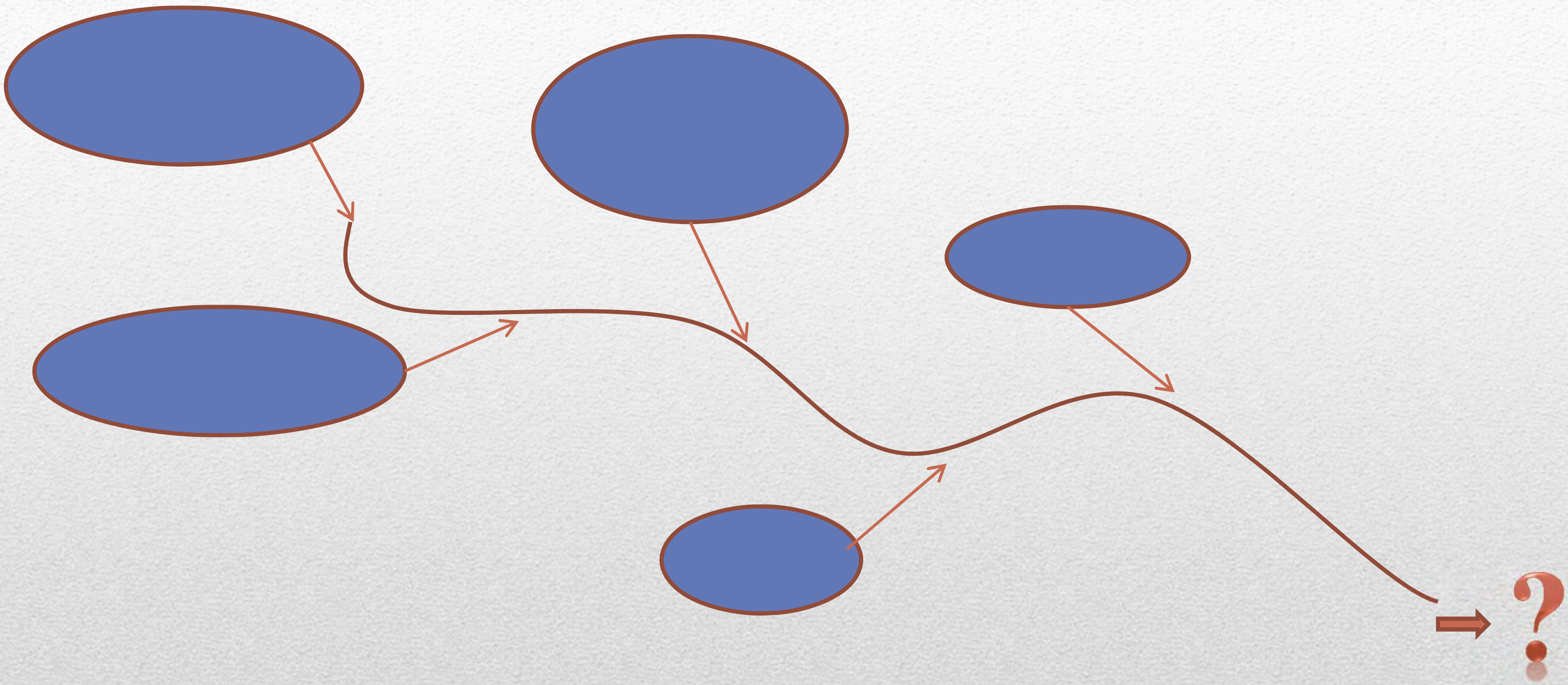
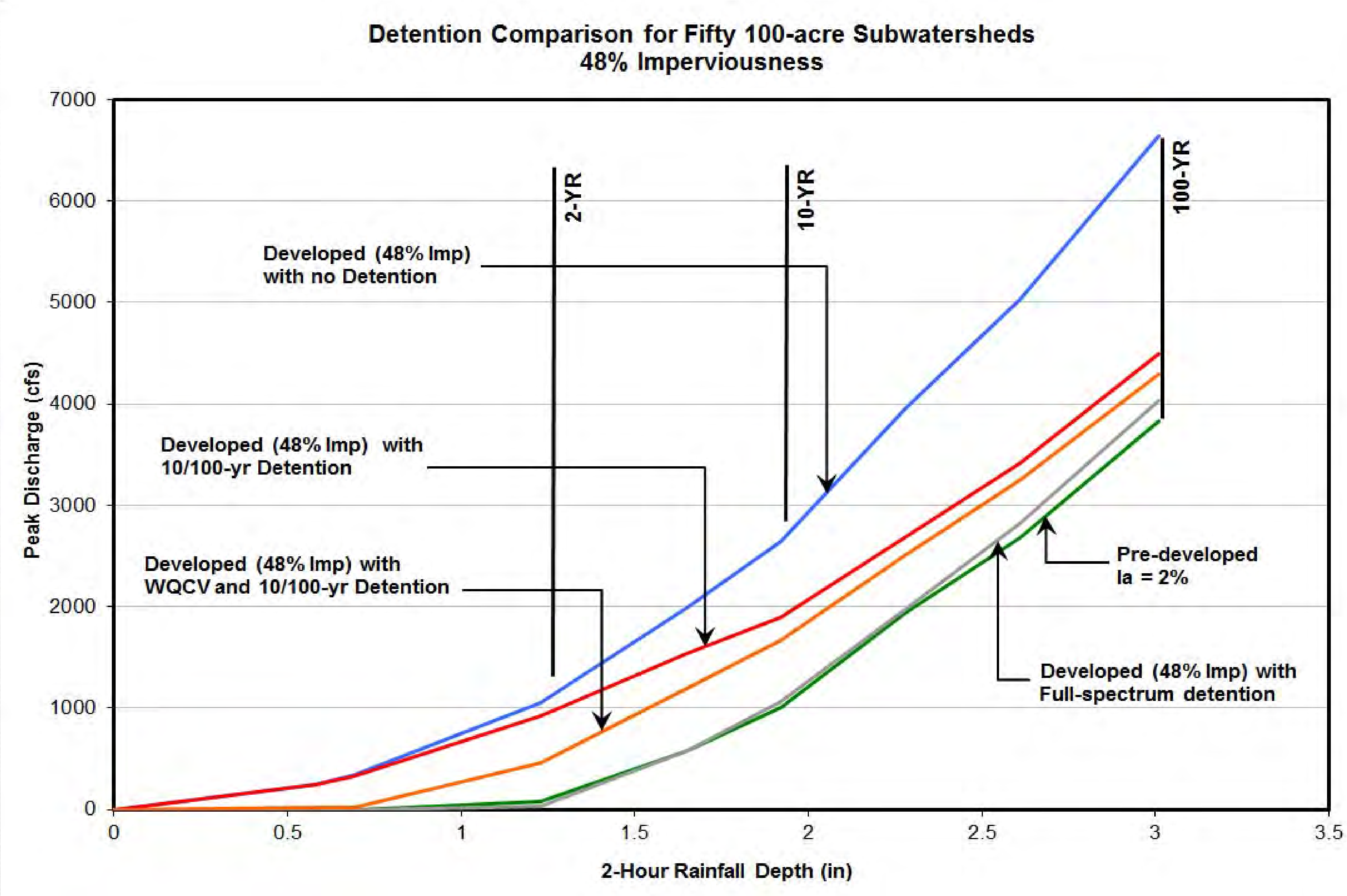



**Figure OS-2. Typical Outlet Structure for Full Spectrum Detention**



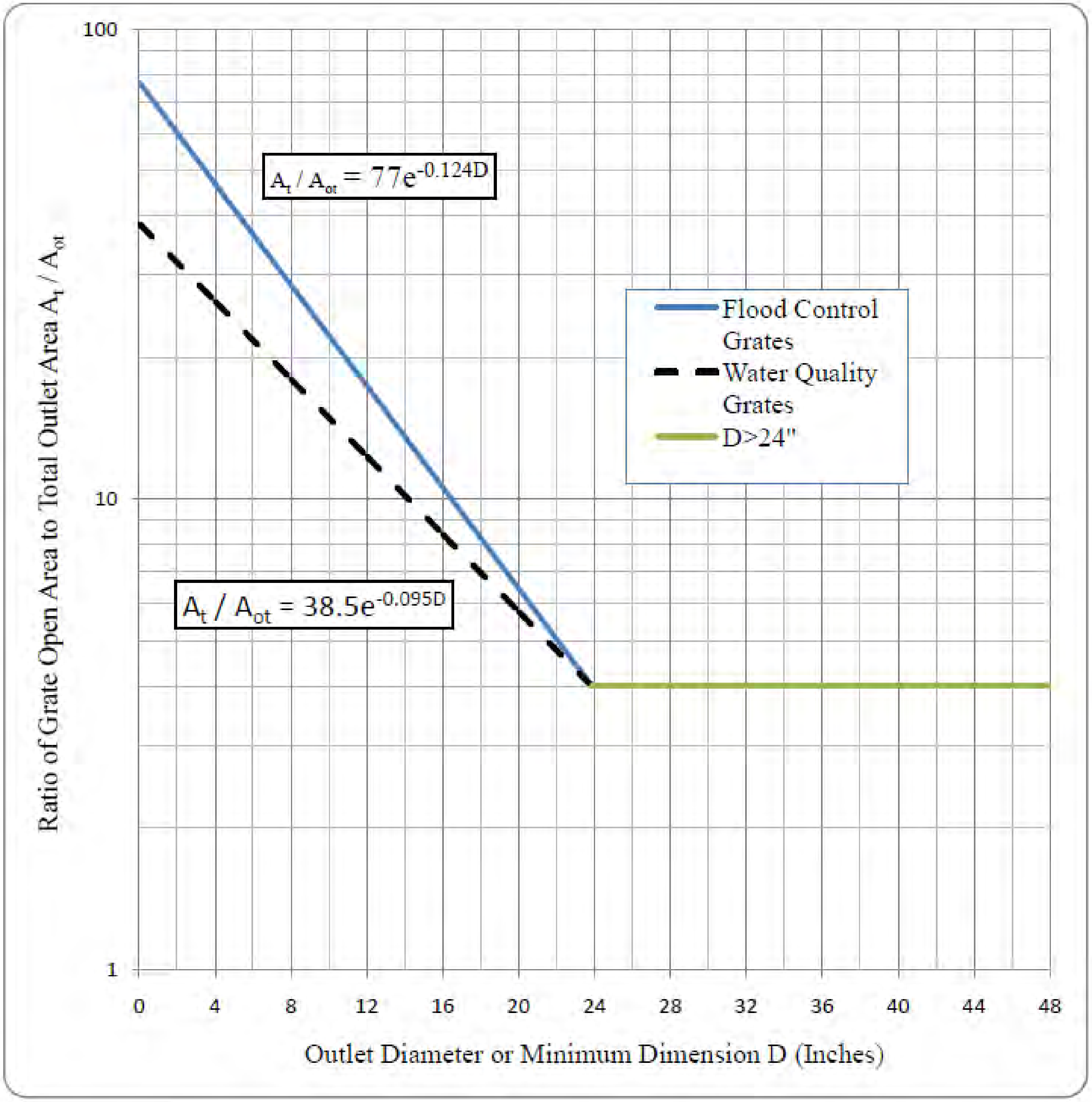
# Allowable vs. Pre-development Release Rates




# Replicating Pre-development Peak Discharge

- Maintenance access
- Ensure neither the crest of the box nor the (partially clogged) grate limit flow
- Safety (trapping velocity): Use Volume 3 figure (OS-1) while ensuring that velocity does not exceed 2 fps.

# Drop Box Considerations



100
10
1
Ratio of Grate Open Area to Total Outlet Area $A_t / A_{ot}$
$A_t / A_{ot} = 77e^{-0.124D}$
$A_t / A_{ot} = 38.5e^{-0.095D}$
Flood Control Grates
Water Quality Grates
D>24"
0
4
8
12
16
20
24
28
32
36
40
44
48
Outlet Diameter or Minimum Dimension D (Inches)

| Watershed Properties | Sizing Method | | |
|---|---|---|---|
| | Simplified Equations | UD-FSD | CUHP/SWMM Hydrograph Routing |
| Less than 10 acre | X | X | |
| 10 to 50 acres | | X | X |
| 50 to 130 acres | | X | X |
| 130 acres to 1 $mile^2$ | | X | X |
| Greater than 1 $mile^2$ | | X | X |
| Multiple detention facilities in parallel or series | | | X |

# Sizing Methods

- UDFCD Policy on Maintaining Criteria

Review of 23 EDBs in the UDFCD region

- Determine cause of clogging:
  - Criteria can be improved
  - Criteria was not met

April 2, 2013

- Micropool not well defined (no initial surcharge volume)
- Soft bottom micropool
- Soft trickle channels

- No micropool or insufficient depth

- “Micropool”

- Lack of maintenance
- Orifice plate removed or modified
- None had gaskets
- 9 of 23 were loose (or off)

- Well Screen removed

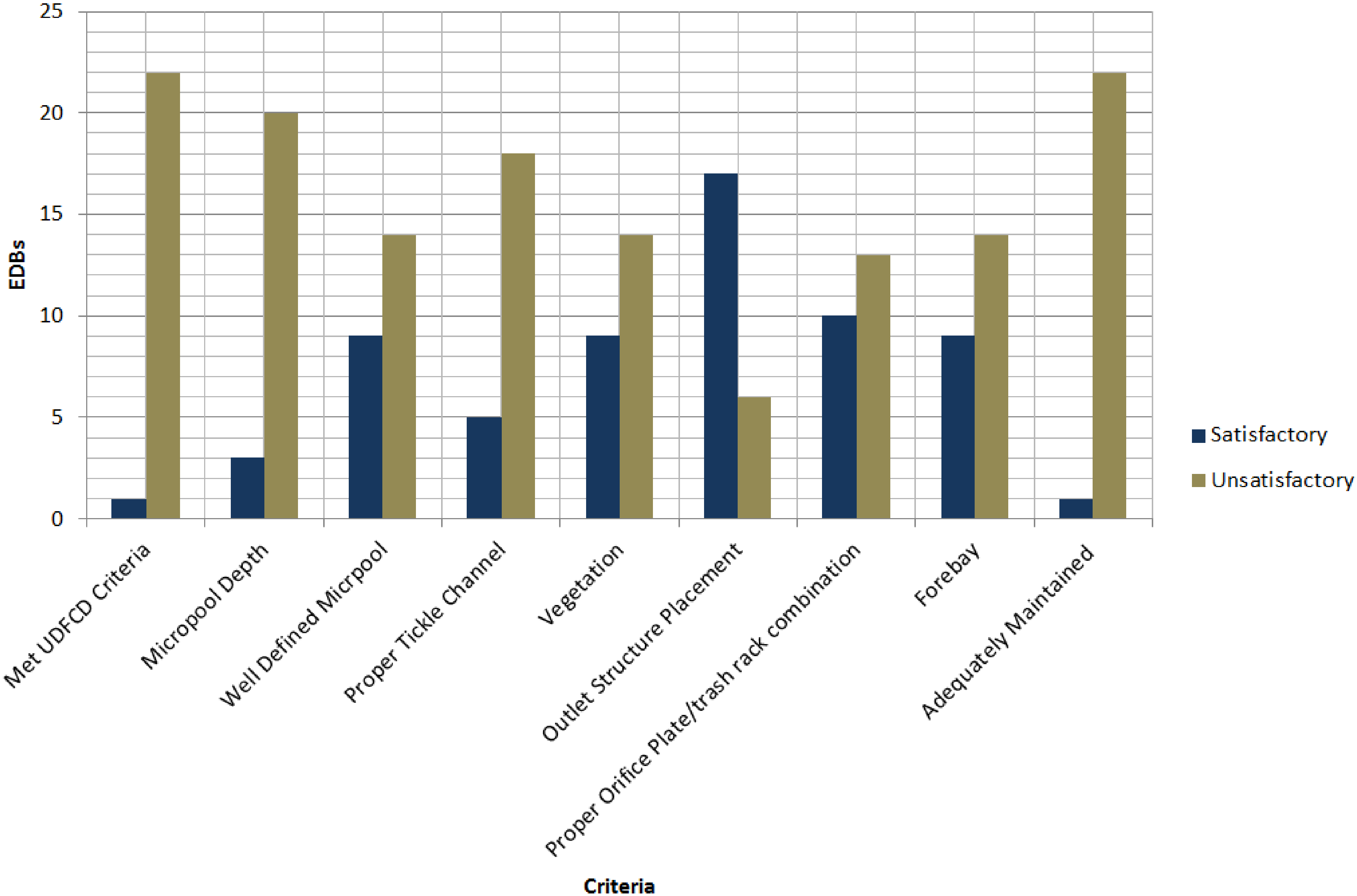
- Trash rack not appropriate for orifice diameter

- Unprotected orifice plate
- Insufficient trash rack width

- Lack of micropool maintenance

- Scary maintenance

# Extended Detention Basin Inspection Results



# Questions…

Holly Piza, PE
hpiza@udfcd.org

# The New NOAA Atlas: What's Changed?

Shannon Tillack, P.E.
Wright Water Engineers, Inc.

Ben Urbonas, P.E., D.WRC
Urban Watersheds, LLC

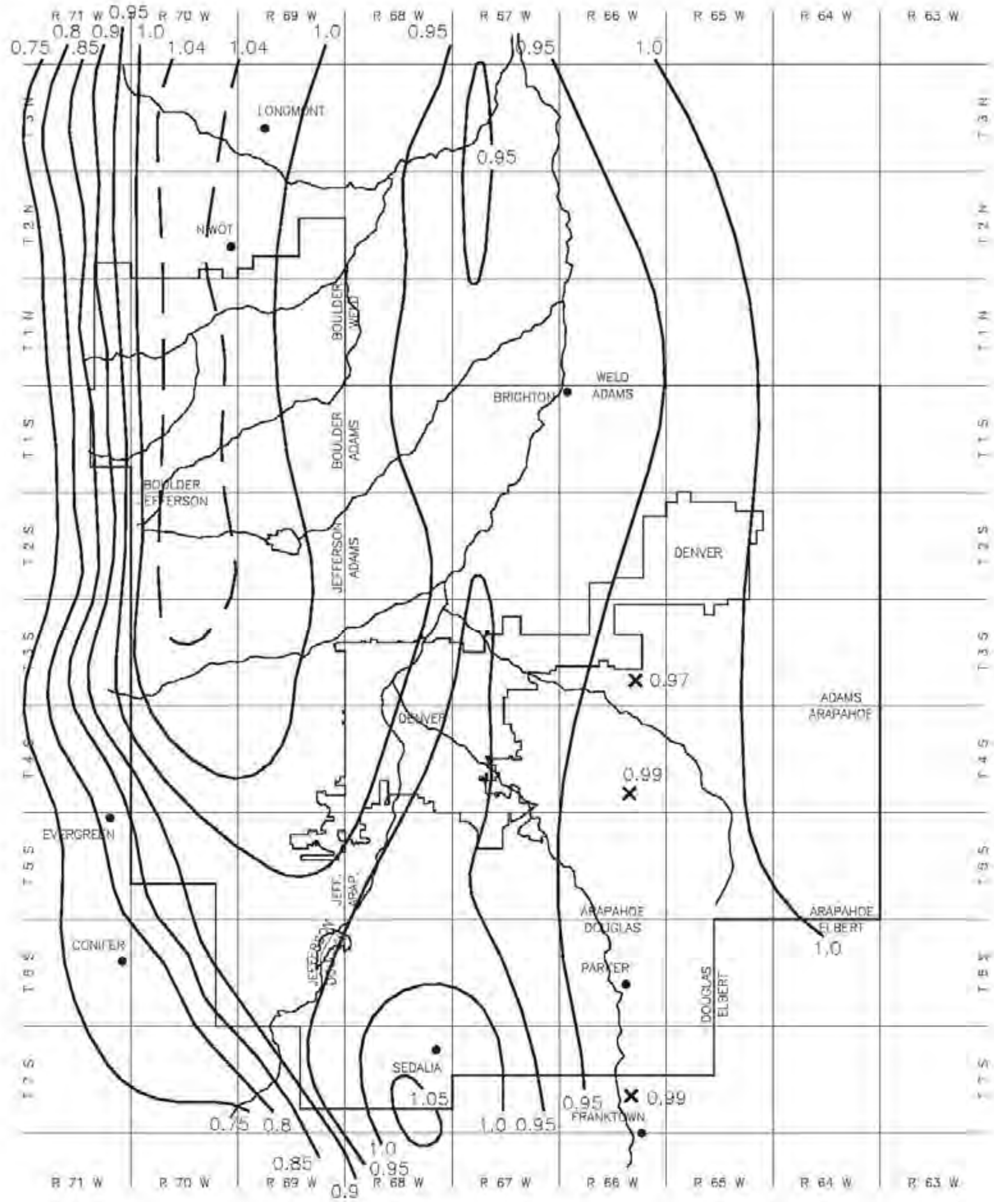
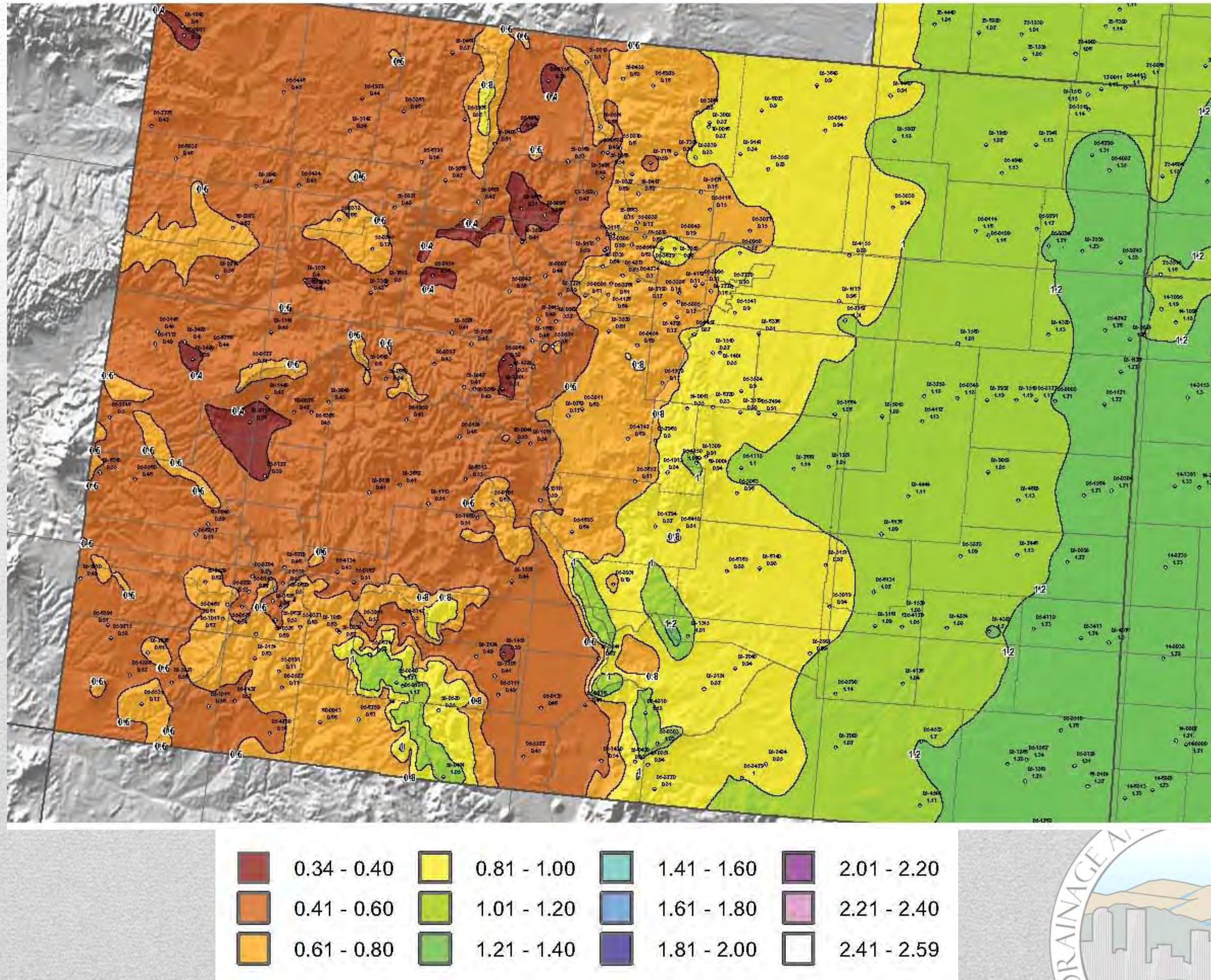


Figure RA-1—Rainfall Depth-Duration-Frequency: 2-Year, 1-Hour Rainfall

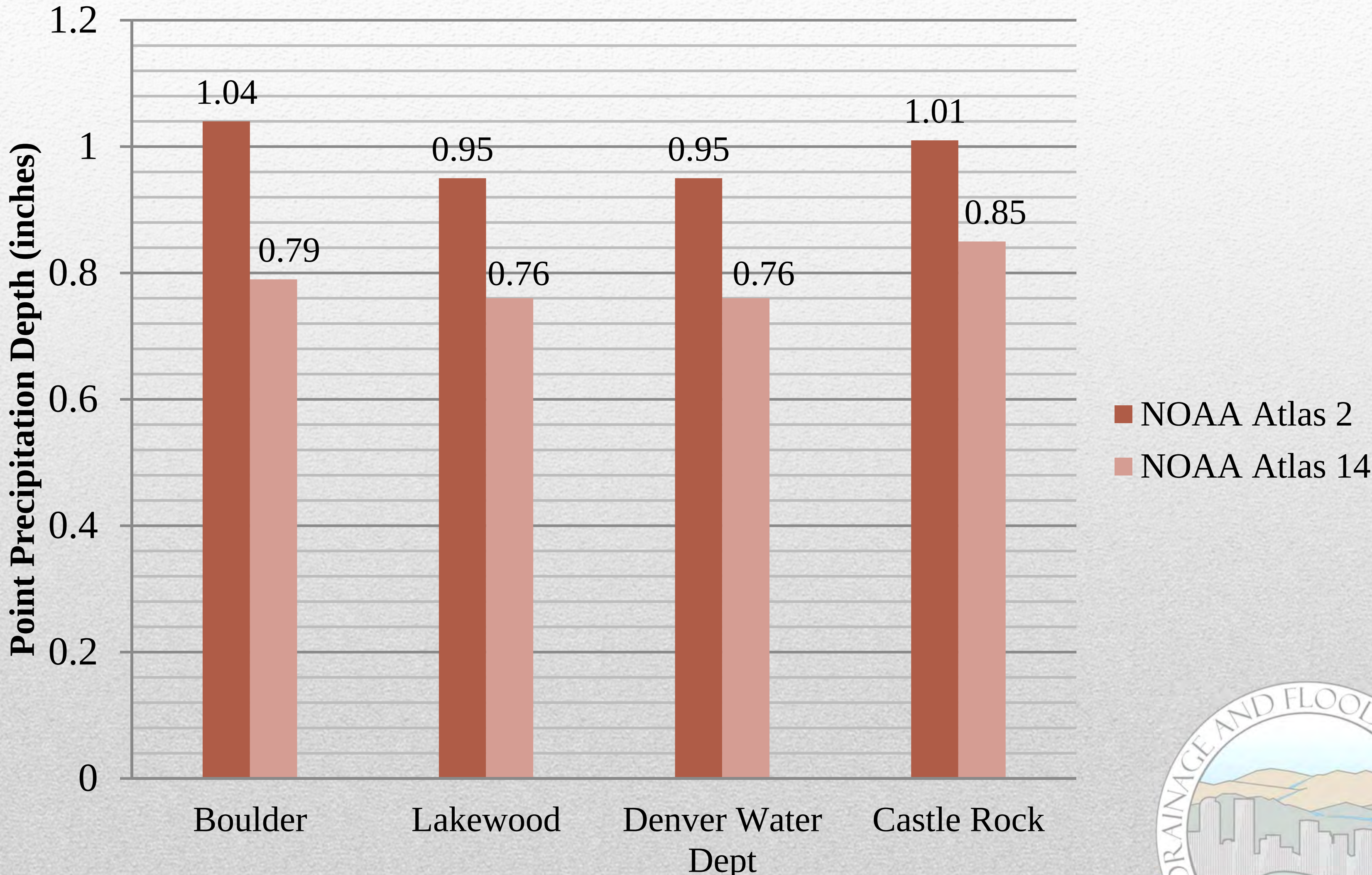
# NOAA Atlas 14: Precipitation-Frequency Atlas of the United states
# Volume 8 Version 1: Midwestern States

- Fall 2012 NOAA released draft NOAA Atlas 14
- Peer review from October 11 – November 16, 2012
  - Evaluate accuracy of metadata
  - Evaluate reasonableness of point precipitation frequency estimates and their spatial patterns
- Received comments from 46 individuals including USACE, USGS, State Climatology Offices, Water Management Districts, etc.
- Final Atlas 14 published by mid-April 2013

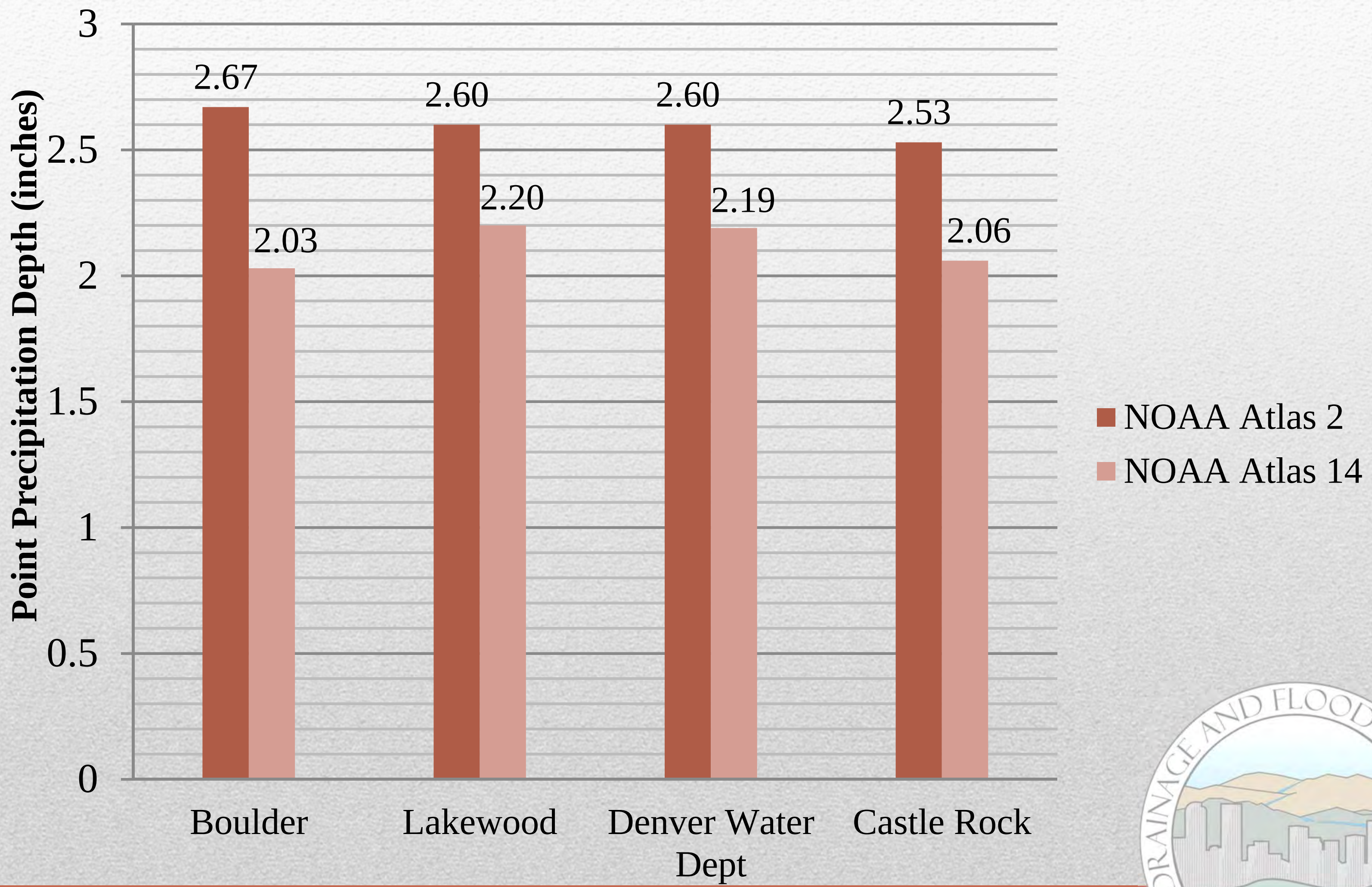
# Isopluvials of 2-Year, 1-Hour Precipitation (inches)



# Comparison of NOAA Atlas 2 to Draft NOAA Atlas 14 2-yr, 1-hour



# Comparison of NOAA Atlas 2 to Draft NOAA Atlas 14 100-yr, 1-hour



# Changes to Point Precipitation Depths Affect.....

- The design of all stormwater management facilities
- The regulation of all future floodplain delineation and watershed master planning projects
- Sizing of the “minor” storm sewers
- Could result in facilities that provide less protection to the public
- Delineation of flood hazard zones that could result in less adequate safeguards against flood damages

**Any significant changes to point rainfall values have to be fully defensible for UDFCD to adopt the draft Atlas values**

## Meeting with UDFCD, NOAA, NWS, CWCB, State Climatologist, City of Ft. Collins to discuss….

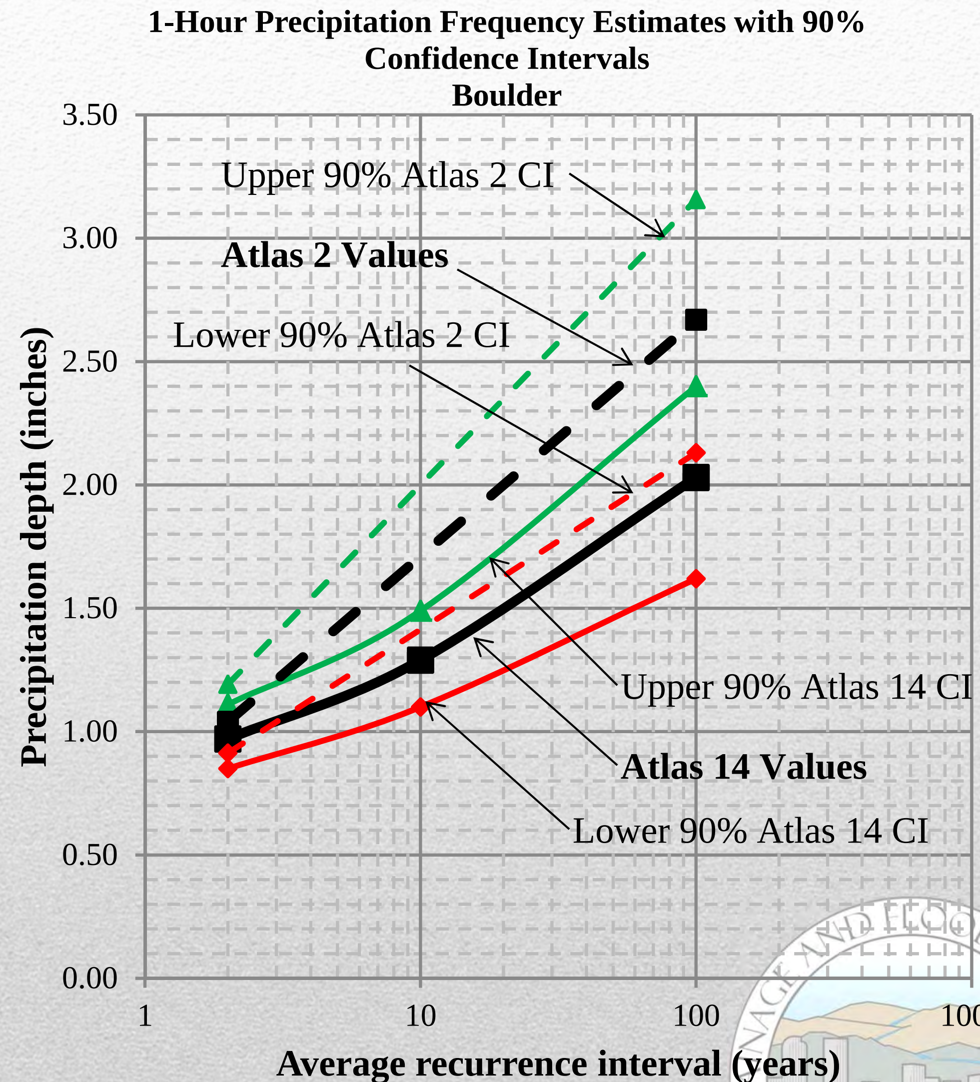
- Differences between NOAA Atlas 2 and draft Atlas 14
- NOAA's methodology in developing draft Atlas 14 point precipitation values

UDFCD provided comment letters to NOAA

# UDFCD Comment #1

1. Consider showing changes in the point rainfall information in the draft Atlas only if the 90% confidence intervals for the point rainfall depths from the 1973 Atlas and the draft Atlas do not overlap.

   <u>Otherwise the shift in the mean is not statistically justified</u>



# UDFCD Comment #2

2. In 1995, the Denver Stapleton gage minimum reporting depth changed from 0.01 inch to 0.1 inch.

   The way the rainfall depths are recorded after 1995 may be underestimating the true rainfall depths.

| | Mean Storm Depth using 1-hour Data | | |
|---|---|---|---|
| Period of Analysis: | 08/02/1948 to 11/27/1990 | 08/02/1948 to 07/01/2011 | 08/01/1995 to 07/01/2011 |
| Years in Record: | 42 | 63 | 16 |
| Mean Storm Depth (inches) | 0.42 | 0.36 | 0.24 |

**Notes:**
**New storm defined by 6-hr of no rain**
**Includes only storm events ≥ 0.1 inch**

# UDFCD Comment #3

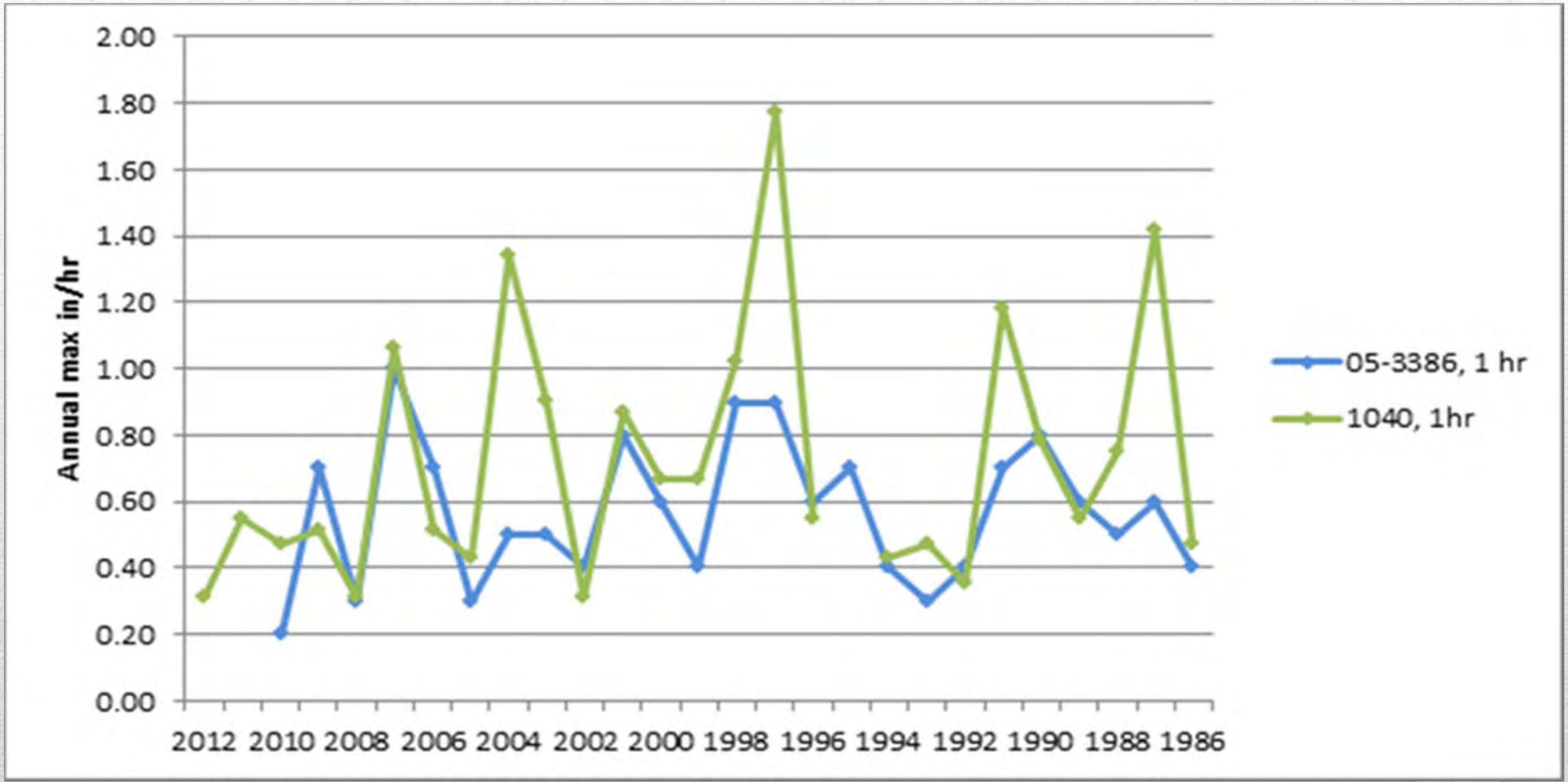
3. Draft NOAA Atlas 14 used annual maximum hourly clock precipitation depths vs. actual annual maximum 1-hour precipitation depths (not hourly clock dependent).

- Used UDFCD's ALERT data to determine the ratios between 1-hour clock depths and maximum depths recorded within 60 minutes

# Question the One-hour maximum rainfall depth

- Kevin Stewart extracted 1-hour maximum depths recorded from 11 ALERT gages within a 2-mile radius of the NCDC reported gage site
- Compared these to the annual maximum hourly clock depths of the nearest NCDC gage
- Based on this analysis, the NOAA hourly clock-dependent annual maximum depths underestimate the actual 1-hour intensity (not clock dependent) by approximately 3% to 38%.

