The History of the Urban Drainage & Flood Control District

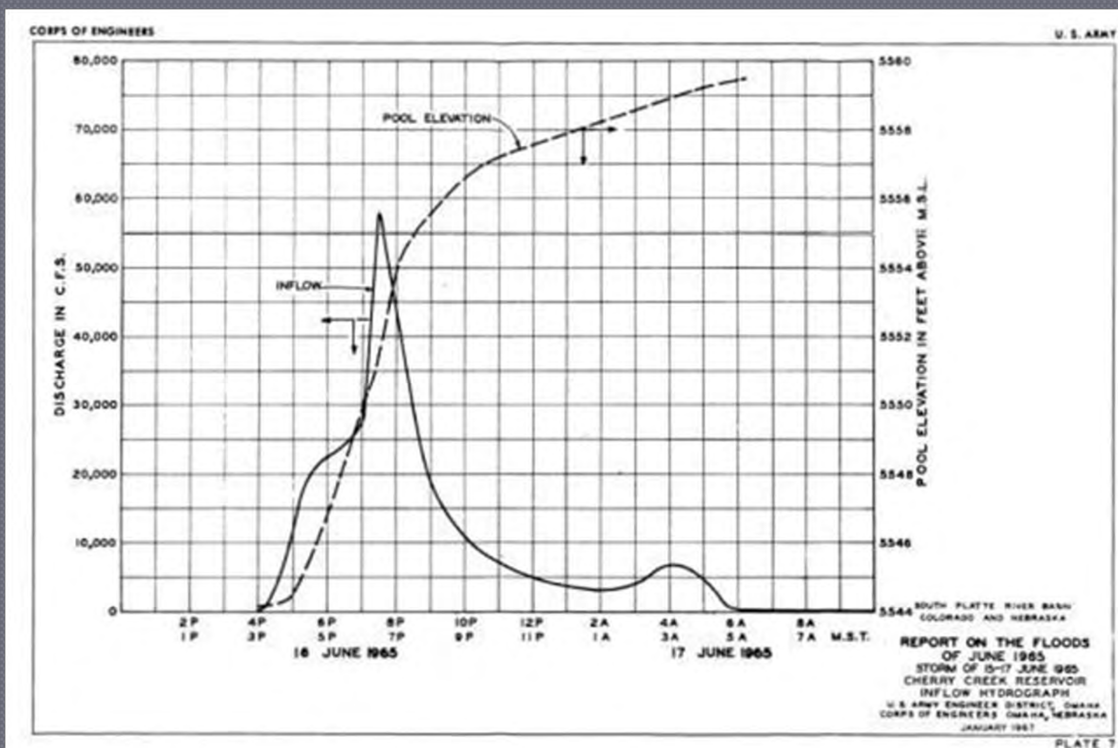
By Bill DeGroot

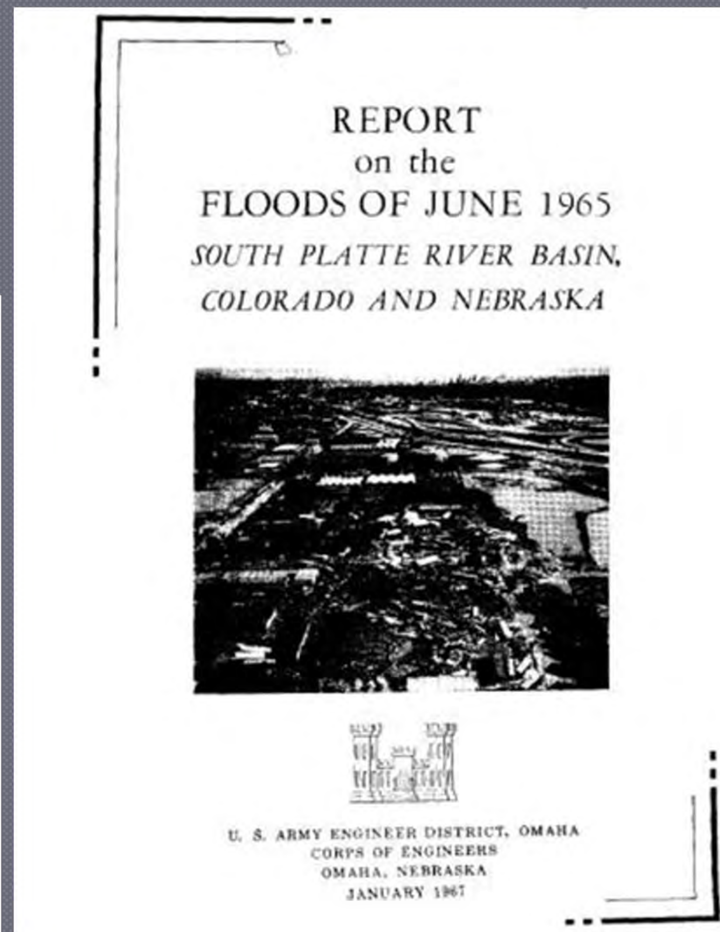
2011 Urban Drainage Seminar

Where were you in 1965?

- Medicare and Medicaid signed into law
- First American combat troops arrive in Viet Nam
- Beatles perform first stadium concert at Shea Stadium in New York
- Edward White is first American to walk in space
- I graduated from high school
- Many of you were a twinkle in your daddy's eye
- Major floods in Colorado

The impetus for creation of the District was the 1965 floods





(32) Some of the greatest losses in Metropolitan Denver occured north and south of West Alameda Ave. and west of the river. Many homes and businesses were completely destroyed by the great flood of June 16th, 1965. This scene of desolation is at West Alameda Ave. and Navajo Street, looking toward the river.

43) The twin spans which once gracefully carried West Hampden Ave. across the South Platte River were dropped into the torrent when the center piers were taken out by the collapse of the old Hampden Ave. bridge, part of which is seen along the west bank, on the left.

(3) At East 78th Ave. the river destroyed the old Welby Road bridge and the wooden pile trestle on the Union Pacific Railroad's Dent Branch.

(28) The greatest single concentration of flood debris within Denver, containing cars, truck trailers, house trailers, campers, tanks and hundreds of thousands of board feet of new and used lumber is lodged against the West 6th Ave. bridge. Note the car crushed by the huge pipe in the foreground.

(44) Both the railroad and road bridges at West Oxford Ave. were torn away by the violent assault of the debris laden flood waters.