# Question the One-hour maximum rainfall depth




% Difference in Arithmetic Mean of Maximum 1-hour Precipitation Depths = 27% at Lena G. & 6th Ave. Gage

## Next Steps

- NOAA has already responded to UDFCD's comments
  - They think the final numbers will be closer to Atlas 2
- Review final Atlas 14 point precipitation depths
- Review all of NOAA's responses to UDFCD comments
- Identify and address issues that may affect UDFCD's recommendations for:
  - Sizing of facilities (storm severs, detention, etc.)
  - Delineation of flood hazard zones
- Work with cities/counties to identify what changes, if any, should be incorporated into the USDCM

# QUESTIONS?

# NO MOSS GROWING HERE

Kyle Hamilton – CH2M Hill

Shea Thomas – Master Planning

# Construction Specifications Update

- Updated to Construction Specifications Institute (CSI) format
- Front end documents, technical specs, and measurement and payment updated
- Sections are posted to UDFCD.org as they become available


| | | |
|---|---|---|
| DIVISION 02: EXISTING CONDITIONS | | |
| Selective Site Demolition | 02 41 13 | 1 – 2 |
| | | |
| DIVISION 03: CONCRETE | | |
| Concrete Forming | 03 11 00 | 1 – 10 |
| Construction Joints | 03 15 00 | 1 – 4 |
| Waterstops | 03 15 13 | 1 – 4 |
| Reinforcing Steel | 03 21 00 | 1 – 6 |
| Structural Concrete | 03 31 00 | 1 – 10 |
| Sculpted Concrete | 03 31 01 | 1 – 8 |
| Concrete Finishing | 03 35 00 | 1 – 8 |

- Engineer prepares the E-Bid Form based on project elements
- Over 500 commonly used items are included
- Bid Item terminology and pay units are now standardized
- Non-standard items can be entered
- Integrates with Online Bidding

**[INSERT PROJECT NAME]**
**UDFCD ELECTRONIC BID FORM**
**ENGINEER: [INSERT NAME]**
**DATE: [INSERT DATE]**

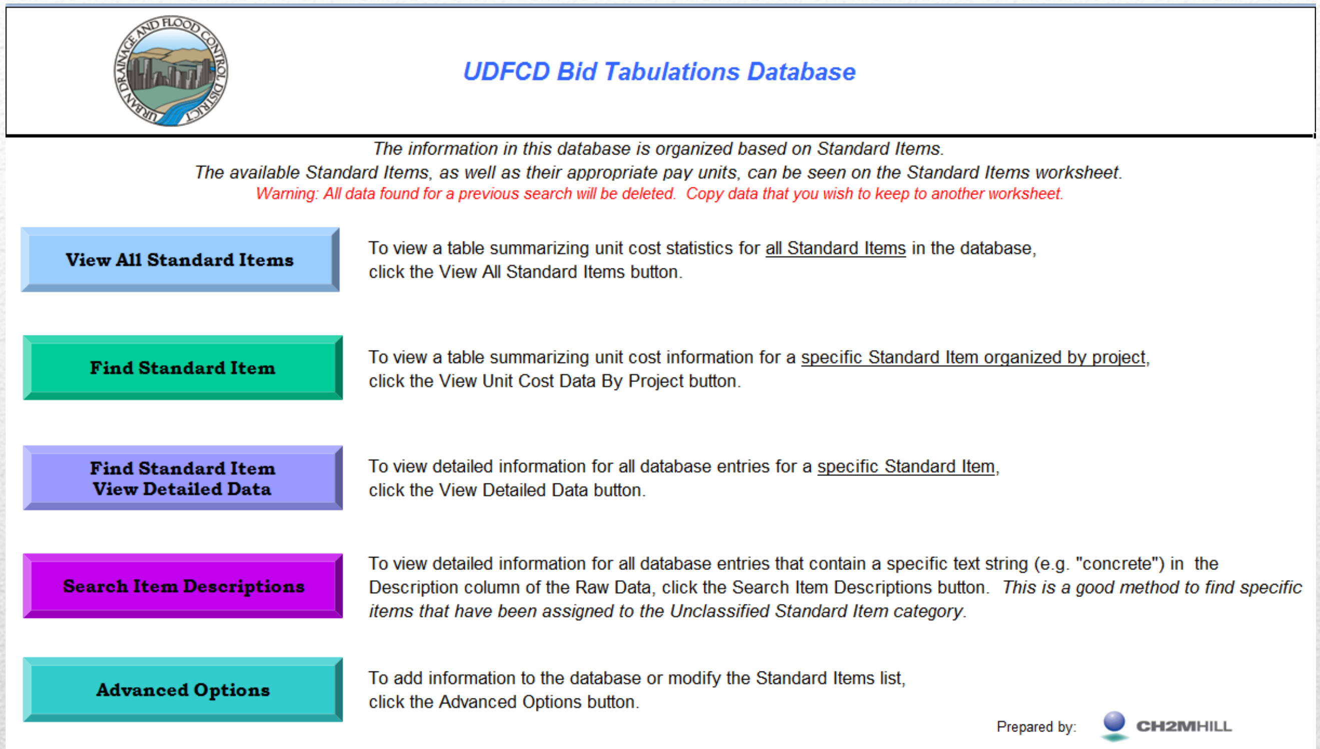
**Instructions:**
= User Input or Drop Down List
= Calculated Value
** If the Category needs to change, delete the Bid Item to the right if already selected.*
*Step 1: Select Category* *Step 2: Select Bid Item*

| BID ITEM | DESCRIPTION | QUANTITY | PAY UNIT | UNIT PRICE | TOTAL COST OF BID ITEM | CATEGORY (DROP DOWN LIST) | BID ITEM (DROP DOWN LIST) |
|---|---|---|---|---|---|---|---|
| 1 | Mobilization | 1.0 | LS | $1.00 | $1.00 | General | Mobilization |
| 2 | Removal Curb and Gutter | 2.0 | LF | $1.00 | $2.00 | Remove, Relocate, or Abandon | Removal Curb and Gutter |
| 3 | Check Dam | 3.0 | CY | $1.00 | $3.00 | Erosion and Sediment Control | Check Dam |
| 4 | Fence, Barbed Wire | 4.0 | LF | $1.00 | $4.00 | Fencing | Fence, Barbed Wire |
| 5 | Muck Excavation and Replace with Type VL Riprap | 5.0 | CY | $1.00 | $5.00 | Earthwork and Subgrade Prep | Muck Excavation and Replace with Type VL Riprap |
| 6 | Storm Inlet, Type R, (Single) (0-5 ft. deep) | 6.0 | EA | $1.00 | $6.00 | Storm Sewer System | Storm Inlet, Type R, (Single) (0-5 ft. deep) |

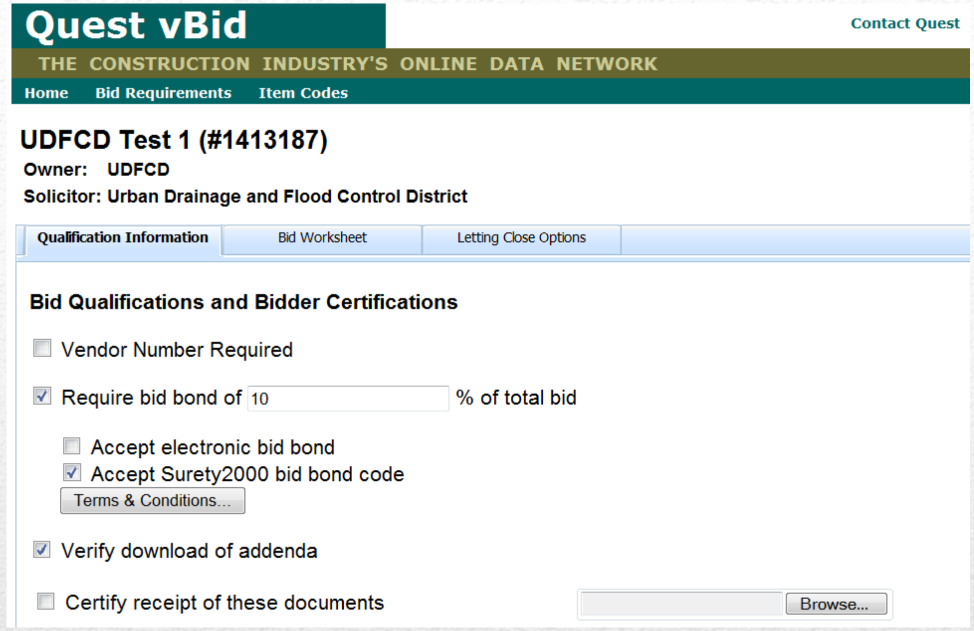
# Electronic Bid Form

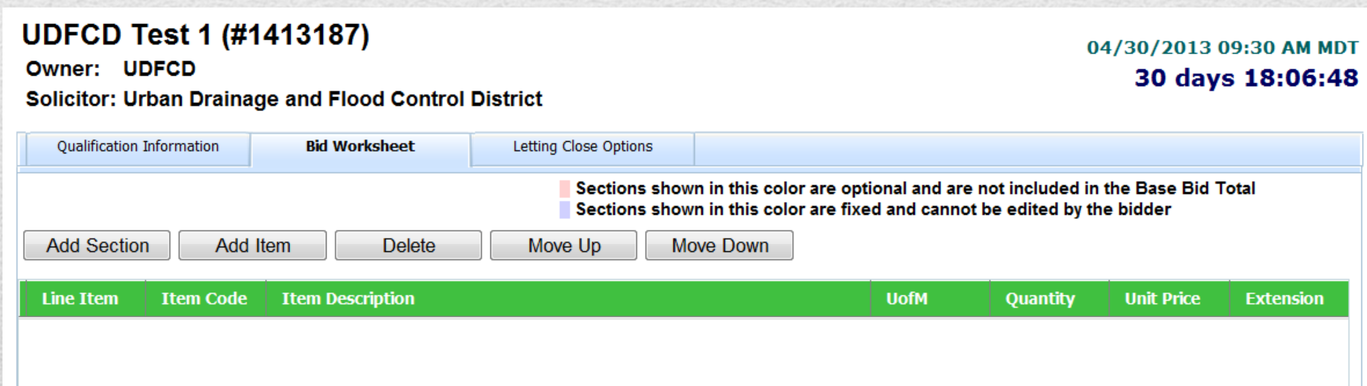
# Bid Tabs Program

- Database of UDFCD projects used for estimating construction costs
- Updated to use new Bid Item terminology
- Provides consistency with a new static Measurement and Payment specification



- Used by Contractors for bidding on projects
- E-Bid Form data is imported by UDFCD staff
- Contractor logs-in to QuestCDN via UDFCD.org
- Contractor uploads required bid documents and enters unit costs




# Online Bidding

# Bid Opening

- Bid period closes
- Conduct bid opening
- Bids reviewed by UDFCD
- Apparent low bidder published online
- Notice of Award provided to winning contractor

## Project Bid Results

**10CP2 Sidewalk Improvements (Quest project #1270008)**

| | |
|---|---|
| **owner:** | City of East Grand Forks |
| **soliciting agent:** | FS Engineering |
| **contact:** | Greg Boppre |
| **phone:** | 218-773-1185 |
| **e-mail:** | gboppre@fs-mn.com |
| **bid date:** | 08/04/2010 10:00 AM CDT |
| **award date:** | |
| **comments:** | |
| **award status:** | Pending |
| **bid result/award information:** | (no information presently available) |
| **electronic bid tabulation:** | (no tabulation available) |

| Company/Contact | Phone/e-mail | Amount | Awarded |
|---|---|---|---|
| Opp Construction<br>Bryan Benson | 701-775-3322<br>bryanbenson@oppconstruction.com | $220,772.40 | |
| Paras Contracting<br>Russ Davis | 701-232-6972<br>parascontracting@yahoo.com | $240,834.90 | |
| Strata Corporation<br>Rob Martens | 701-775-4205<br>quotes@strata-corp.com | $288,876.86 | |

- Online bid data for all bidders is migrated into Bid Tabs
- New bid information is ready to use when estimating costs for future projects

Summary of Statistics for All Standard Items in Database

**To display data for only specific items, click the dropdown arrow on the Description header and clear the checkmarks from the items that you do not want to see.**

| Standard Item Description | Pay Unit | Min of Unit Price | Max of Unit Price | Average of Unit Price |
|---|---|---|---|---|
| Handrail, Steel 3-Rail | LF | $26.00 | $139.00 | $106.10 |
| Imported Fill | CY | $4.05 | $24.00 | $11.93 |
| Imported Topsoil | CY | $10.67 | $48.00 | $33.00 |
| Inlet Protection | EA | $96.00 | $1,745.00 | $390.61 |

# Bid Tabs Integration

# Schedule and Training

- New tools are expected to rollout this summer
- UDFCD will provide training to those that will regularly use the tools
- Go to www.UDFCD.org for the latest updates

# NO MOSS GROWING HERE

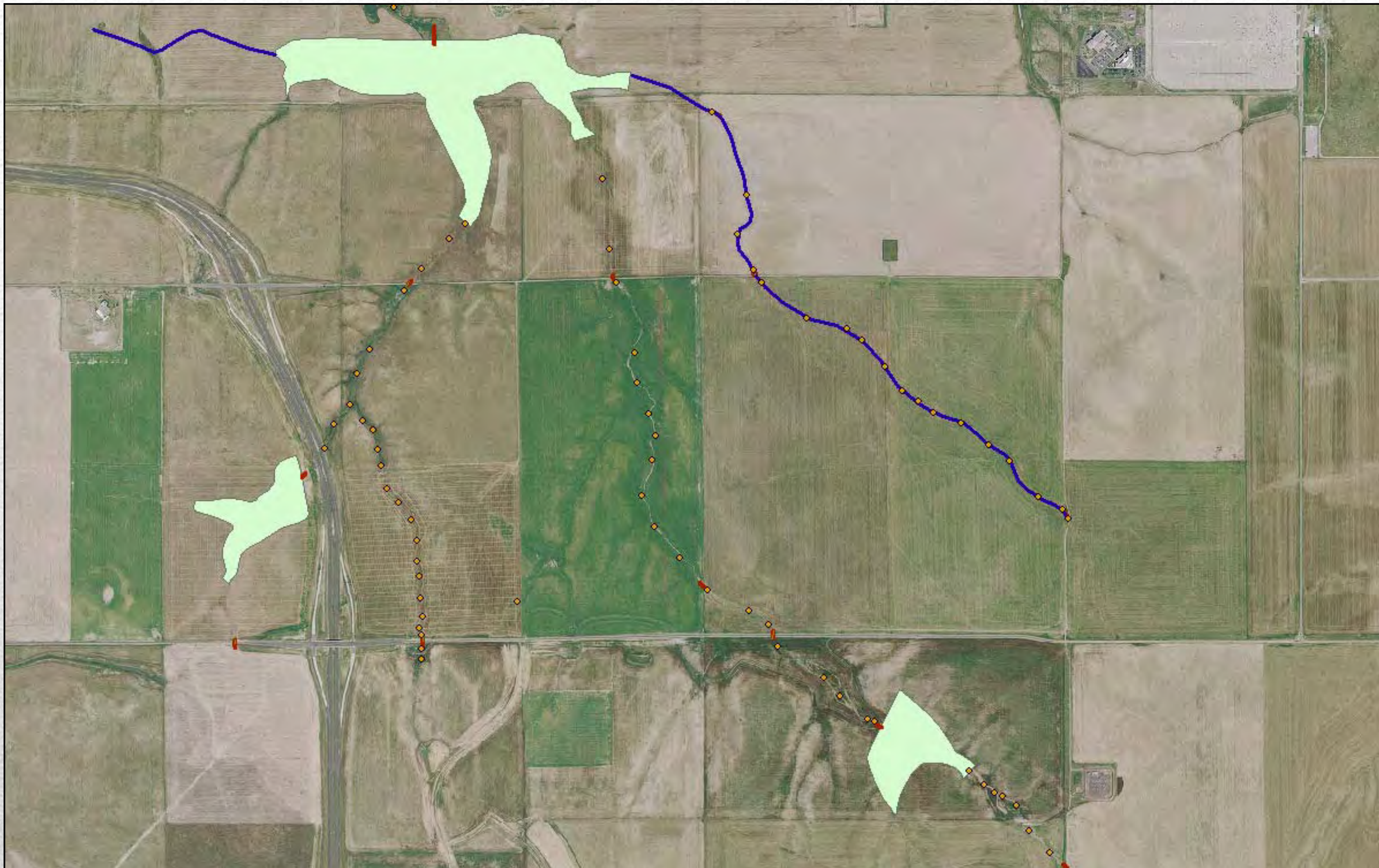
Kyle Hamilton – CH2M Hill

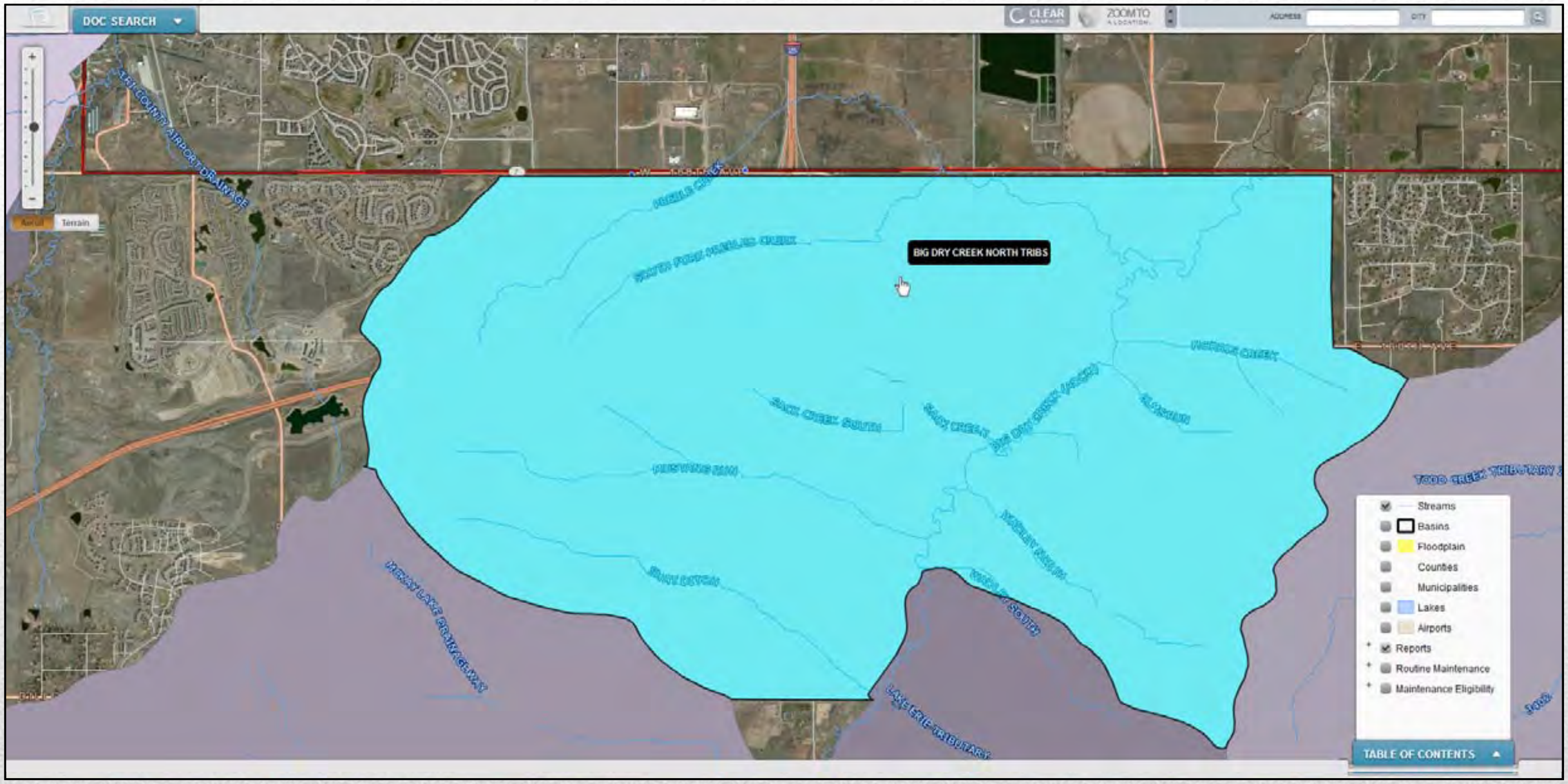
Shea Thomas – Master Planning

- Box Elder Creek MDP & FHAD
- Coal Creek/Rock Creek MDP & FHAD
- Dry Gulch OSP
- East Toll Gate Creek MDP & FHAD
- Town of Erie OSP
- Globeville/Utah Junction OSP
- Happy Canyon Creek MDP & FHAD
- Kalcevik Gulch MDP
- Newlin Gulch MDP
- North Dry Gulch MDP
- Sand Creek MDP & FHAD
- Sanderson Gulch MDP & FHAD
- South Boulder Creek MDP
- Weir Gulch MDP & FHAD
- West Toll Gate Creek MDP & FHAD
- Westerly Creek MDP & FHAD

# Master Planning

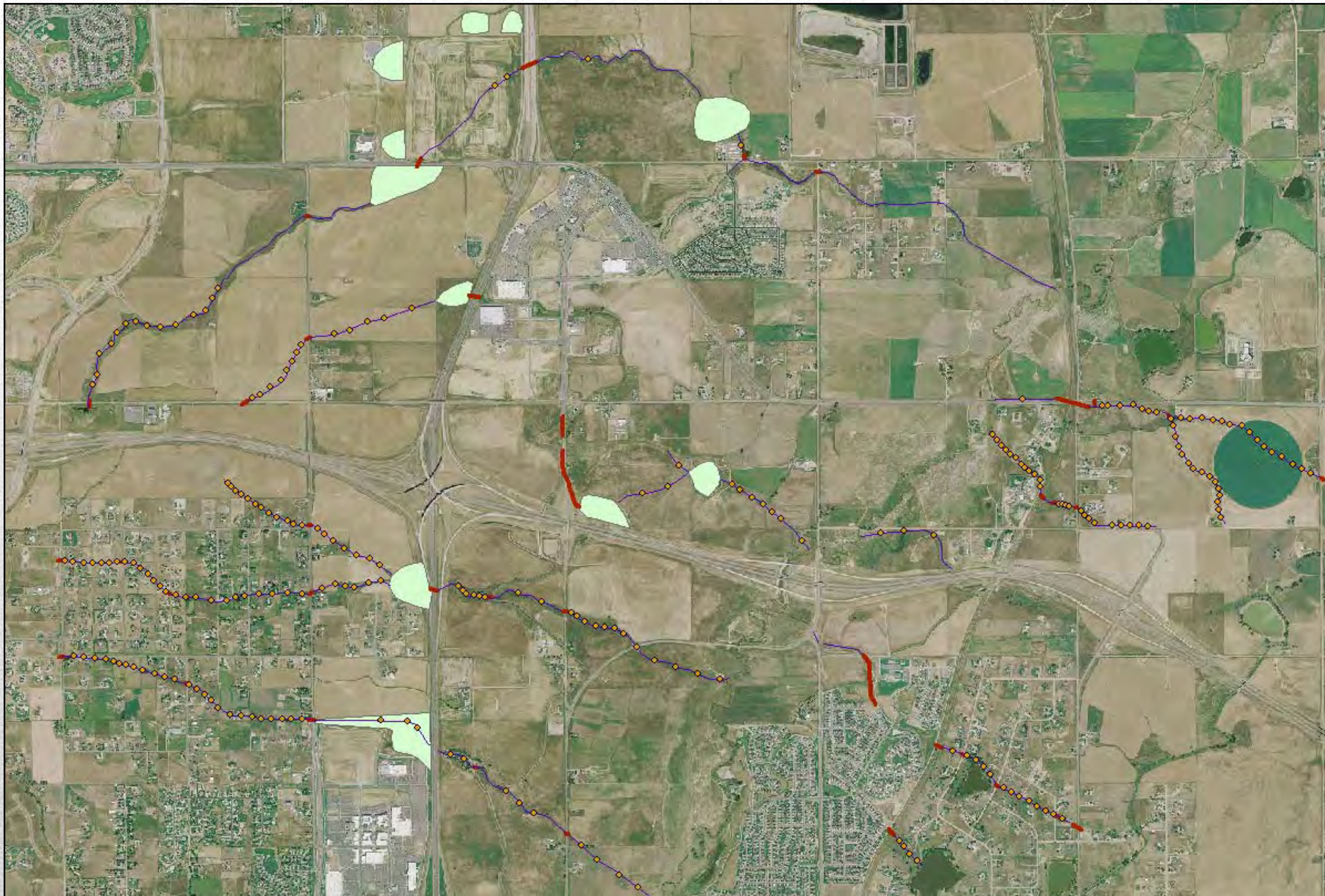

DOC SEARCH
CLEAR
ZOOM TO
Terrain
SECOND CREEK
Streams
Basins
Floodplain
Counties
Municipalities
Lakes
Airports
Reports
Routine Maintenance
Maintenance Eligibility
TABLE OF CONTENTS

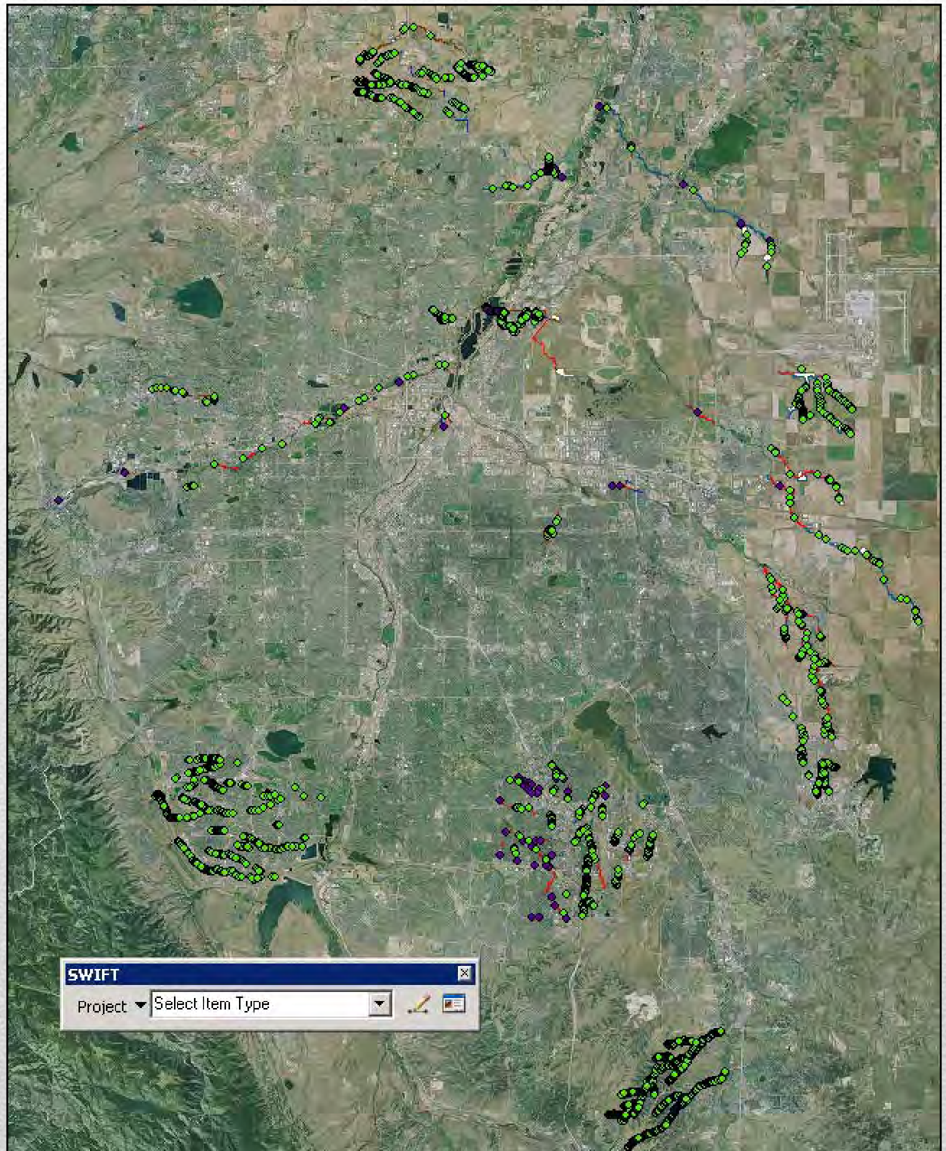


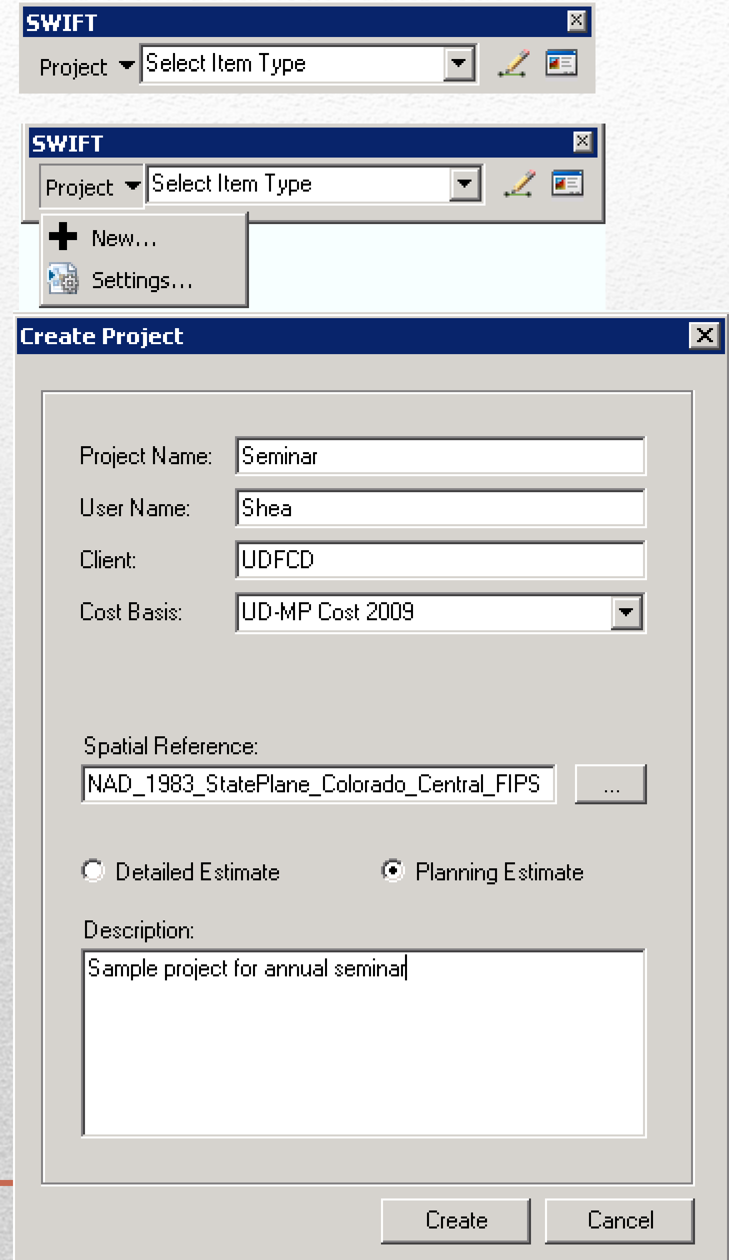


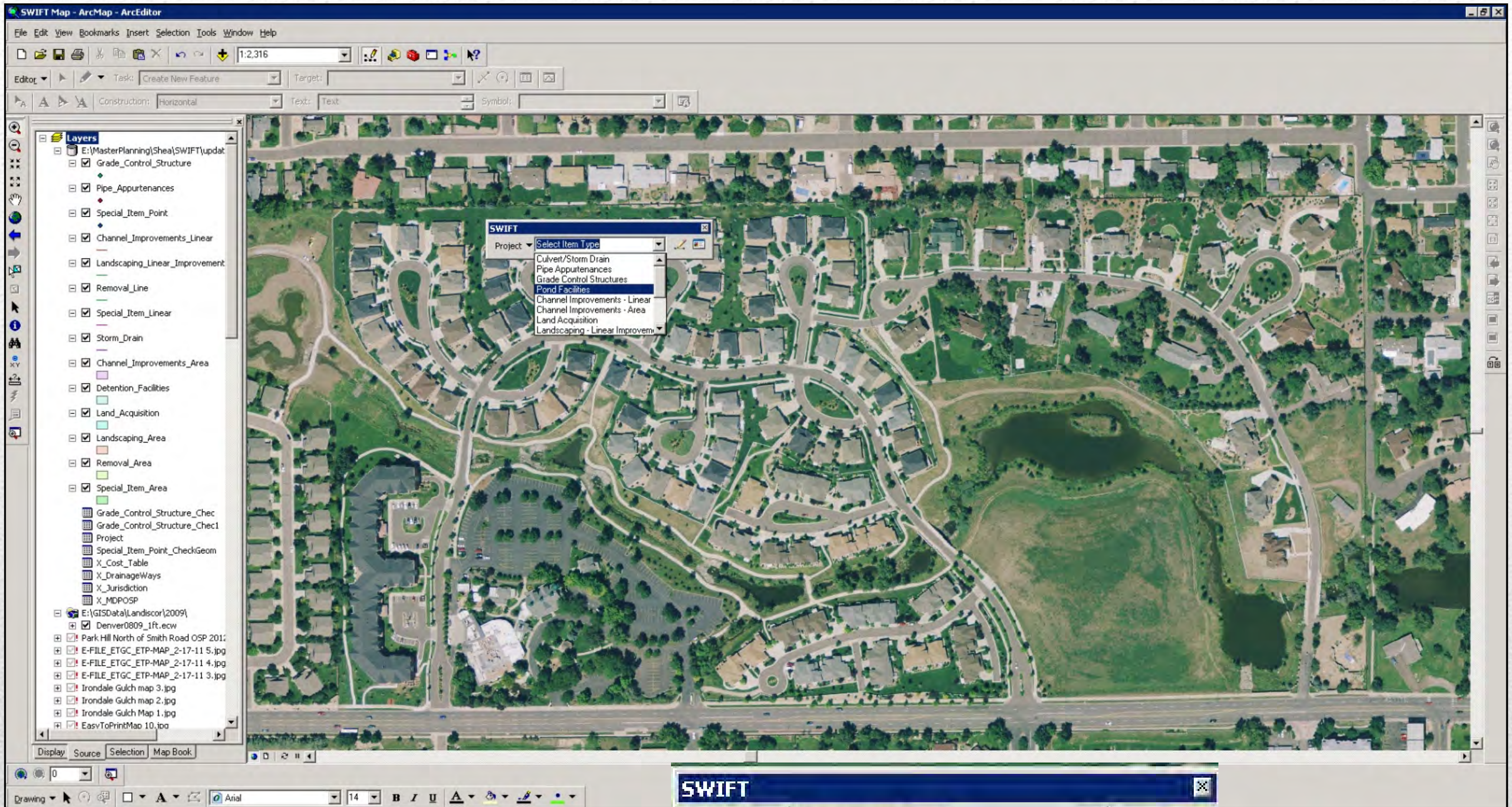



URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

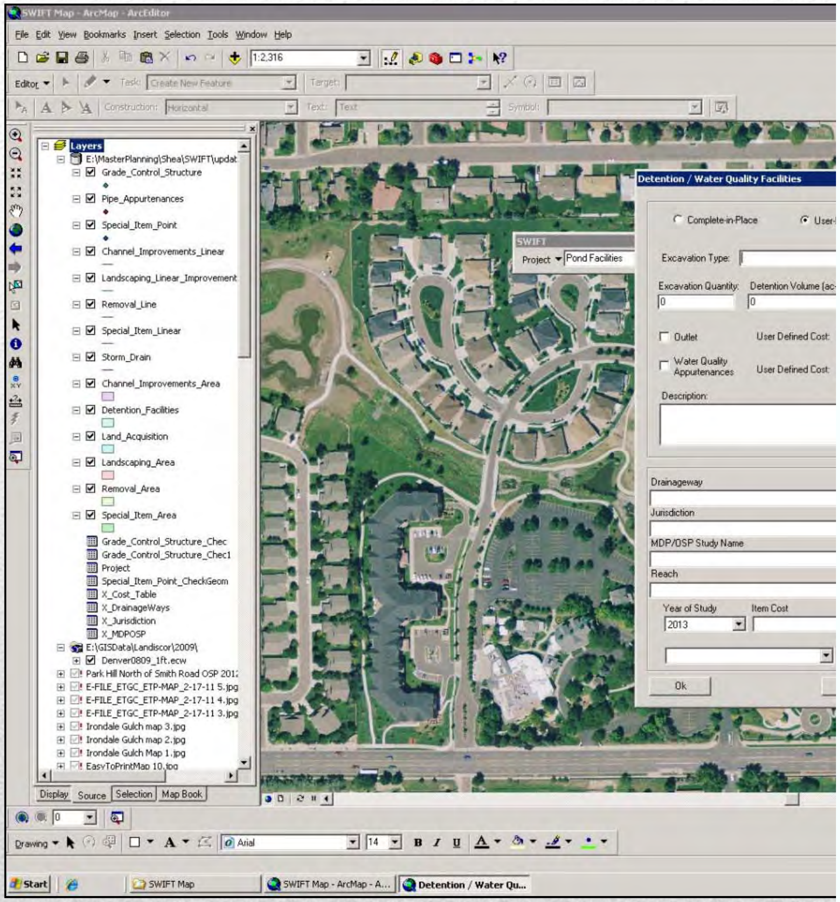



SWIFT
Project
Select Item Type

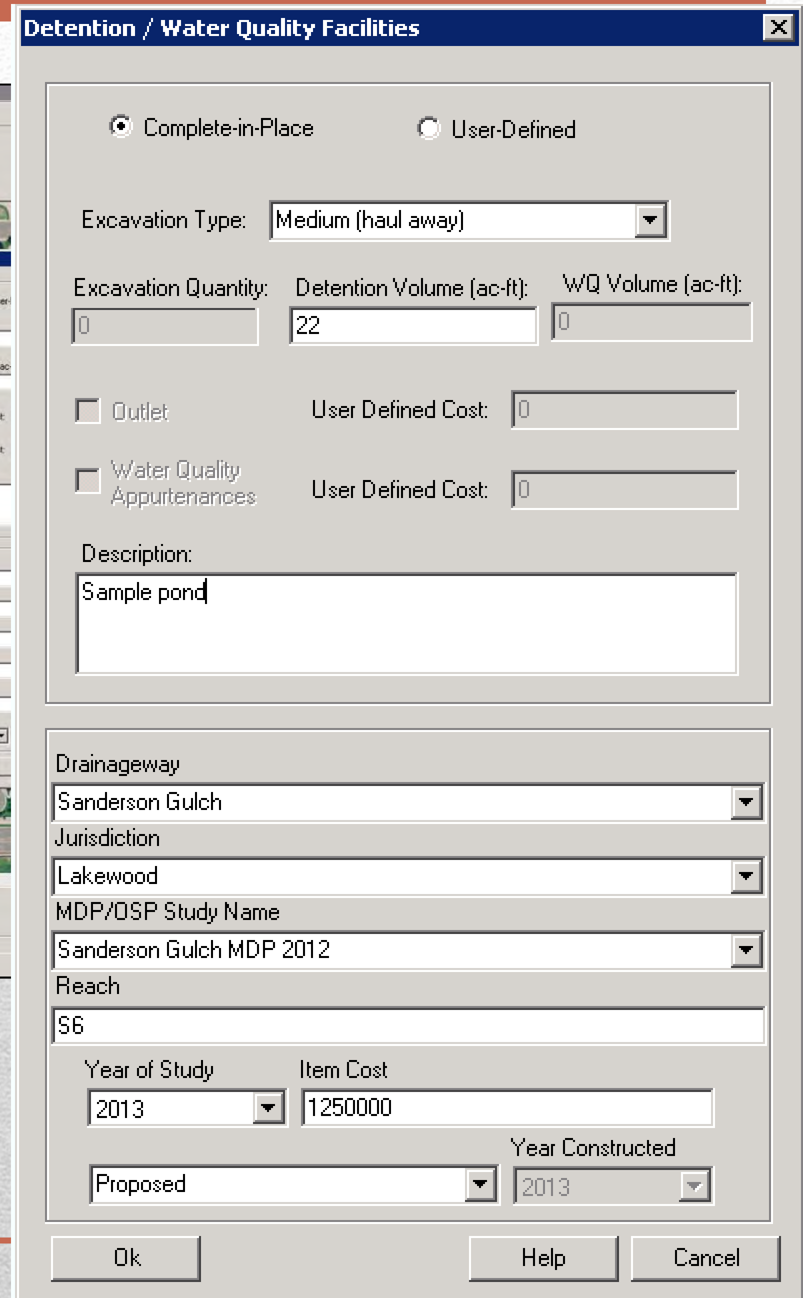

SWIFT
Project
Select Item Type
SWIFT
Project
Select Item Type
New...
Settings...
Create Project
Project Name:
Seminar
User Name:
Shea
Client:
UDFCD
Cost Basis:
UD-MP Cost 2009
Spatial Reference:
NAD_1983_StatePlane_Colorado_Central_FIPS
...
Detailed Estimate
Planning Estimate
Description:
Sample project for annual seminar
Create
Cancel


SWIFT Map - ArcMap - ArcEditor
File Edit View Bookmarks Insert Selection Tools Window Help
Layers
Grade_Control_Structure
Pipe_Appurtenances
Special_Item_Point
Channel_Improvements_Linear
Landscaping_Linear_Improvement
Removal_Line
Special_Item_Linear
Storm_Drain
Channel_Improvements_Area
Detention_Facilities
Land_Acquisition
Landscaping_Area
Removal_Area
Special_Item_Area
Display Source Selection Map Book

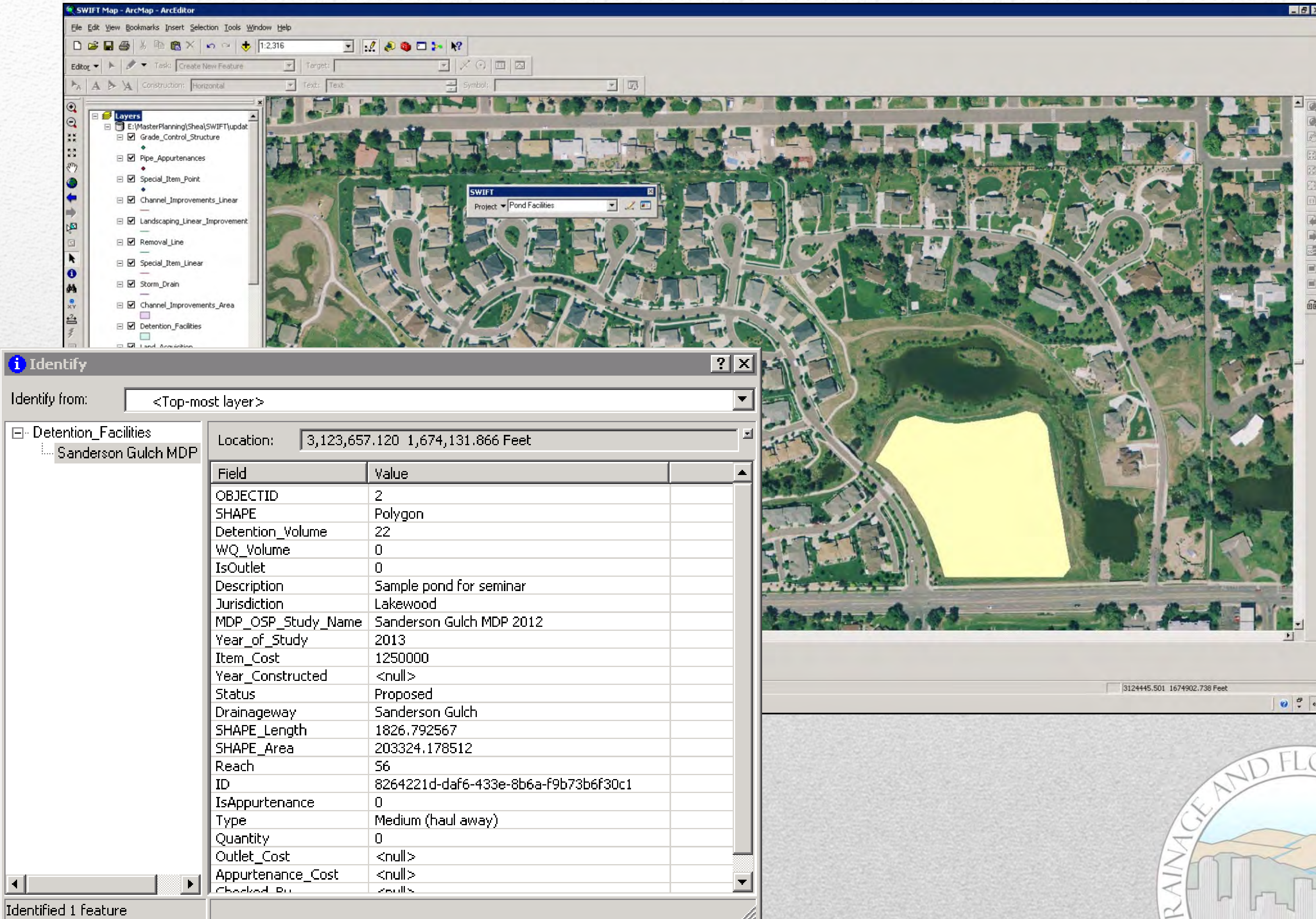

SWIFT
Project
Select Item Type
Culvert/Storm Drain
Pipe Appurtenances
Grade Control Structures
Pond Facilities
Channel Improvements - Linear
Channel Improvements - Area
Land Acquisition
Landscaping - Linear Improvem



SWIFT Map - ArcMap - ArcEditor

Detention / Water Quality Facilities
Complete-in-Place
User-Defined
Excavation Type:
Medium (haul away)
Excavation Quantity:
Detention Volume (ac-ft):
WQ Volume (ac-ft):
0
22
0
Outlet
User Defined Cost:
0
Water Quality Appurtenances
User Defined Cost:
0
Description:
Sample pond
Drainageway
Sanderson Gulch
Jurisdiction
Lakewood
MDP/OSP Study Name
Sanderson Gulch MDP 2012
Reach
S6
Year of Study
Item Cost
2013
1250000
Year Constructed
Proposed
2013
Ok
Help
Cancel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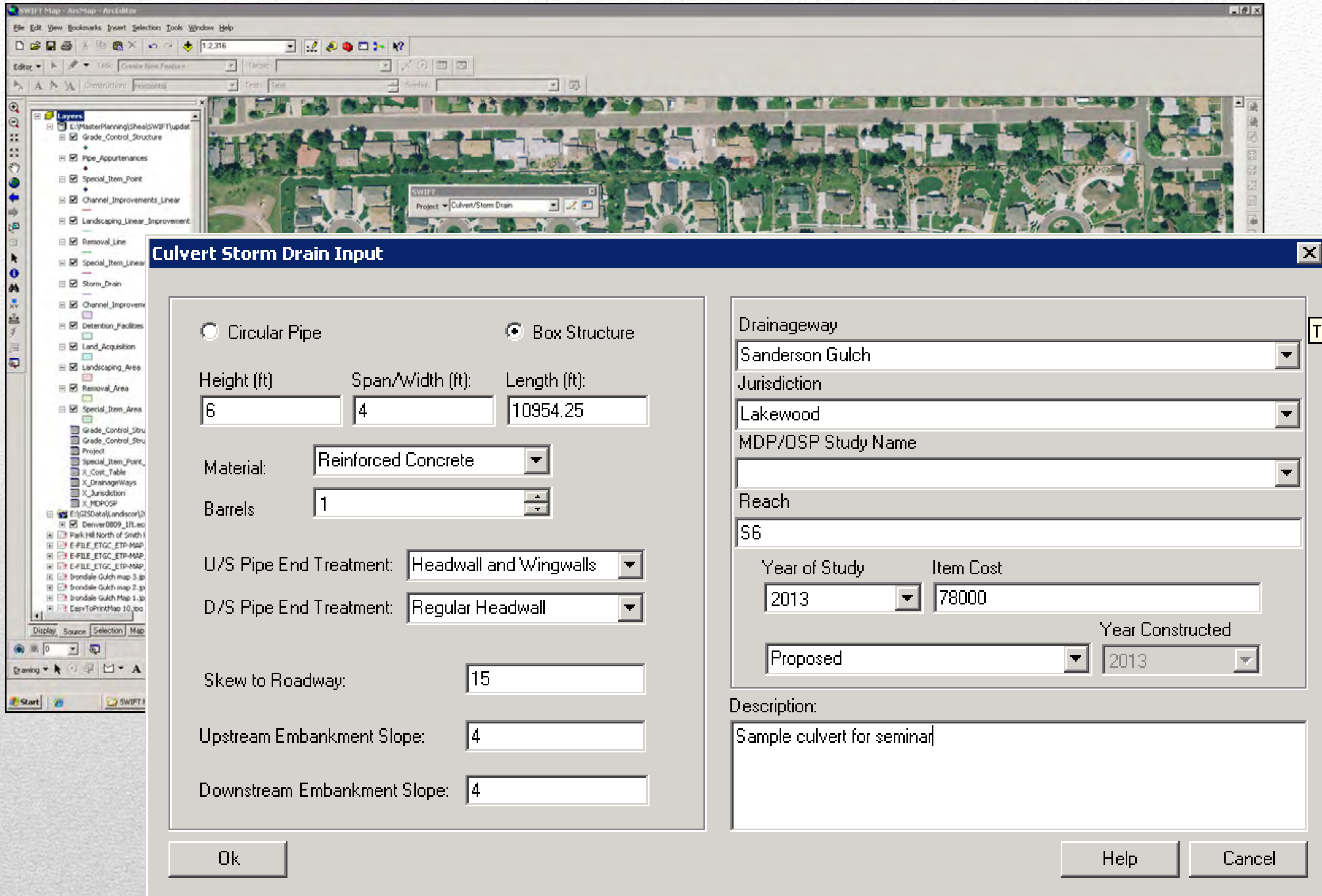
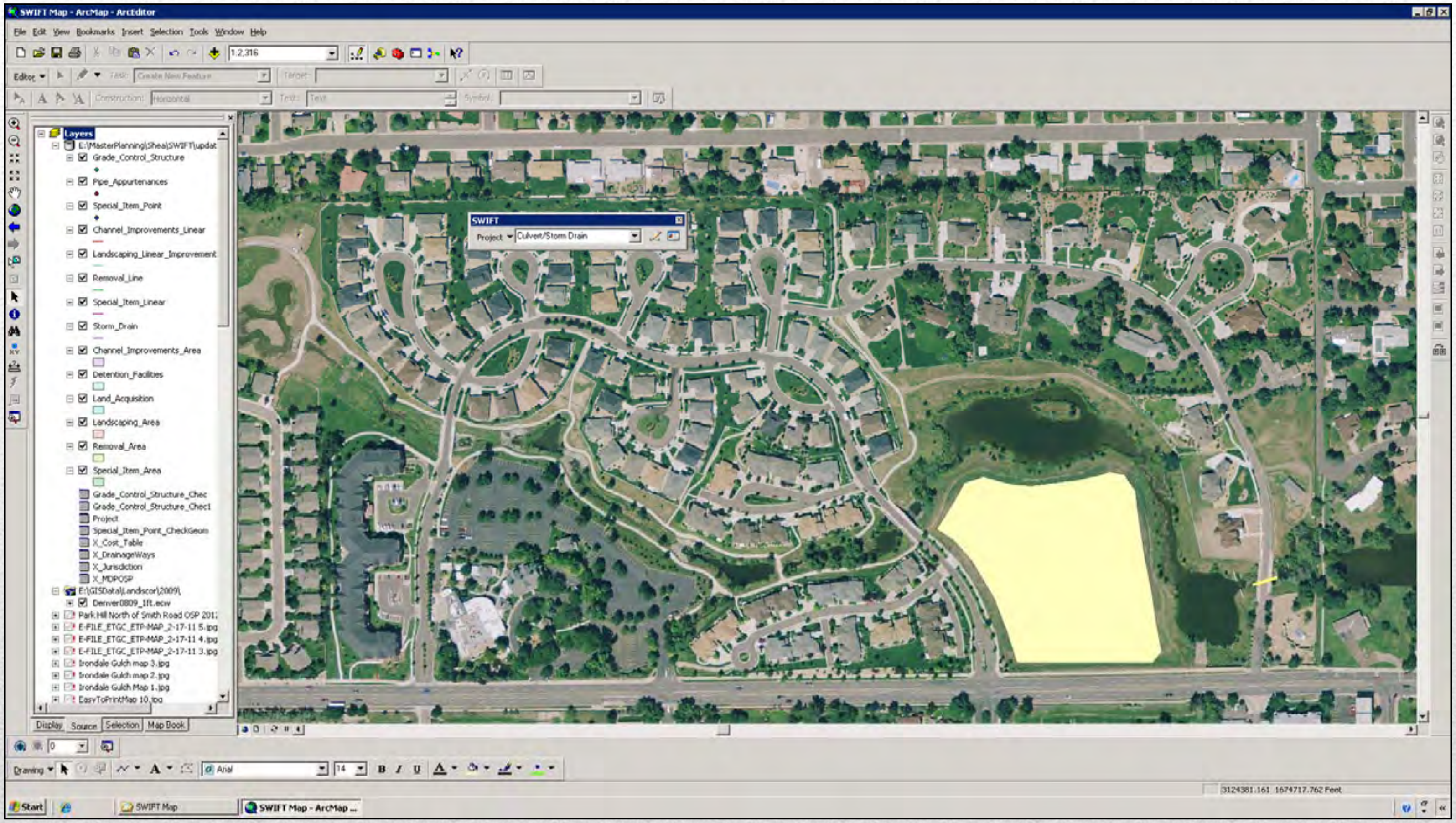
File Edit View Bookmarks Insert Selection Tools Window Help
Layers
Grade_Control_Structure
Pipe_Appurtenances
Special_Item_Point
Channel_Improvements_Linear
Landscaping_Linear_Improvement
Removal_Line
Special_Item_Linear
Storm_Drain
Channel_Improvements_Area
Detention_Facilities
SWIFT
Project
Pond Facilities
Identify
Identify from:
<Top-most layer>
Detention_Facilities
Sanderson Gulch MDP
Location:
3,123,657.120 1,674,131.866 Feet
Field
Value
OBJECTID 2
SHAPE Polygon
Detention_Volume 22
WQ_Volume 0
IsOutlet 0
Description Sample pond for seminar
Jurisdiction Lakewood
MDP_OSP_Study_Name Sanderson Gulch MDP 2012
Year_of_Study 2013
Item_Cost 1250000
Year_Constructed <null>
Status Proposed
Drainageway Sanderson Gulch
SHAPE_Length 1826.792567
SHAPE_Area 203324.178512
Reach 56
ID 8264221d-daf6-433e-8b6a-f9b73b6f30c1
IsAppurtenance 0
Type Medium (haul away)
Quantity 0
Outlet_Cost <null>
Appurtenance_Cost <null>
Identified 1 feature
3124445.501 1674902.738 Feet