(1) The massive flood on the South Platte River spreads out over a wide expanse of land just east of Thornton.

Table 9
SUB-BASIN FLOOD DAMAGE SUMMARY
(JUNE 1965 FLOOD)

Stream-Basin	Rural	Urban	Trans. w/delays	Total
Plum Creek	$4,234,000	$1,548,000	$6,652,000	$ 12,434,000
So. Platte River				
Denver Metro	2,188,000	184,932,000	135,268,000	322,388,000
Brighton to Bijou Cr.	4,829,000	25,000	1,878,000	6,732,000
Bijou Cr. to Colo. Line	19,400,000	2,676,000	3,853,000	25,929,000
Colo. Line to No. Platte	4,951,000	5,000	432,000	5,388,000
Cherry Creek	795,000	0	511,000	1,306,000
Sand Creek	94,000	316,000	2,107,000	2,517,000
Toll Gate Creek	51,000	169,000	468,000	688,000
Cache La Poudre R.	711,000	85,000	1,915,000	2,711,000
Kiowa Creek	1,480,000	0	1,064,000	2,544,000
Commanche Creek	1,150,000	0	1,798,000	2,948,000
Bijou Creek				
Mouth to Damsite	908,000	0	2,200,000	3,108,000
Damsite to Forks	423,000	0	650,000	1,073,000
West Bijou	765,000	106,000	1,319,000	2,190,000
East & Middle Bijou	1,331,000	711,000	4,629,000	6,671,000
Badger Creek	753,000	0	1,561,000	2,314,000
Beaver Creek	876,000	249,000	605,000	1,730,000
Pawnee Creek	849,000	77,000	1,788,000	2,714,000
Platte River	413,000	5,000	130,000	548,000
Miscellaneous Areas	6,404,000	255,000	2,484,000	9,143,000
Total	$52,605,000	$191,159,000	$171,312,000	$415,076,000

Zymurgy's Seventh Exception to Murphy's Law:

When it rains it pours

1965-1967

- Five County Engineer's Council
  - County engineers from Adams, Arapahoe, Boulder, Denver and Jefferson Counties
  - Also engineers from Public Service Company, Mountain Bell, Denver Water Board, Littleton, Englewood, Portland Cement Association and Wheat Ridge Water and Sanitation District
  - State Senator Joe Shoemaker became involved in 1967

1967-1968

- The Five County Engineer's Council became the Metropolitan Urban Drainage Advisory Committee of the Denver Regional Council of Governments (DRCOG)
- DRCOG hired Wright-McLaughlin to prepare an *Urban Storm Drainage Criteria Manual*
- The Advisory Committee helped DRCOG with policy questions during preparation of the *Manual*

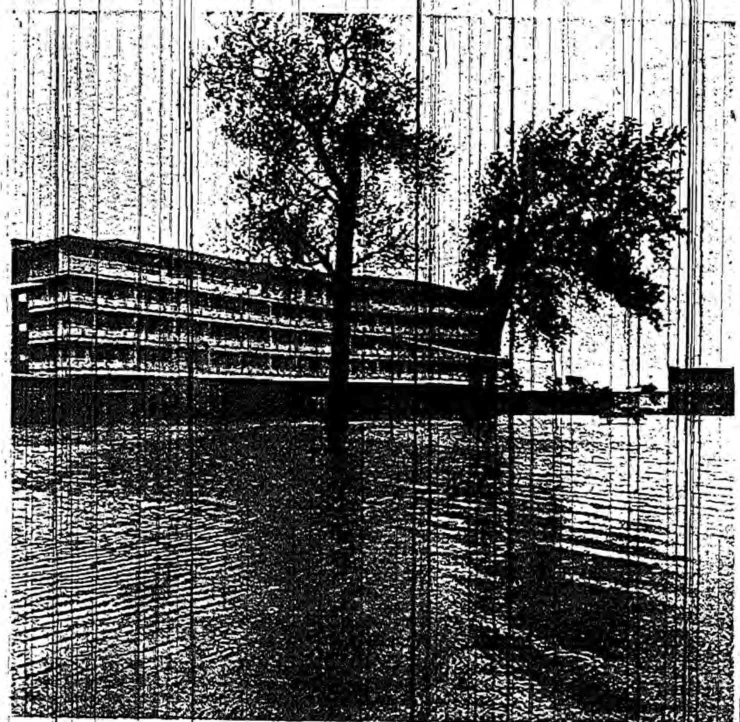
1968

- The policy decisions and 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 District
- The Advisory Committee decided to pursue legislation in 1969 which would create an Urban Drainage and Flood Control District

1969

- Senator Shoemaker introduced the legislation in the Senate, and it passed 26 to 7 with 2 absent
- Representative Ted Bryant introduced the legislation in the House, where it was going nowhere
- Then, on a Saturday in May it began to rain. It rained all weekend and gave no sign of letting up

New Flooding Perils Denver, Other Areas



The Harvest House in Boulder was only one of the many places in the Denver area where water filled a good part of the scenery.

ROCKY MOUNTAIN NEWS PHOTO BY JOHN GORDON

Mud and rockslides caused by nearly three days of rain closed most of the roads near Denver leading into the snowy mountains.

By GEORGE KANE
Rocky Mountain News Writer

Continued heavy rains and snow in Colorado's isolated mountain communities Wednesday sent tributaries of the South Platte River out of their banks. One unconfirmed death was reported in Boulder County.

A flood warning was issued by the U.S. Weather Bureau Wednesday morning, and by midnight some areas of Denver, Littleton, Englewood, Sheridan, Arvada and Westminster reported farmland, residential areas, streets, highways and railyards flooded.

Boulder police reported a possible drowning at mid-afternoon, but a 40-man search team had failed to find a body by midnight. They reported a 21-year-old former University of Colorado student was seen floating in an inner tube on flooded Boulder Creek east of that city.

The inner tube was later seen passing under a bridge. Police would release no name for the possible drowning victim, saying the death was still unconfirmed.

Debris Piled Up

Nearly a dozen locations spotted over the Denver Metropolitan Area were evacuated or partially-evacuated as debris piled up against bridges and caused speeding waters to back up and overflow banks on a half-dozen creeks.

Meat packing plants and residents in the area around E. 51st Ave. and Franklin St. were reported evacuating, as were residents near W. Dartmouth Ave. and S. Gray St., S. Wadsworth Blvd. and Bowles Ave., W. Hampden Ave., low areas between S. Federal Blvd. and S. Wadsworth Blvd. and W. Colfax Ave. and 16th and W. 17th Aves. at the river.