Culvert Storm Drain Input
Circular Pipe
Box Structure
Height (ft)
6
Span/Width (ft):
4
Length (ft):
10954.25
Material:
Reinforced Concrete
Barrels
1
U/S Pipe End Treatment:
Headwall and Wingwalls
D/S Pipe End Treatment:
Regular Headwall
Skew to Roadway:
15
Upstream Embankment Slope:
4
Downstream Embankment Slope:
4
Drainageway
Sanderson Gulch
Jurisdiction
Lakewood
MDP/OSP Study Name
Reach
S6
Year of Study
2013
Item Cost
78000
Year Constructed
Proposed
2013
Description:
Sample culvert for seminar
Ok
Help
Cancel


SWIFT Map - ArcMap - ArcEditor
Layers
Grade_Control_Structure
Pipe_Appurtenances
Special_Item_Point
Channel_Improvements_Linear
Landscaping_Linear_Improvement
Removal_Line
Special_Item_Linear
Storm_Drain
Channel_Improvements_Area
Detention_Facilities
Land_Acquisition
Landscaping_Area
Removal_Area
Special_Item_Area
SWIFT
Project
Culvert/Storm Drain

Tables

- Channel_Improvements_A...
- Channel_Improvements_A...
- Channel_Improvements_Li...
- Channel_Improvements_Li...
- Detention_Facilities
- Detention_Facilities_SHAP...
- GDB_AnnoSymbols
- GDB_AttrRules
- GDB_CodedDomains
- GDB_ColumnInfo
- GDB_DatabaseLocks
- GDB_DefaultValues
- GDB_Domains
- GDB_EdgeConnRules
- GDB_ExtensionDatasets
- GDB_Extensions
- GDB_FeatureClasses
- GDB_FeatureDataset
- GDB_FieldInfo
- GDB_GeomColumns
- GDB_JnConnRules
- GDB_ObjectClasses
- GDB_RangeDomains
- GDB_RasterCatalogs
- GDB_RelClasses
- GDB_ReleaseInfo
- GDB_RelRules
- GDB_ReplicaDatasets
- GDB_ReplicaLog
- GDB_Replicas
- GDB_ReplicasEx
- GDB_SpatialRefs
- GDB_Subtypes
- GDB_Toolboxes

| OBJECTID | SHAPE | Detention_\ | WQ_Volume | IsOutlet | Description | Jurisdiction | MDP_OSP_S | Year_of_Stu | Item_Cost | Year_Constr | Status | Drainagewa | SHAPE_Leng | SHAPE_Area | Reach |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ong binary data | 24.6 | 0 | 1 | Reach 1. Pond | Aurora | East Toll Gate C | 2011 | 914500 | 2012 | Proposed | | 2489.29684740 | 312083.277773 | East Toll Gate C |
| 2 | ong binary data | 56.8 | 0 | 1 | Reach 2. Pond | Arapahoe Cour | East Toll Gate C | 2011 | 1692675 | 2012 | Proposed | | 4304.75601034 | 395682.709068 | East Toll Gate C |
| 3 | ong binary data | 796 | 0 | 1 | Reach S-1. 796 | Adams County | Second Creek l | 2011 | 5709320 | 2012 | Proposed | | 16862.8931636 | 4604875.4983 | Second Creek |
| 4 | ong binary data | 113 | 0 | 1 | Reach S-4. Low | Aurora | Second Creek l | 2011 | 2624195 | 2012 | Proposed | | 5503.63002712 | 1208332.98928 | Second Creek |
| 7 | ong binary data | 73 | 0 | 1 | Reach P-3. Pon | Aurora | Second Creek l | 2011 | 11358618 | 2012 | Proposed | | 6150.26362627 | 1124116.96553 | Possum Gully |
| 8 | ong binary data | 113 | 0 | 1 | Reach 5.2. Offl | Adams County | First Creek Upp | 2010 | 2063025 | 2012 | Proposed | | 3387.47667648 | 856758.539419 | First Creek |
| 9 | ong binary data | 132 | 0 | 1 | Reach F7.4. Exc | Aurora | First Creek Upp | 2010 | 2333400 | 2012 | Proposed | | 4325.95820725 | 1021891.9363 | First Creek |
| 10 | ong binary data | 228 | 0 | 1 | Reach F8.1. Exc | Aurora | First Creek Upp | 2010 | 3623475 | 2012 | Proposed | | 5733.40492121 | 1794400.37378 | First Creek |
| 11 | ong binary data | 132 | 0 | 1 | Reach F11. | Aurora | First Creek Upp | 2010 | 2333400 | 2012 | Proposed | | 4093.9438741 | 999598.885661 | First Creek |
| 12 | ong binary data | 36 | 0 | 1 | Reach T2.1. Exc | Aurora | First Creek Upp | 2010 | 991825 | 2012 | Proposed | | 2657.26406455 | 328495.235652 | First Creek Trib |
| 13 | ong binary data | 319 | 0 | 1 | Basin 8507. Exc | Aurora | First Creek Upp | 2010 | 2173815 | 2012 | Proposed | | 6660.11388330 | 2401630.23283 | First Creek Trib |
| 14 | ong binary data | 75 | 0 | 1 | Basin 8515. Exc | Aurora | First Creek Upp | 2010 | 1070685 | 2012 | Proposed | | 2878.21579966 | 588231.720472 | First Creek Trib |
| 15 | ong binary data | 17.3 | 0 | 0 | PP-2. Pond L-2 | Arapahoe Cour | Lone Tree Cree | 2010 | 597852 | 2012 | Proposed | | 1659.52907711 | 154285.706396 | Lone Tree Cree |
| 16 | ong binary data | 55.63 | 0 | 0 | DRG L6. E-470 F | Douglas Count | Cottonwood Cr | 2010 | 257380 | 2012 | Proposed | | 2254.46830040 | 230656.537198 | Cottonwood Cr |
| 17 | ong binary data | 0 | 0 | 0 | DRG L6. Meridi | Douglas Count | Cottonwood Cr | 2010 | 30000 | 2012 | Proposed | | 2249.02842617 | 283641.774932 | Cottonwood Cr |
| 18 | ong binary data | 7.2 | 0 | 0 | DRG L7. Arapah | Arapahoe Cour | Cottonwood Cr | 2010 | 268800 | 2012 | Proposed | | 1576.29860602 | 106467.269217 | Peoria Tributar |
| 19 | ong binary data | 21.2 | 0 | 0 | DRG L7. Airport | Arapahoe Cour | Cottonwood Cr | 2010 | 368250 | 2012 | Proposed | | 1962.30321010 | 160282.208475 | Peoria Tributar |
| 20 | ong binary data | 0 | 0 | 0 | DRG L8. Rampa | Centennial | Cottonwood Cr | 2010 | 20160 | 2012 | Proposed | | 1086.03687337 | 62612.1632624 | Havana Tributa |
| 21 | ong binary data | 0 | 0 | 0 | DRG L8. Rampa | Centennial | Cottonwood Cr | 2010 | 47040 | 2012 | Proposed | | 1777.00445435 | 125286.164562 | Havana Tributa |
| 22 | ong binary data | 1.4 | 0 | 0 | DRG L8.Blue Sk | Centennial | Cottonwood Cr | 2010 | 67470 | 2012 | Proposed | | 445.1528453 | 13704.0500126 | Havana Tributa |
| 23 | ong binary data | 0 | 0 | 0 | DRG L9. Fulton | Centennial | Cottonwood Cr | 2010 | 6720 | 2012 | Proposed | | 1005.15918106 | 47304.4393724 | Havana Tributa |
| 24 | ong binary data | 15.5 | 0 | 0 | DRG L10. Airpo | Douglas Count | Cottonwood Cr | 2010 | 295010 | 2012 | Proposed | | 1792.17715408 | 124683.977964 | Airport Tributa |
| 25 | ong binary data | 0 | 0 | 0 | DRG L11. Meric | Douglas Count | Cottonwood Cr | 2010 | 5380 | 2012 | Proposed | | 865.911558519 | 49073.6051762 | Airport Tributa |
| 26 | ong binary data | 25 | 0 | 0 | 67+00 to 94+00. | Centennial | Willow Little D | 2010 | 265000 | 2012 | Proposed | | 1430.13493286 | 89757.0942311 | Little Dry Creel |
| 27 | ong binary data | 41 | 0 | 0 | 41 Acre-ft Dete | Centennial | Willow Little D | 2010 | 409000 | 2012 | Proposed | | 2610.95174838 | 216727.671852 | Willow Creek |
| 28 | ong binary data | 9.6 | 0 | 0 | 9.6 Acre-ft Det | Lonetree | Willow Little D | 2010 | 126400 | 2012 | Proposed | | 1792.30623744 | 183653.825774 | Willow Creek |
| 29 | ong binary data | 23.7 | 6.9 | 1 | PP-5. Meridian | Douglas Count | Lone Tree Cree | 2010 | 1078500 | 2012 | Proposed | | 2308.67882630 | 288041.197984 | Windmill Creel |
| 30 | ong binary data | 112 | 15.8 | 0 | PP-6. Detentio | Arapahoe Cour | Lone Tree Cree | 2010 | 940100 | 2012 | Proposed | | 3432.84144282 | 603724.200001 | Windmill Creel |
| 31 | ong binary data | 17.1 | 4.7 | 0 | PP-9. South Bla | Arapahoe Cour | Lone Tree Cree | 2010 | 797945 | 2012 | Proposed | | 2184.18925243 | 277504.974786 | Windmill Creel |
| 32 | ong binary data | 28.2 | 0 | 1 | PP-12. | Arapahoe Cour | Lone Tree Cree | 2010 | 396610 | 2012 | Proposed | | 1654.37632564 | 167425.608429 | Dove Creek |
| 33 | ong binary data | 19.6 | 15.4 | 1 | PP-13. Pond D2 | Arapahoe Cour | Lone Tree Cree | 2010 | 1391990 | 2012 | Proposed | | 3243.93704274 | 429062.982326 | Dove Creek |
| 34 | ong binary data | 55.3 | 0 | 0 | Caley West Por | Centennial | Cottonwood Cr | 2010 | 290980 | 2012 | Proposed | | 1838.32071554 | 246010.439887 | Cottonwood Cr |
| 35 | ong binary data | 35.7 | 0 | 0 | Lincoln Executi | Centennial | Cottonwood Cr | 2010 | 405890 | 2012 | Proposed | | 2159.80942472 | 213640.048303 | Cottonwood Cr |
| 36 | ong binary data | 18 | 0 | 0 | Centennial Cor | Centennial | Cottonwood Cr | 2010 | 284260 | 2012 | Proposed | | 1396.64794706 | 125141.901404 | Cottonwood Cr |
| 37 | ong binary data | 105.5 | 0 | 0 | Inverness Regi | Arapahoe Cour | Cottonwood Cr | 2010 | 281570 | 2012 | Proposed | | 4620.65637207 | 485843.546166 | Cottonwood Cr |
| 38 | ong binary data | 0 | 0 | 0 | DRG L4. Airport | Arapahoe Cour | Cottonwood Cr | 2010 | 47040 | 2012 | Proposed | | 872.041515139 | 38472.1309991 | Cottonwood Cr |
| 39 | ong binary data | 0 | 0 | 0 | DRG L4. Airport | Arapahoe Cour | Cottonwood Cr | 2010 | 47040 | 2012 | Proposed | | 610.478434179 | 20689.9789786 | Cottonwood Cr |
| 40 | ong binary data | 18.3 | 0 | 0 | DRG L5. Liberty | Douglas Count | Cottonwood Cr | 2010 | 277540 | 2012 | Proposed | | 2014.03382642 | 210638.078333 | Cottonwood Cr |
| 41 | ong binary data | 18 | 0 | 0 | 18 Acre-ft dete | Centennial | Willow Little D | 2010 | 202000 | 2012 | Proposed | | 930.329128571 | 44603.2469272 | Spring Creek |
| 42 | ong binary data | 24 | 0 | 1 | Pond 2001 | | Murphy Creek | 2008 | 631550 | 2012 | Proposed | | 1801.04896137 | 201012.709340 | Richard Run |
| 43 | ong binary data | 16.1 | 0 | 1 | Pond 3001W | | Murphy Creek | 2008 | 1027980 | 2012 | Proposed | | 2666.46880628 | 465408.857538 | Murphy Creek |

"If you don't have time to do it right,

when will you have time to do it over?"

– John Wooden

# Questions?

# How the District Violated the Clean Water Act, and How You Can Avoid Doing the Same

**David Bennetts, UDFCD**
**Kiel Downing, Corps of Engineers**
**Richard Clark, EPA**
**Mary Powell, ERO Resources**

# Presentation Overview

- Urban Drainage - District's History with Enforcement Actions
- USACE – Sediment Removal Authorizations Corps Role in Enforcement Actions
- EPA – Role in Enforcement Actions
- ERO Resources – General Guidance & Considerations for 404 Permits

- District has been in business for 44 years and actively doing construction projects for about 40 of those years

| | Projects | Funds Spent |
|---|---|---|
| CIP | Over 600 | $225,400,000 |
| Maintenance & SPR | Over 2500 | $201,847,000 |
| Totals | Over 3100 | $427,247,000 |

- All of those projects were construction along the major drainageways, and requires review and approval from the USACE

# District - 404 Permit Violations

Coal Creek, Boulder County – 1993

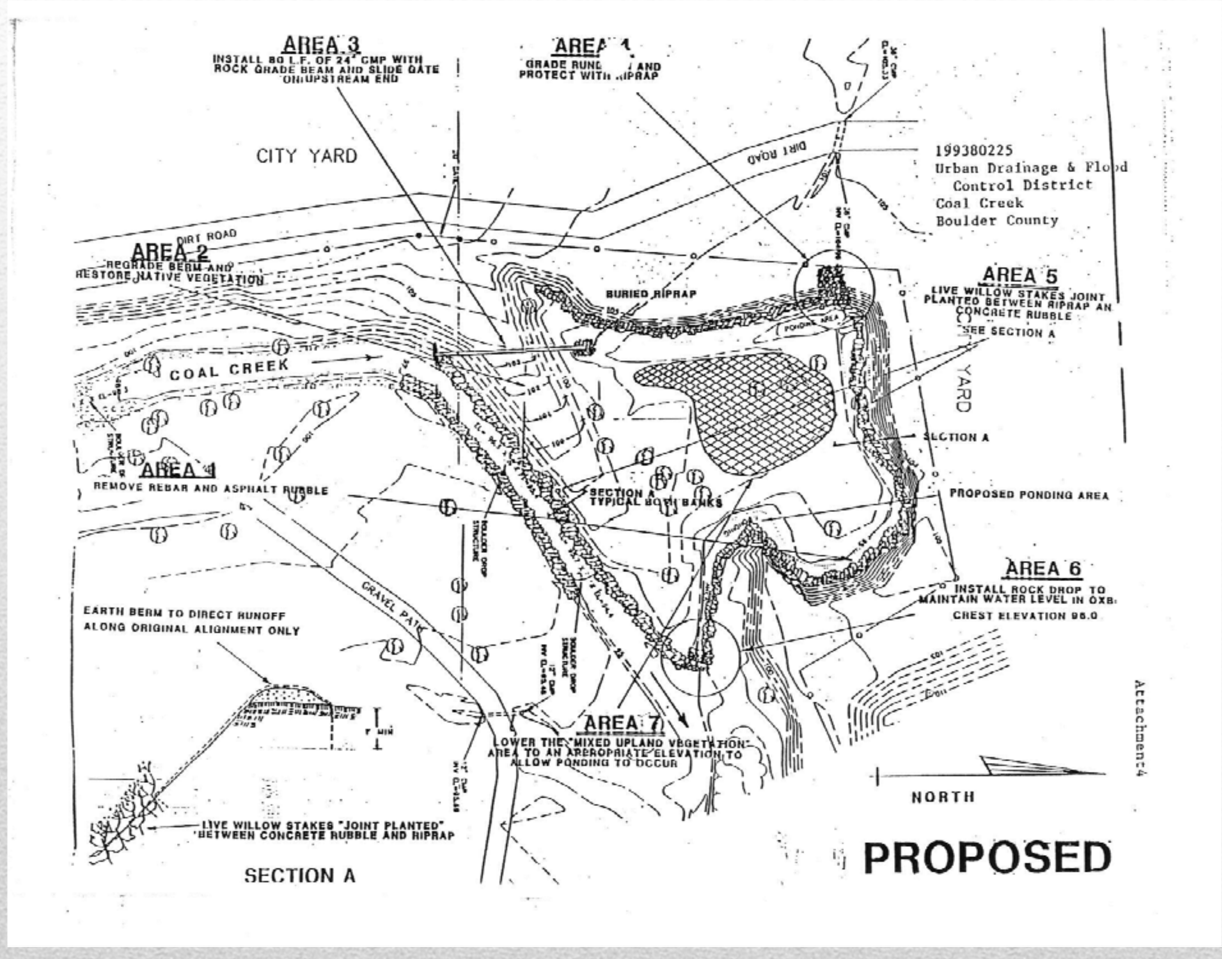
Piney Creek, Arapahoe County - 2012

# Coal Creek

# Coal Creek

# Coal Creek

# Coal Creek


AREA 3
INSTALL 80 L.F. OF 24" CMP WITH ROCK GRADE BEAM AND SLIDE GATE ON UPSTREAM END
CITY YARD
DIRT ROAD
199380225
Urban Drainage & Flood Control District
Coal Creek
Boulder County
AREA 2
REGRADE BERM AND RESTORE NATIVE VEGETATION
BURIED RIPRAP
AREA 5
LIVE WILLOW STAKES JOINT PLANTED BETWEEN RIPRAP AND CONCRETE RUBBLE
SEE SECTION A
COAL CREEK
YARD
SECTION A
AREA 4
REMOVE REBAR AND ASPHALT RUBBLE
SECTION A
TYPICAL BOTH BANKS
PROPOSED PONDING AREA
AREA 6
INSTALL ROCK DROP TO MAINTAIN WATER LEVEL IN OXB.
CREST ELEVATION 96.0
GRAVEL PATH
EARTH BERM TO DIRECT RUNOFF ALONG ORIGINAL ALIGNMENT ONLY
AREA 7
LOWER THE MIXED UPLAND VEGETATION AREA TO AN APPROPRIATE ELEVATION TO ALLOW PONDING TO OCCUR
Attachment4
NORTH
LIVE WILLOW STAKES "JOINT PLANTED" BETWEEN CONCRETE RUBBLE AND RIPRAP
SECTION A
PROPOSED

# Coal Creek

# Coal Creek


# Piney Creek

# Piney Creek

# Piney Creek

# Piney Creek

# Piney Creek

# Piney Creek

# Piney Creek

- **Mitigation Project**
  - Address adverse effects of sediment removal project
- **Supplemental Environmental Project (SEP)**
  - To Stabilize Banks on upstream reach of Piney Creek
- **Pay a Fine**
  - Offset by SEP
- **Improved Process at District**
  - Avoid future violations
- **Discuss at our Annual Seminar**
  - Educate Others

# Mitigation Project

# Supplemental Environmental Project

# Improved Processes at District

**New Clean Water Act Section 404 Protocol**

- Each project reviewed by outside consultant with expertise in Section 404 Authorizations
- Consultant prepares all submittals to the Corps and facilitates coordination
- Consultant remains on the project team to address changes as they arise


**David Bennetts**

**dbennetts@udfcd.org**

# U. S. Army Corps of Engineers
# Section 404

Denver Regulatory Office

9307 S. Wadsworth Blvd

Littleton, CO 80128

303-979-4120

https://www.nwo.usace.army.mil/html/od-tl/tri-

# 404 Jurisdiction

- Regulatory Jurisdiction
  - based on activity being undertaken
  - triggered by the placement of fill

- Geographical Jurisdiction
  - Rapanos Guidance
  - Isolated Waters
  - Preamble Waters

# Jurisdictional Waters

- All surface waters such as rivers, creeks and tributaries
  - jurisdiction based on flow regime
  - duration, volume and frequency
  - can include man-made tributaries

- All wetlands adjacent to these waters

- All impoundments of these waters

# Non-Jurisdictional Waters

- Isolated Waters with no nexus to interstate commerce
- Preamble Waters – case-by-case basis (no RPW flow)
  - Non-tidal drainage and irrigation ditches excavated on dry land
  - - Artificial lakes or ponds created by excavating and/or diking dry land to collect and retain water and which are used exclusively for such purposes as stock watering, irrigation, settling basins

# Non-Regulated Activities
# Sediment Removal

- Dredging /Excavation– excavated material removed and placed in uplands
- Activity cannot push or scrape sediment into a pile
- No channel shaping or regrading of banks
- No temporary fill for access or dewatering



URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

# NWPs

3 Maintenance

(a) repair/rehabilitation – no PCN

(b) sediment removal up to 200’ of structure – PCN

(c) temp work or structures

7 Outfalls

- require PCN

- activity must comply with NPDES Program

# NWPs

12 Utility Lines

- must restore to preconstruction contours

13 Bank Stabilization

- 500' limit
- 1 cy per running foot, unless bioengineering techniques are used

18 Minor Discharges

- 25 cy discharge, 10cy PCN, no diversions

# NWPs

33 Temporary Construction/Access/Dewatering

- PCN

43 Stormwater Management Facilities

- 0.5 acre/300' impact
- PCN for expansion or construction of facilities
- does not authorize construction in perennial streams
- No PCN for maintenance

# Regulated Activities
# NWP 3 – Maintenance

- Repair, rehabilitation, or replacement of structures (3a)
  - currently serviceable
  - only minor deviations from original design
- Removal of accumulated sediment and debris in the vicinity of existing structures (3b)
  - Cannot exceed 200 feet linear from the structure
  - New or additional riprap to protect the structure
- Allows temporary fills and structures during work (3c)

# Regulated Activities
# NWP 43 – Sediment Removal

- Stormwater ponds and detention/retention basins
  - construction
  - maintenance (including maintenance dredging)
- <0.5 acre/<300 linear feet of impacts to WUS
  - may be waived for intermittent streams at Corps' discretion
- No new stormwater management facilities in perennial streams

# USACE Role in Enforcement Actions

- Initial Investigations
- Referral to EPA
- Support and Assistance/Permitting of Completed Enforcement Actions (NWP 32)

# USACE Lead Enforcement Actions

- Voluntary Restoration
- Restoration Order or Settlement Agreement
- Civil Penalties ($32,500 per violation per day)
- Referral to DOJ

# U. S. Army Corps of Engineers
# Section 404

Kiel Downing

US Army Corps of Engineers

Omaha District – Denver Regulatory Office

9307 South Wadsworth Blvd.

Denver, CO  80128

kiel.g.downing@usace.army.mil

(303) 979-4120

# U.S. Environmental Protection Agency (EPA)

Richard Clark
Clean Water Act, Section 404 Enforcement Program
clark.richard@epa.gov
(303) 312-6748

# EPA Region 8 Clean Water Act Section 404 Program

The CWA Section 404 program is jointly administered by EPA and the Corps

- States covered by EPA Region 8 (Utah, Colorado, Wyoming, Montana, South Dakota and North Dakota)
- CWA Section 404 permit review
- CWA Section 404 enforcement

# When does EPA take an enforcement action?

- Repeat violator
- Flagrant violator (knowing and willful)
- Requests specific cases or actions
- Impacts occurred to a high value ecological system

# What does it mean when EPA takes a case?

- EPA does not issue permits.

- Violator in most cases will be required to
  1. Remove the unauthorized fill from waters of the U.S.
  2. Restore the area to it pre violation condition
  3. Mitigate for impacts to waters of the U.S.
  4. Penalty

# Clean Water Act - Section 404 Enforcement Program Contacts

Richard Clark
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Monica Heimdal
(303) 312-6359
heimdale.monica@epa.gov

# ERO Resources

Mary Powell
mpowell@eroresources.com
(303) 830-1188

# NEW DISTRICT COMPLIANCE PROCEDURES

- All Projects Get Reviewed by Consultant
  - Regulatory review
  - Consistency
- Consultant is Primary Corps Contact
  - Consistency
- Quarterly Lunch and Learns
  - Regulatory updates and share knowledge

To Permit or Not to Permit?

That is the Question…for the Corps.

# FIVE MINUTE VERSION OF AN HOUR TALK ON SECTION 404 OF THE CLEAN WATER ACT

# REGULATED ACTION

Discharge of dredged or fill material

- Addition of material – bank reconstruction, drop structure
- Redeposit of material – bulldozing material, shaping with bucket

## REGULATED AREAS

- 40 CFR 230.3(s) The term waters of the United States means:
- All waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide;
- All interstate waters including interstate wetlands;
- All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sand flats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation or destruction of which could affect interstate or foreign commerce including any such waters:
- (I) Which are or could be used by interstate or foreign travelers for recreational or other purposes; or
  (ii)(From which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or
  (iii) Which are used or could be used for industrial purposes by industries in interstate commerce;
- All impoundments of waters otherwise defined as waters of the United States under this definition;
- Tributaries of waters identified in paragraphs (s)(1) through (4) of this section;
- The territorial sea;
- Wetlands adjacent to waters (other than waters that are themselves wetlands) identified in paragraphs (s)(1) through (6) of this section; waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of CWA (other than cooling ponds as defined in 40 CFR 423.11(m) which also meet the criteria of this definition) are not waters of the United States.

# TYPES OF PERMITS

- Individual Permits
- Regional General Permits
- Nationwide Permits

# POST PERMIT CHANGES (Design or Field)

- ASK FIRST!!
    - Coordinate with consultant
    - Coordinate with the Corps

# MINOR vs. MAJOR AMENDMENT

- Minor
    - Reduced impacts
    - Small changes in location, details
- Major
    - Increased impacts
    - Different approach to solution
    - Major amendment goes back to public notice

# DURING CONSTRUCTION

- Integrated Team
  - Owner, Engineer, Consultant, Contractor
- Pre-construction Meeting
  - Identify permit requirements - Legally binding
- Site Preparation
  - Protect sensitive areas, clearing, dewatering, access
- On-site Construction Monitoring
  - Owner’s rep
  - Immediate correction

# VIOLATIONS

- Unpermitted discharge
  - Disclose minor discharges
- Permit violations
  - Excess discharge/disturbance
  - Not built to permit
  - Monitoring

# LESSONS LEARNED

- Identify Potential WUS
  - Is there a regulated area? ASSUME NOTHING!
- Coordinate with Agencies
  - What is required?
  - Continue to communicate
- Develop a Strategy
  - Avoidance and Minimization
  - Permitting Approach
  - Compliance

# MORE LESSONS LEARNED

Keep current

Sooner is better than later

Do not let permits expire

Equity is in concrete

Resources can be dynamic

Construct what you permitted

Build credibility with agencies

Follow through on commitments

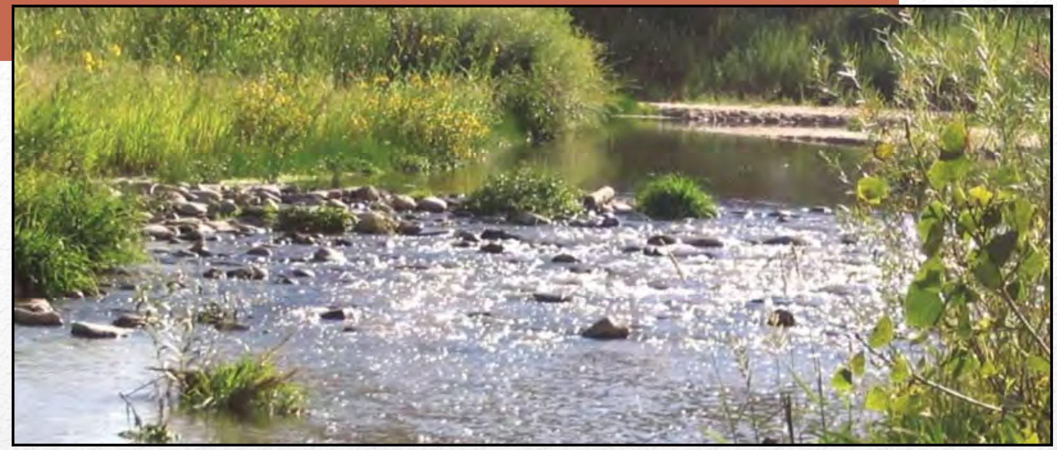
Include permitting and compliance in schedule

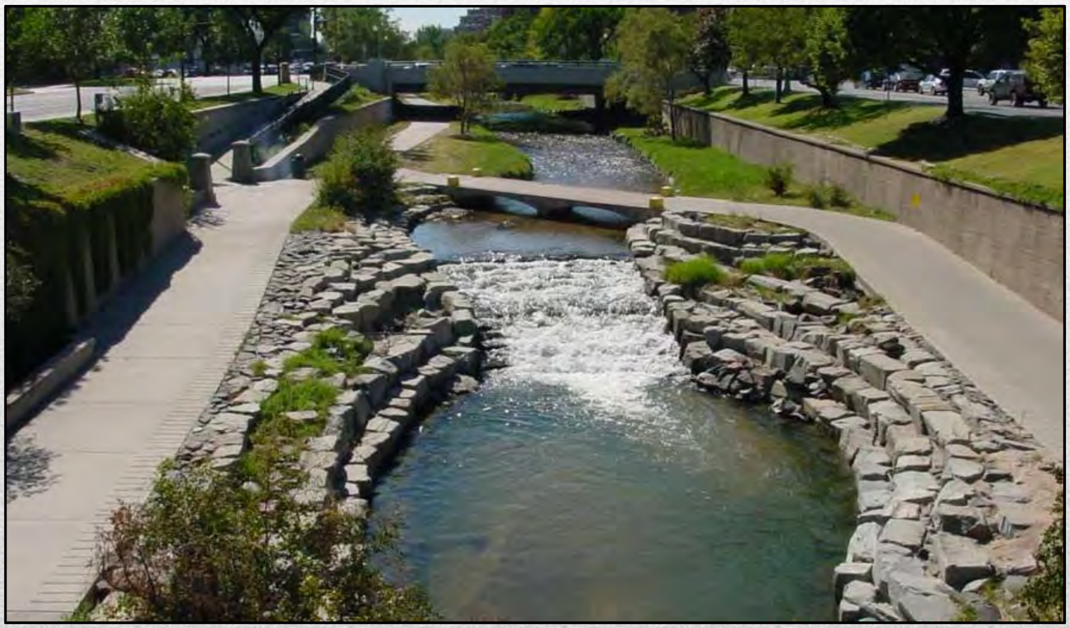
# Sculpted Concrete Drop Structures

Design Criteria and Construction Guidance

2013 UDFCD Annual Seminar

April 2, 2013





# NOT THE ONLY OPTION !

**Shop Creek, Cherry Creek State Park**

- Soil Cement
- Early 1990s

# History

**Grange Hall Creek, City of Thornton**
Sculpted Concrete, Late 1990s

# History

## Chapter 8
## Hydraulic Structures

### Contents





## Additional Resources

- Sculpted Concrete
- Sculpted Concrete Finishing
- GFRC (Glass Fiber Reinforced Concrete)

# USDCM Update



URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

- Denver metro area geology primarily consists of sedimentary rock.
- More than 12,000 feet of sedimentary rocks underlie Denver.

| Types of Rock | Description |
|---|---|
| **Sandstone** | Grains of sand cemented together. |
| **Shale** | Grains of silt and clay cemented together, usually breaking into flat slabs. |
| **Conglomerate** | Sand and pebbles deposited as gravel and then cemented together. |
| **Limestone** | A sedimentary rock composed mostly of calcite, deposited as a limy mud. Usually white or gray, often containing fossils. |
| **Claystone** | Composed of clay sized particles (less than 1/256 mm in diameter) cemented together. |

# Background


**Exposed Sedimentary Rock**

# Background

**Exposed Claystone Layers**

# Background

**Red Rocks Park**

# Background

# Simple Sculpted Concrete Drop Structures

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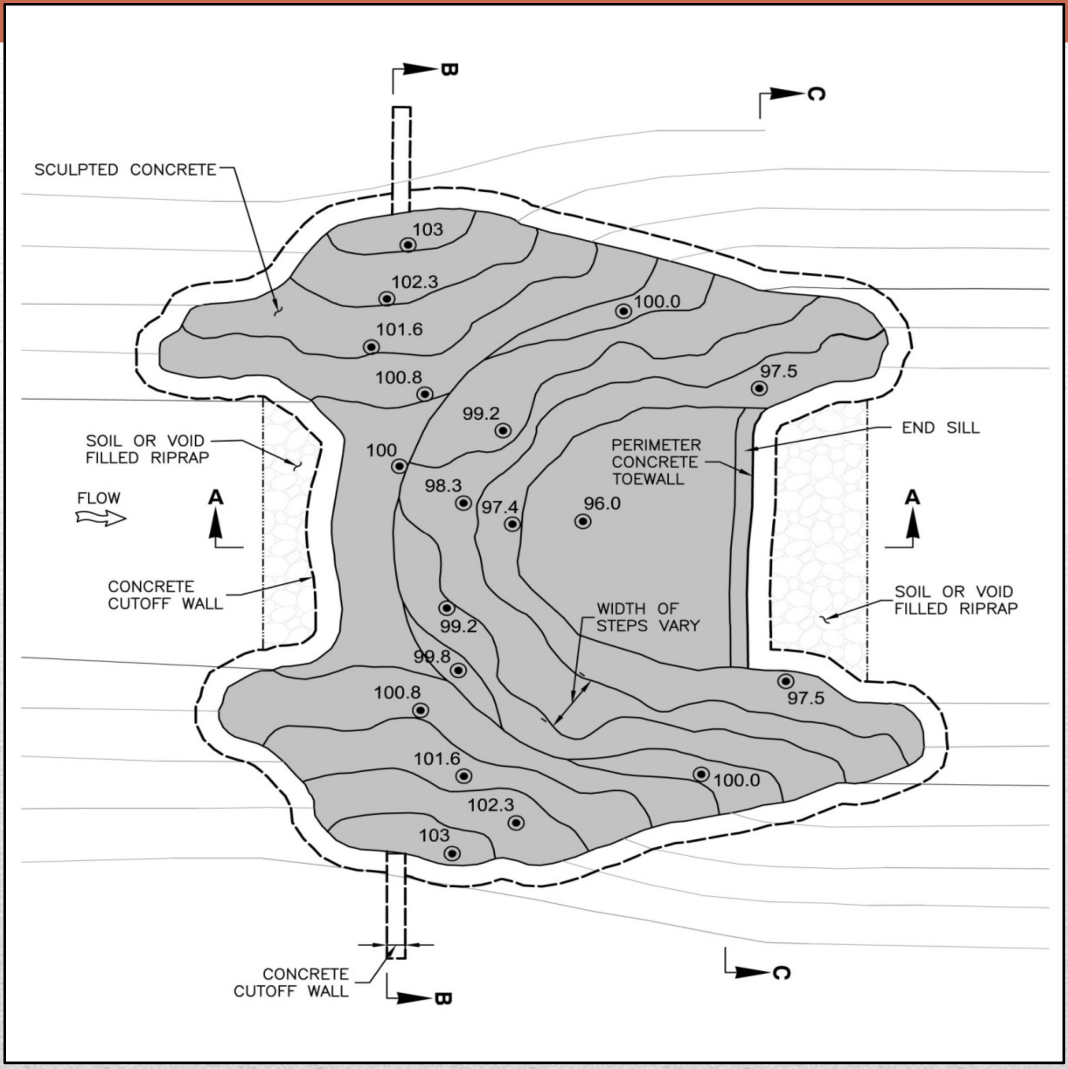
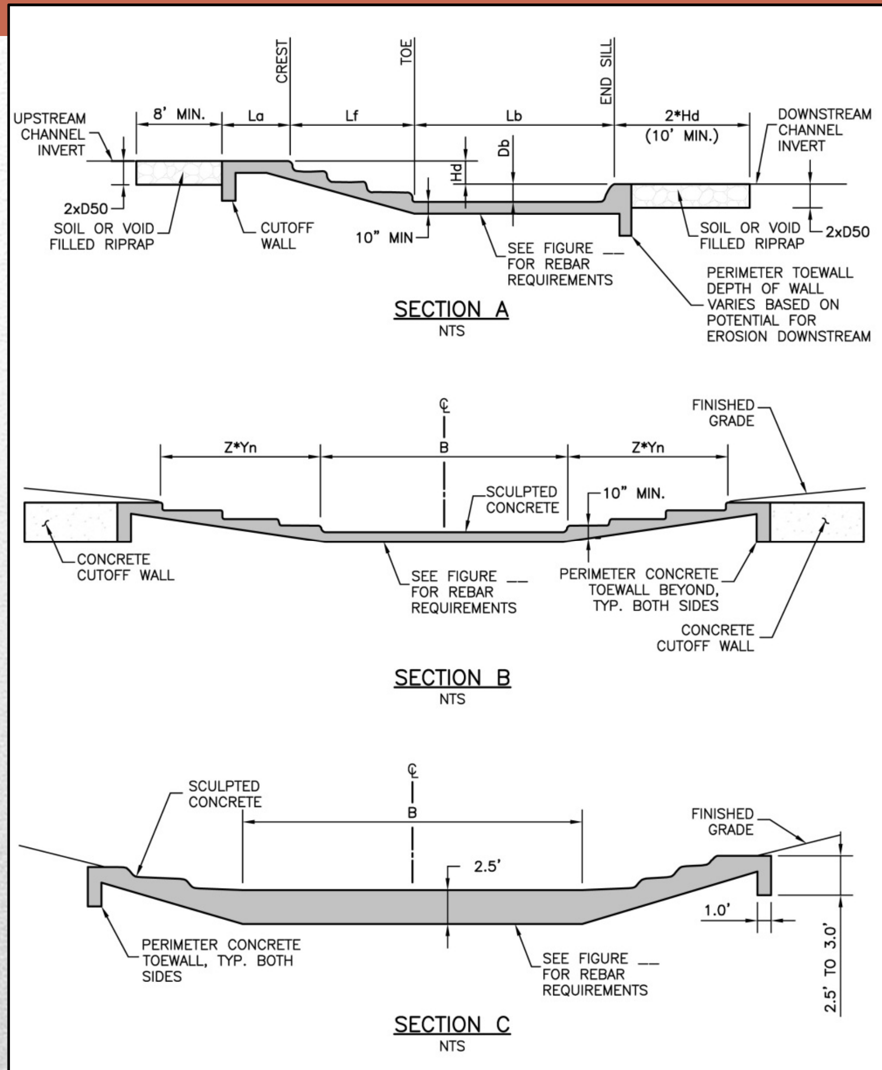
April 2, 2013




Plan View

# Simple Structure




Profile and Cross Sections

# Simple Structure

# Complex Sculpted Concrete Drop Structures

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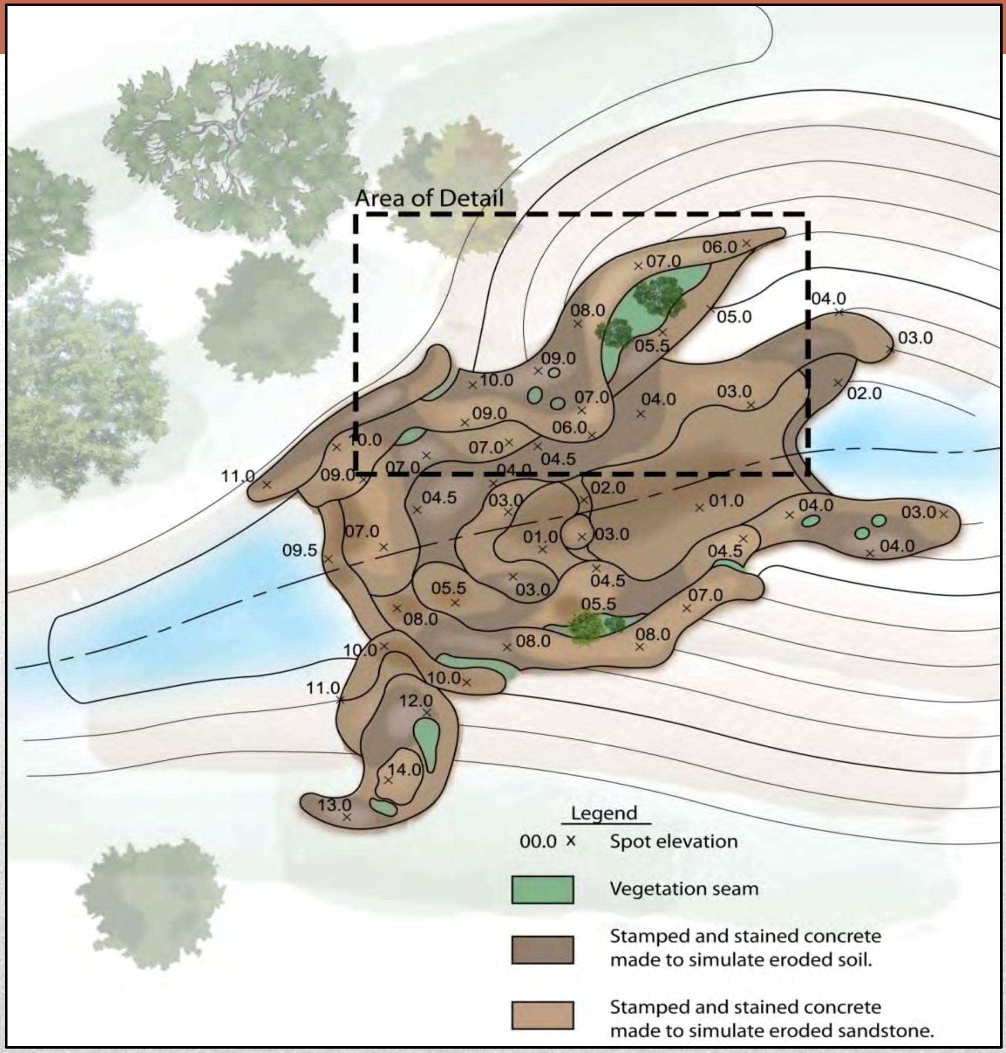
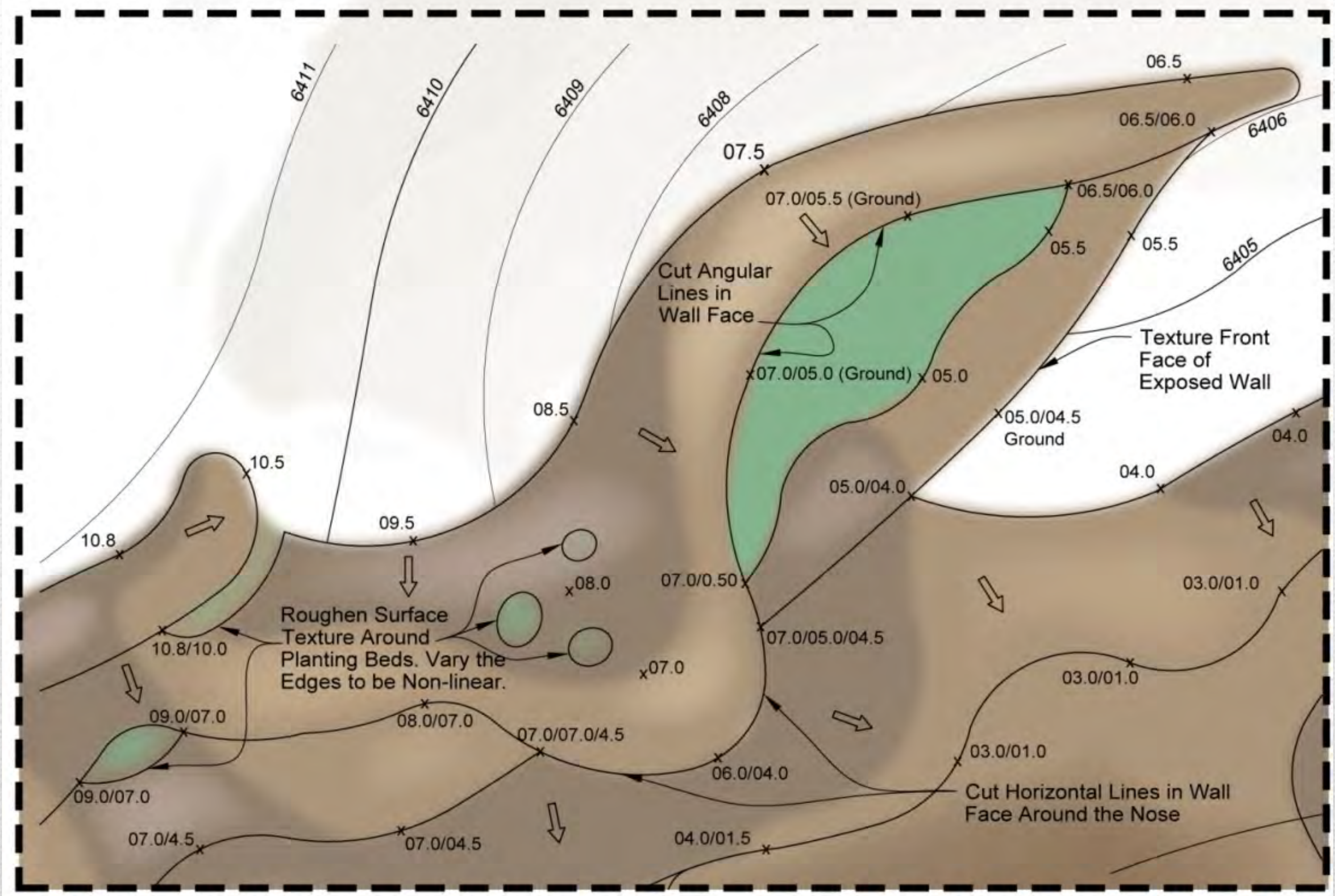