Sixty Metropolitan State College students volunteered their help in evacuating families from some of the areas, and temporary shelters were set up in the Platte Valley Action Center, 3204 W. Colfax Ave., and Rudy Center at W. 13th Ave. and Decatur St.

Telephone service in Southwest Denver areas was reported disrupted, and power was out in a few isolated areas.

In Denver, the W. Evans Ave. Bridge over the Platte at S. Santa Fe Dr. was in danger, and highway crews expected a bridge over Bear Creek at W. Hampden Ave. and S. Knox Ct. to wash away at any time.

Navajo Freight Lines moved all of its trucks and much other equipment to high ground on Ruby Hill, overlooking the Platte, and dozens of businesses along S. Santa Fe Dr. were evacuating.

Railyards Flooded

Denver's railyards were flooded by rising waters of the Platte. The switching line around the north edge of the city was closed by washouts. Rock Island trains were detoured through Union Depot.

In the Colorado & Southern Railway's Seventh St. yard, workmen were building a two-foot earthen dike to hold back water from the Platte. The yard adjoins the river and suffered heavy damage in the 1965 flood.

There was no damage reported at the railyards nor at Centennial Race Track, although officials at the latter were moving records out of offices.

A tornado was reported south of Haxtun, Colo., in the northeast corner of the state. Haxtun is south of Julesburg. There were no reports of damage.

The mountain communities of Georgetown, Idaho Springs, Central City, Granby, Fairplay, Deckers, Jamestown and Bailey were reported totally isolated.

Public Service Co. (PSC) reported 17 inches of snow at Allenspark, and the Colorado State Patrol said 15 inches fell at Ward, west of Boulder.

The isolated communities were reported without electric power, long distance telephone communications and cut off by snow-covered and mud-slide-covered roads.

A Mountain States Telephone Co. spokesman said all crews are on the job, and said wet cables in Denver were causing widespread telephone interruptions throughout the area.

Building Collapses

Another unconfirmed report from Georgetown said the Silver Queen Theater there, one

- Representative Bryant advised the House that if they wanted the rain to stop they should pass the bill, which they did, 49 to 14 with 2 absent
- Governor Love signed the bill and the District was born
- The District began operations later in 1969 with a staff of two and authorization to levy up to 0.1 mills for general fund operating expenses

1969-1970

- The District assumes responsibility for the *Urban Storm Drainage Criteria Manual*

1970

Wheat Ridge Sentinel 11/11/70

Commission OKs PUD, Flood Plan

Better planning and better living for Wheat Ridge residents were the subject of the Nov. 2 Planning Commission meeting where a Planned Unit Development (PUD) ordinance and Flood Plain Ordinance were given final approval.

The PUD ordinance, months in preparation, will go to the City Council on Nov. 19.

In general, PUD will allow the developer greater freedom in planning a development without the the restrictions of conventional setbacks, rigid requirement of square feet per lot, etc. Instead, the developer can use clusters of homes, provide more open space for community of use, and cut down on street construction by emphasizing cul-de-sacs and more imaginative layouts.

PUD has the added advantage, as far as the city is concerned, of requiring the developer to submit a specific development plan and to follow that plan, once approved, or lose his zoning. Under the tradtional concept of zoning, a developer can promise to build a beautiful restaurant but put up a gas station instead, once he had obtained commercial zoning.

THE FLOOD PLAIN ordinance will allow the city to keep the wrong kind of development, development which would be destroyed in the event of floods, out of flood plains.

Establishing a flood plain zoning classificiation also is the first requirement for applying for federal aid to develop parks along Clear Creek. Hopefully, riding trails, playground areas, fishing and hiking, will be developed eventually.

James Quinn, director of the Urban Drainage and Flood Control District, will be at the Nov. 19 Council meeting to discuss the ordinance. State Rep. George Fentress (R), also has pledged his full support.

Secretary of the Interior Walter J. Hickel has highly praised the concept of a greenbelt recreation area, Four Seasons National Recreation Area, within the South Platte drainage area, noting that it would provide badly needed "close-in" recreation areas for Denver area residents, Wheat Ridge officials said.

If the flood plain measure is approved Nov. 19, Wheat Ridge will be the first city in the Colorado to pass flood plain zoning.

Flood Insurance Aid OKd for Englewood

Englewood has been approved by federal officials for subsidized flood insurance—the first city in the state to qualify.

The announcement was made in Washington Tuesday by the U.S. Department of Housing and Urban Development (HUD).

Effective Friday, local casualty and property insurance agents may start selling HUD National Flood Insurance policies on most homes and "small" businesses in Englewood.

Other communities in the metropolitan area, including Denver, are close to getting HUD approval.

The program in metropolitan Denver is being pushed by the Urban Drainage and Flood Control District (UDFCD), a regional agency created by the legislature in 1969.

The federally subsidized insurance is available under a 1968 act of Congress to residential structures of one to four units and to so-called small businesses—defined generally as businesses having assets of less than $5 million, a "net worth" of less than $2.5 million and an average net income after federal taxes of less than $250,000.

Rates Listed

The subsidized premium rates per $100 are:

—One-family residence up to $17,500 in value and multifamily residences to $30,000: 40 cents on buildings and 50 cents on contents.

—One-family homes from $17,501 to $35,000, and multifamily homes from $30,001 to $60,000: 45 cents on buildings and 55 cents on contents.

—One-family homes over $35,000 and multifamily homes over $60,000: 50 cents on buildings; 55 cents on contents.

—Small businesses: from 50 cents to 70 cents on buildings and $1 on contents.

While the premium rates are tied to the cash value of the property, the federally subsidized insurance doesn't cover the total value of more costly homes and business buildings.

Coverage is limited to $17,500 for single-family homes and $30,000 for apartments and small businesses.

Minimum Is $25

The minimum premium is $25. There is a deductible clause of $200 or 2 per cent of the amount of insurance, whichever is greater, on both buildings and contents.

The federal act provides that anyone eligible to buy the insurance who doesn't do so within a year after it becomes available in his community may be denied U.S. disaster relief in the event of a flood.

The insurance program is only the interim phase of a comprehensive federal plan for flood control and flood-plain zoning.

Eventually the federal government will develop an actuarial insurance program with premiums based on flood probabilities.

The government requires communities seeking the interim insurance plan to pledge to adopt effective land-use and flood-control measures. The long-range goal is to eliminate homes and businesses from flood plains.

1971

RMN 4/13/71

Flood insurance to be available

Half of the residents in the Urban Drainage and Flood Control District will be eligible for flood insurance before the spring runoff starts, James R. Quinn, the district's director, said Monday.

"The cities of Denver, Boulder, Lakewood and Wheat Ridge will be added to the city of Englewood under the emergency flood program of the Department of Housing and Urban Development," Quinn said.

HUD Secretary George Romney in Washington announced Monday that owners of one-to-four-family residences and small businesses in Denver may now buy flood insurance from local agents at low subsidized rates under the emergency flood insurance program.

Many Englewood residents are now taking out flood insurance through private sources after the city became the first to become eligible.

"Flood insurance is a step in the right direction," Quinn said. "More important than this is the strong determination of city officials to take steps to prevent encroachment upon the flood plains of our area.

"In the resolution qualifying the city for participation in the flood insurance program, city councils have agreed to begin land use controls to prevent building in the water courses," he said.

The HUD insurance program provides insurance against damage from flooding. Prior to this time insurance was impossible under any circumstances. An attempt was made in previous sessions of the legislature to require the insurance industry to write flood insurance. It did not succeed.

1971

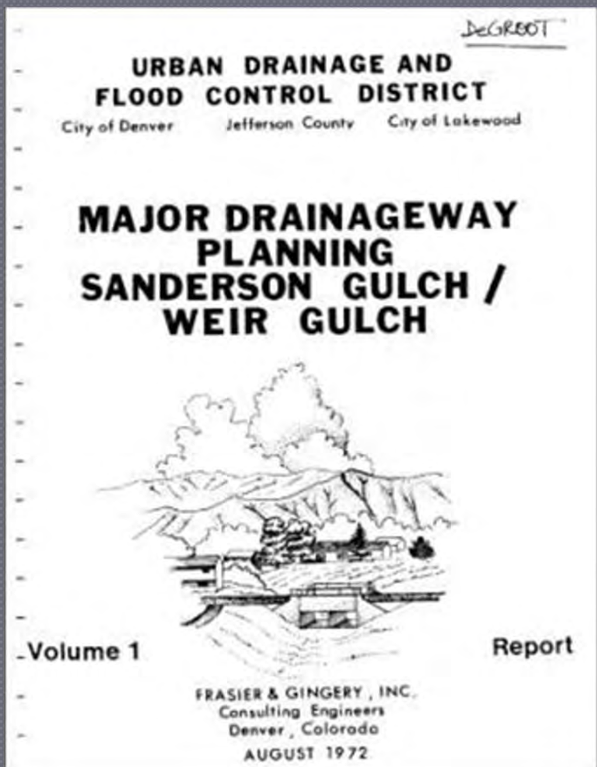
- Longmont and surrounding areas removed from the District