Standard Plan View

# Complex Structure

# Complex Structure



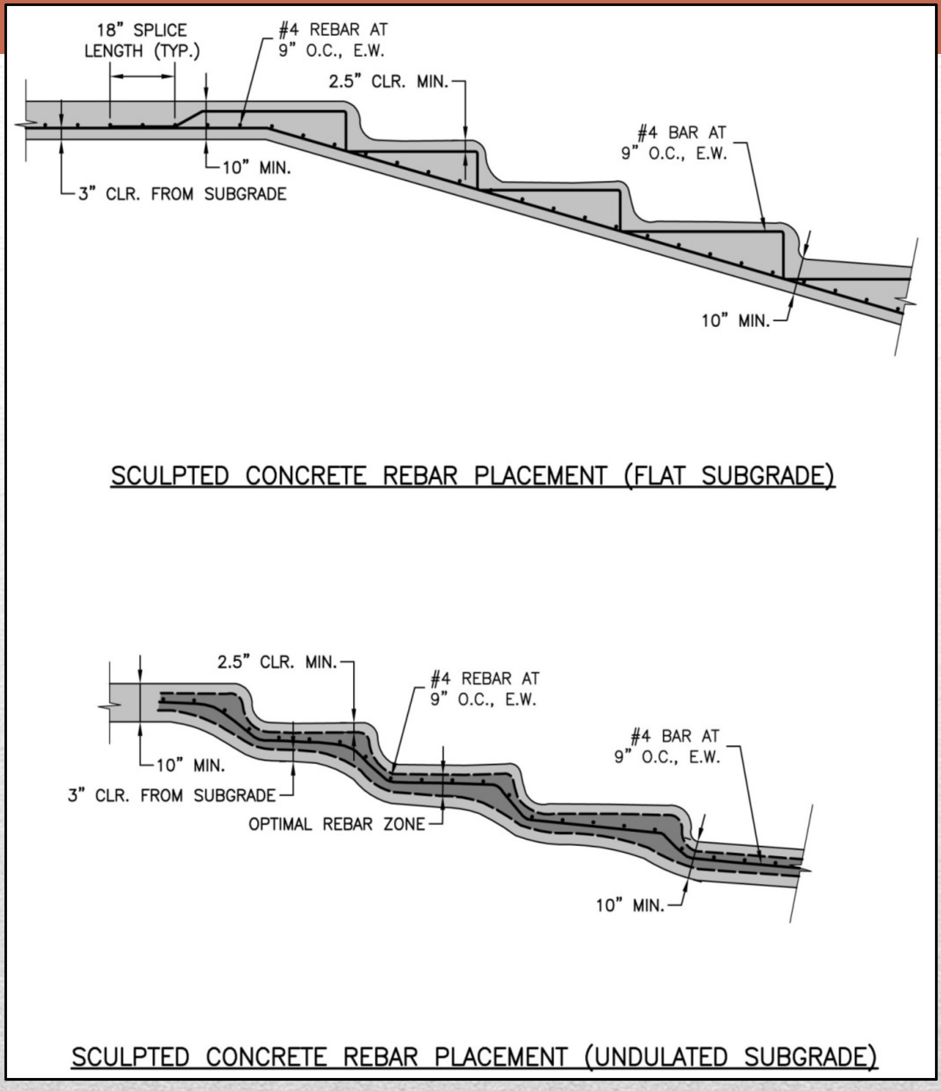

Detailed View

- Point Elevations
- Slope Arrows
- Descriptions

**Prioritize Safety!**

- Keep Vertical Step Heights less than 30 inches
- Provide at least one 12 inch wide step for every 30 inches of vertical.
- Sloped Surfaces are Acceptable, Provide Roughened Surface Texture

# Design Considerations




- 10 inch Concrete Thickness
- No. 4 Steel bars at 9-inch on Center, or Equivalent

# Design Considerations

## Interface with Cutoff Wall

- Weld Steel to Sheet Pile
- Tie Cutoff Wall Steel to Structure Steel

# Design Considerations

**Perimeter Edge Wall**

- 2'-6" to 3' Deep

**Buried Riprap**

**Potential for Erosion**

# Design Considerations

- Stamping
- Troweling, Sculpting, and Carving
- Top Dressing with Sand, Gravel, Cobbles, or other Material
- Vegetation Seams, Pockets, or Beds
- Coloring/Staining

# Finishing



URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

Polyurethane Skin or Mats

# Stamping

**Natural Rock**

**Concrete**

# Troweling, Sculpting and Carving

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**Concrete**

**Natural Rock**

# Top Dressing

**Nature**

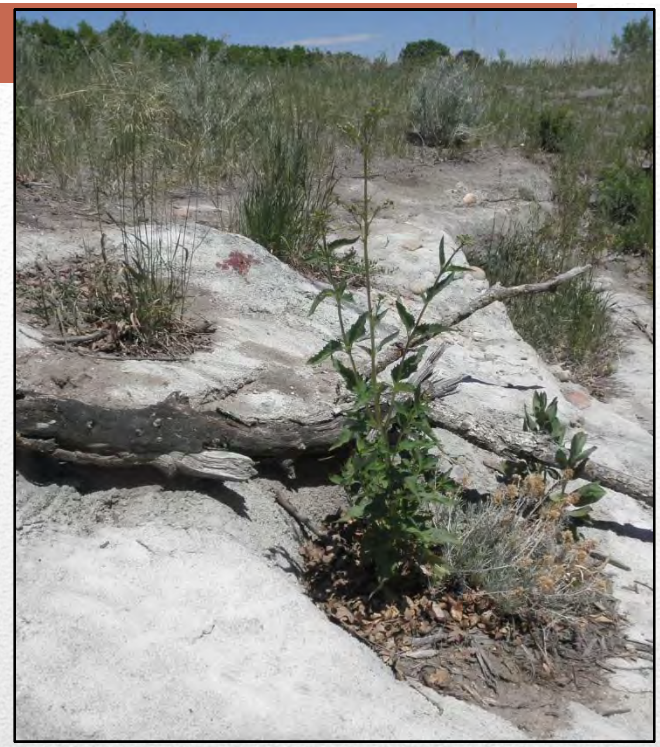
# Vegetation

**Subgrade Preparation**

# Vegetation

**Form Pockets in Concrete**

# Vegetation

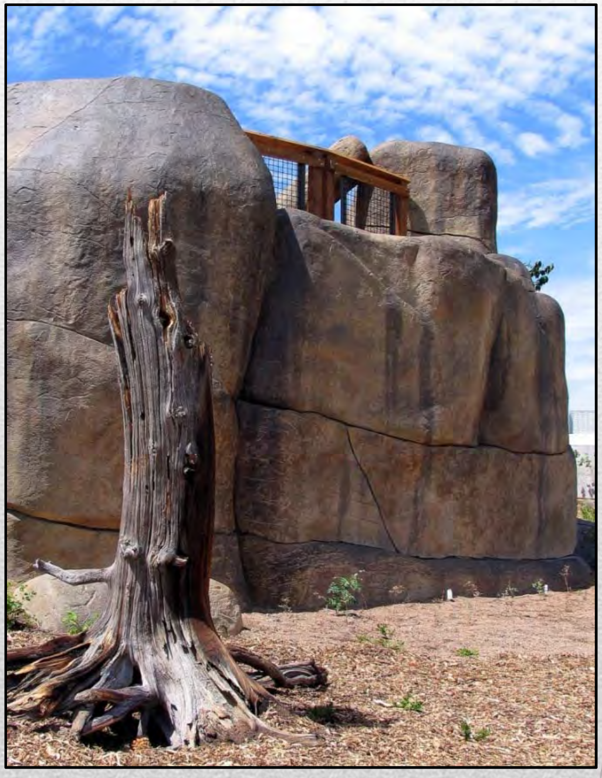


**Engineered**

- **Landscape Architect**
- **Ecologist**

# Vegetation

- Concrete Stains
- Watered Down Latex Paint



# Staining


# Bring it all Together

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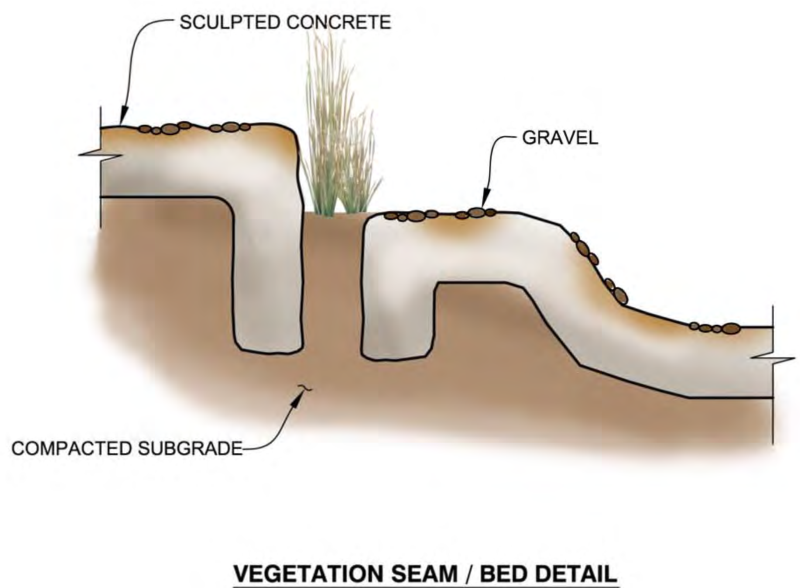
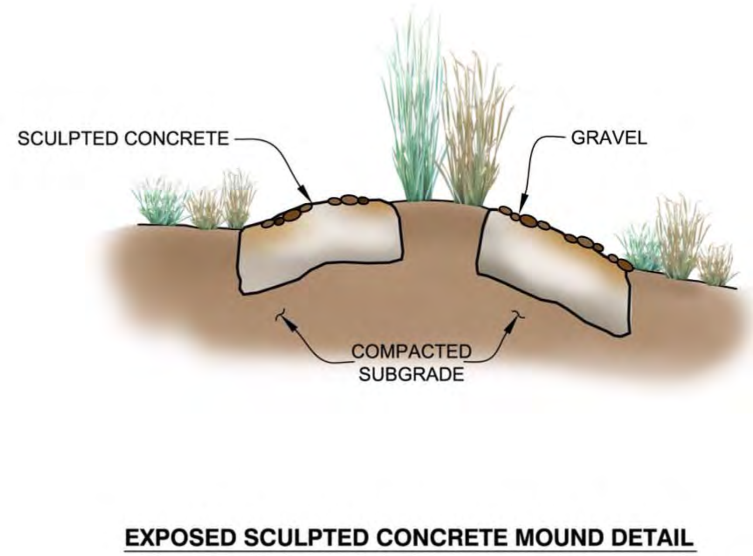



# Bring it all Together


**Subgrade Preparation**

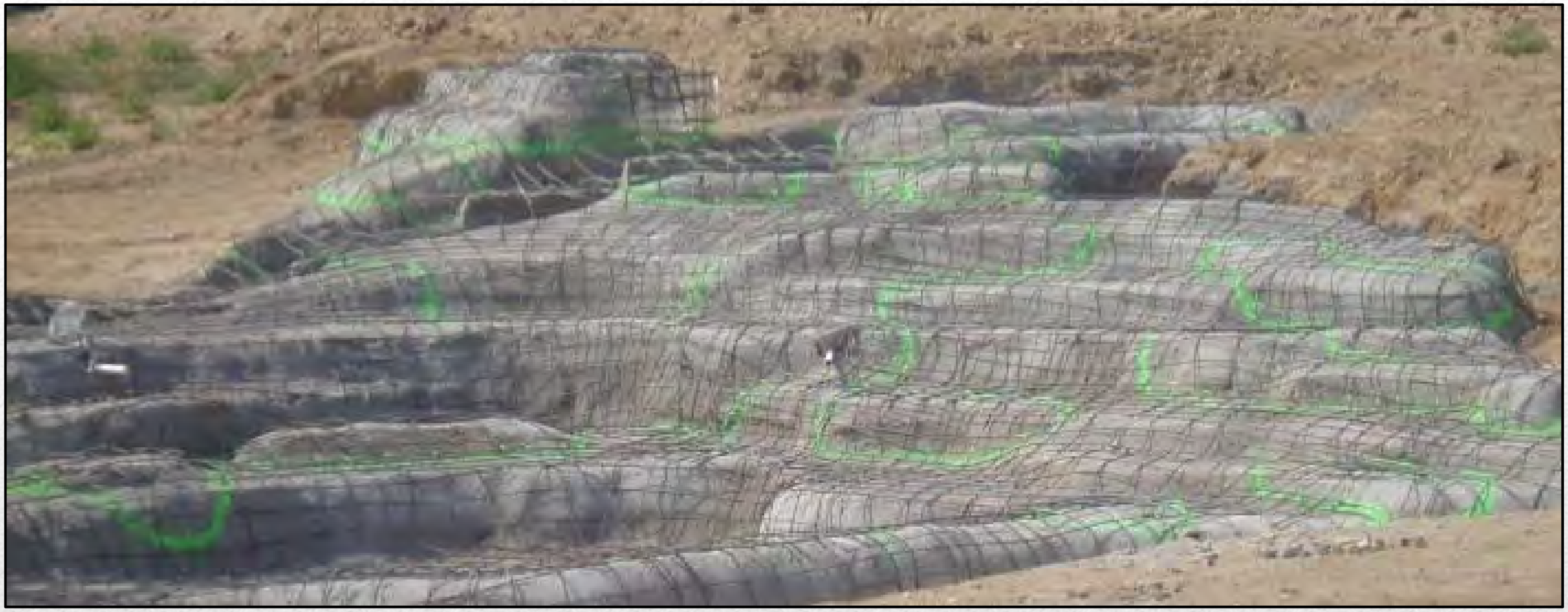
- Dewatered Conditions
- +/- 2% Optimum Moisture and 95% Maximum Dry Density
- Cover Subgrade with Plastic to Prevent Excessive Drying

# Construction Guidance

**Shotcrete Skin Coat**

- 1-2 inches of Shotcrete on Subgrade
- Protects the Subgrade
- Keeps Steel Reinforcement Clean
- Reduces Weather Delays

# Construction Guidance



## Concrete Placement Tips

- Paint Texture Lines
- Distribute Example Photos
- Construct a Test Panel

# Construction Guidance

**Construction Oversight**

- Engineer/Designer
- Landscape Architect/Ecologist

# Construction Guidance

**Sculpted Concrete Jetty**

# What’s Next ?

**Sculpted Concrete Log Structure**

# What's Next ?

**Learn from Others**

# What's Next ?

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April 2, 2013

**Is that Real Rock?**

# What's Next ?

2013 UDFCD Annual Seminar

April 2, 2013

USGS
science for a changing world

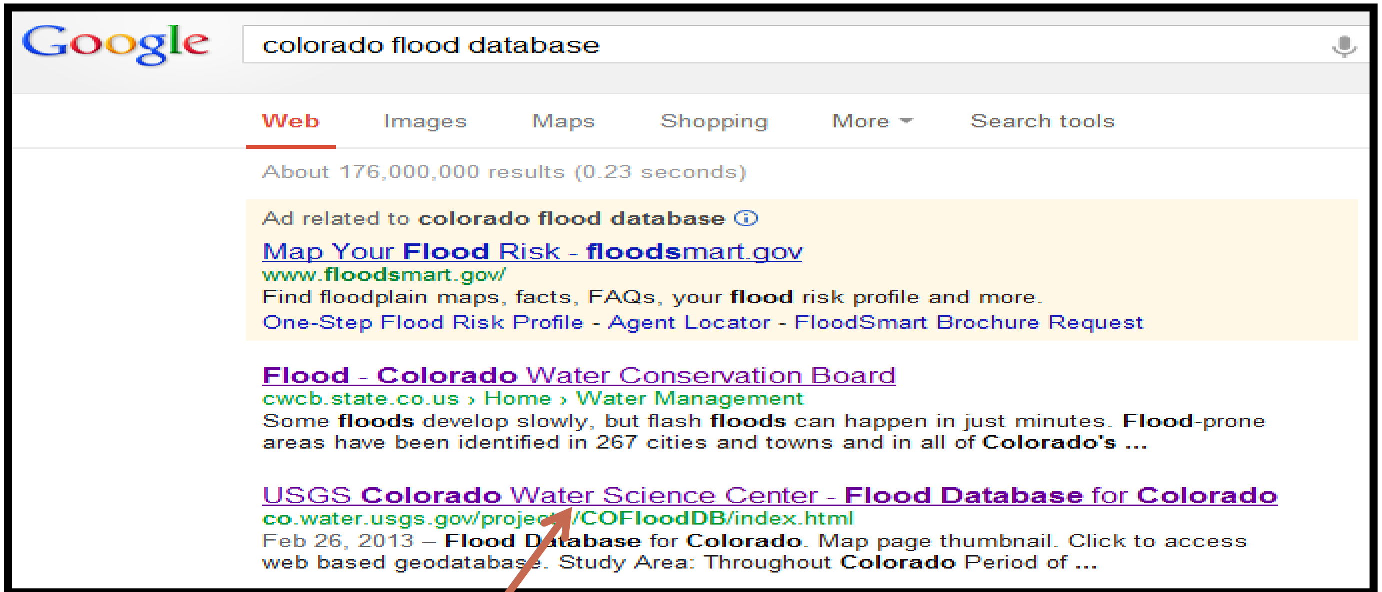
Prepared in cooperation with the Colorado Department of Transportation

# Web-Based Flood Database for Colorado, Water Years 1867 through 2011

By Michael S. Kohn, Robert D. Jarrett, Gary S. Krammes, and Amanullah Mommandi

Amanullah Mommandi, P.E. M.S.
CDOT
Hydraulic Program Manager
Tel: (303) 757-9044
amanullah.mommandi@state.co.us

## *Step 1. Go to Google and Type: Colorado Flood Database*




## *Step 2: Click on*

USGS
science for a changing world

USGS Home
Contact USGS
Search USGS

Colorado Water Science Center

Home Information/Data Projects Publications Contact

PROJECT INDEX

**Historic Flood Database for Colorado**

- *Overview*
- Data
- Related Links
- Publications
- References
- Email for Information

PROJECTS

**Projects by topic**

- Data Collection
- Surface Water & Geomorphology
- Ground Water
- Water Quality
- Multi-Discipline
- All projects

USGS IN YOUR STATE

USGS Water Science Centers are located in each state.

## Flood Database for Colorado

Select

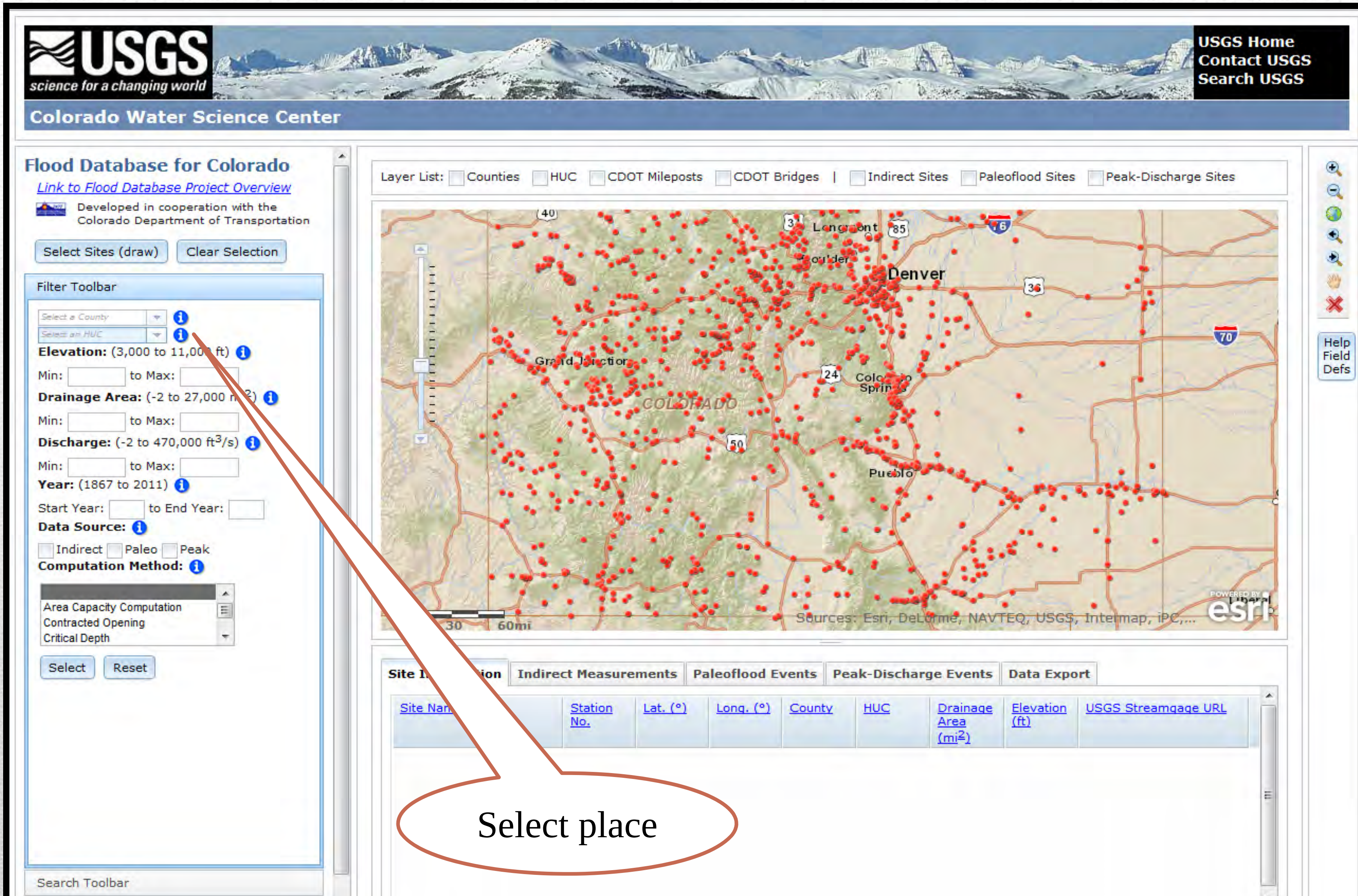
**Study Area:** Throughout Colorado
**Period of Project:** October, 2010 - September 2013
**Project Number:** RE00EDY
**Project Chief:** Michael Kohn
**Cooperator:** Colorado Department of Transportation

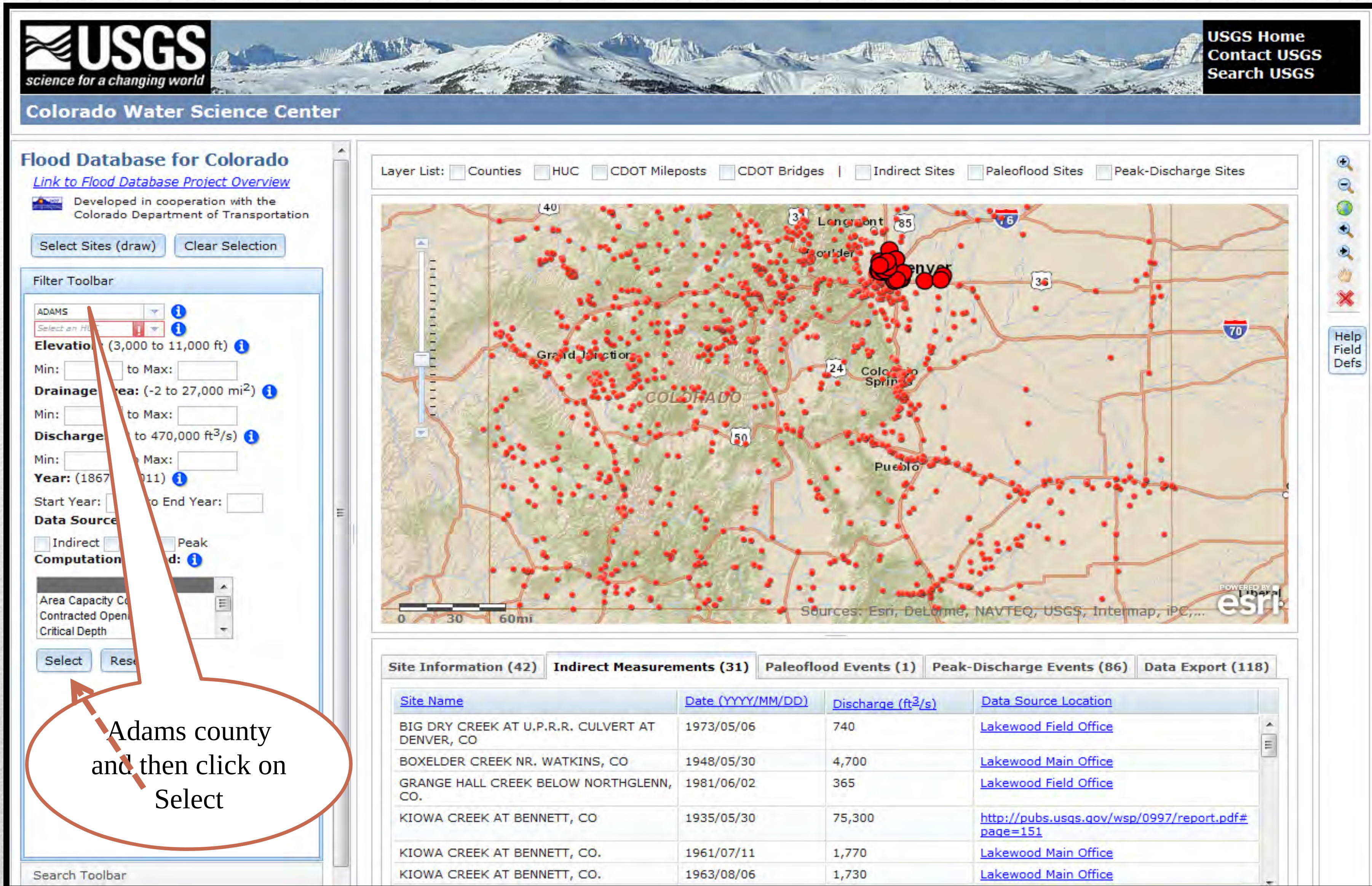
Click to access web based geodatabase

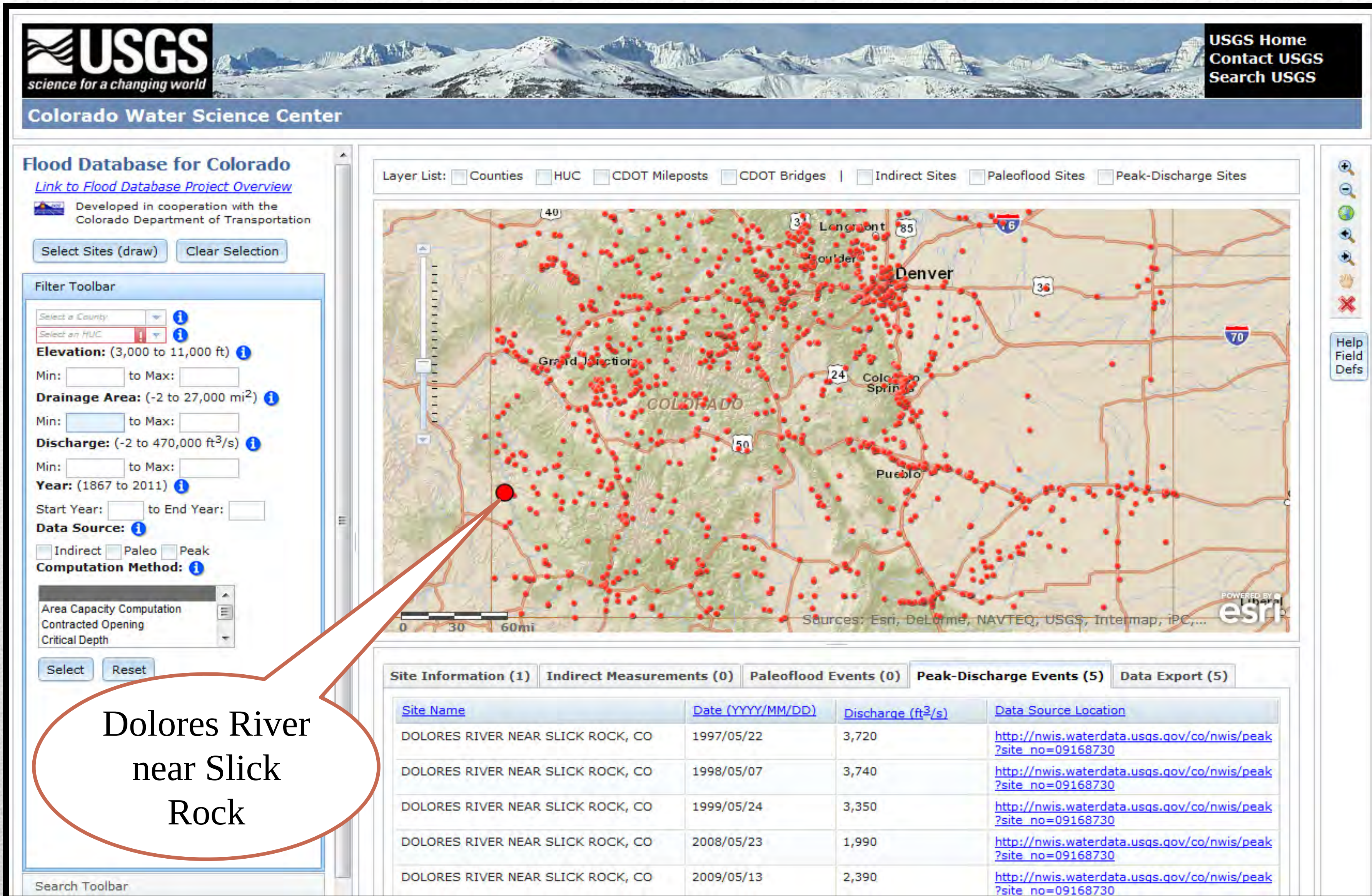
### BACKGROUND:

The accuracy of flood-frequency estimates can be greatly improved when historical flood information is included with systematically collected flood data (Interagency Committee on Water Data, 1982). Although many reports contain flood information for streams in Colorado, there is no centralized repository for this information, making it difficult to access flood data. Prior to the completion the Web-based flood database, much of the historic flood information for Colorado was stored in numerous published and unpublished reports and files in local, State, and Federal government agencies and the offices of engineering firms and universities. Although considerable research has been conducted using ;historical flood information in flood-frequency analyses, this information is often underutilized because of the uniqueness of each site and a lack of knowledge of the site location. Having an easy-to-use, Web-based geodatabase of historical flood and paleoflood information with links to sources of flood data allows engineers and water-resource managers to fully use these data to provide information on the largest floods and leads to improved flood-frequency estimates of the largest floods in Colorado. The U.S. Geological Survey (USGS), in cooperation with the Colorado Department of Transportation, created a Web-based geodatabase for information on floods from 1867 through water year 2011 and information on paleofloods occurring in the past 5,000 to 10,000 years. The geodatabase was created using Environmental Systems Research Institute (ESRI) ArcGIS JavaScript Application Programing Interface (JavaScript API) 3.2. Engineers, scientists, and water-resource managers will be able to use these data for floodplain regulation, dam-safety, infrastructure design, and other uses.

Interactive map to the flood database


USGS
science for a changing world
USGS Home
Contact USGS
Search USGS
Colorado Water Science Center
Flood Database for Colorado
Link to Flood Database Project Overview
Developed in cooperation with the Colorado Department of Transportation
Select Sites (draw)
Clear Selection
Filter Toolbar
Elevation: (3,000 to 11,000 ft)
Min: to Max:
Drainage Area: (-2 to 27,000 mi2)
Min: to Max:
Discharge: (-2 to 470,000 ft3/s)
Min: to Max:
Year: (1867 to 2011)
Start Year: to End Year:
Data Source:
Indirect Paleo Peak
Computation Method:
Area Capacity Computation
Contracted Opening
Critical Depth
Select
Reset
Search Toolbar
Layer List: Counties HUC CDOT Mileposts CDOT Bridges | Indirect Sites Paleoflood Sites Peak-Discharge Sites
Denver
Pueblo
COLORADO
Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC,...
esri
Help Field Defs
Indirect Measurements
Paleoflood Events
Peak-Discharge Events
Data Export
Station No.
Lat. (°)
Long. (°)
County
HUC
Drainage Area (mi2)
Elevation (ft)
USGS Streamgage URL
Select place


USGS
science for a changing world
USGS Home
Contact USGS
Search USGS
Colorado Water Science Center
Flood Database for Colorado
Link to Flood Database Project Overview
Developed in cooperation with the Colorado Department of Transportation
Select Sites (draw)
Clear Selection
Filter Toolbar
ADAMS
Elevation (3,000 to 11,000 ft)
Min: to Max:
Drainage Area: (-2 to 27,000 mi2)
Discharge to 470,000 ft3/s)
Year: (1867 2011)
Start Year: to End Year:
Data Source
Indirect
Peak
Computation Method:
Area Capacity
Contracted Openi
Critical Depth
Select
Search Toolbar
Layer List: Counties HUC CDOT Mileposts CDOT Bridges | Indirect Sites Paleoflood Sites Peak-Discharge Sites
Grand Junction
COLORADO
Colorado Springs
Pueblo
Denver
Boulder
Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC,...
esri
0 30 60mi
Help Field Defs
Site Information (42)
Indirect Measurements (31)
Paleoflood Events (1)
Peak-Discharge Events (86)
Data Export (118)
Site Name | Date (YYYY/MM/DD) | Discharge (ft3/s) | Data Source Location
BIG DRY CREEK AT U.P.R.R. CULVERT AT DENVER, CO | 1973/05/06 | 740 | Lakewood Field Office
BOXELDER CREEK NR. WATKINS, CO | 1948/05/30 | 4,700 | Lakewood Main Office
GRANGE HALL CREEK BELOW NORTHGLENN, CO. | 1981/06/02 | 365 | Lakewood Field Office
KIOWA CREEK AT BENNETT, CO | 1935/05/30 | 75,300 | http://pubs.usgs.gov/wsp/0997/report.pdf#page=151
KIOWA CREEK AT BENNETT, CO. | 1961/07/11 | 1,770 | Lakewood Main Office
KIOWA CREEK AT BENNETT, CO. | 1963/08/06 | 1,730 | Lakewood Main Office
Adams county and then click on Select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Select Sites (draw)
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Elevation: (3,000 to 11,000 ft)
Min: to Max:
Drainage Area: (-2 to 27,000 mi2)
Min: to Max:
Discharge: (-2 to 470,000 ft3/s)
Min: to Max:
Year: (1867 to 2011)
Start Year: to End Year:
Data Source:
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Computation Method:
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Denver
Pueblo
COLORADO
Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC,...
esri
Help Field Defs
Dolores River near Slick Rock
Site Information (1)
Indirect Measurements (0)
Paleoflood Events (0)
Peak-Discharge Events (5)
Data Export (5)
Site Name
Date (YYYY/MM/DD)
Discharge (ft3/s)
Data Source Location
DOLORES RIVER NEAR SLICK ROCK, CO 1997/05/22 3,720 http://nwis.waterdata.usgs.gov/co/nwis/peak?site_no=09168730
DOLORES RIVER NEAR SLICK ROCK, CO 1998/05/07 3,740 http://nwis.waterdata.usgs.gov/co/nwis/peak?site_no=09168730
DOLORES RIVER NEAR SLICK ROCK, CO 1999/05/24 3,350 http://nwis.waterdata.usgs.gov/co/nwis/peak?site_no=09168730
DOLORES RIVER NEAR SLICK ROCK, CO 2008/05/23 1,990 http://nwis.waterdata.usgs.gov/co/nwis/peak?site_no=09168730
DOLORES RIVER NEAR SLICK ROCK, CO 2009/05/13 2,390 http://nwis.waterdata.usgs.gov/co/nwis/peak?site_no=09168730

# Questions?

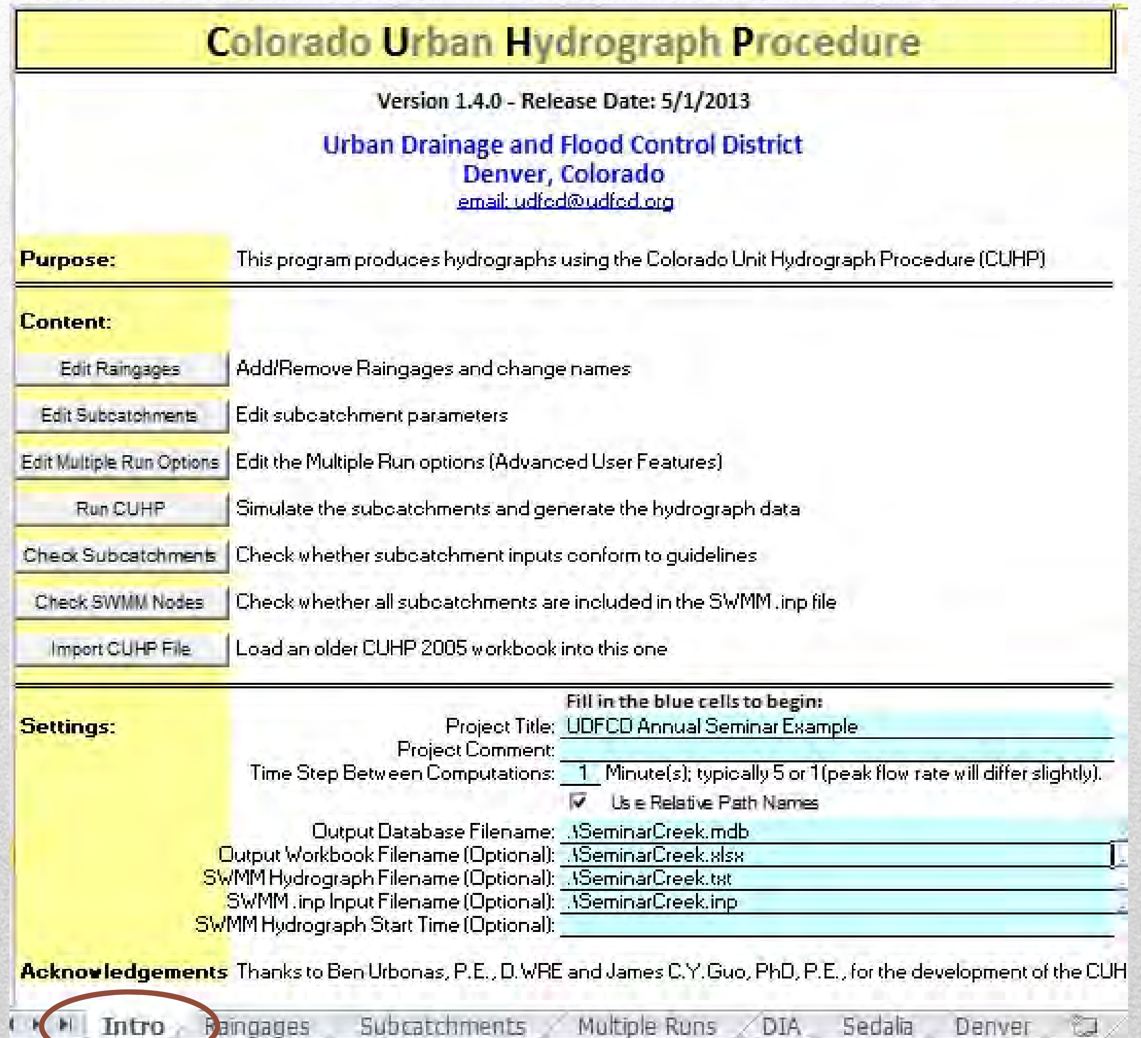
# User Interface and File Management Improvements to the Colorado Urban Hydrograph Procedure (CUHP)

Derek Rapp - Peak Stormwater Engineering

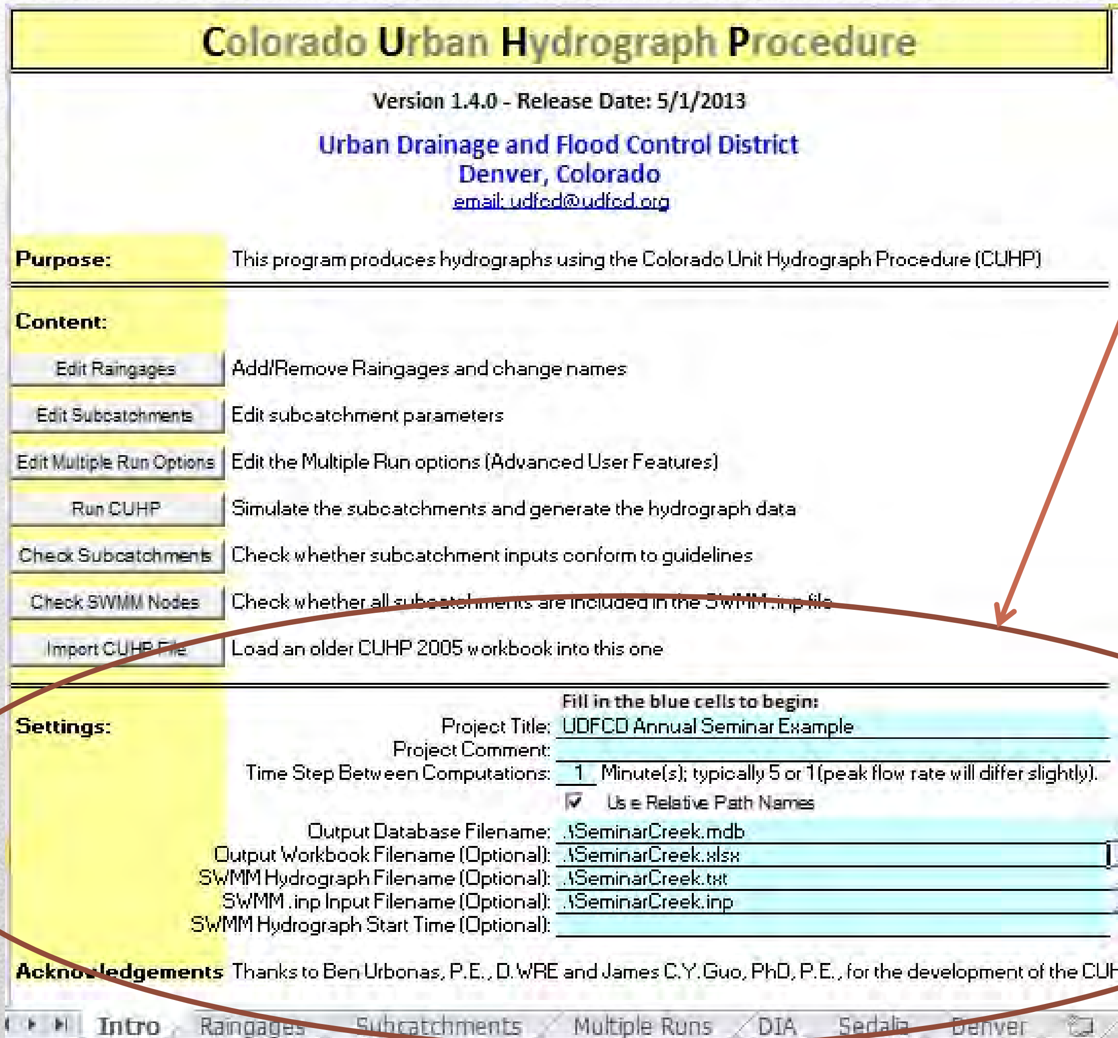
# Overview of CUHP Update

- Created a standalone Excel spreadsheet that does not require separate code files for the math engine
- Simplified the user interface by removing unnecessary worksheets and consolidating user-input cells
- Updated the rainfall depth-area reduction factors (DARFs) and effective imperviousness calculations to be consistent with recent USDCM updates
- Added tools to allow the user to change input units and to run reasonableness checks on these inputs
- Added a check to compare SWMM target nodes for consistency with the actual SWMM input file
- Ability to create a single input file and then run several CUHP scenarios to generate multiple output files

# Intro Sheet

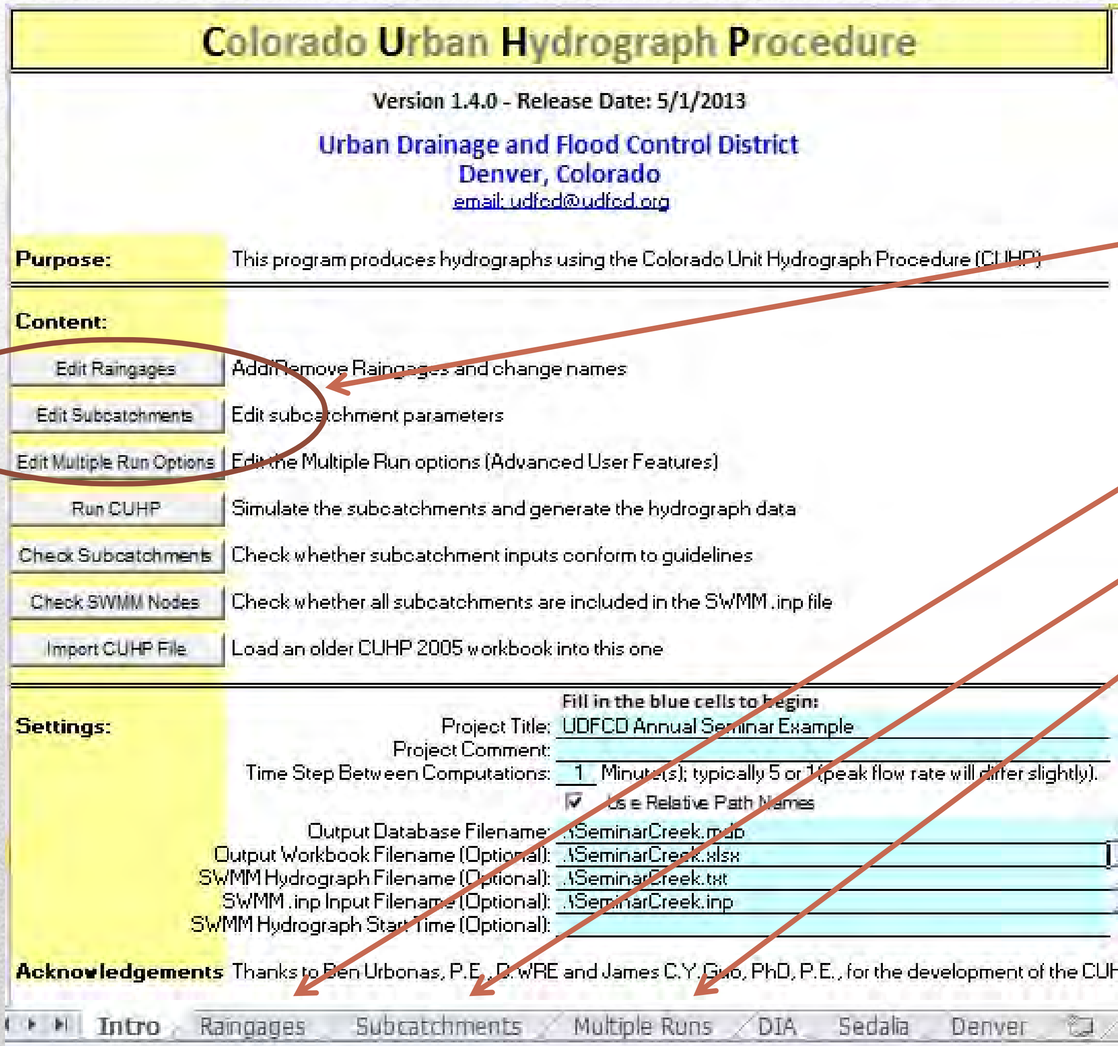

Colorado Urban Hydrograph Procedure
Version 1.4.0 - Release Date: 5/1/2013
Urban Drainage and Flood Control District
Denver, Colorado
email: udfcd@udfcd.org
Purpose:
This program produces hydrographs using the Colorado Unit Hydrograph Procedure (CUHP)
Content:
Edit Raingages
Add/Remove Raingages and change names
Edit Subcatchments
Edit subcatchment parameters
Edit Multiple Run Options
Edit the Multiple Run options (Advanced User Features)
Run CUHP
Simulate the subcatchments and generate the hydrograph data
Check Subcatchments
Check whether subcatchment inputs conform to guidelines
Check SWMM Nodes
Check whether all subcatchments are included in the SWMM .inp file
Import CUHP File
Load an older CUHP 2005 workbook into this one
Settings:
Fill in the blue cells to begin:
Project Title: UDFCD Annual Seminar Example
Project Comment:
Time Step Between Computations: 1 Minute(s); typically 5 or 1 (peak flow rate will differ slightly).
Use Relative Path Names
Output Database Filename: .\SeminarCreek.mdb
Output Workbook Filename (Optional): .\SeminarCreek.xlsx
SWMM Hydrograph Filename (Optional): .\SeminarCreek.txt
SWMM .inp Input Filename (Optional): .\SeminarCreek.inp
SWMM Hydrograph Start Time (Optional):
Acknowledgements
Thanks to Ben Urbonas, P.E., D.WRE and James C.Y. Guo, PhD, P.E., for the development of the CUH
Intro
Raingages
Subcatchments
Multiple Runs
DIA
Sedalia
Denver

# Intro Sheet




Time Step and File Settings have been moved to the Intro Sheet

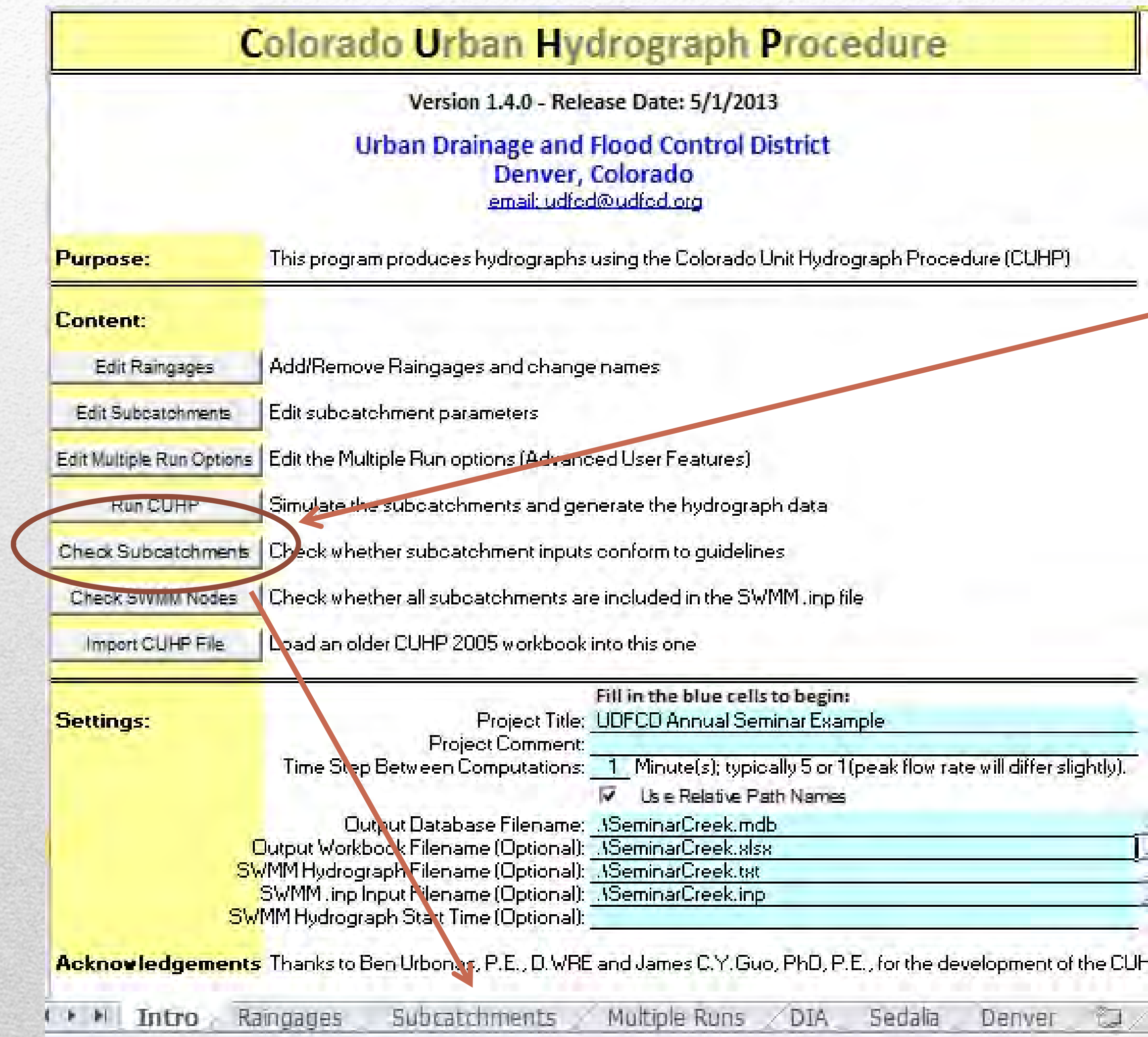
# Intro Sheet




Shortcuts to other worksheets

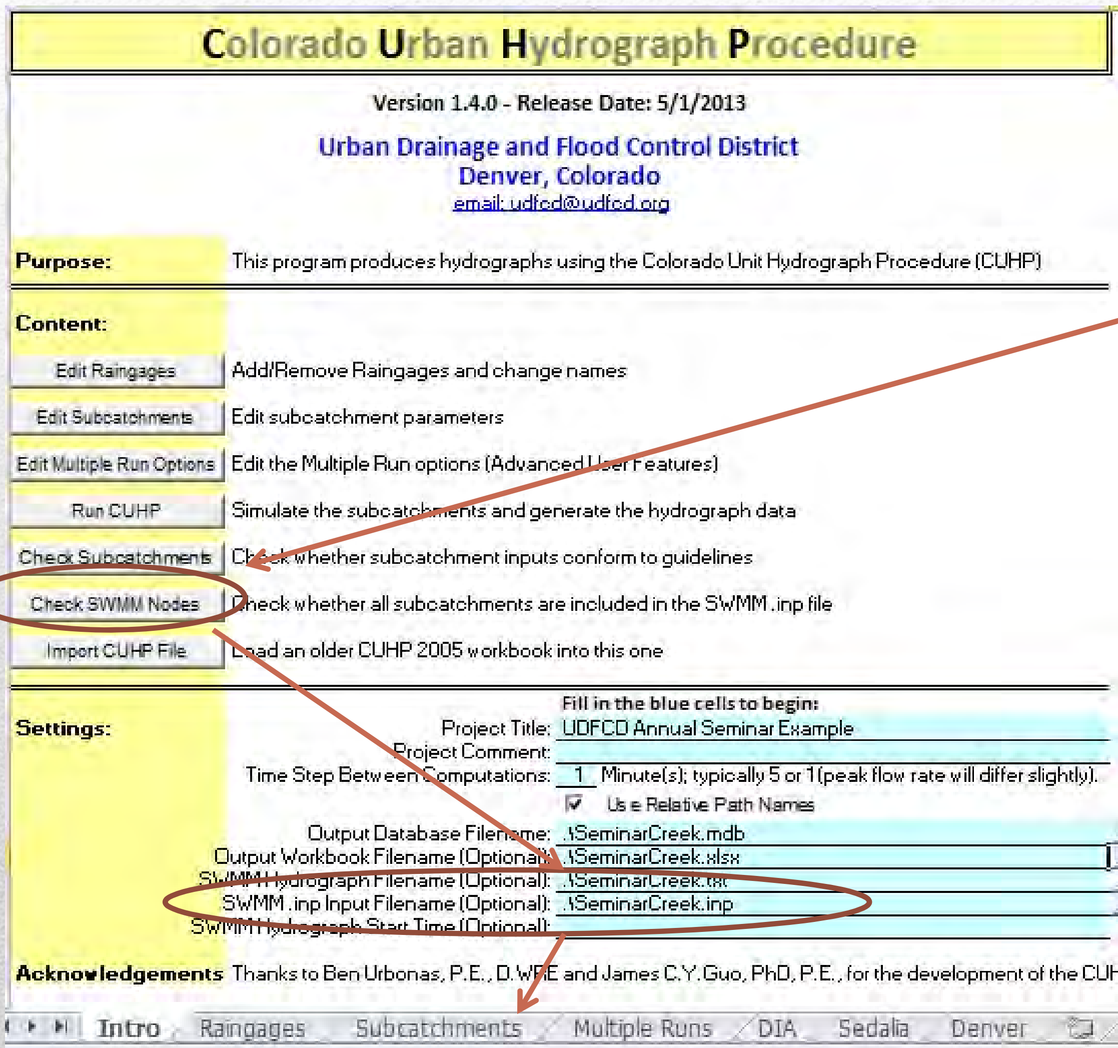
- Raingages
- Subcatchments
- Multiple Runs

# Intro Sheet



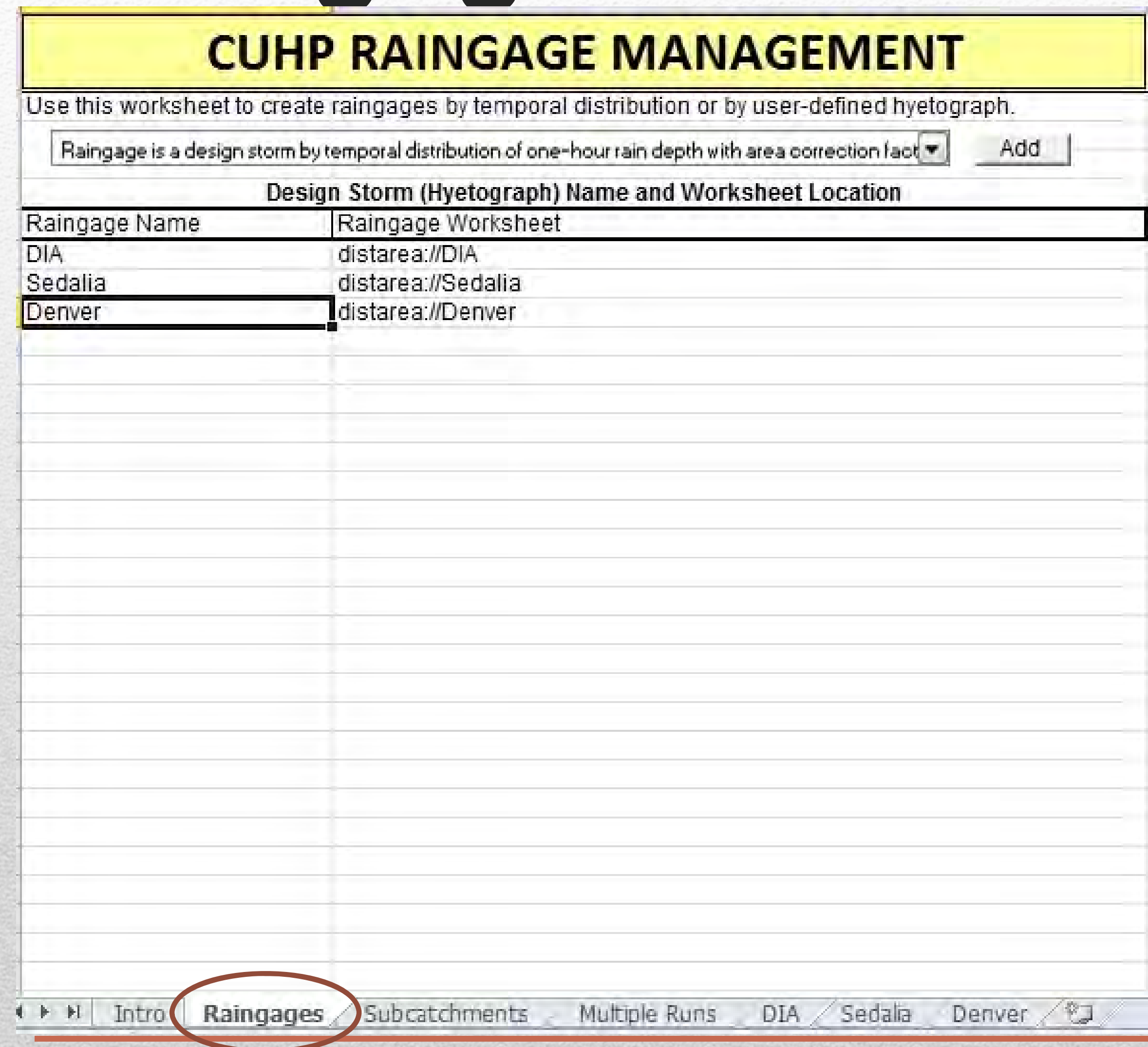

New tool added to check Subcatchment input parameters for reasonableness

# Intro Sheet



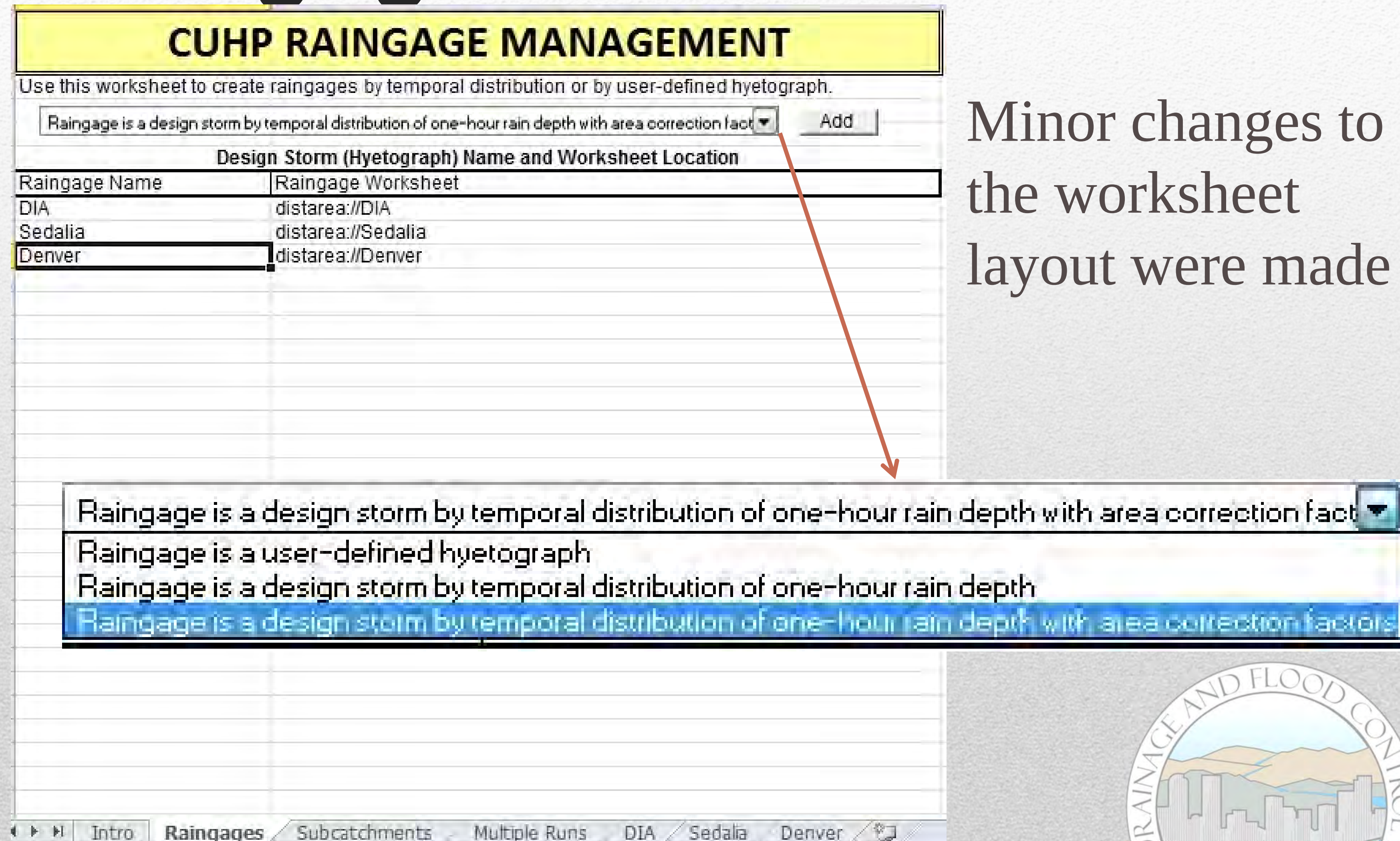

New tool to check that user-entered SWMM nodes are consistent with node names in SWMM input file (.inp)

# Raingages Sheet



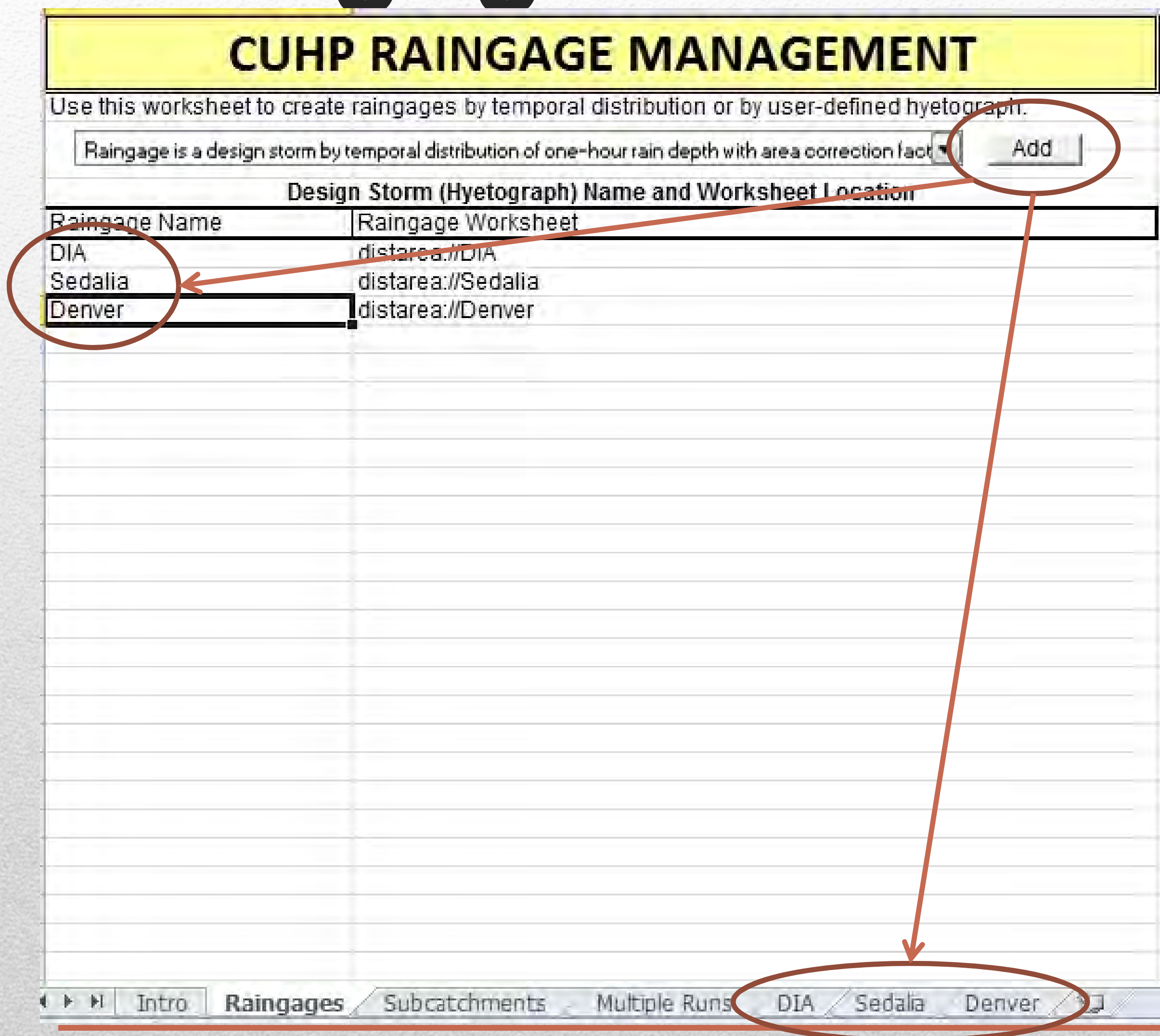

Minor changes to the worksheet layout were made

# Raingages Sheet



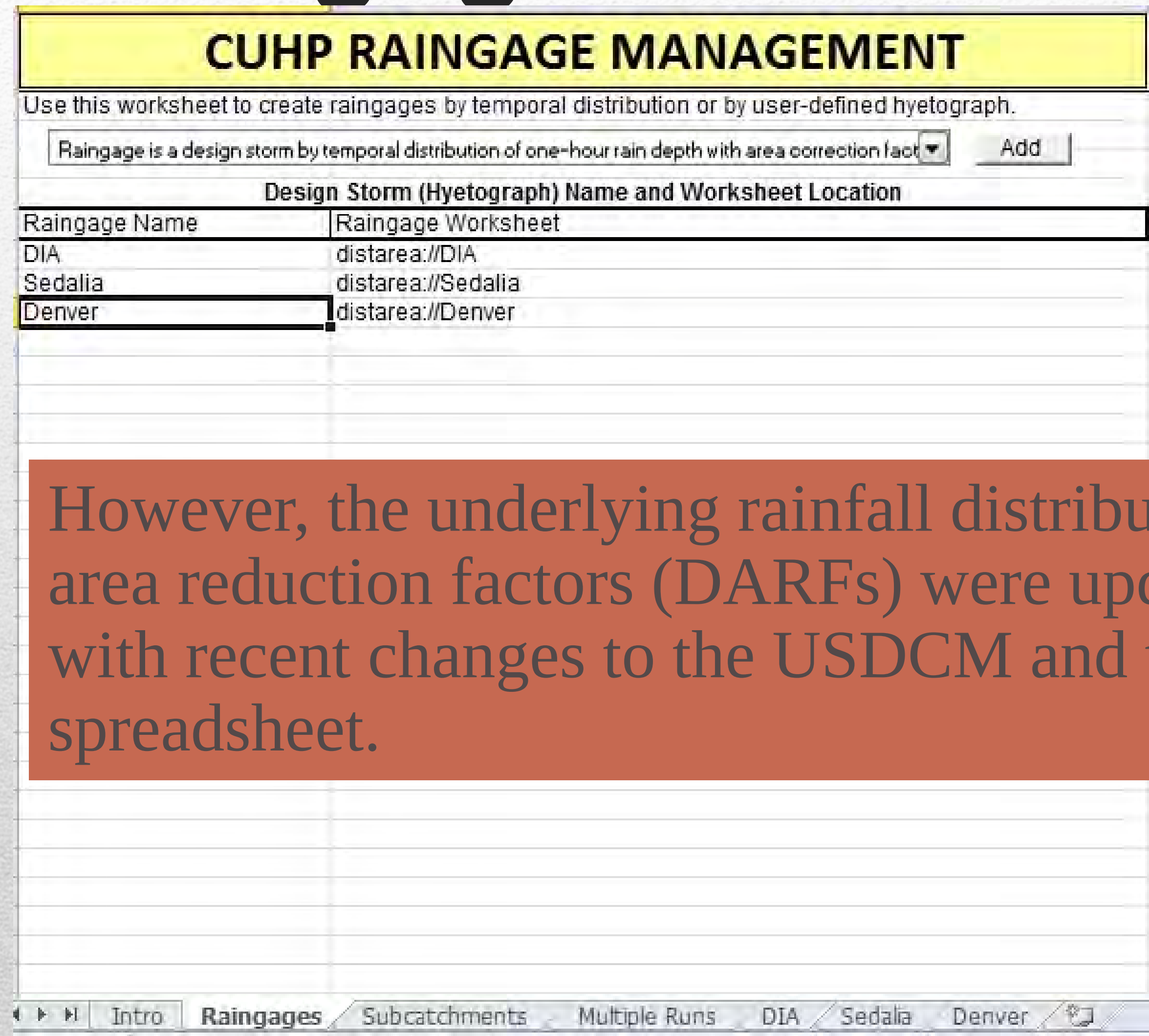

Minor changes to the worksheet layout were made

# Raingages Sheet




Minor changes to the worksheet layout were made

# Raingages Sheet



CUHP RAINGAGE MANAGEMENT

Use this worksheet to create raingages by temporal distribution or by user-defined hyetograph.

Raingage is a design storm by temporal distribution of one-hour rain depth with area correction fact | Add

Design Storm (Hyetograph) Name and Worksheet Location

| Raingage Name | Raingage Worksheet |
|---|---|
| DIA | distarea://DIA |
| Sedalia | distarea://Sedalia |
| Denver | distarea://Denver |

Intro | Raingages | Subcatchments | Multiple Runs | DIA | Sedalia | Denver

However, the underlying rainfall distributions and depth-area reduction factors (DARFs) were updated consistent with recent changes to the USDCM and the UD-Rain spreadsheet.

# Subcatchments Sheet

**CUHP SUBCATCHMENTS**

Click Here For Explanation Of Input Checks

Check Subcatchment Inputs

Columns with this color heading are for required user-input
Columns with this color heading are for optional overide values
Columns with this color heading are for program-calculated values

Units are in miles and square miles (click to change)

| Subcatchment Name | EPA SWMM Target Node | Raingage | Area ($mi^2$) | Length to Centroid (mi) | Length (mi) | Slope (ft/ft) | Percent Imperviousness | Maximum Depression Storage (Watershed inches): Pervious | Maximum Depression Storage (Watershed inches): Impervious | Horton's Infiltration Parameters: Initial Rate (in/hr) | Horton's Infiltration Parameters: Decay Coefficient (1/seconds) | Horton's Infiltration Parameters: Final Rate (in/hr) | DCIA: Level 0, 1, or 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SC100 | 100 | DIA | 0.00625 | 0.056818182 | 0.1136364 | 0.025 | 10 | 0.35 | 0.1 | 4.5 | 0.0018 | 0.6 | 2 |
| SC101 | 101 | DIA | 0.08125 | 0.473484848 | 0.4924242 | 0.03 | 40 | 0.35 | 0.1 | 4.5 | 0.0018 | 0.6 | 2 |
| SC102 | 102 | DIA | 0.171875 | 0.151515152 | 0.3030303 | 0.0047 | 35 | 0.35 | 0.1 | 4.5 | 0.0018 | 0.6 | 0 |
| SC103 | 103 | DIA | 0.0578125 | 0.047348485 | 0.4852273 | 0.044 | 80 | 0.35 | 0.1 | 4.5 | 0.0018 | 0.6 | 1 |
| SC201 | 201 | Denver | 0.09375 | 0.4875 | 0.7575758 | 0.052 | 60 | 0.35 | 0.1 | 3 | 0.0018 | 0.5 | 1 |
| SC202 | 202 | Denver | 0.0859375 | 0.319507576 | 0.5350379 | 0.007 | 15 | 0.35 | 0.1 | 3 | 0.0018 | 0.5 | 2 |
| SC301 | 301 | Denver | 0.053125 | 0.083333333 | 0.4314394 | 0.087 | 2 | 0.35 | 0.1 | 3 | 0.0018 | 0.5 | 0 |
| SC302 | 302 | Denver | 0.1671875 | 0.265151515 | 0.5443182 | 0.04 | 40 | 0.35 | 0.1 | 3 | 0.0018 | 0.5 | 1 |
| SC303 | 303 | Denver | 6.21 | 2.272727273 | 4.0621212 | 0.04 | 2 | 0.35 | 0.1 | 3 | 0.0018 | 0.5 | 0 |
| SC401 | 4001 | Sedalia | 0.09375 | 0.09469697 | 0.5089015 | 0.025 | 55 | 0.35 | 0.1 | 6 | 0.0007 | 1 | 1 |

Intro | Raingages | Subcatchments | Multiple Runs | DIA | Sedalia | Denver

# Subcatchments Sheet

## CUHP SUBCATCHMENTS

Click Here For Explanation Of Input Checks

Check Subcatchment Inputs

Columns with this color heading are for required user-input
Columns with this color heading are for optional overide values
Columns with this color heading are for program-calculated values

Units are in miles and square miles (click to change)

| | | | | | | | | Maximum Depression Storage (Watershed inches) | | Horton's Infiltration Parameters | | | DCIA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subcatchment Name | EPA SWMM Target Node | Raingage | Area ($mi^2$) | Length to Centroid (mi) | Length (mi) | Slope (ft/ft) | Percent Imperviousness | Pervious | Impervious | Initial Rate (in/hr) | Decay Coefficient (1/seconds) | Final Rate (in/hr) | Level 0, 1, or 2 |
| SC100 | 100 | DIA | 0.00625 | 0.056818182 | 0.1136364 | 0.025 | 10 | 0.35 | 0.1 | 4.5 | 0.0018 | 0.6 | 2 |
| SC101 | 101 | DIA | 0.08125 | 0.473484848 | 0.4924242 | 0.03 | 40 | 0.35 | 0.1 | 4.5 | 0.0018 | 0.6 | 2 |
| SC102 | 102 | DIA | 0.171875 | 0.151515152 | 0.3030303 | 0.0047 | 35 | 0.35 | 0.1 | 4.5 | 0.0018 | 0.6 | 0 |
| SC103 | 103 | DIA | 0.0578125 | 0.047348485 | 0.4852273 | 0.044 | 80 | 0.35 | 0.1 | 4.5 | 0.0018 | 0.6 | 1 |
| SC201 | 201 | Denver | 0.09375 | 0.4875 | 0.7575758 | 0.052 | 60 | 0.35 | 0.1 | 3 | 0.0018 | 0.5 | 1 |
| SC202 | 202 | Denver | 0.0859375 | 0.319507576 | 0.5350379 | 0.007 | 15 | 0.35 | 0.1 | 3 | 0.0018 | 0.5 | 2 |
| SC301 | 301 | Denver | 0.053125 | 0.083333333 | 0.4314394 | 0.087 | 2 | 0.35 | 0.1 | 3 | 0.0018 | 0.5 | 0 |
| SC302 | 302 | Denver | 0.1671875 | 0.265151515 | 0.5443182 | 0.04 | 40 | 0.35 | 0.1 | 3 | 0.0018 | 0.5 | 1 |
| SC303 | 303 | Denver | 6.21 | 2.272727273 | 4.0621212 | 0.04 | 2 | 0.35 | 0.1 | 3 | 0.0018 | 0.5 | 0 |
| SC401 | 4001 | Sedalia | 0.09375 | 0.09469697 | 0.5089015 | 0.025 | 55 | 0.35 | 0.1 | 6 | 0.0007 | 1 | 1 |

Intro | Raingages | Subcatchments | Multiple Runs | DIA | Sedalia | Denver

The SWMM Node corresponding to the Subcatchment Name has been has been moved into this worksheet. The Print Mode option has been removed and all subcatchments now use the old Option 3.

# Subcatchments Sheet

## CUHP SUBCATCHMENTS

Click Here For Explanation Of Input Checks

Check Subcatchment Inputs

Columns with this color heading are for required user-input
Columns with this color heading are for optional overide values
Columns with this color heading are for program-calculated values

Units are in miles and square miles (click to change)

| | | | | | | | | Maximum Depression Storage (Watershed inches) | | Horton's Infiltration Parameters | | | DCIA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subcatchment Name | EPA SWMM Target Node | Raingage | Area ($mi^2$) | Length to Centroid (mi) | Length (mi) | Slope (ft/ft) | Percent Imperviousness | Pervious | Impervious | Initial Rate (in/hr) | Decay Coefficient (1/seconds) | Final Rate (in/hr) | Level 0, 1, or 2 |
| SC100 | 100 | DIA | 0.00625 | 0.056818182 | 0.1136364 | 0.025 | 10 | 0.35 | 0.1 | 4.5 | 0.0018 | 0.6 | 2 |
| SC101 | 101 | DIA | 0.08125 | 0.473484848 | 0.4924242 | 0.03 | 40 | 0.35 | 0.1 | 4.5 | 0.0018 | 0.6 | 2 |
| SC102 | 102 | DIA | 0.171875 | 0.151515152 | 0.3030303 | 0.0047 | 35 | 0.35 | 0.1 | 4.5 | 0.0018 | 0.6 | 0 |
| SC103 | 103 | DIA | 0.0578125 | 0.047348485 | 0.4852273 | 0.044 | 80 | 0.35 | 0.1 | 4.5 | 0.0018 | 0.6 | 1 |
| SC201 | 201 | Denver | 0.09375 | 0.4875 | 0.7575758 | 0.052 | 60 | 0.35 | 0.1 | 3 | 0.0018 | 0.5 | 1 |
| SC202 | 202 | Denver | 0.0859375 | 0.319507576 | 0.5350379 | 0.007 | 15 | 0.35 | 0.1 | 3 | 0.0018 | 0.5 | 2 |
| | | | 0.053125 | 0.083333333 | 0.4314394 | 0.087 | | | | | 0.0018 | 0.5 | 0 |
| | | | 0.1671875 | 0.265151515 | 0.5443182 | 0.04 | | | | | 0.0018 | 0.5 | 1 |
| | | | 6.21 | 2.272727273 | 4.0621212 | 0.04 | | | | | 0.0018 | 0.5 | 0 |
| | | | 0.09375 | 0.09469697 | 0.5089015 | 0.025 | | | | | 0.0007 | 1 | 1 |

Intro | ...ltiple Runs | DIA | Sedalia | Denver

**Feet and Sq. Ft.**

Units are in feet and square feet (click to change)

| Area ($ft^2$) | Length to Centroid (ft) | Length (ft) |
|---|---|---|
| 174240 | 300 | 600 |
| 2265120 | 2500 | 2600 |
| 4791600 | 800 | 1600 |
| 1611720 | 250 | 2562 |
| 2613600 | 2574 | 4000 |
| 2395800 | 1687 | 2825 |
| 1481040 | 440 | 2278 |
| 4660920 | 1400 | 2874 |
| 173124864 | 12000 | 21448 |
| 2613600 | 500 | 2687 |

User can change units for input length and area

**Feet and Acres**

Units are in feet and acres (click to change)

| Area (acre) | Length to Centroid (ft) | Length (ft) |
|---|---|---|
| 4 | 300 | 600 |
| 52 | 2500 | 2600 |
| 110 | 800 | 1600 |
| 37 | 250 | 2562 |
| 60 | 2574 | 4000 |
| 55 | 1687 | 2825 |
| 34 | 440 | 2278 |
| 107 | 1400 | 2874 |
| 3974.4 | 12000 | 21448 |
| 60 | 500 | 2687 |

# Subcatchments Sheet

## CUHP SUBCATCHMENTS

Click Here For Explanation Of Input Checks

Check Subcatchment Inputs

Columns with this color heading are for required user-input
Columns with this color heading are for optional overide values
Columns with this color heading are for program-calculated values

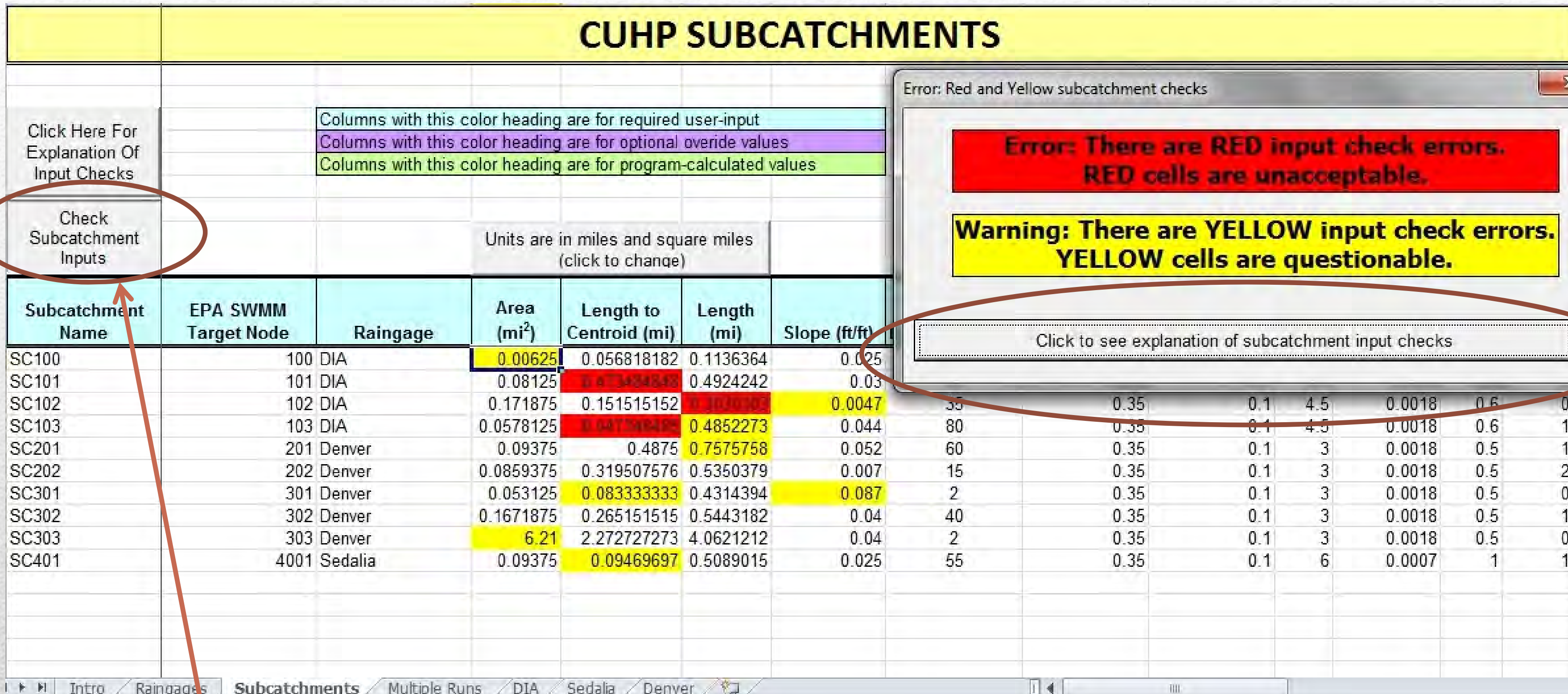
Units are in feet and acres (click to change)

| Subcatchment Name | EPA SWMM Target Node | Raingage | Area (acre) | Length to Centroid (ft) | Length (ft) | Slope (ft/ft) | Percent Imperviousness | Maximum Depression Storage (Watershed inches) | | Horton's Infiltration Parameters | | | DCIA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Pervious | Impervious | Initial Rate (in/hr) | Decay Coefficient (1/seconds) | Final Rate (in/hr) | Level 0, 1, or 2 |
| SC100 | 100 | DIA | 4 | 300 | 600 | 0.025 | 10 | 0.35 | 0.1 | 4.5 | 0.0018 | 0.6 | 2 |
| SC101 | 101 | DIA | 52 | 2500 | 2600 | 0.03 | 40 | 0.35 | 0.1 | 4.5 | 0.0018 | 0.6 | 2 |
| SC102 | 102 | DIA | 110 | 800 | 1600 | 0.0047 | 35 | 0.35 | 0.1 | 4.5 | 0.0018 | 0.6 | 0 |
| SC103 | 103 | DIA | 37 | 250 | 2562 | 0.044 | 80 | 0.35 | 0.1 | 4.5 | 0.0018 | 0.6 | 1 |
| SC201 | 201 | Denver | 60 | 2574 | 4000 | 0.052 | 60 | 0.35 | 0.1 | 3 | 0.0018 | 0.5 | 1 |
| SC202 | 202 | Denver | 55 | 1687 | 2825 | 0.007 | 15 | 0.35 | 0.1 | 3 | 0.0018 | 0.5 | 2 |
| SC301 | 301 | Denver | 34 | 440 | 2278 | 0.087 | 2 | 0.35 | 0.1 | 3 | 0.0018 | 0.5 | 0 |
| SC302 | 302 | Denver | 107 | 1400 | 2874 | 0.04 | 40 | 0.35 | 0.1 | 3 | 0.0018 | 0.5 | 1 |
| SC303 | 303 | Denver | 3974.4 | 12000 | 21448 | 0.04 | 2 | 0.35 | 0.1 | 3 | 0.0018 | 0.5 | 0 |
| SC401 | 4001 | Sedalia | 60 | 500 | 2687 | 0.025 | 55 | 0.35 | 0.1 | 6 | 0.0007 | 1 | 1 |

Intro | Raingages | Subcatchments | Multiple Runs | DIA | Sedalia | Denver

User can check their inputs for reasonableness

# Subcatchments Sheet

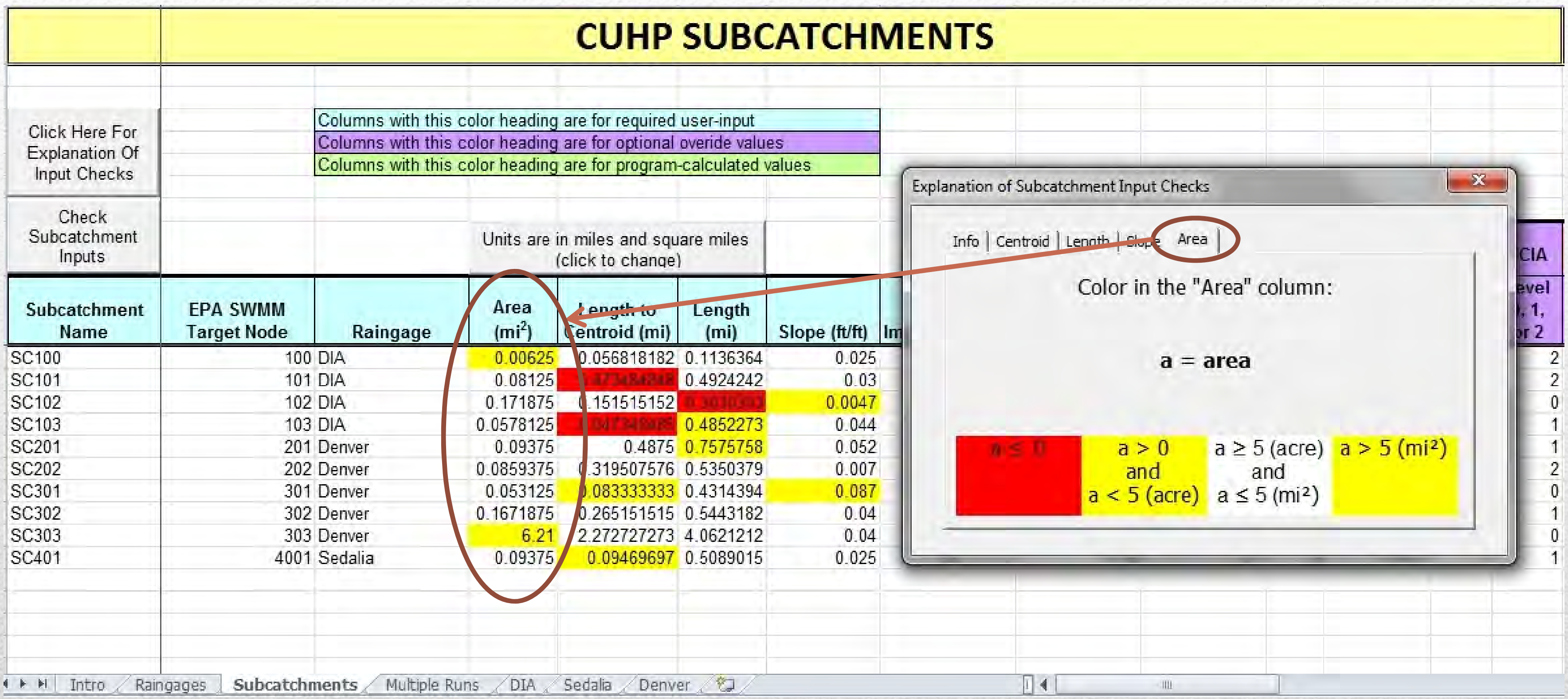




| Subcatchment Name | EPA SWMM Target Node | Raingage | Area ($mi^2$) | Length to Centroid (mi) | Length (mi) | Slope (ft/ft) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SC100 | 100 | DIA | 0.00625 | 0.056818182 | 0.1136364 | 0.025 | | | | | | | |
| SC101 | 101 | DIA | 0.08125 | [illegible] | 0.4924242 | 0.03 | | | | | | | |
| SC102 | 102 | DIA | 0.171875 | 0.151515152 | [illegible] | 0.0047 | 35 | 0.35 | 0.1 | 4.5 | 0.0018 | 0.6 | 0 |
| SC103 | 103 | DIA | 0.0578125 | [illegible] | 0.4852273 | 0.044 | 80 | 0.35 | 0.1 | 4.5 | 0.0018 | 0.6 | 1 |
| SC201 | 201 | Denver | 0.09375 | 0.4875 | 0.7575758 | 0.052 | 60 | 0.35 | 0.1 | 3 | 0.0018 | 0.5 | 1 |
| SC202 | 202 | Denver | 0.0859375 | 0.319507576 | 0.5350379 | 0.007 | 15 | 0.35 | 0.1 | 3 | 0.0018 | 0.5 | 2 |
| SC301 | 301 | Denver | 0.053125 | 0.083333333 | 0.4314394 | 0.087 | 2 | 0.35 | 0.1 | 3 | 0.0018 | 0.5 | 0 |
| SC302 | 302 | Denver | 0.1671875 | 0.265151515 | 0.5443182 | 0.04 | 40 | 0.35 | 0.1 | 3 | 0.0018 | 0.5 | 1 |
| SC303 | 303 | Denver | 6.21 | 2.272727273 | 4.0621212 | 0.04 | 2 | 0.35 | 0.1 | 3 | 0.0018 | 0.5 | 0 |
| SC401 | 4001 | Sedalia | 0.09375 | 0.09469697 | 0.5089015 | 0.025 | 55 | 0.35 | 0.1 | 6 | 0.0007 | 1 | 1 |

User can check their inputs for reasonableness

# Subcatchments Sheet

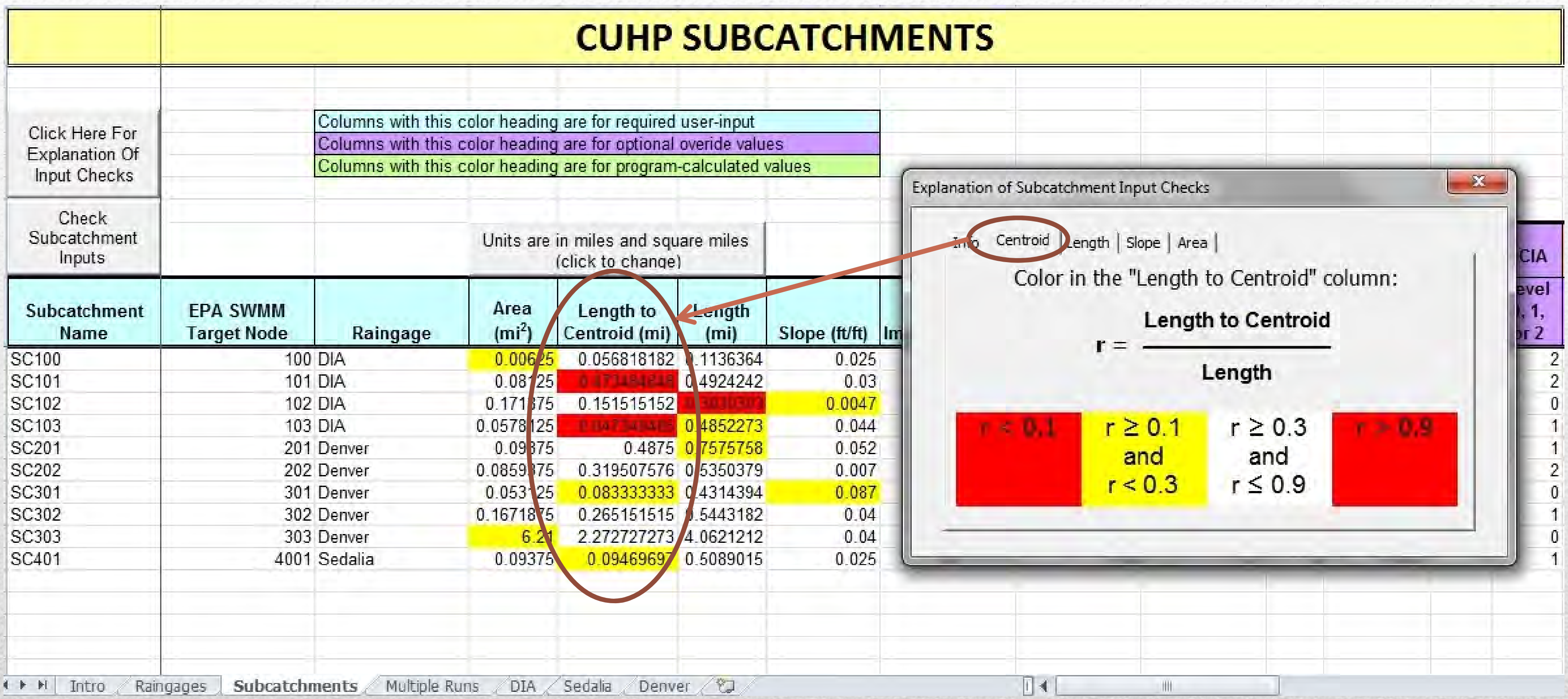



Highlights: A < 5 acres & A > 5 sq.mi.

In these ranges, special guidelines apply.

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

# Subcatchments Sheet



CUHP SUBCATCHMENTS

Click Here For Explanation Of Input Checks

Check Subcatchment Inputs

Columns with this color heading are for required user-input
Columns with this color heading are for optional overide values
Columns with this color heading are for program-calculated values

Units are in miles and square miles (click to change)

| Subcatchment Name | EPA SWMM Target Node | Raingage | Area ($mi^2$) | Length to Centroid (mi) | Length (mi) | Slope (ft/ft) |
|---|---|---|---|---|---|---|
| SC100 | 100 | DIA | 0.00625 | 0.056818182 | 0.1136364 | 0.025 |
| SC101 | 101 | DIA | 0.08125 | 0.473484848 | 0.4924242 | 0.03 |
| SC102 | 102 | DIA | 0.171875 | 0.151515152 | 0.03030303 | 0.0047 |
| SC103 | 103 | DIA | 0.0578125 | 0.047348485 | 0.4852273 | 0.044 |
| SC201 | 201 | Denver | 0.09375 | 0.4875 | 0.7575758 | 0.052 |
| SC202 | 202 | Denver | 0.0859375 | 0.319507576 | 0.5350379 | 0.007 |
| SC301 | 301 | Denver | 0.053125 | 0.083333333 | 0.4314394 | 0.087 |
| SC302 | 302 | Denver | 0.1671875 | 0.265151515 | 0.5443182 | 0.04 |
| SC303 | 303 | Denver | 6.21 | 2.272727273 | 4.0621212 | 0.04 |
| SC401 | 4001 | Sedalia | 0.09375 | 0.09469697 | 0.5089015 | 0.025 |



Acceptable Range is: $0.1 \leq \frac{L_{centroid}}{L} < 0.9$

Values less than 0.3 are questionable

# Subcatchments Sheet

**CUHP SUBCATCHMENTS**

Click Here For Explanation Of Input Checks

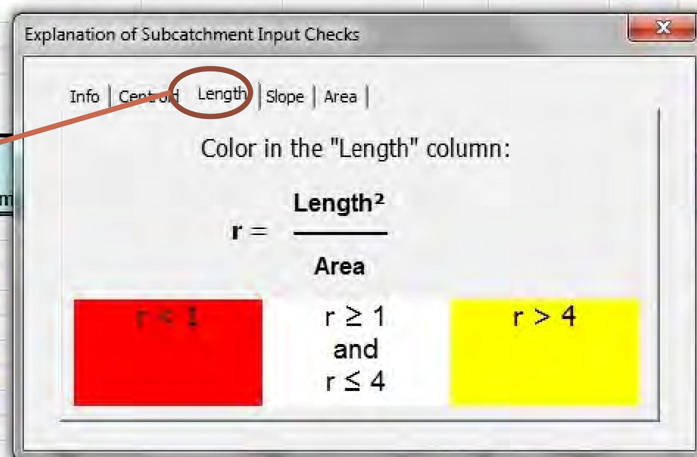
Check Subcatchment Inputs

Columns with this color heading are for required user-input
Columns with this color heading are for optional overide values
Columns with this color heading are for program-calculated values

Units are in miles and square miles (click to change)

| Subcatchment Name | EPA SWMM Target Node | Raingage | Area ($mi^2$) | Length to Centroid (mi) | Length (mi) | Slope (ft/ft) | CIA ...evel ..., 1, ...r 2 |
|---|---|---|---|---|---|---|---|
| SC100 | 100 | DIA | 0.00625 | 0.056818182 | 0.1136364 | 0.025 | 2 |
| SC101 | 101 | DIA | 0.08125 | [illegible] | 0.4924242 | 0.03 | 2 |
| SC102 | 102 | DIA | 0.171875 | 0.151515152 | [illegible] | 0.0047 | 0 |
| SC103 | 103 | DIA | 0.0578125 | [illegible] | 0.4852273 | 0.044 | 1 |
| SC201 | 201 | Denver | 0.09375 | 0.4875 | 0.7575758 | 0.052 | 1 |
| SC202 | 202 | Denver | 0.0859375 | 0.319507576 | 0.5350379 | 0.007 | 2 |
| SC301 | 301 | Denver | 0.053125 | 0.083333333 | 0.4314394 | 0.087 | 0 |
| SC302 | 302 | Denver | 0.1671875 | 0.265151515 | 0.5443182 | 0.04 | 1 |
| SC303 | 303 | Denver | 6.21 | 2.272727273 | 4.0621212 | 0.04 | 0 |
| SC401 | 4001 | Sedalia | 0.09375 | 0.09469697 | 0.5089015 | 0.025 | 1 |

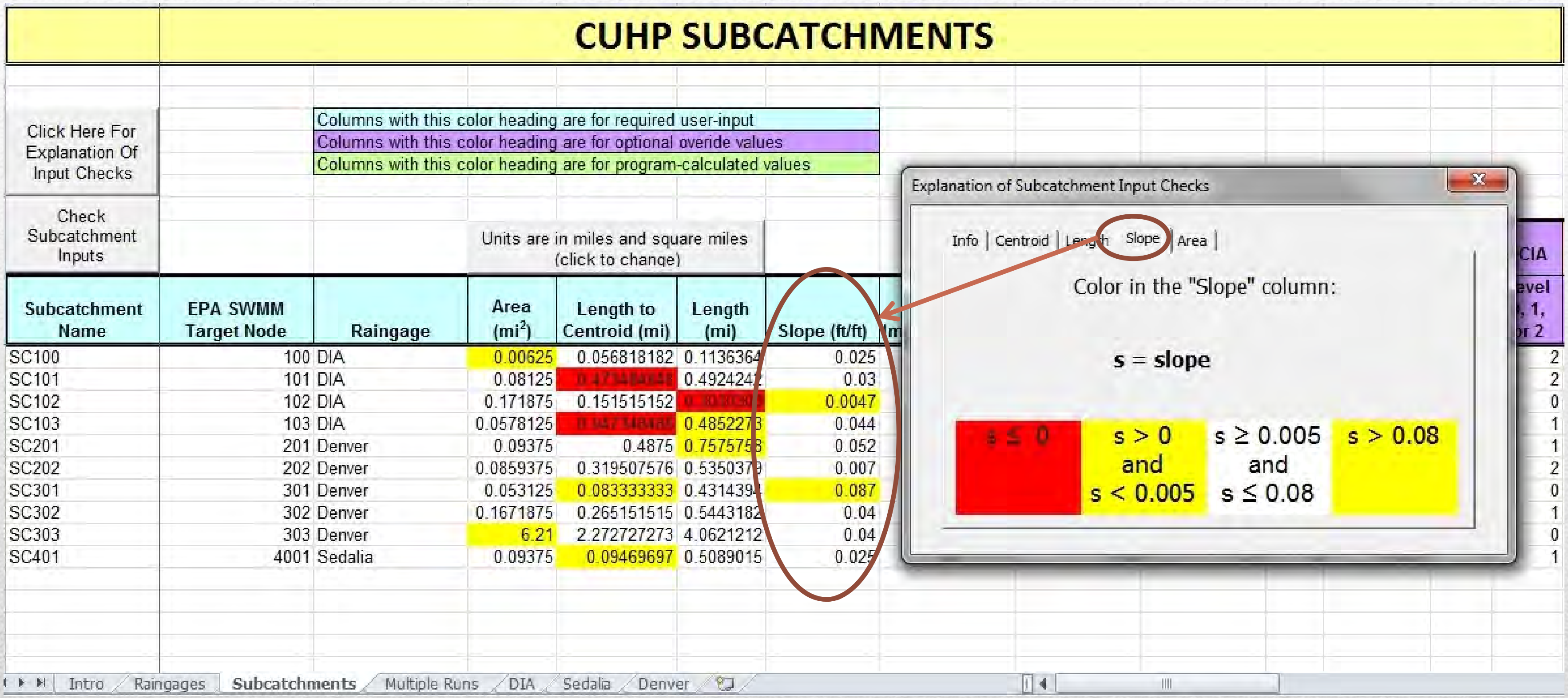
Intro | Raingages | Subcatchments | Multiple Runs | DIA | Sedalia | Denver




Acceptable Range is: $\frac{L^2}{Area} \geq 1$ ;

values greater than 4 are questionable

# Subcatchments Sheet



CUHP SUBCATCHMENTS

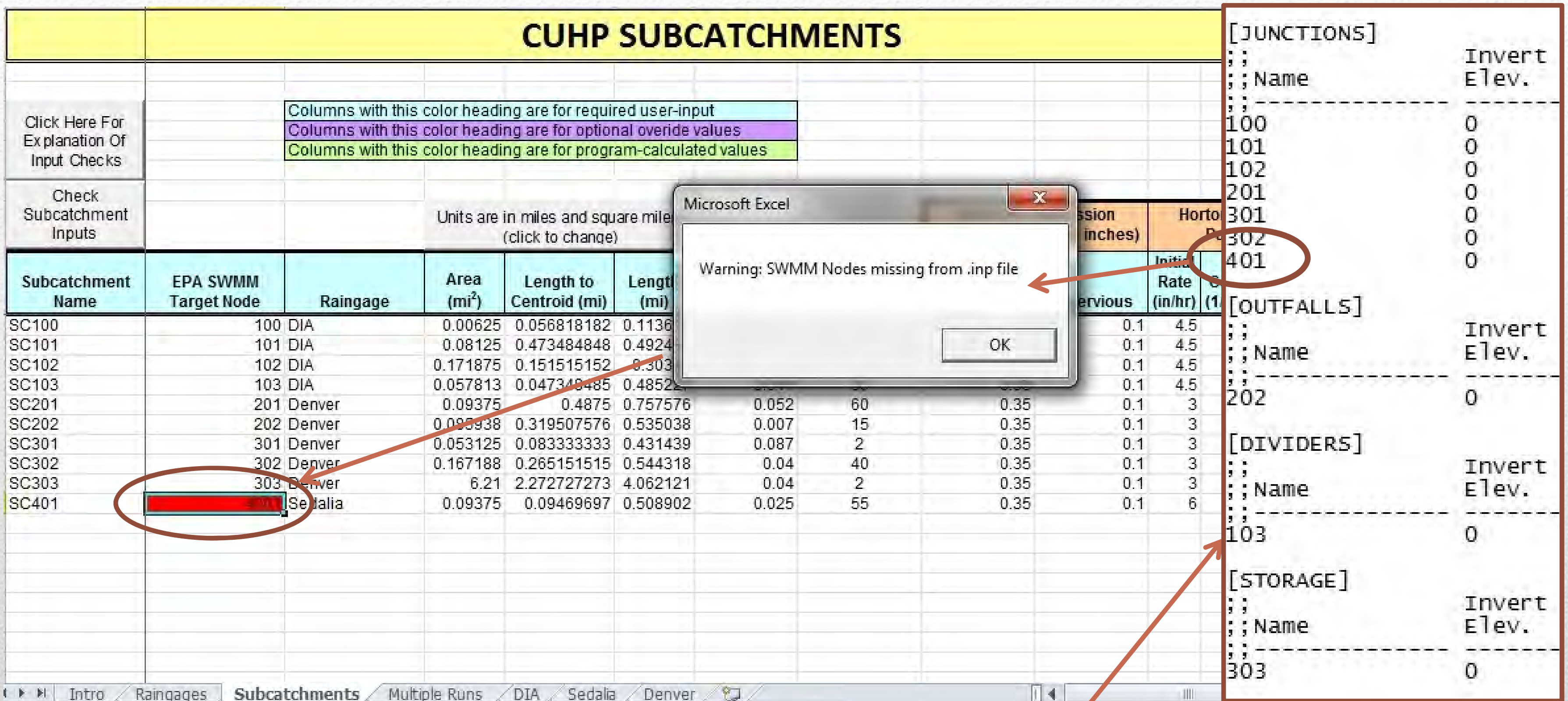
| Subcatchment Name | EPA SWMM Target Node | Raingage | Area ($mi^2$) | Length to Centroid (mi) | Length (mi) | Slope (ft/ft) |
|---|---|---|---|---|---|---|
| SC100 | 100 | DIA | 0.00625 | 0.056818182 | 0.1136364 | 0.025 |
| SC101 | 101 | DIA | 0.08125 | [illegible] | 0.4924242 | 0.03 |
| SC102 | 102 | DIA | 0.171875 | 0.151515152 | [illegible] | 0.0047 |
| SC103 | 103 | DIA | 0.0578125 | [illegible] | 0.4852273 | 0.044 |
| SC201 | 201 | Denver | 0.09375 | 0.4875 | 0.7575758 | 0.052 |
| SC202 | 202 | Denver | 0.0859375 | 0.319507576 | 0.5350379 | 0.007 |
| SC301 | 301 | Denver | 0.053125 | 0.083333333 | 0.4314394 | 0.087 |
| SC302 | 302 | Denver | 0.1671875 | 0.265151515 | 0.5443182 | 0.04 |
| SC303 | 303 | Denver | 6.21 | 2.272727273 | 4.0621212 | 0.04 |
| SC401 | 4001 | Sedalia | 0.09375 | 0.09469697 | 0.5089015 | 0.025 |



Highlights: S < 0.005 & S > 0.08 ft/ft

In these ranges, results may not be accurate

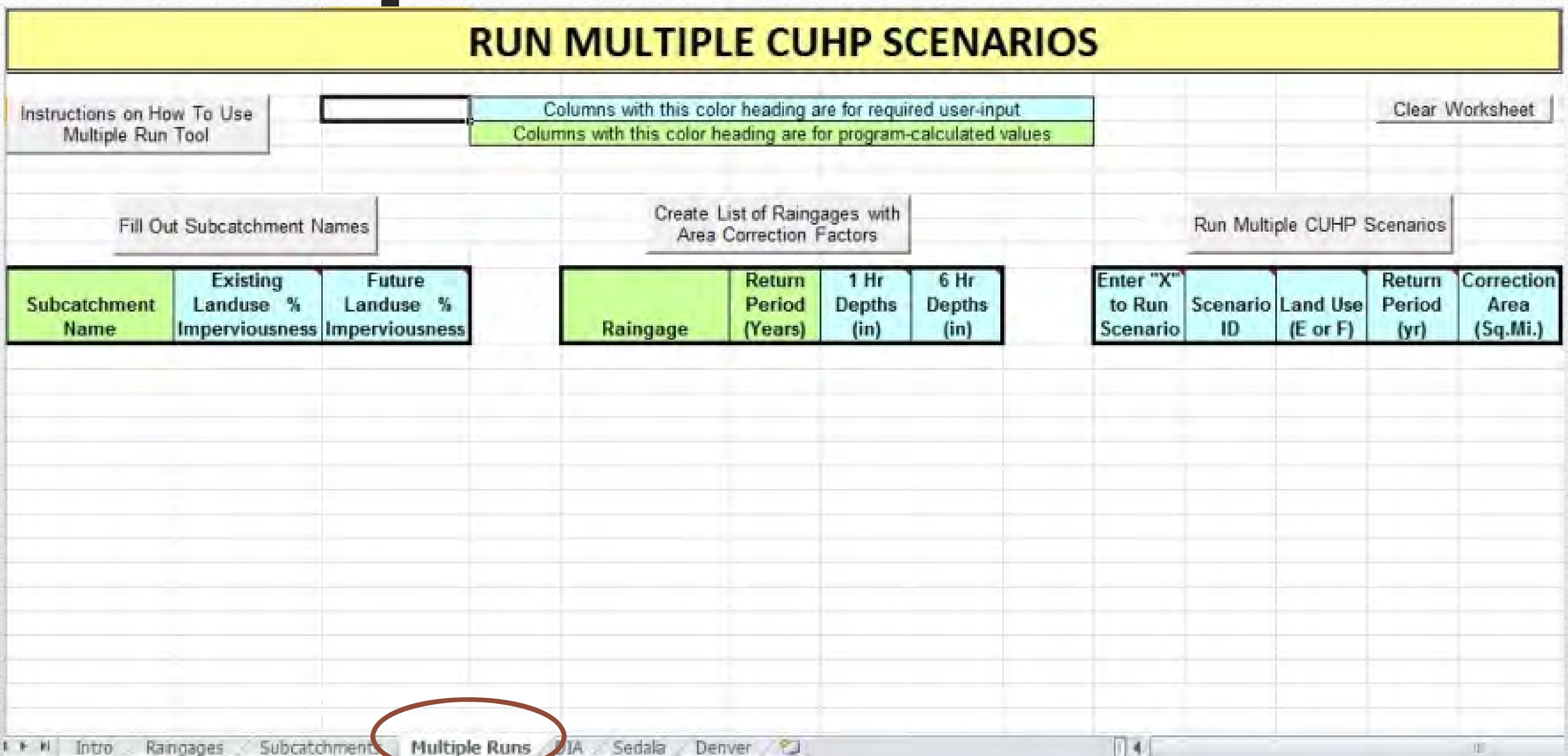
# Subcatchments Sheet




When checking SWMM nodes for consistency, any nodes not found in the SWMM input file (.inp) will be highlighted

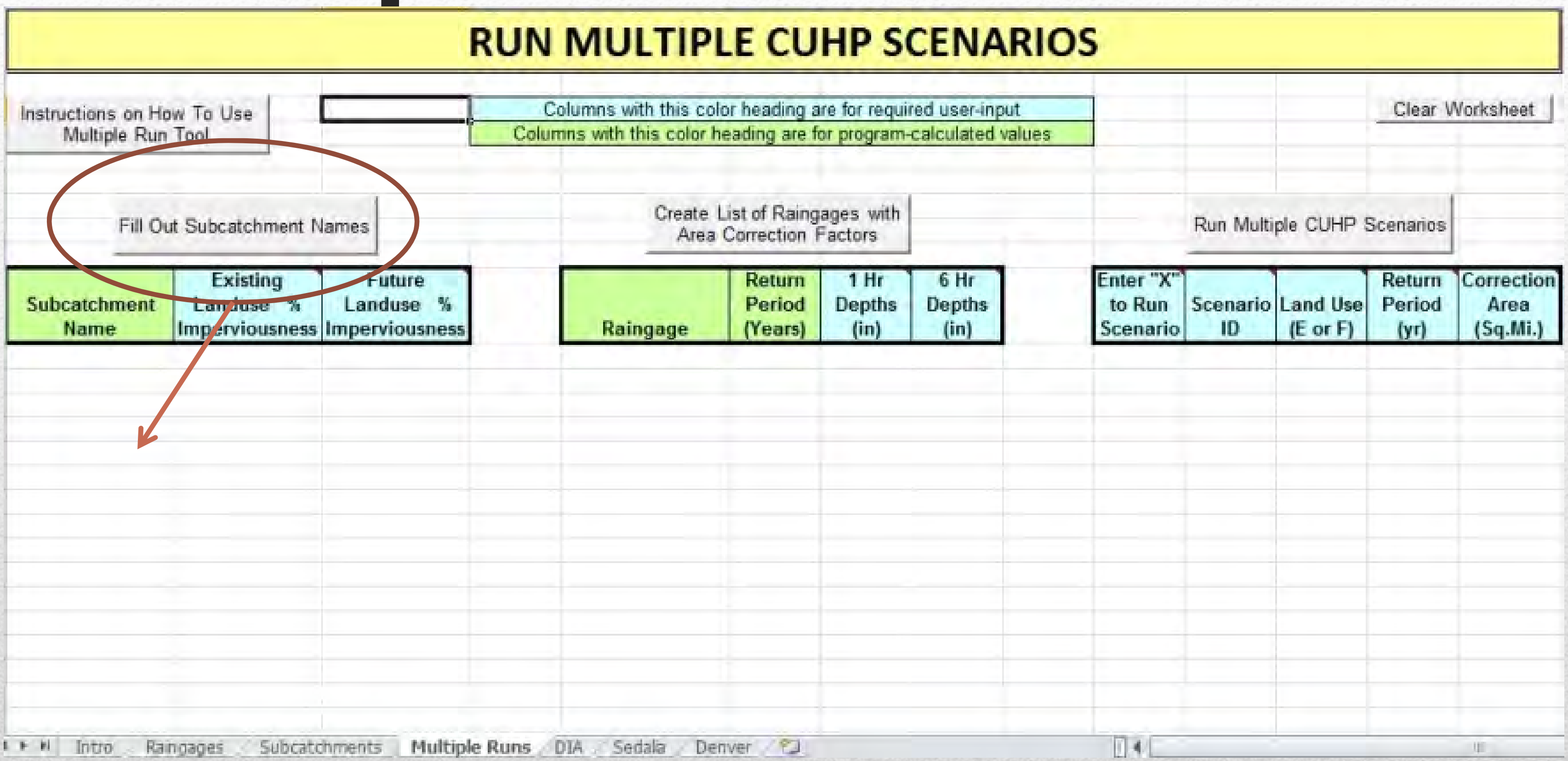
Check SWMM Nodes

# Multiple Runs Sheet



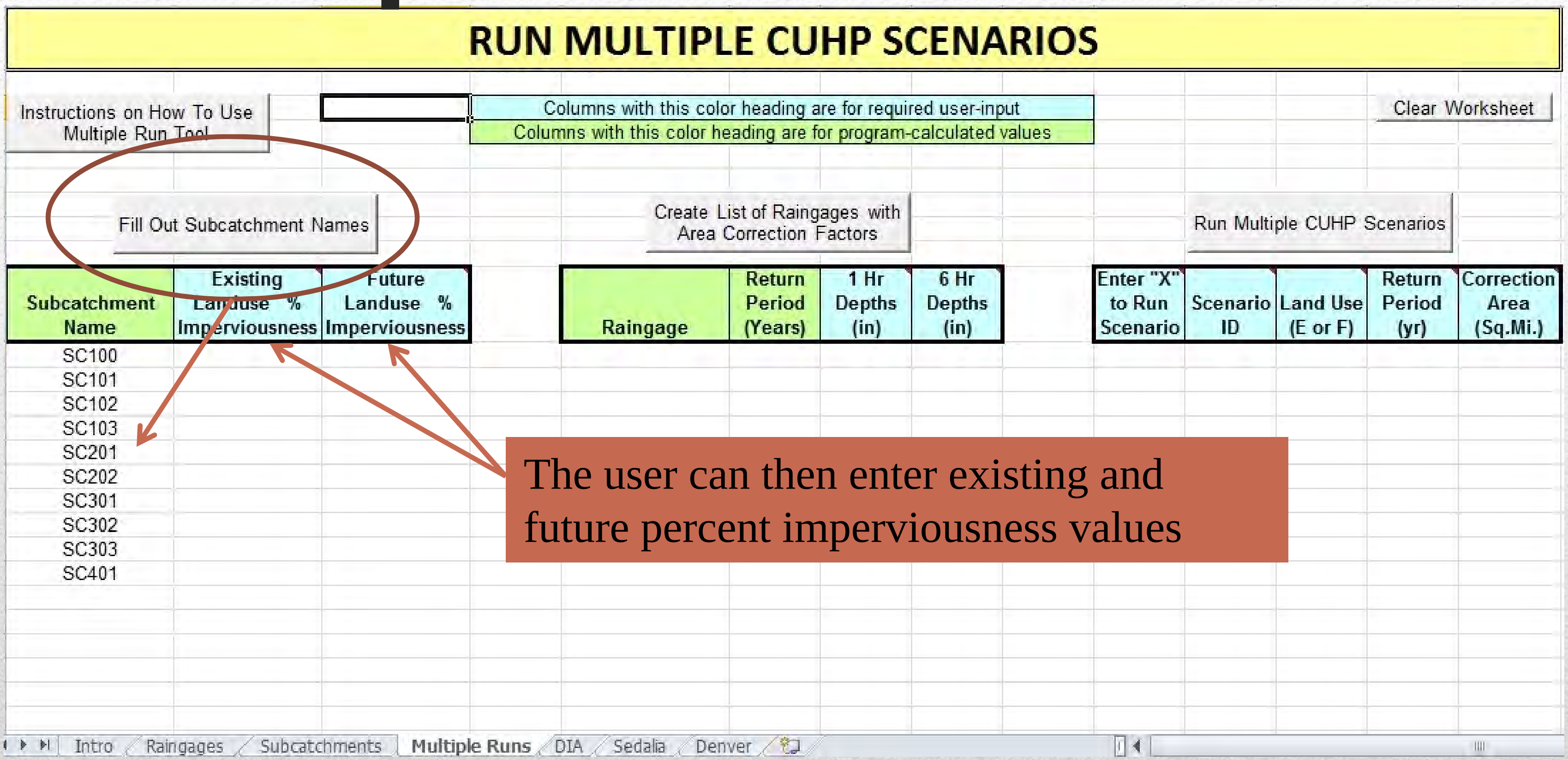

Allows the user to create a single input file that will run several different scenarios and create multiple output files

# Multiple Runs Sheet




Allows the user to create a single input file that will run several different scenarios and create multiple output files

# Multiple Runs Sheet




These imperviousness values will be copied and pasted to the subcatchments sheet for each scenario.

# Multiple Runs Sheet

## RUN MULTIPLE CUHP SCENARIOS

Instructions on How To Use Multiple Run Tool

Columns with this color heading are for required user-input
Columns with this color heading are for program-calculated values

Clear Worksheet

Fill Out Subcatchment Names

Create List of Raingages with Area Correction Factors

Run Multiple CUHP Scenarios

| Subcatchment Name | Existing Landuse % Imperviousness | Future Landuse % Imperviousness |
|---|---|---|
| SC100 | 10 | 40 |
| SC101 | 40 | 40 |
| SC102 | 35 | 35 |
| SC103 | 80 | 80 |
| SC201 | 60 | 60 |
| SC202 | 15 | 80 |
| SC301 | 2 | 40 |
| SC302 | 40 | 40 |
| SC303 | 2 | 40 |
| SC401 | 55 | 55 |

| Raingage | Return Period (Years) | 1 Hr Depths (in) | 6 Hr Depths (in) |
|---|---|---|---|

| Enter "X" to Run Scenario | Scenario ID | Land Use (E or F) | Return Period (yr) | Correction Area (Sq.Mi.) |
|---|---|---|---|---|

Intro | Raingages | Subcatchments | **Multiple Runs** | DIA | Sedalia | Denver

The next step is to create a table of the available raingages with area correction

# Multiple Runs Sheet

## RUN MULTIPLE CUHP SCENARIOS

Instructions on How To Use Multiple Run Tool

Columns with this color heading are for required user-input
Columns with this color heading are for program-calculated values

Clear Worksheet

Fill Out Subcatchment Names

Create List of Raingages with Area Correction Factors

Run Multiple CUHP Scenarios

| Subcatchment Name | Existing Landuse % Imperviousness | Future Landuse % Imperviousness |
|---|---|---|
| SC100 | 10 | 40 |
| SC101 | 40 | 40 |
| SC102 | 35 | 35 |
| SC103 | 80 | 80 |
| SC201 | 60 | 60 |
| SC202 | 15 | 80 |
| SC301 | 2 | 40 |
| SC302 | 40 | 40 |
| SC303 | 2 | 40 |
| SC401 | 55 | 55 |

| Raingage | Return Period (Years) | 1 Hr Depths (in) | 6 Hr Depths (in) |
|---|---|---|---|
| DIA | 2 | | |
| | 5 | | |
| | 10 | | |
| | 25 | | |
| | 50 | | |
| | 100 | | |
| | 500 | | |
| SEDALIA | 2 | | |
| | 5 | | |
| | 10 | | |
| | 25 | | |
| | 50 | | |
| | 100 | | |
| | 500 | | |
| DENVER | 2 | | |
| | 5 | | |
| | 10 | | |
| | 25 | | |
| | 50 | | |
| | 100 | | |
| | 500 | | |

| Enter "X" to Run Scenario | Scenario ID | Land Use (E or F) | Return Period (yr) | Correction Area (Sq.Mi.) |
|---|---|---|---|---|

Intro | Raingages | Subcatchments | Multiple Runs | DIA | Sedalia | Denver

The user can then fill out the table with the appropriate depths from UD-Rain or the NOAA Atlas

# Multiple Runs Sheet

## RUN MULTIPLE CUHP SCENARIOS

Instructions on How To Use Multiple Run Tool

Columns with this color heading are for required user-input

Columns with this color heading are for program-calculated values

Clear Worksheet

Fill Out Subcatchment Names

Create List of Raingages with Area Correction Factors

Run Multiple CUHP Scenarios

| Subcatchment Name | Existing Landuse % Imperviousness | Future Landuse % Imperviousness |
|---|---|---|
| SC100 | 10 | 40 |
| SC101 | 40 | 40 |
| SC102 | 35 | 35 |
| SC103 | 80 | 80 |
| SC201 | 60 | 60 |
| SC202 | 15 | 80 |
| SC301 | 2 | 40 |
| SC302 | 40 | 40 |
| SC303 | 2 | 40 |
| SC401 | 55 | 55 |

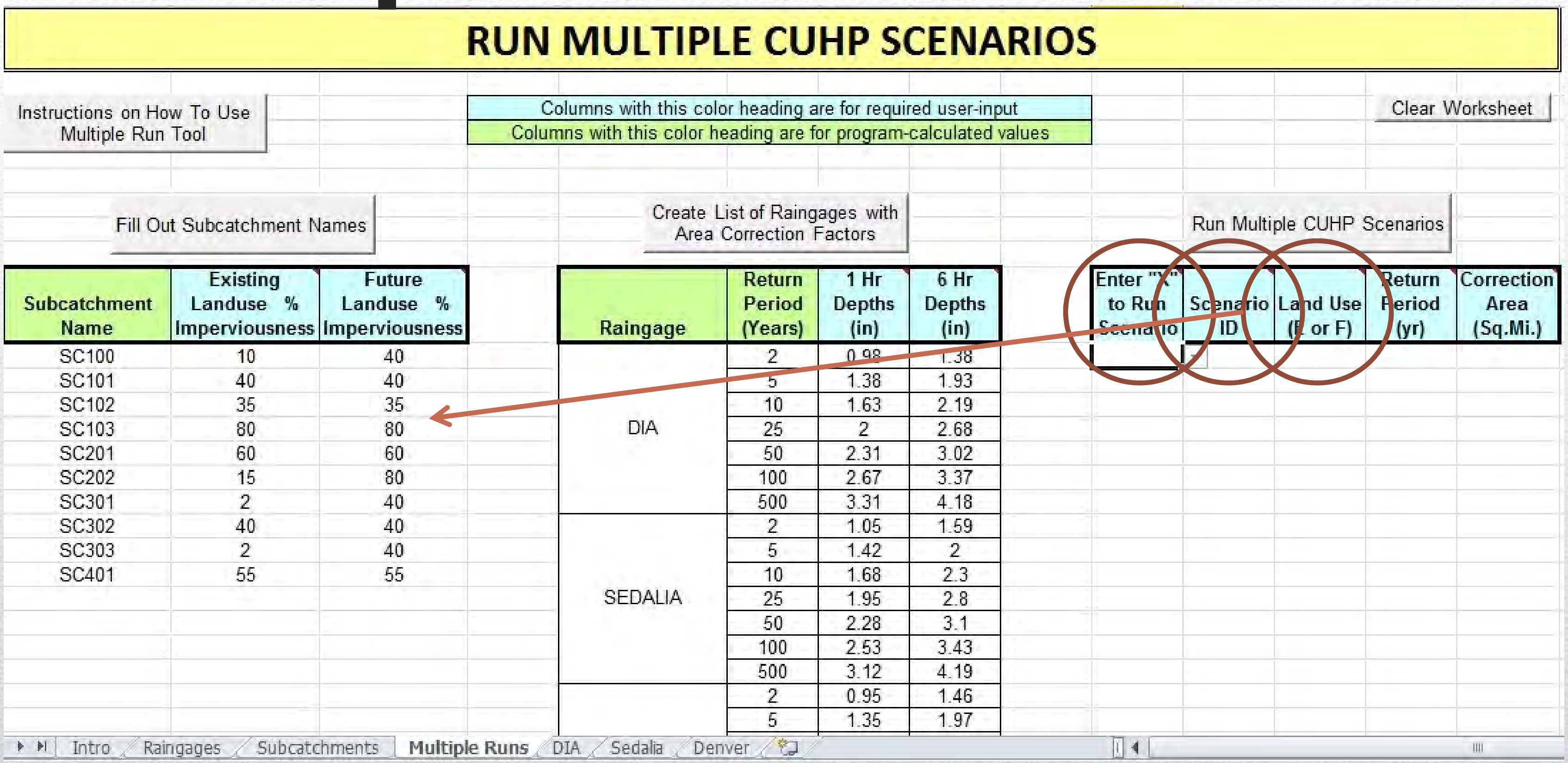
| Raingage | Return Period (Years) | 1 Hr Depths (in) | 6 Hr Depths (in) |
|---|---|---|---|
| DIA | 2 | 0.98 | 1.38 |
| | 5 | 1.38 | 1.93 |
| | 10 | 1.63 | 2.19 |
| | 25 | 2 | 2.68 |
| | 50 | 2.31 | 3.02 |
| | 100 | 2.67 | 3.37 |
| | 500 | 3.31 | 4.18 |
| SEDALIA | 2 | 1.05 | 1.59 |
| | 5 | 1.42 | 2 |
| | 10 | 1.68 | 2.3 |
| | 25 | 1.95 | 2.8 |
| | 50 | 2.28 | 3.1 |
| | 100 | 2.53 | 3.43 |
| | 500 | 3.12 | 4.19 |
| DENVER | 2 | 0.95 | 1.46 |
| | 5 | 1.35 | 1.97 |
| | 10 | 1.55 | 2.32 |
| | 25 | 2 | 2.84 |
| | 50 | 2.24 | 3.14 |
| | 100 | 2.58 | 3.51 |
| | 500 | 3.22 | 4.36 |

| Enter "X" to Run Scenario | Scenario ID | Land Use (E or F) | Return Period (yr) | Correction Area (Sq.Mi.) |
|---|---|---|---|---|

Intro | Raingages | Subcatchments | Multiple Runs | DIA | Sedalia | Denver

The user can then fill out the table with the appropriate depths from UD-Rain or the NOAA Atlas

# Multiple Runs Sheet



## RUN MULTIPLE CUHP SCENARIOS

Instructions on How To Use Multiple Run Tool

Columns with this color heading are for required user-input
Columns with this color heading are for program-calculated values

Clear Worksheet

Fill Out Subcatchment Names

Create List of Raingages with Area Correction Factors

Run Multiple CUHP Scenarios

| Subcatchment Name | Existing Landuse % Imperviousness | Future Landuse % Imperviousness |
|---|---|---|
| SC100 | 10 | 40 |
| SC101 | 40 | 40 |
| SC102 | 35 | 35 |
| SC103 | 80 | 80 |
| SC201 | 60 | 60 |
| SC202 | 15 | 80 |
| SC301 | 2 | 40 |
| SC302 | 40 | 40 |
| SC303 | 2 | 40 |
| SC401 | 55 | 55 |

| Raingage | Return Period (Years) | 1 Hr Depths (in) | 6 Hr Depths (in) |
|---|---|---|---|
| DIA | 2 | 0.98 | 1.38 |
| | 5 | 1.38 | 1.93 |
| | 10 | 1.63 | 2.19 |
| | 25 | 2 | 2.68 |
| | 50 | 2.31 | 3.02 |
| | 100 | 2.67 | 3.37 |
| | 500 | 3.31 | 4.18 |
| SEDALIA | 2 | 1.05 | 1.59 |
| | 5 | 1.42 | 2 |
| | 10 | 1.68 | 2.3 |
| | 25 | 1.95 | 2.8 |
| | 50 | 2.28 | 3.1 |
| | 100 | 2.53 | 3.43 |
| | 500 | 3.12 | 4.19 |
| | 2 | 0.95 | 1.46 |
| | 5 | 1.35 | 1.97 |

| Enter "X" to Run Scenario | Scenario ID | Land Use (E or F) | Return Period (yr) | Correction Area (Sq.Mi.) |
|---|---|---|---|---|
| | | | | |

Intro / Raingages / Subcatchments / Multiple Runs / DIA / Sedalia / Denver

The final step is create input file scenarios by selecting an ID, Landuse, return period and correction area for each scenario.

# Multiple Runs Sheet

## RUN MULTIPLE CUHP SCENARIOS

Instructions on How To Use Multiple Run Tool

Columns with this color heading are for required user-input

Columns with this color heading are for program-calculated values

Clear Worksheet

Fill Out Subcatchment Names

Create List of Raingages with Area Correction Factors

Run Multiple CUHP Scenarios

| Subcatchment Name | Existing Landuse % Imperviousness | Future Landuse % Imperviousness |
|---|---|---|
| SC100 | 10 | 40 |
| SC101 | 40 | 40 |
| SC102 | 35 | 35 |
| SC103 | 80 | 80 |
| SC201 | 60 | 60 |
| SC202 | 15 | 80 |
| SC301 | 2 | 40 |
| SC302 | 40 | 40 |
| SC303 | 2 | 40 |
| SC401 | 55 | 55 |

| Raingage | Return Period (Years) | 1 Hr Depths (in) | 6 Hr Depths (in) |
|---|---|---|---|
| DIA | 2 | 0.98 | 1.38 |
| | 5 | 1.38 | 1.93 |
| | 10 | 1.63 | 2.19 |
| | 25 | 2 | 2.68 |
| | 50 | 2.31 | 3.02 |
| | 100 | 2.67 | 3.37 |
| | 500 | 3.31 | 4.18 |
| SEDALIA | 2 | 1.05 | 1.59 |
| | 5 | 1.42 | 2 |
| | 10 | 1.68 | 2.3 |
| | 25 | 1.95 | 2.8 |
| | 50 | 2.28 | 3.1 |
| | 100 | 2.53 | 3.43 |
| | 500 | 3.12 | 4.19 |
| | 2 | 0.95 | 1.46 |
| | 5 | 1.35 | 1.97 |

| Enter "X" to Run Scenario | Scenario ID | Land Use (E or F | Return Period (yr) | Correction Area (Sq.Mi.) |
|---|---|---|---|---|
| | | | | |

| | | | | |
|---|---|---|---|---|
| Comment | Denver International Airport (DIA) | | | |
| 1Hr Depth | 2.67 | inches | 2hr Depth | 2.91 inches |
| 6Hr Depth | 3.37 | inches | 3hr Depth | 3.09 inches |
| Correction Area | 53 | Sq. Mi. | | |
| Return Period | 100 | Years | Calculate | Clear |
| Time | Adjusted Depth | Unadjusted Depth | | |
| 0:05 | 0.0305 | 0.0267 | | |
| 0:10 | 0.0916 | 0.0801 | | |
| 0:15 | 0.1405 | 0.1228 | | |
| 0:20 | 0.2110 | 0.2136 | | |
| 0:25 | 0.2155 | 0.3738 | | |
| 0:30 | 0.3847 | 0.6675 | | |

Intro | Raingages | Subcatchments | Multiple Runs | DIA | Sedalia | Denver

The final step is create input file scenarios by selecting an ID, Landuse, return period and correction area for each scenario.

# Multiple Runs Sheet

## RUN MULTIPLE CUHP SCENARIOS

Instructions on How To Use Multiple Run Tool

Columns with this color heading are for required user-input
Columns with this color heading are for program-calculated values

Clear Worksheet

Fill Out Subcatchment Names

Create List of Raingages with Area Correction Factors

Run Multiple CUHP Scenarios

| Subcatchment Name | Existing Landuse % Imperviousness | Future Landuse % Imperviousness |
|---|---|---|
| SC100 | 10 | 40 |
| SC101 | 40 | 40 |
| SC102 | 35 | 35 |
| SC103 | 80 | 80 |
| SC201 | 60 | 60 |
| SC202 | 15 | 80 |
| SC301 | 2 | 40 |
| SC302 | 40 | 40 |
| SC303 | 2 | 40 |
| SC401 | 55 | 55 |

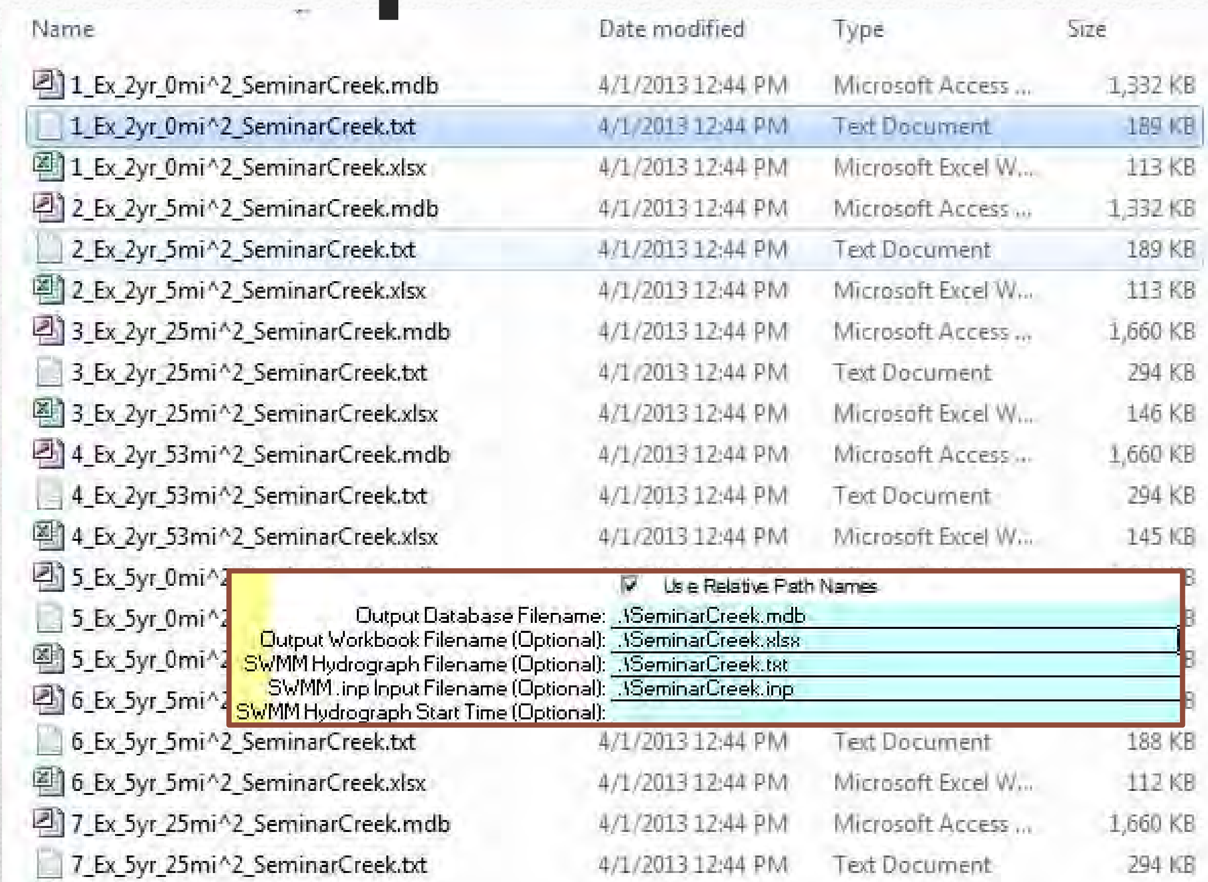
| Raingage | Return Period (Years) | 1 Hr Depths (in) | 6 Hr Depths (in) |
|---|---|---|---|
| DIA | 2 | 0.98 | 1.38 |
| | 5 | 1.38 | 1.93 |
| | 10 | 1.63 | 2.19 |
| | 25 | 2 | 2.68 |
| | 50 | 2.31 | 3.02 |
| | 100 | 2.67 | 3.37 |
| | 500 | 3.31 | 4.18 |
| SEDALIA | 2 | 1.05 | 1.59 |
| | 5 | 1.42 | 2 |
| | 10 | 1.68 | 2.3 |
| | 25 | 1.95 | 2.8 |
| | 50 | 2.28 | 3.1 |
| | 100 | 2.53 | 3.43 |
| | 500 | 3.12 | 4.19 |
| | 2 | 0.95 | 1.46 |
| | 5 | 1.35 | 1.97 |

| Enter "X" to Run Scenario | Scenario ID | Land Use (E or F) | Return Period (yr) | Correction Area (Sq.Mi.) |
|---|---|---|---|---|
| X | 1 | E | 2 | 0 |
| X | 2 | E | 2 | 5 |
| X | 3 | E | 2 | 25 |
| X | 4 | E | 2 | 53 |
| X | 5 | E | 5 | 0 |
| X | 6 | E | 5 | 5 |
| X | 7 | E | 5 | 25 |
| X | 8 | E | 5 | 53 |
| X | 9 | E | 10 | 0 |
| X | 10 | E | 10 | 5 |
| X | 11 | E | 10 | 25 |
| X | 12 | E | 10 | 53 |
| X | 13 | E | 25 | 0 |
| X | 14 | E | 25 | 5 |
| X | 15 | E | 25 | 25 |
| X | 16 | E | 25 | 53 |

Intro | Raingages | Subcatchments | **Multiple Runs** | DIA | Sedalia | Denver

Once all input scenarios are created, a push of the button creates all of the output files.

# Multiple Runs Sheet




For each scenario CUHP creates the following files:

- database (.mdb)
- Output Summary (.xlsx)
- SWMM Inflow hydrographs (.txt)

A prefix is added to each output file in the form of:

RunID_Landuse_RetPeriod_CorrectionArea

# Summary

- Standalone Excel spreadsheet that anyone can open and run without installing software package.
- Simplified user interface with additional tools to check for reasonableness of inputs
- Updated code to be consistent with USDCM
- Tool to check consistency between SWMM nodes and SWMM input file
- Running multiple scenarios from a single input file enhances file management and prevents repetitive input mistakes for large watershed studies

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

# Questions ?
# or
# Comments !

PEAK STORMWATER ENGINEERING, LLC



URBAN DRAINAGE AND FLOOD CONTROL DISTRICT


# Real-Time Flash Flood Forecasting Using New Hydrologic Models

Kevin Stewart, P.E. – Manager/UDFCD Information Services & Flood Warning Program

Baxter Vieux, Ph.D. P.E. – Principal/Vieux & Associates, Norman, OK

**Boulder Creek and Fourmile Burn Area**

Forecast Seasons

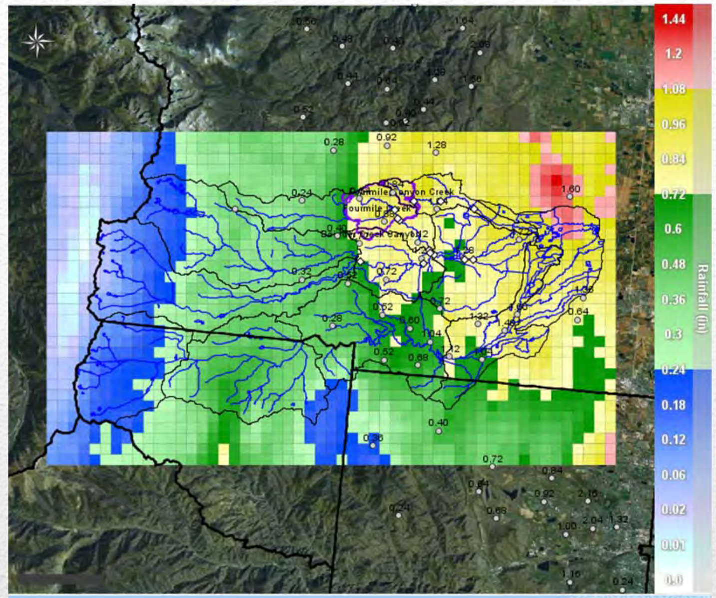
- 2011 and 2012
- Beginning 2013

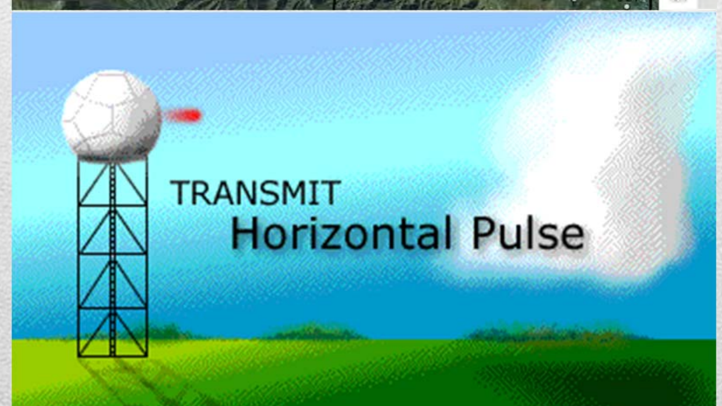
# Forecast locations and Fourmile Burn Area

2013 UDFCD Annual Seminar

April 2, 2013

- NEXRAD radar provides detailed mapping of reflectivity
- Conversion to rainfall rates
- Adjusted to match rain gauge amounts (Alert)
- Gauge-adjusted radar rainfall (GARR)





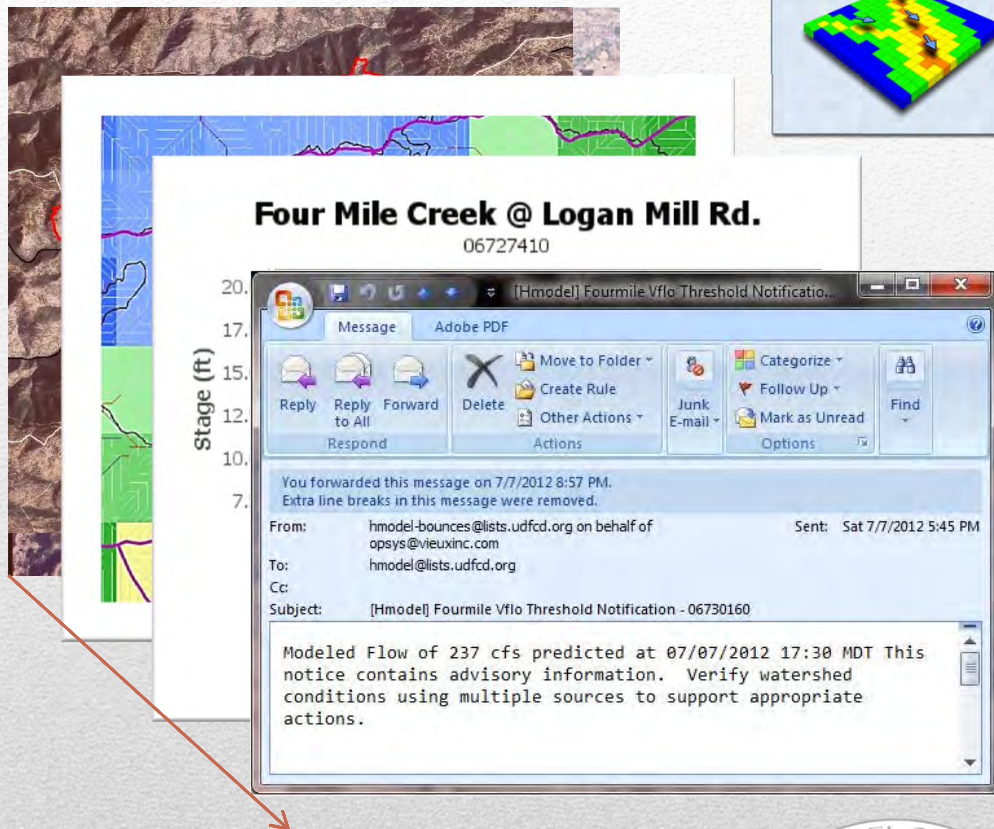


Alert


Radar

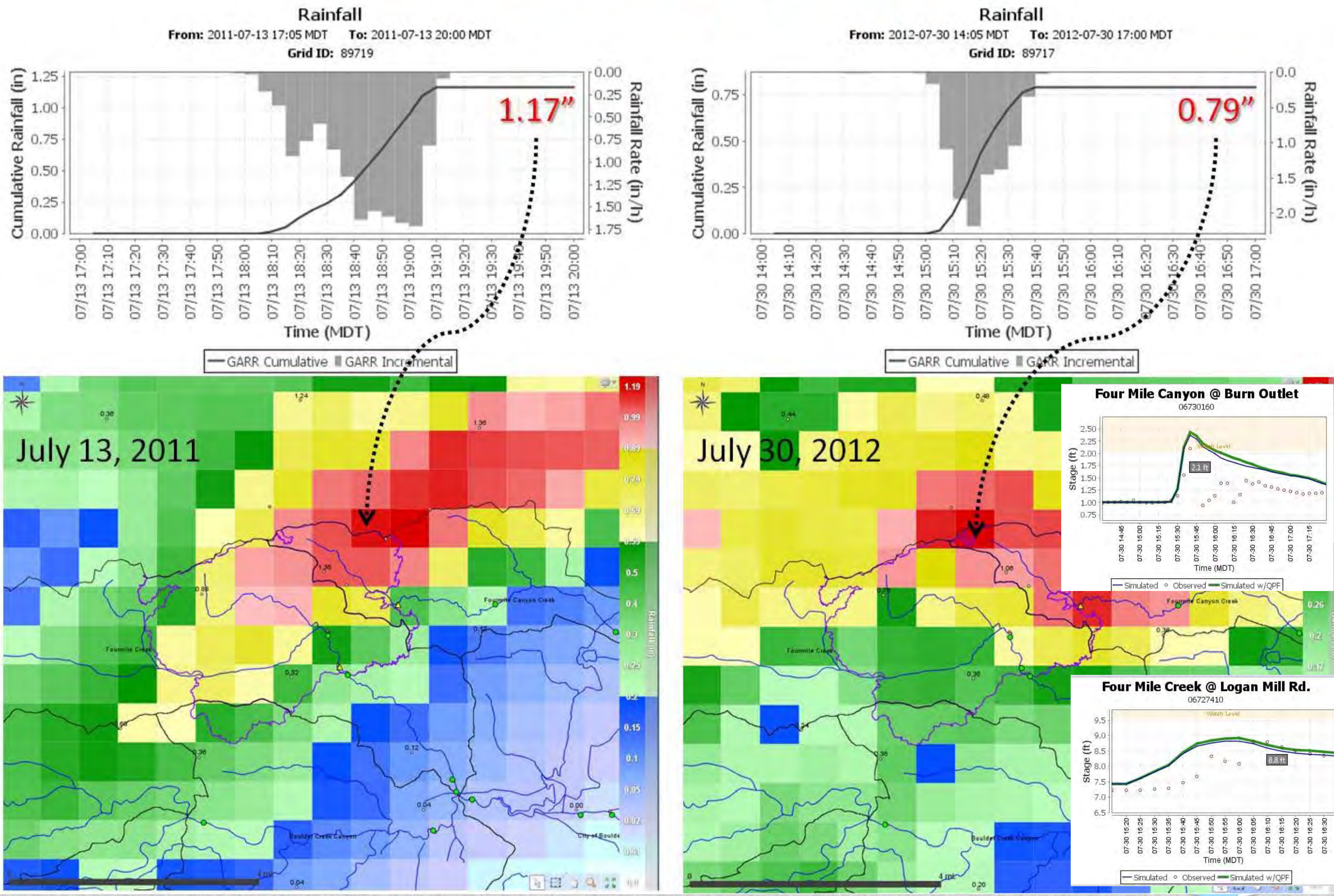
# Radar/Gauge Technology

- *Vflo*® is a gridded model that depends on hydraulics to predict flash floods
- Uses gauge-adjusted radar rainfall intensities
- Outputs hydrographs at locations within the drainage network.
- Email notifications of predicted flood stage.




# Modeling technology

# Rainfall Comparison

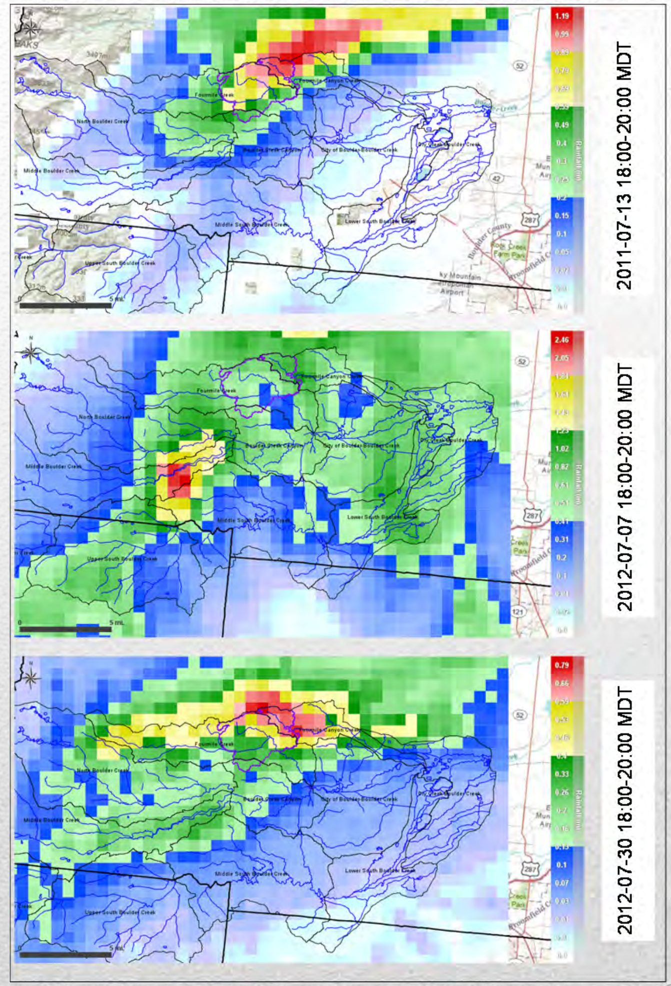


Three storms produced some flooding

- July 13, 2011
- July 7, 2012
- July 30, 2012

Different predictability

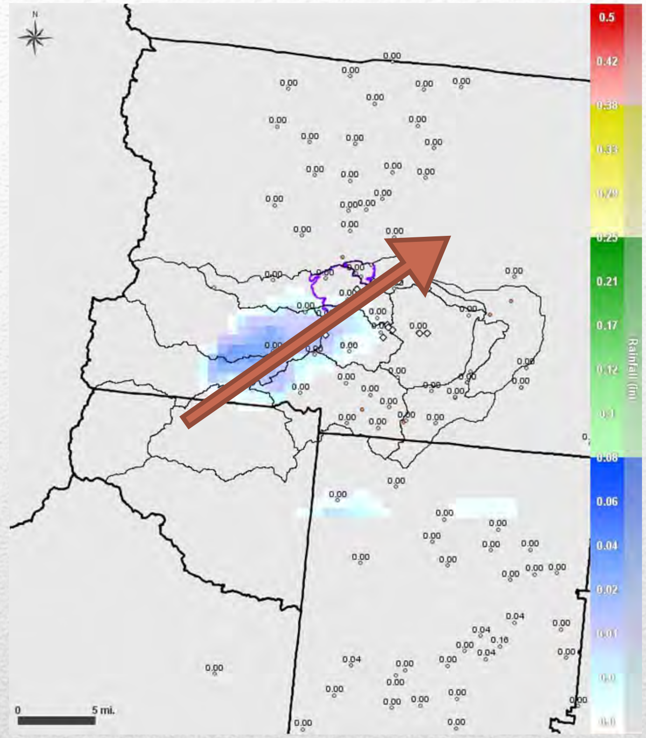
- Depends on where the storm cell developed
- Its persistence and storm track over the burn area

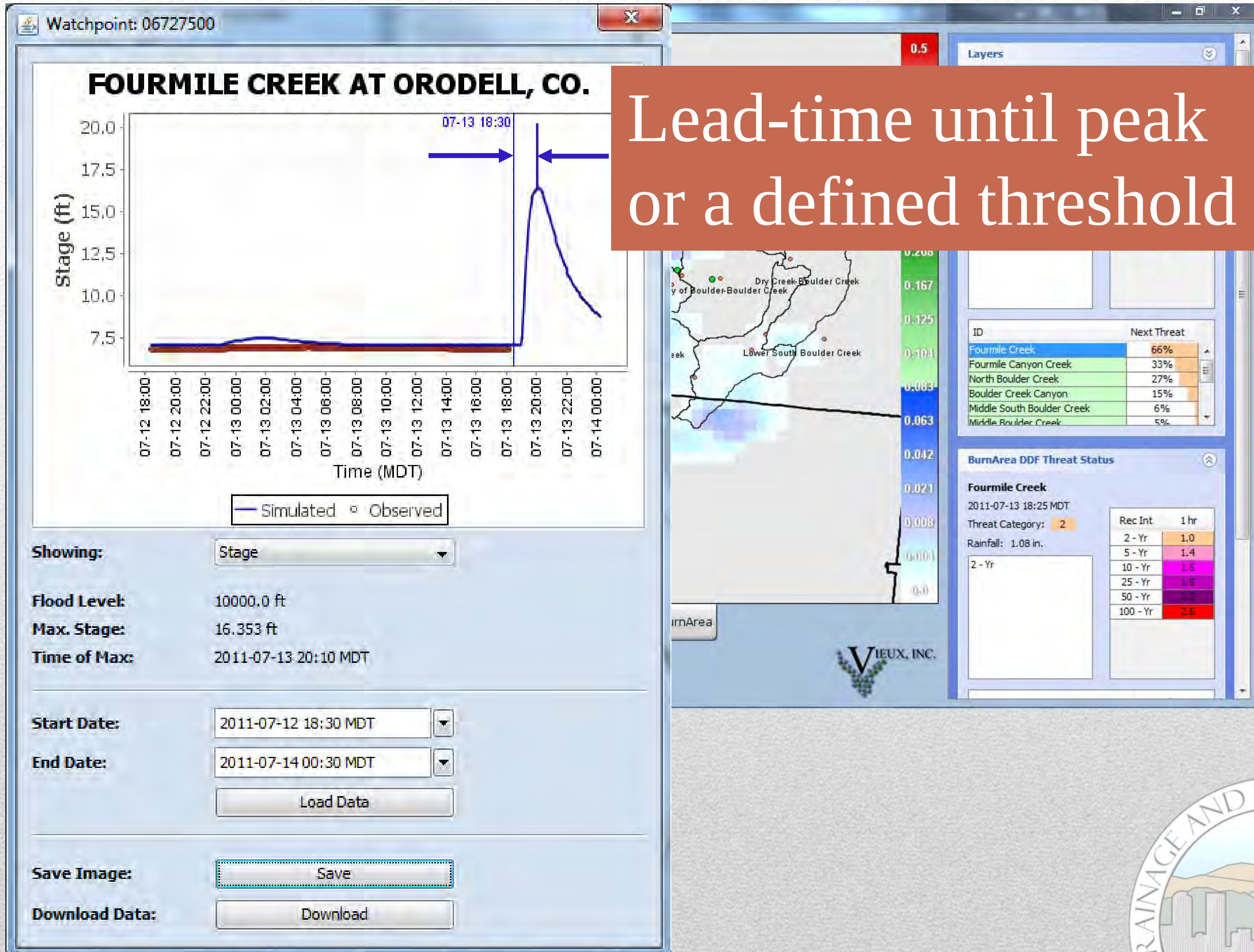



# QPF – evaluation
# How much added lead-time?

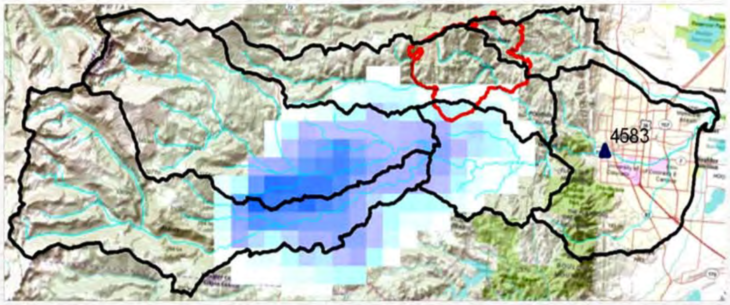
# Quantitative Precipitation Forecasts – QPF

- Automated algorithm applied to
- Motion detected from successive radar scans
- Projected forward with intensification/decay
- Generate forecast rainfall intensities
- Input added to GARR

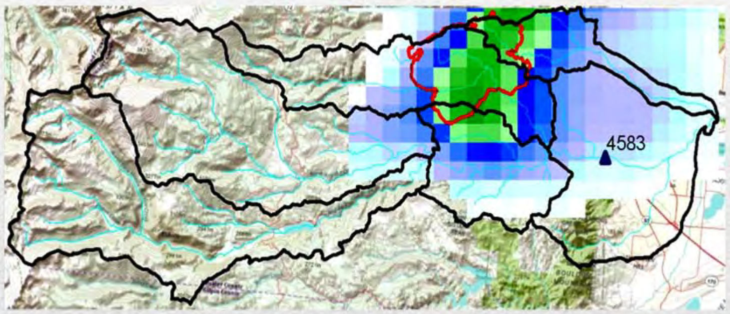




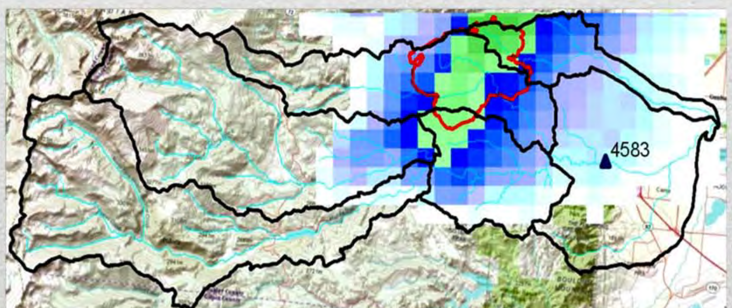

# Lead-time until peak or a defined threshold



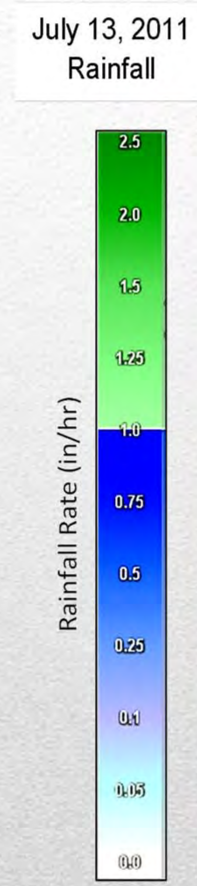

a) QPE detected by radar at 2011-07-13 17:45 MDT

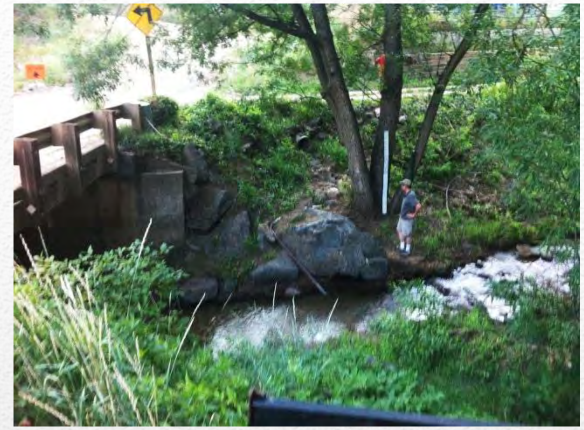


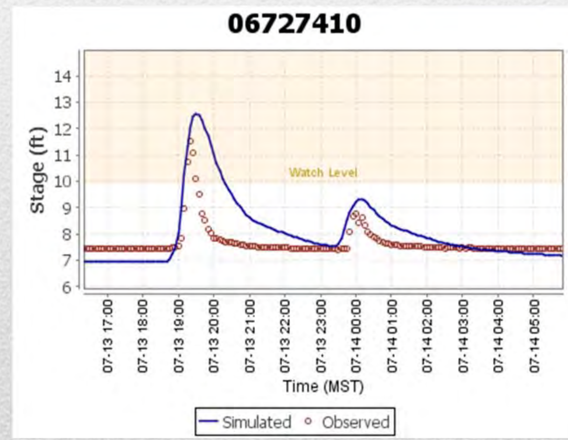

b) QPF estimated for 18:45 MDT, but produced an hour earlier from the QPE at 17:45 MDT (Figure 2a above)



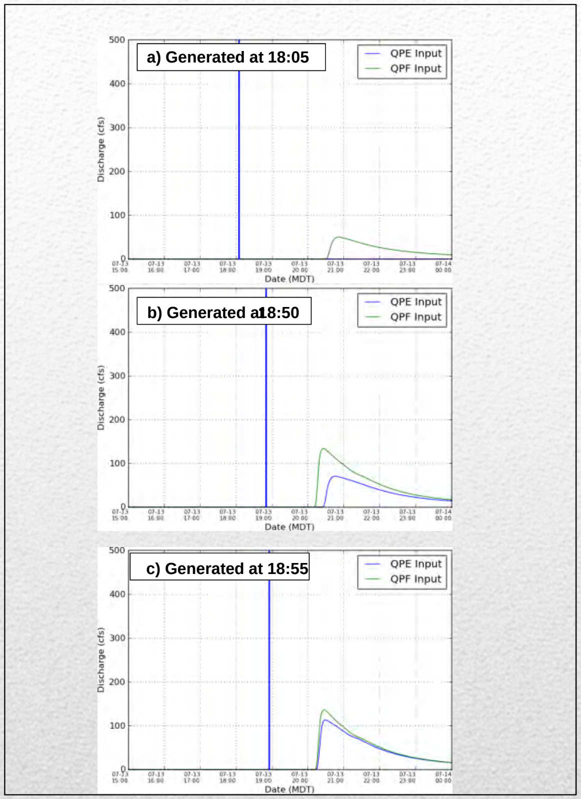

c) Actual QPE that occurred at 18:45 MDT comparable to Figure 2b above.

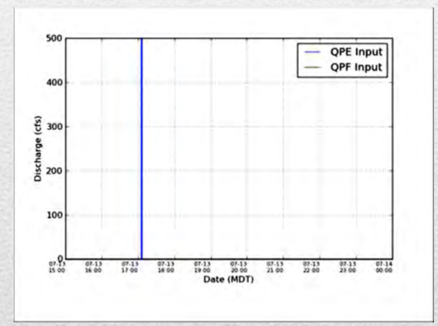




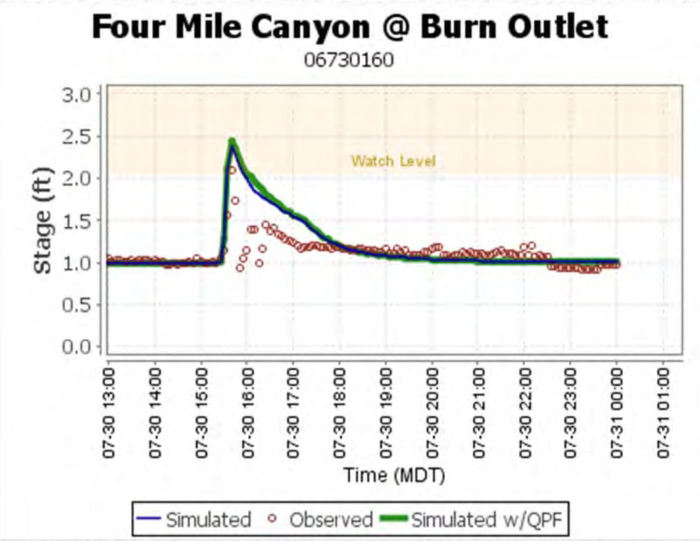
- Added 42 minutes of lead-time during the July 13, 2011 event and
- 45 minutes during the July 7, 2012 event, but minimal time during July 30, 2012

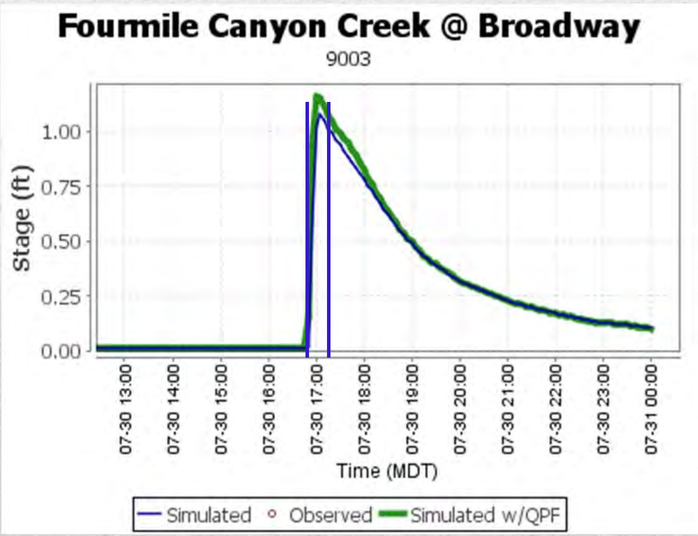



**Fourmile Canyon Creek at Broadway (9003) for July 13, 2011**

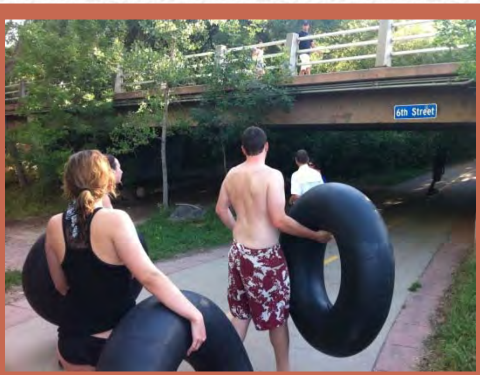
# Hydrologic lead-time QPF + QPE




July 30, 2011 Fourmile Canyon Creek at Broadway, Boulder

July 30, 2011 Fourmile Canyon Creek at Broadway, Boulder




Can we forecast a flood in real-time?

- Yes we can with a high resolution rain gauge/radar technology.
- It takes a distributed model to handle the variability of the rainfall.
- Additional lead-time from QPF depends on where the storm cell forms
- Even in the downstream areas from the Fourmile Burn Area there is time to take action.

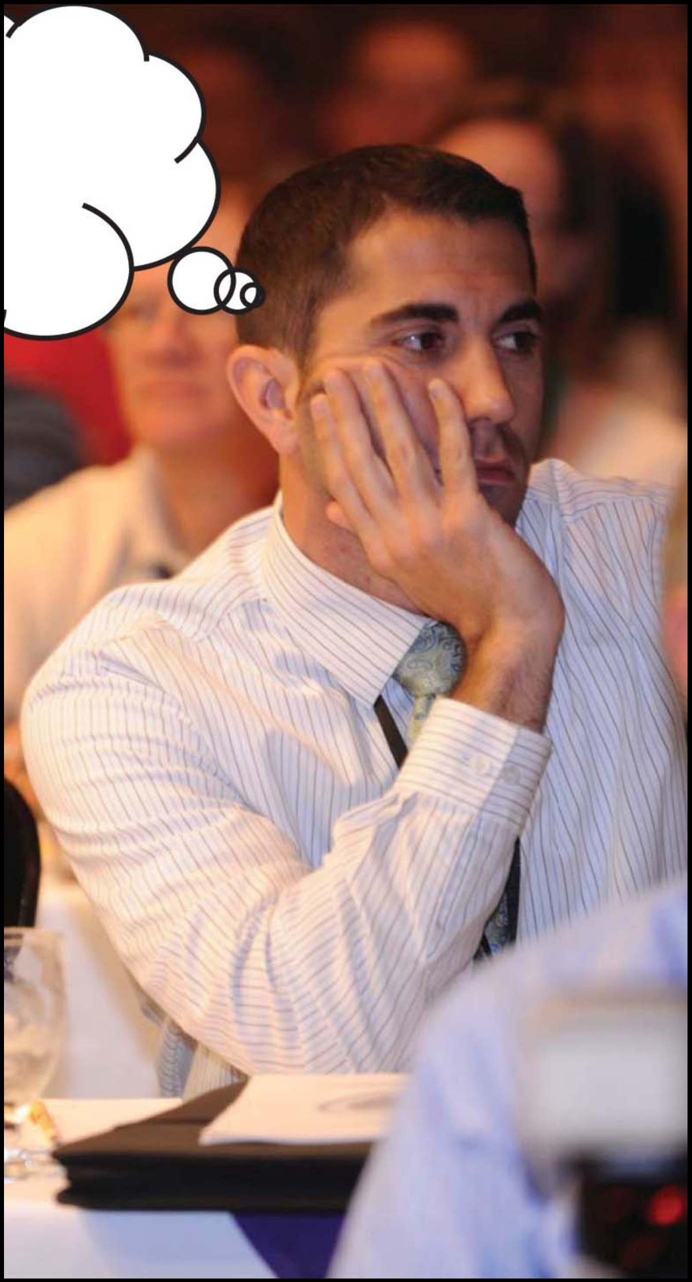
# Summary

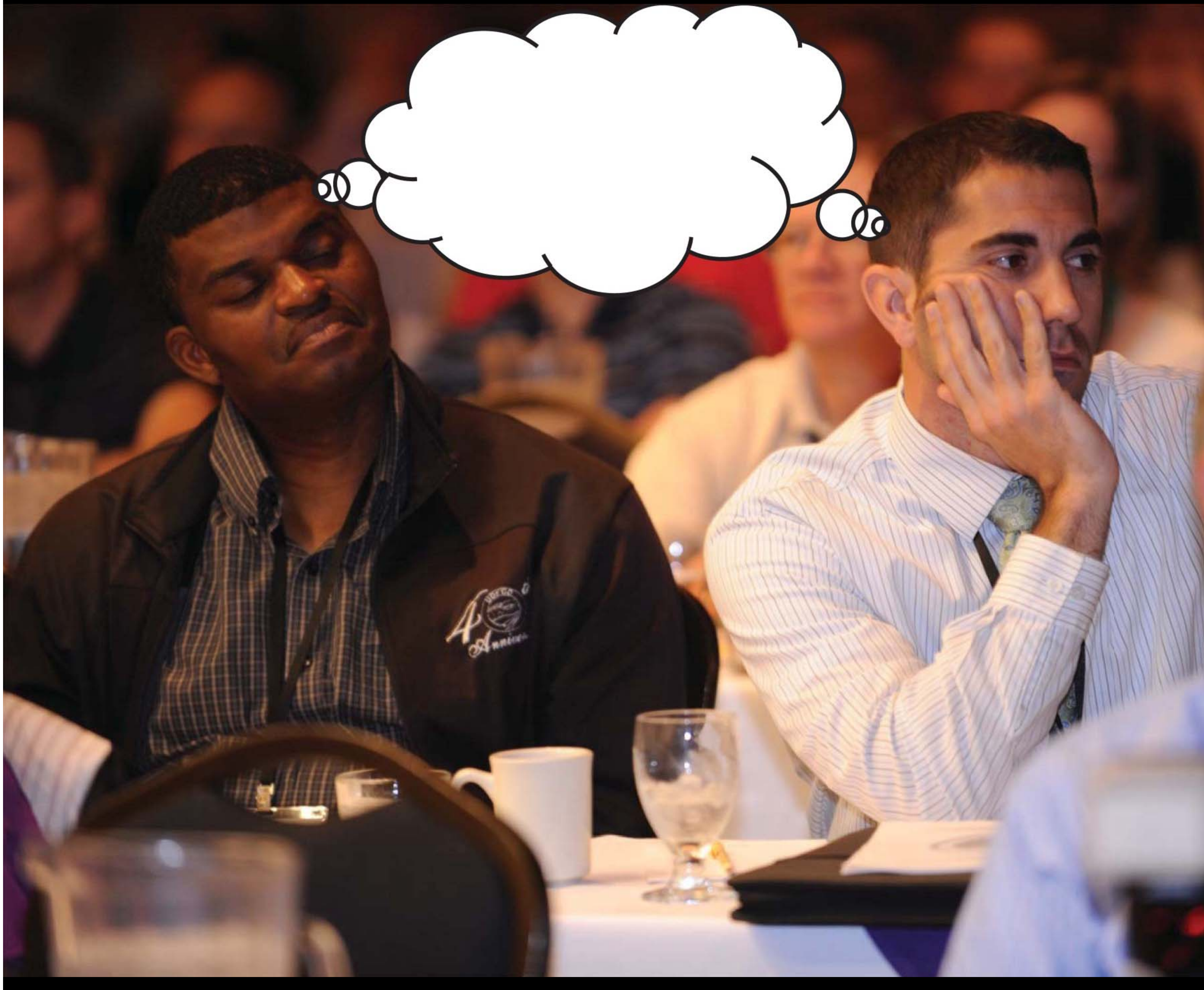
# Things We Learned the Hard Way

David Skuodas, Rich Borchardt, Bryan Kohlenberg, Barbara Chongtoua

2013 UDFCD Annual Seminar

April 2, 2013





# Our Dealings with *Cynomys ludovicianus*

**David J. Skuodas**

dskuodas@udfcd.org


Prairie Dogs


108th Ave
E 107th Pl
City of Thornton
Riverdale
Open Space
& Prairie Dog Habitat
Birch Ct
Ash Ct
Grange Hall Creek
Clermont St
Cherry Ct
E 107th Ave
106th Dr
Cherry St
Bellaire St
E 106th Ct
Clermont Way
Riverdale Rd
Bellaire Ct
E 105th Ave
E 105th Dr
104th Ave
Birch St
E 104th Ave
44



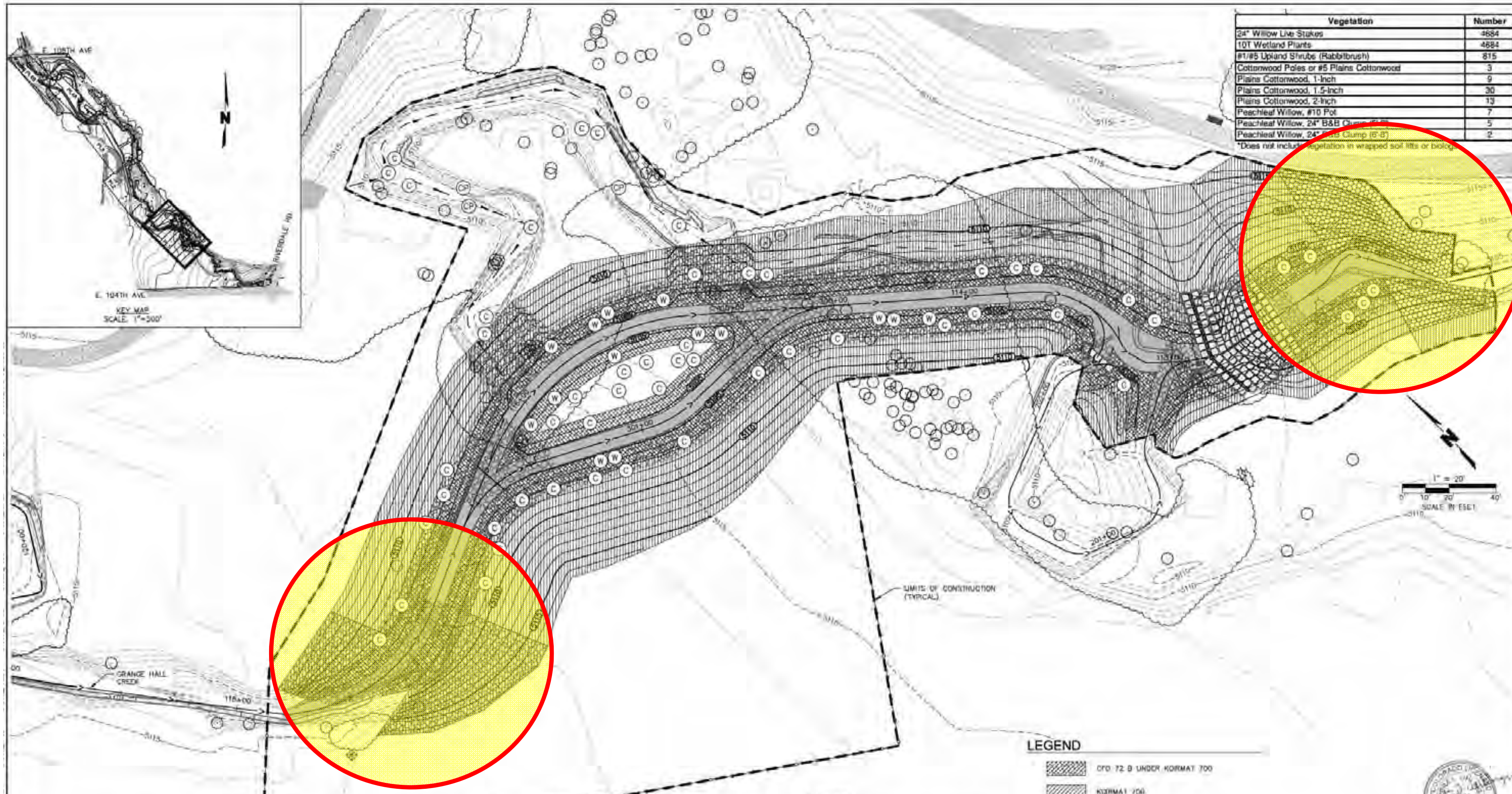
# Existing Conditions



# Existing Conditions


# Existing Conditions

108th Ave
E 108th Ave
E 107th Pl
Birch Ct
Ash Ct
Grange Hall Creek
Clermont St
Cherry Ct
Dexter Dr
E 107th Dr
E 107th Ave
Elm Dr
E 106th Cir
Eudora Way
106th Dr
Cherry St
Riverdale Rd
E 106th Ct
Bellaire St
Clermont Way
Bellaire Ct
E 105th Ave
E 105th Dr
Riverdale Rd
Birch St
104th Ave
44
E 104th Ave




| Vegetation | Number |
|---|---|
| 24" Willow Live Stakes | 4684 |
| 10T Wetland Plants | 4684 |
| #1/#5 Upland Shrubs (Rabbitbrush) | 815 |
| Cottonwood Poles or #5 Plains Cottonwood | 3 |
| Plains Cottonwood, 1-Inch | 9 |
| Plains Cottonwood, 1.5-Inch | 30 |
| Plains Cottonwood, 2-Inch | 13 |
| Peachleaf Willow, #10 Pot | 7 |
| Peachleaf Willow, 24" B&B Clump (5'-6') | 5 |
| Peachleaf Willow, 24" B&B Clump (6'-8') | 2 |

*Does not include [illegible] vegetation in wrapped soil lifts or biolog[illegible]

## LEGEND

- CFD 72 B UNDER KORMAT 700
- KORMAT 700
- WRAPPED SOIL LIFTS
- SILT/PRAIRIE DOG FENCE
- (C) PLAINS COTTONWOOD
- (W) PEACHLEAF WILLOW
- (CP) COTTONWOOD POLES OR #5 PLAINS COTTONWOOD

## NOTES:

1. ALL DISTURBED AREAS OUTSIDE OF LIMITS OF EROSION CONTROL MATS SHALL HAVE UPLAND SEEDING AND HYDROMULCH.
2. ALL TREES ARE TO BE PROTECTED UNLESS OTHERWISE NOTED ON SHEETS EC1-EC2.
3. SEE PLAN AND PROFILE SHEETS FOR LOCATIONS OF SPECIFIC BANK PROTECTION.
4. SEE BANK PROTECTION DETAILS ON SHEET DT4 FOR TYPICAL BANK PROTECTION SECTIONS.

FINAL PLANTING PLACEMENT SHALL BE FIELD VERIFIED BY THE ENGINEER PRIOR TO PLANTING

CALL UTILITY NOTIFICATION CENTER OF COLORADO
811
CALL 3-BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

REVISIONS


OLSSON ASSOCIATES
143 Union Boulevard
Suite 700
Lakewood, CO 80228-1825
TEL 720.962.6072
FAX 720.962.6195

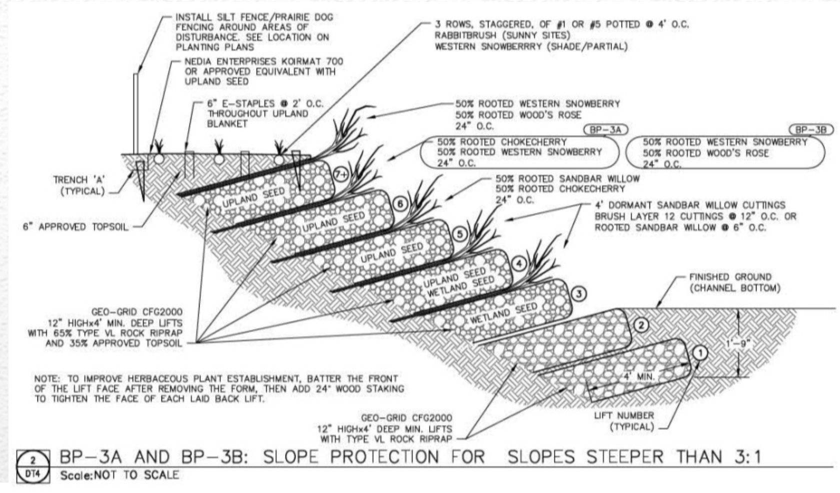

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
CITY OF THORNTON

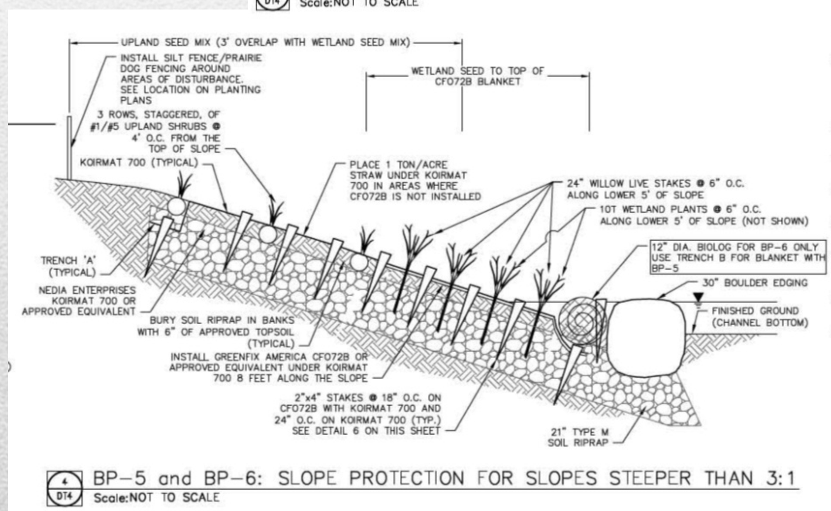
GRANGE HALL CREEK
108TH AVENUE TO RIVERDALE ROAD
CHANNEL IMPROVEMENTS, PHASE II

PLANTING AND MITIGATION PLAN

PL1

- Wrapped soil lifts
- Biolog toe protection
- Vegetated slopes with and without boulder toe
- Tie-ins between improvements and no improvements




# Bank Protection Details

- "Scooching"
- Add'l Silt Fence

# Prairie Dog Countermeasures


Google earth

# During Construction

**DEPARTMENT OF THE ARMY**
CORPS OF ENGINEERS, OMAHA DISTRICT
DENVER REGULATORY OFFICE, 9307 S. WADSWORTH BOULEVARD
LITTLETON, COLORADO 80128-6901

June 22, 2010

RECEIVED
JUN 24 2010
UDFCD

Mr. Paul Hindman
Urban Drainage and Flood Control District
2480 W. 26th Ave
Suite 156-B
Denver, CO 80211

**Re: Department of the Army Permit No. NWO-2009-830-DEN**
**Grange Hall Creek 108th Avenue to Riverdale Road**

Dear Mr. Hindman:

Enclosed is Department of the Army Permit No. NWO-2009-830-DEN for the excavation and placement of fill material into Grange Hall Creek and associated wetlands to construct a channel and bank stabilization project along Grange Hall Creek in Thornton, Colorado. The project area is located along Grange Hall Creek within an open space property between East 108th Avenue and Riverdale Road, within the southern ½ of Section 7, Township 2 South, Range 67 West of the 6th Principal Meridian, in Adams County, Colorado.

General Condition No. 1 of the permit establishes the time limit for completing the work. It reflects a construction period of 5 years from the end of the month of the date of issuance of the permit, **expiring June 30, 2015**.

The Omaha District, Denver Regulatory Branch is committed to providing quality and timely service to our customers. In an effort to improve customer service, please take a moment to complete our Customer Service Survey found on our website at http://per2.nwp.usace.army.mil/survey.html. If you do not have Internet access, you may call and request a paper copy of the survey that you can complete and return to us by mail or fax.

Please notify Matt Montgomery at (303) 979-4120, or the above address, when work on this project is begun and also when completed. He may also be called if you have any questions concerning the permit. When communicating with our office regarding this project please reference File No. NWO-2009-830-DEN.

Sincerely,

Timothy T. Carey
Chief, Denver Regulatory Office

- Add’l Silt Fence
- “Scooching”
- Prairie Dog Fence
- Fence Maintenance
- Select Fumigation

# Prairie Dog Countermeasures


Pre-Construction
Google earth


Mid-Construction
Google earth


Post-Construction
Google earth

# Prairie Dog Fence

# Prairie Dog Fence

2013 UDFCD Annual Seminar

April 2, 2013

# Prairie Dog Fence

**2013 UDFCD Annual Seminar** **April 2, 2013**

# Fence Performance

2013 UDFCD Annual Seminar

April 2, 2013

# Fence Performance

2013 UDFCD Annual Seminar

April 2, 2013

# Fence Performance

2013 UDFCD Annual Seminar

April 2, 2013


© 2013 Google
Goo

# Fence Performance

# Fence Performance

# Prairie Dog Countermeasure Cost

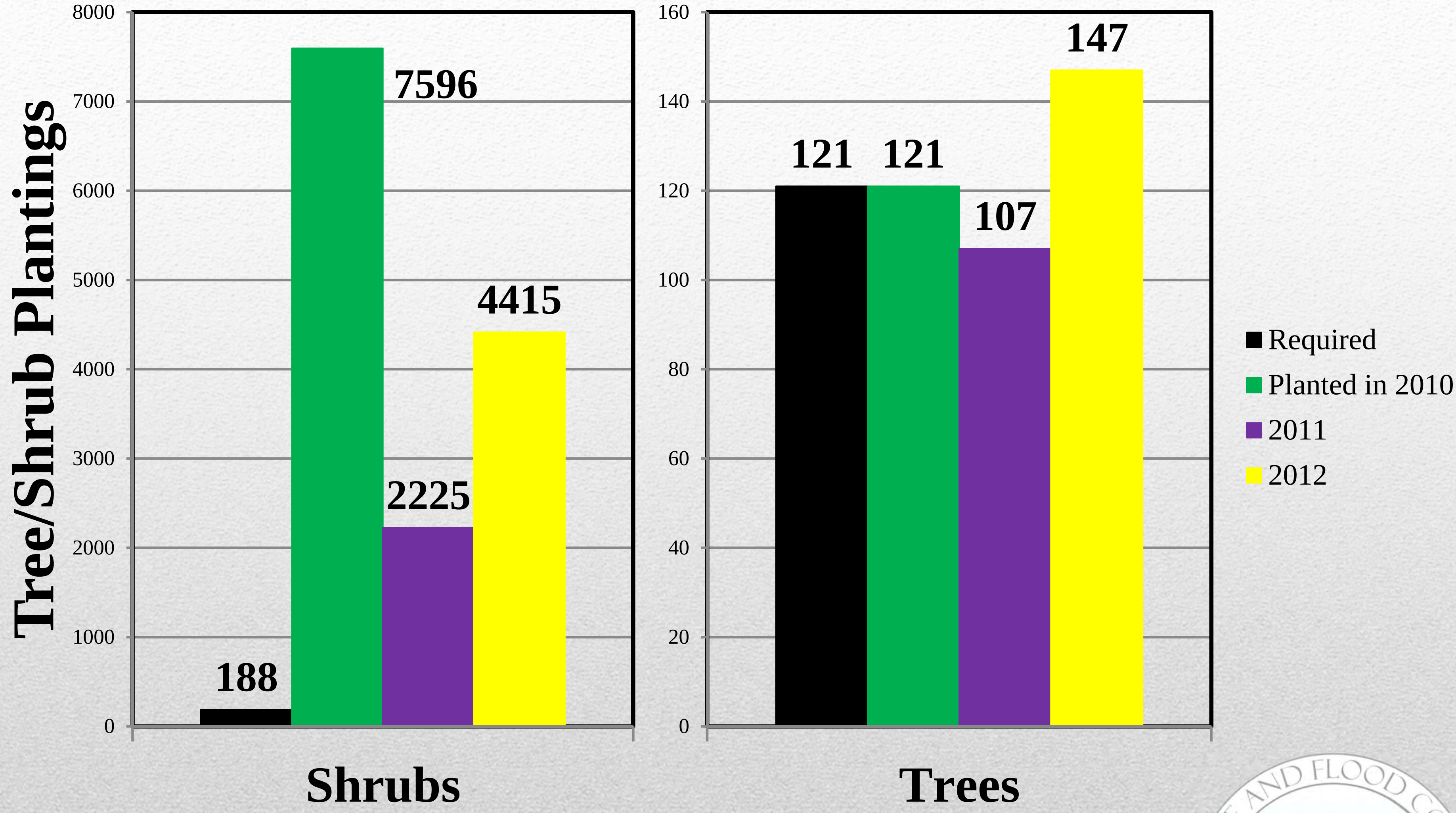
**Total Cost**

**= $58,950**

**Vegetation Cost**

**= $350,000**

- "Scooching" = $1,000
- Add'l Silt Fence = $12,615 ($1.50/LF)
- Prairie Dog Fence = $35,542 ($11.67/LF)
- Fence Maintenance = $4,275
- Fumigation = $5,518 ($250/month)




# 404 Permit Monitoring

# Benefits of Countermeasures

2013 UDFCD Annual Seminar

April 2, 2013

108th Ave
E 108th Ave
E 107th Pl
Birch Ct
Ash Ct
Grange Hall Creek
Clermont St
Cherry Ct
Dexter Dr
E 107th Dr
E 107th Ave
Elm Dr
E 106th Cir
Eudora Way
106th Dr
Cherry St
Bellaire St
E 106th Ct
Clermont Way
Bellaire Ct
E 105th Ave
E 105th Dr
Riverdale Rd
Birch St
104th Ave
44
E 104th Ave

108th Ave
E 108th Ave
E 107th Pl
Birch Ct
Ash Ct
Grange Hall Creek
Clermont St
Dexter Dr
Cherry Ct
E 107th Dr
E 107th Ave
Elm Dr
E 106th Cir
Eudora Way
106th Dr
Cherry St
Bellaire St
E 106th Ct
Clermont Way
Riverdale Rd
Bellaire Ct
E 105th Ave
E 105th Dr
Riverdale Rd
Birch St
104th Ave
E 104th Ave
44

# Conclusions

## Do What's Right for Your Project

- Know your local politics
- Fence helps but will be compromised
- Buried fence works better but costs more (use metal T-posts)
- Fumigation helps but must be continuous
- Anything short of total extermination does not work (BE REALISTIC)
- Consider mitigation options – mitigation credits? (~$65K/acre)

**David J. Skuodas, dskuodas@udfcd.org**

# Close Encounters of the Fence Kind

Richard G. Borchardt, rborchardt@udfcd.org

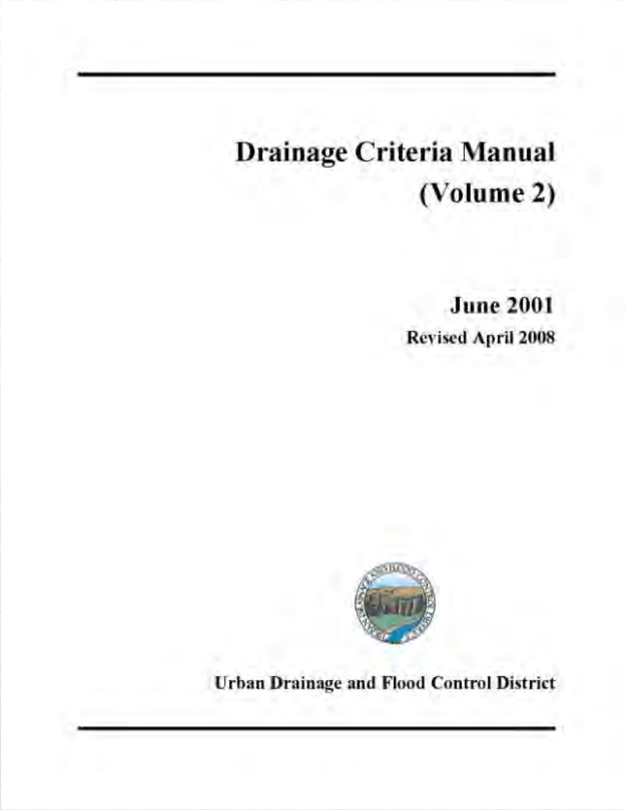

# Goldsmith Gulch – Peakview to Caley


# Goldsmith Gulch – Peakview to Caley

2013 UDFCD Annual Seminar

April 2, 2013


# The Problem with Fences...



Drainage Criteria Manual
(Volume 2)

June 2001
Revised April 2008

Urban Drainage and Flood Control District

- Concrete Channel Section:

  A 6-foot-high chain-link or comparable fence shall be installed to prevent access wherever the 100-year channel concrete section depth exceeds 3 feet. Appropriate numbers of gates, with top latch, shall be placed and staggered where a fence is required on both sides of the channel to permit good maintenance access. Fence is constructed on top culvert. Water pool and riprap in bottom of culvert.

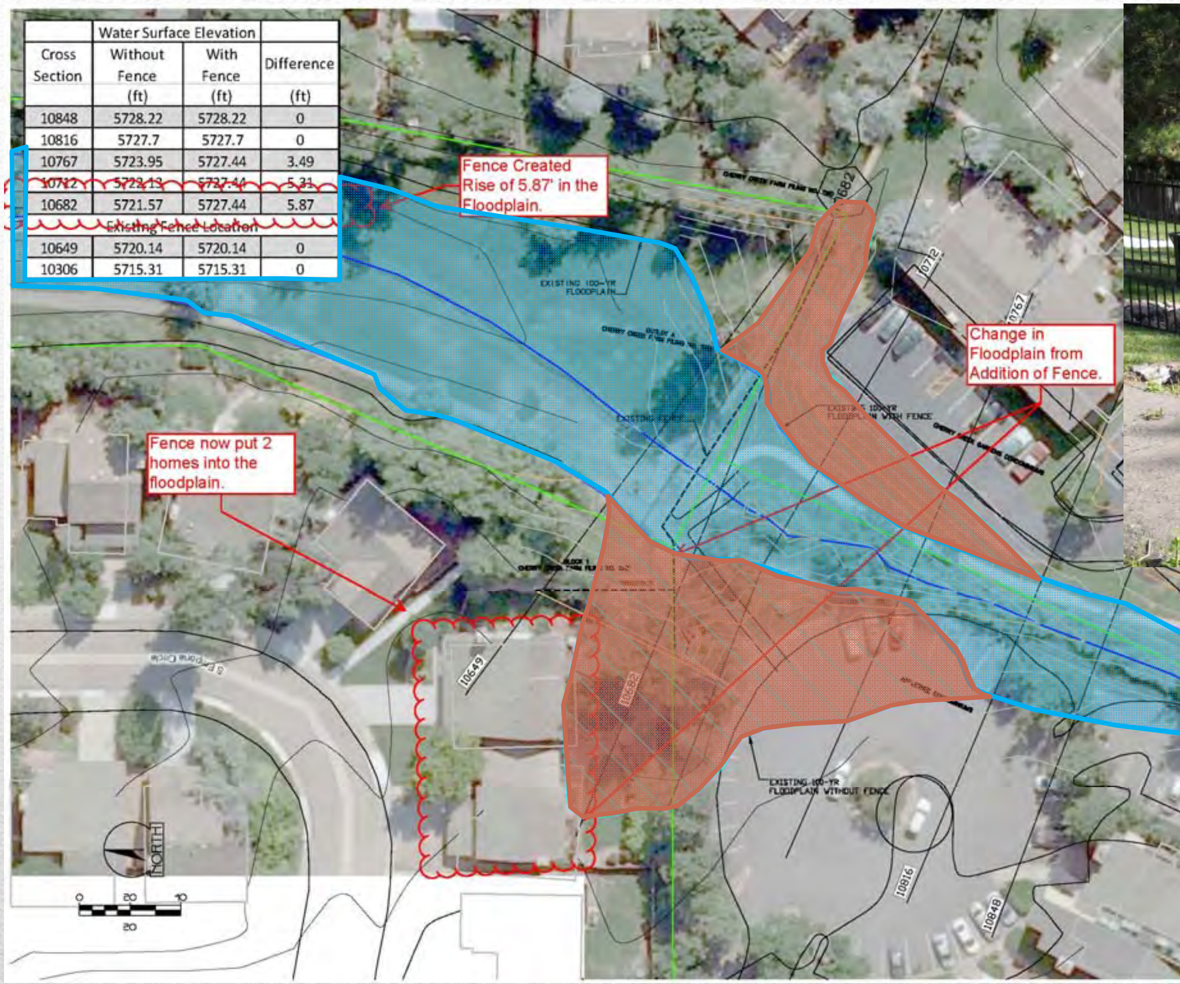
- Storage Chapter :

  Often designers use trash racks and/or fences to minimize hazards. These may become trap debris, impede flows, hinder maintenance, and, ironically, fail to prevent access to the outlet. On the other hand, desirable conditions can be achieved through careful design and positioning of the structure, as well as through landscaping that will discourage access (e.g., positioning the outlet away from the embankment when the permanent pool is present, etc.). Creative designs, integrated with innovative landscaping, can be safe and can also enhance the appearance of the outlet and pond. Such designs often are less expensive initially.

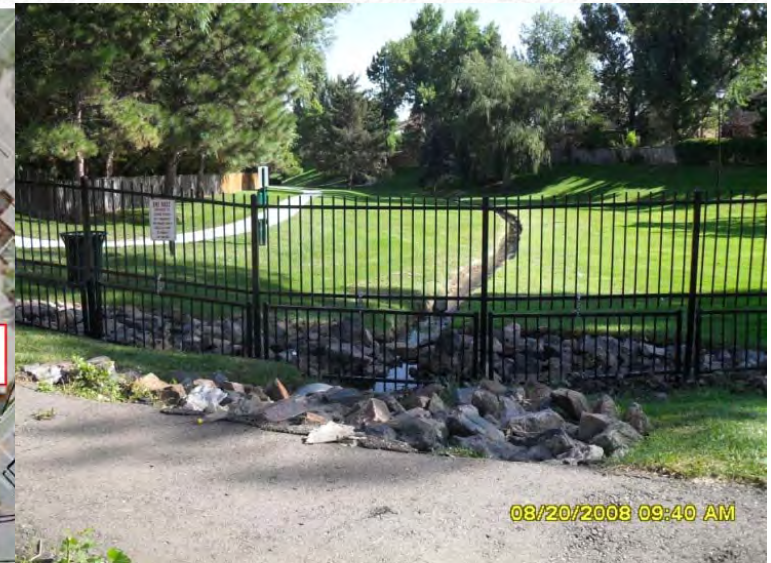
General opinion is no fences in the floodplain is the preferred solution.

# What does UDFCD think?


# No Problem…Bottom is break away.




| | Water Surface Elevation | | |
|---|---|---|---|
| Cross Section | Without Fence (ft) | With Fence (ft) | Difference (ft) |
| 10848 | 5728.22 | 5728.22 | 0 |
| 10816 | 5727.7 | 5727.7 | 0 |
| 10767 | 5723.95 | 5727.44 | 3.49 |
| 10712 | 5722.13 | 5727.44 | 5.31 |
| 10682 | 5721.57 | 5727.44 | 5.87 |
| Existing Fence Location | | | |
| 10649 | 5720.14 | 5720.14 | 0 |
| 10306 | 5715.31 | 5715.31 | 0 |




**What happens when the fence is an obstruction to the floodplain?**

# Two homes are in the floodplain.

# Houston…We Have a Problem.

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- Remove the Fence?
- Wait until something happens or changes?
- Call in extra terrestrial help?

# What do we do now?...Close Encounters of the Fence Kind.



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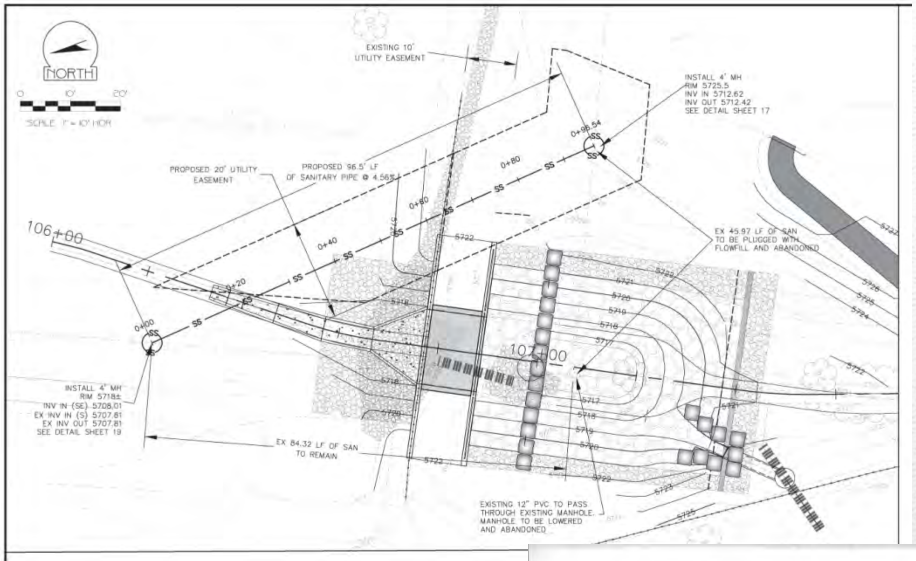
- Hire an experienced and innovative engineer…they can solve anything.
- A balanced approach…evaluate the risks and benefits of each decision and look for ways to minimize risks while maximizing benefits.
- Work with patient and persevering local governments…who can navigate the land acquisition and public outreach.

# What we did…




- Floodplain goes through 3’ (tall) by 15’ (wide) 3-sided box culvert.
- Fence is constructed on top culvert. Water pool and riprap in bottom of culvert.

## What we did…

- Floodplain Management …use to avoid bigger problems later.
- A balanced approach manages risks…involves some compromise and additional expense. Project moves forward if benefits outweigh risks.
- Waiting to do a project …the risks outweigh the benefits. Project waits for shift in circumstance to move forward.


# The Solution = Floodplain Management + Managing Risks + Patience



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# Close Encounters of the Fence Kind

Richard G. Borchardt, rborchardt@udfcd.org

# BEWARE !! LOW-FLOW CROSSINGS AHEAD !

Bryan W. Kohlenberg, PE, CFM
DCM – Senior Project Engineer
bkohlenberg@udfcd.org

## BEWARE OF LOW-FLOW CROSSINGS?

# SERIOUSLY ? ...WHAT ARE YOU TALKING ABOUT ?

# Go Big!
# Obviously Not This

# Not This!


# Not Even This!

# YES….. Like This One

# Lakewood Gulch

## at 8th and Teller Street

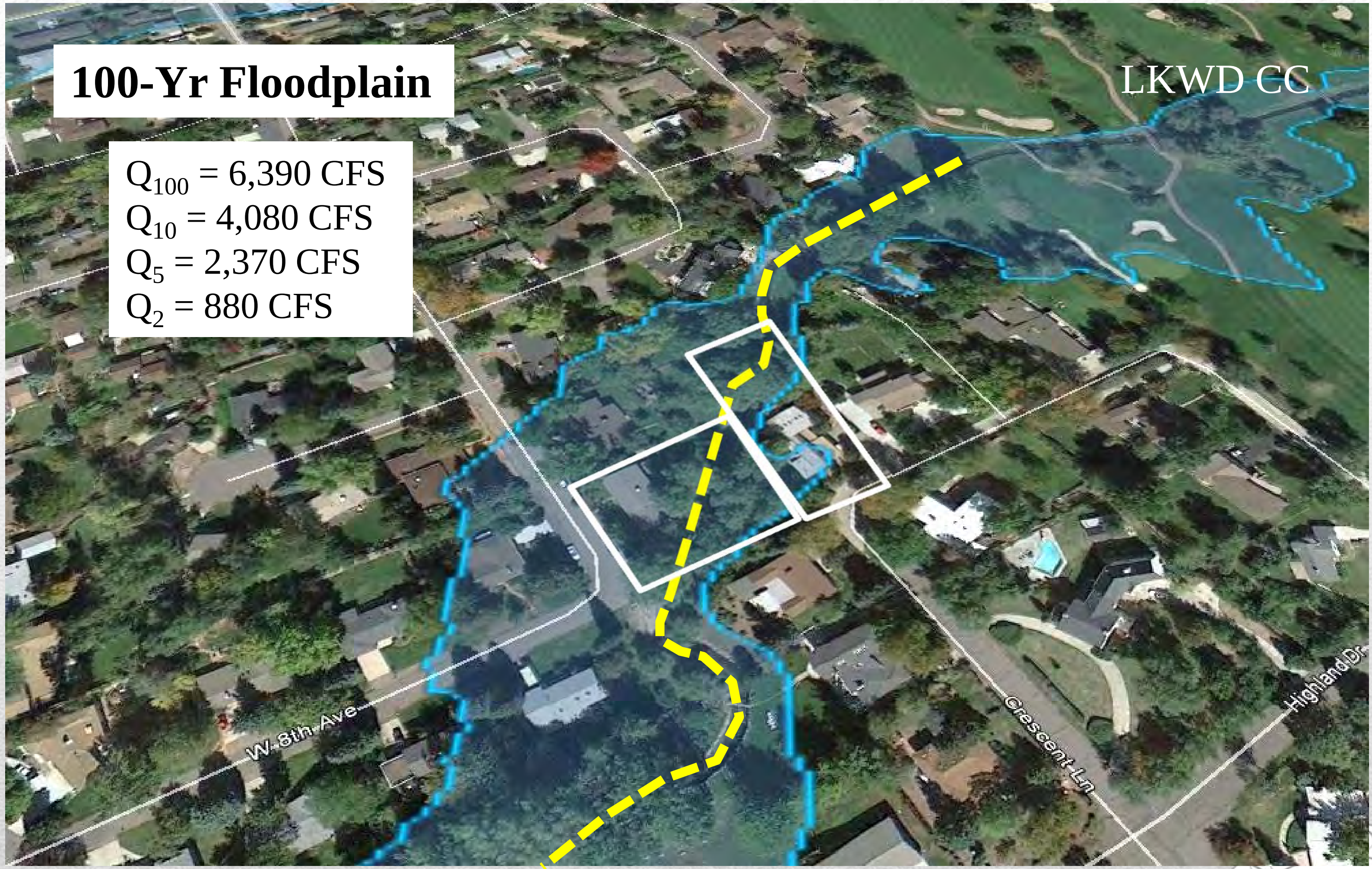
## Lakewood – Jefferson County

## What We Did, Why We Did It, What We Learned

**(The Hard Way)**

Older Residential Neighborhood

# Lakewood Gulch




Older Residential Neighborhood

# Lakewood Gulch

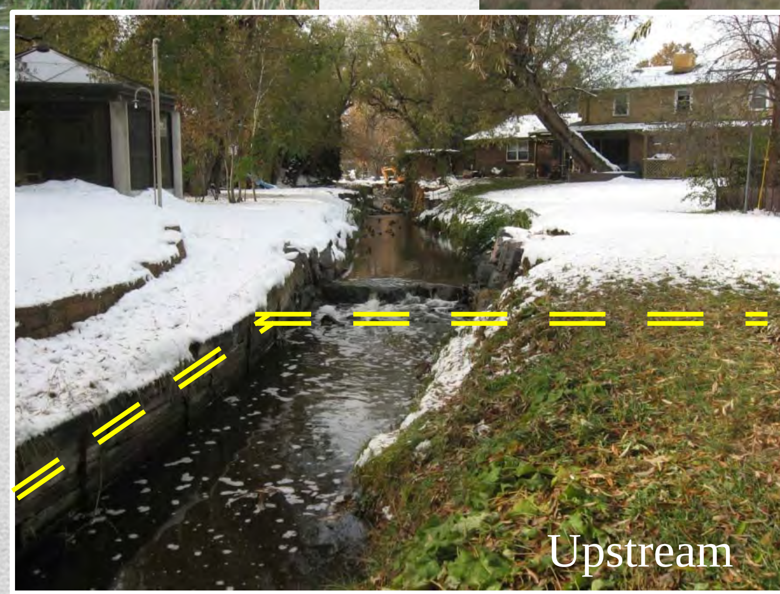
# Lakewood Gulch – Existing Problems


Failing Walls


Failing Banks

Foundation Protection

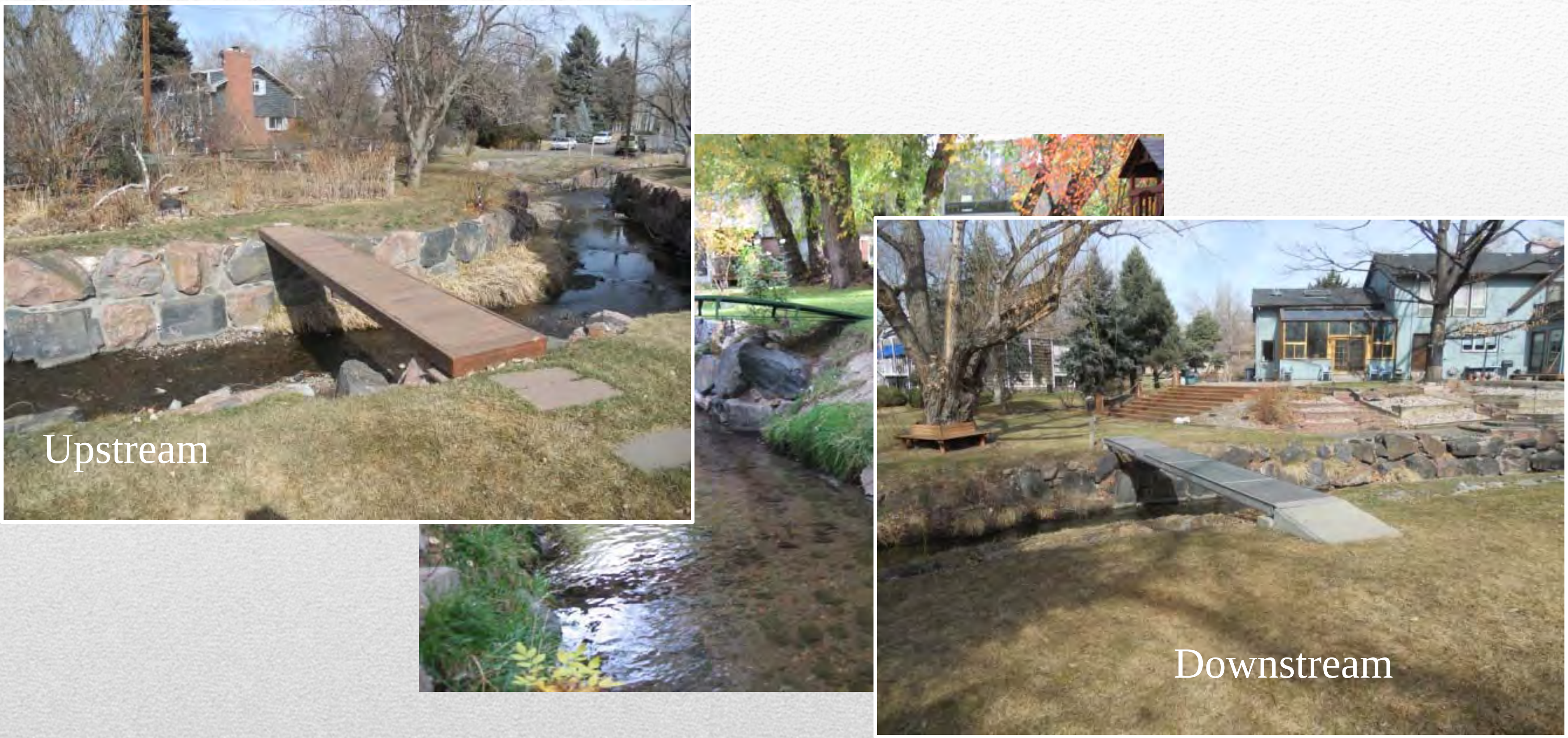
Sewer Protection




# Lakewood Gulch – Existing Problems

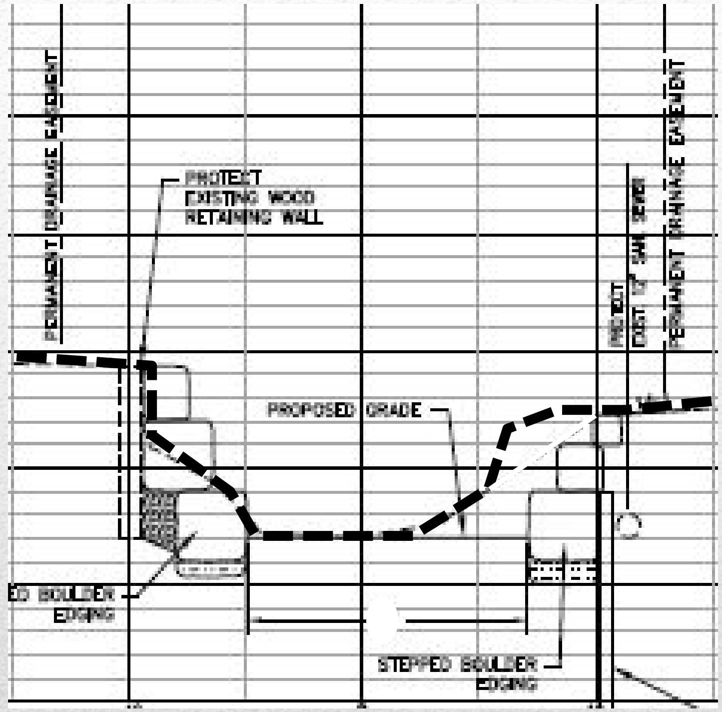
Subject Private Bridge To Backyard Play Area

# Lakewood Gulch - Existing




**Neighbor Bridge Crossings**

# Lakewood Gulch - Existing




Boulder Lined Channel Design Section
Slightly Wider

# Lakewood Gulch - Solution

# "Looks Great, But Where's <u>My</u> Bridge? I Can't Get To My Property"

## Lakewood Gulch



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**POINT:** The existing bridge will not fit the new widened channel section, but the homeowner insists upon having a bridge.

**COUNTERPOINT:** The District does not specifically address private bridges nor do most local, state, or federal floodplain regulations

# WHAT WOULD YOU DO ?

## Lakewood Gulch

"The Zimmerman Family"
Remember… You're dealing with them too!!

# Lakewood Gulch

# Possible Options:

1. Don’t construct project if property owner just can’t live without the bridge crossing.

2. Remove the bridge and place aside during construction. Let property owner mysteriously deal with it. If it comes back owner may be cited.

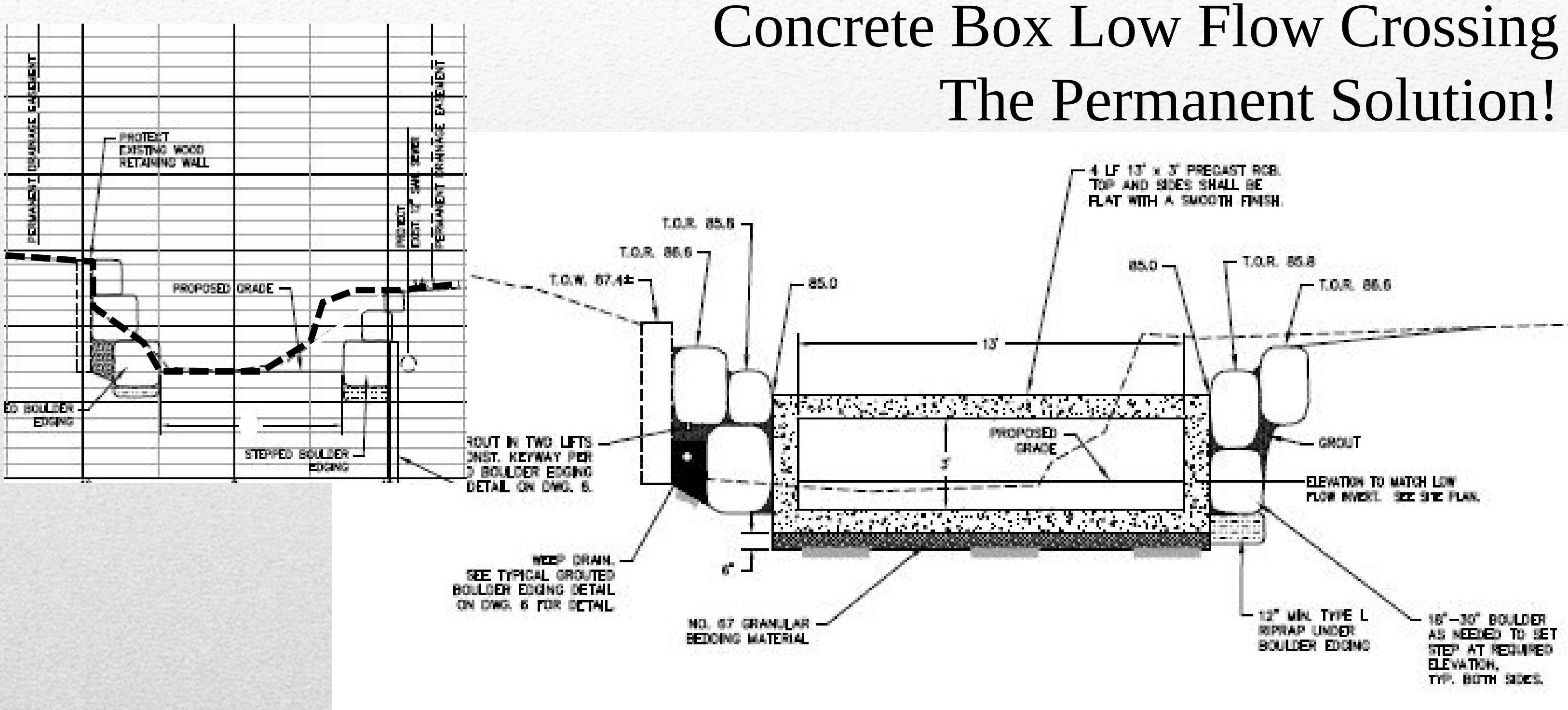
3. Require property owner to re-design and build their bridge to comply with local floodplain regulations.

4. Design and construct a permanent bridge that won’t become debris and won’t increase flood risks upstream.

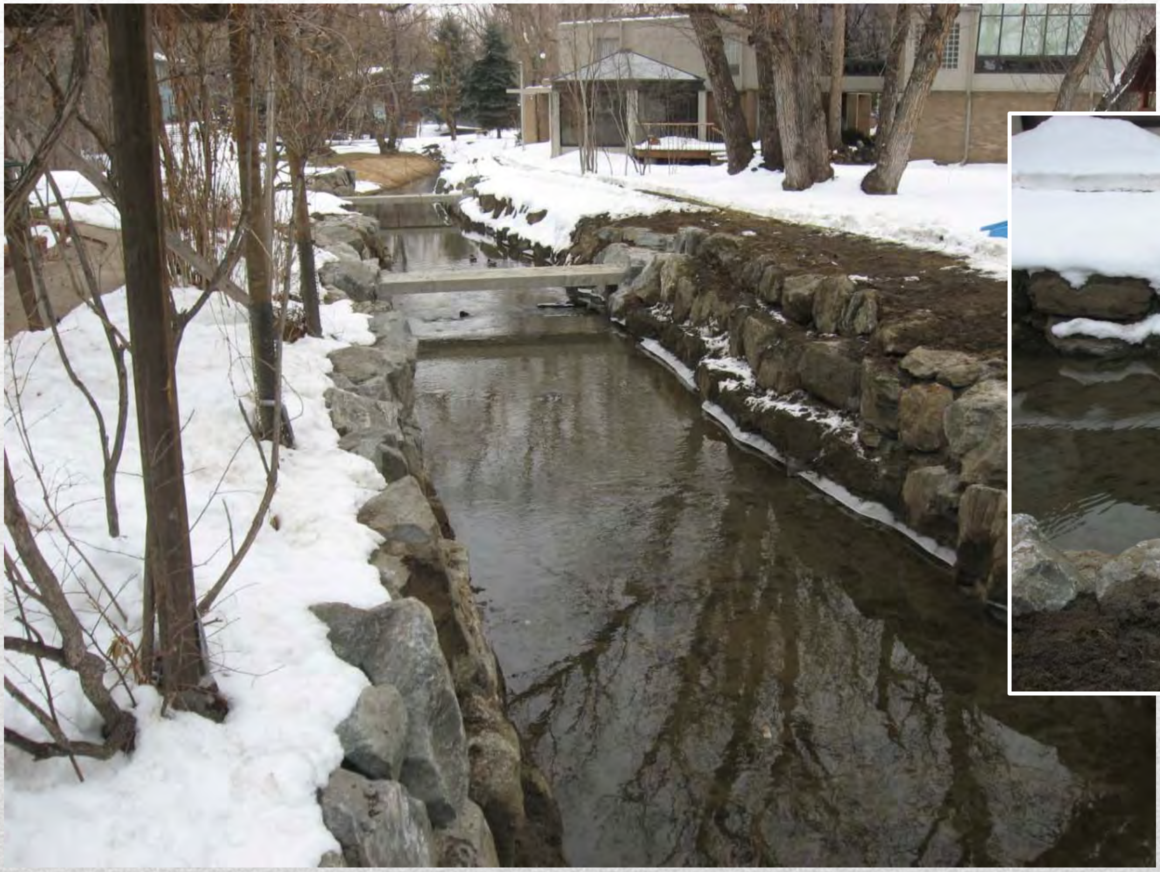
5. Use breakaway/tethered bridges if local floodplain regulations don’t prohibit.

# HERE’S WHAT WE DID

Concrete Box Low Flow Crossing
The Permanent Solution!




## Lakewood Gulch



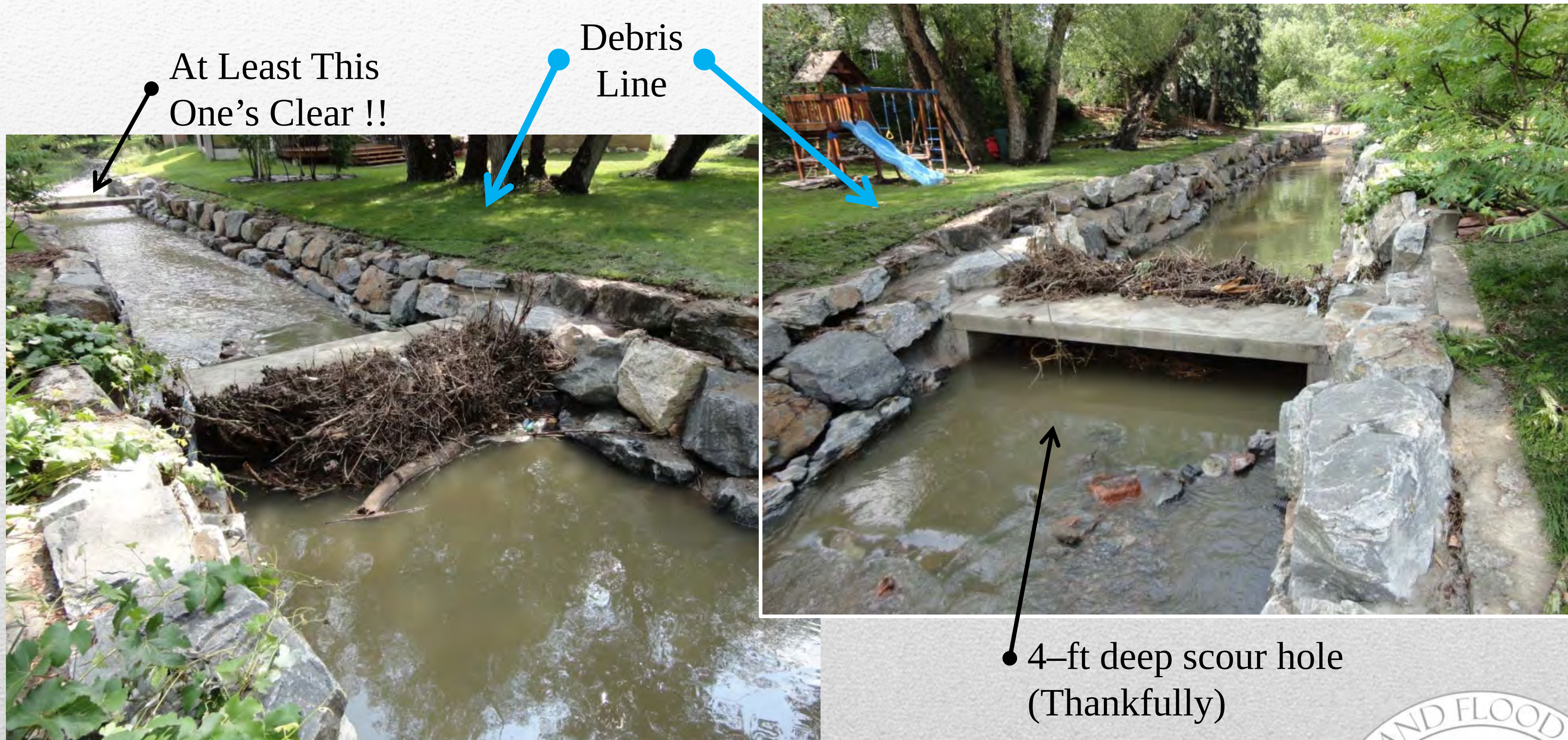
Finished Low Flow Bridges

Everyone's Happy!

# Lakewood Gulch

June 6, 2012 Storm

## 6:30am call: “Help, Your Bridge Is Not Working !”




Qest. = 450 CFS

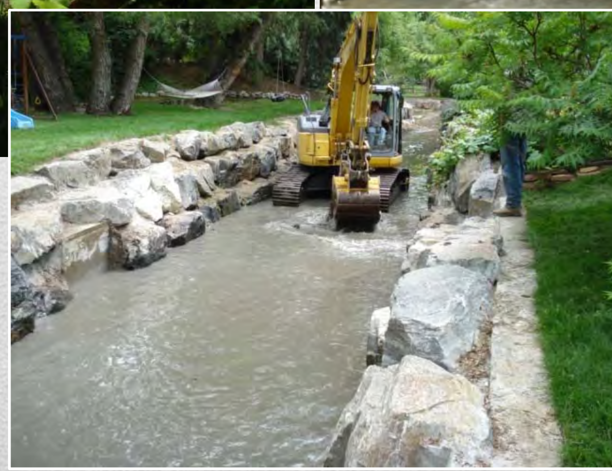
# Lakewood Gulch

June 6, 2012 Storm

4 houses upstream

Tethered upstream wooden bridge was unseated

# Lakewood Gulch



Bridge Removal

All Gone

# Lakewood Gulch

**Owner’s Position:**

- “My neighbors have a bridge - Why can’t we?”
- “It was there when we bought the place”
- “We have to have access to our backyard to maintain it”
- “Why can’t you build us a new bridge?”
- “Can you reset the bridge after the flood?”



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**Things To Consider:**

**Don't Replace Bridge**

- Don't do project
- Backyard property swap
- Floodplain preservation

**Replace/Build New Bridge**

- If the bridge opening becomes plugged where does the overflow go? Is there overbank capacity?
- Permanent vs. Tethered
- Safety issues
- Liability issues – Release of?
- Debris potential

## Here's What We Learned:

✓Floodplain preservation and backyard swap to eliminate bridge not popular with property owners, however, District encourages these techniques first.

✓Debris happens so plan for it – Just modeling small openings plugged may not be enough.

✓ It's not all about the 100-year flood – Identify critical flow thresholds.

✓ Lighter (wood) bridges unseat easy, float and align with flow, but must be tethered to one side.

✓ Build relationships with property owners and educate.

Completed Project

# Lakewood Gulch

# FOR NOW!!!!!

In the end it fit!
Our Problem Solved?

## Lakewood Gulch

# Vegetation and Hydraulics –

**What we have *GROWN* to know…is that we are *saplings* in our understanding**

Barbara Chongtoua, bchongtoua@udfcd.org

Marcy Gulch, Douglas County

# West Harvard Gulch, Denver County

Consider the Balance of Function *(Hydraulics)* and Form *(Vegetation)*


# Fringe Benefits

# Fringe Benefits

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# Fringe Benefits

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# A Liability?

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# A Liability?


# Willow Syndrome

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# Willow Syndrome


# A Liability?

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# Anything is a Liability.

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# Just Need Balance

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# Just Need Balance

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# Just Need Balance

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Flow Path
Just Need Balance



# Promising Results

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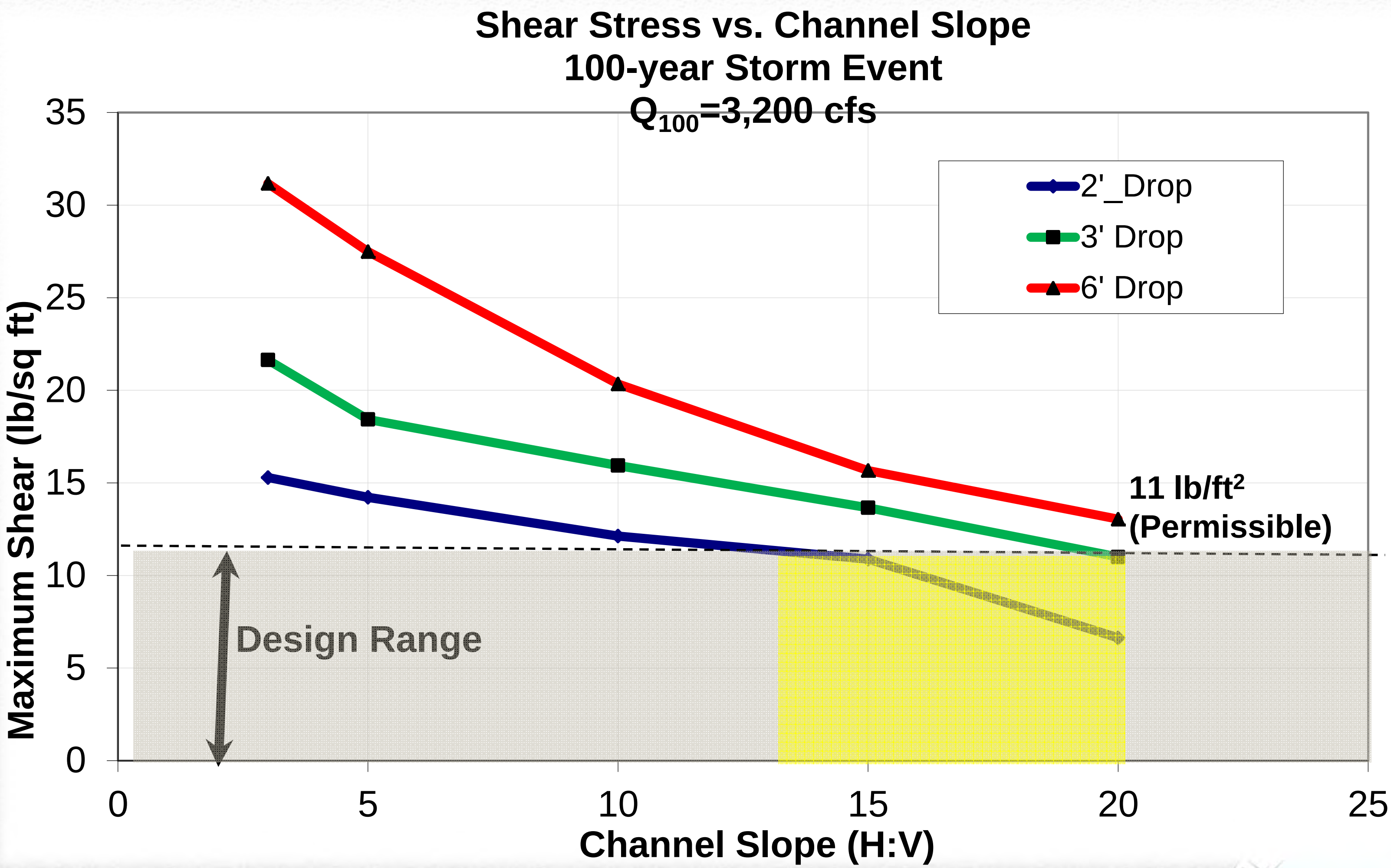
Tree
Failing Drop Structure
Before
Tree
After

# Right Application?




# Sustainable?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•***Be deliberate*** in the selection of plant species considering hydrology, hydraulics, and location.

•Consider the ***application*** and ***mature state of vegetation.***

- •Willowsyndrome
- •Herbaceous vs. Woody
- •Clumps vs. Lineal

•***Promote open discussions and collaboration*** amongst specialists.

# Considerations