1971

- The Master Planning Program was begun
  - The first master planning study was for Weir Gulch and Sanderson Gulch
- Decision to use future conditions hydrology was made

1971?

- Master Planning Program Key Policy Decisions
  - Each master plan must be requested by local governments and be multi-jurisdictional
  - Completed by consultants acceptable to all parties
  - District provides mapping and 50% of consulting costs. Local sponsors pay other 50%
  - Final plan must be acceptable to all affected local governments



DEGROOT

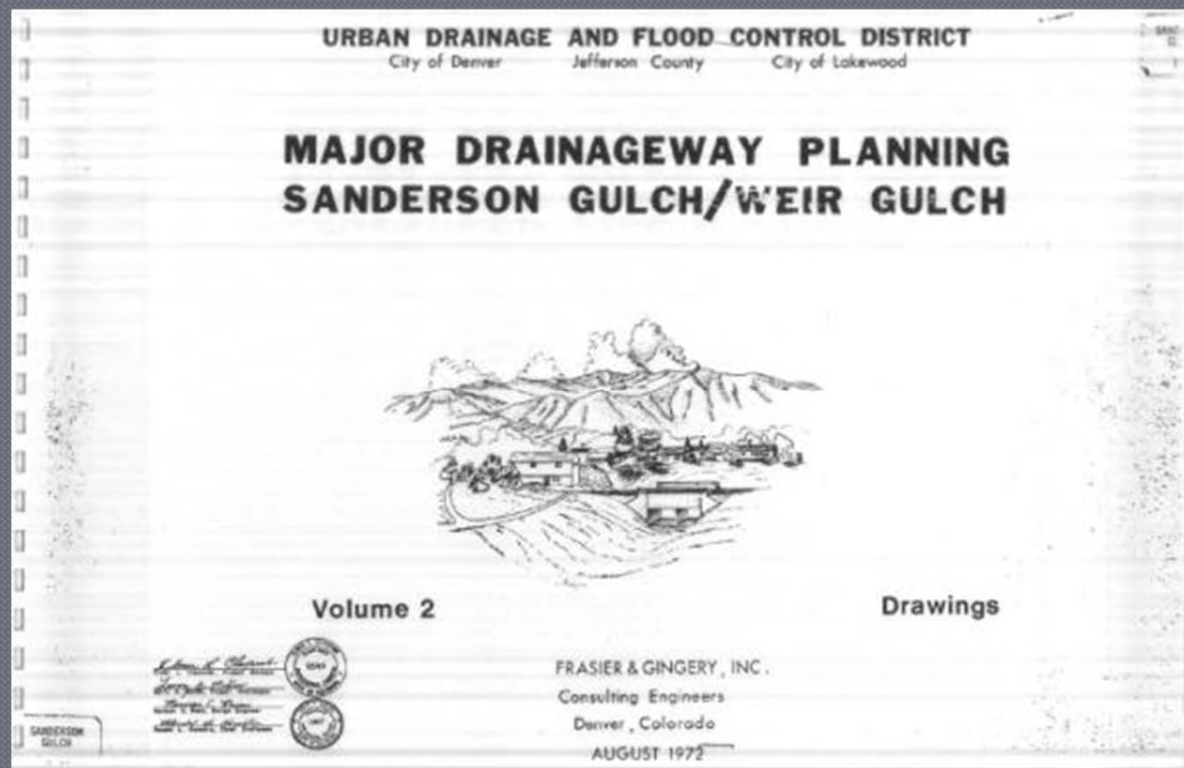
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

City of Denver Jefferson County City of Lakewood

MAJOR DRAINAGEWAY PLANNING SANDERSON GULCH / WEIR GULCH

Volume 1 Report

FRASIER & GINGERY, INC.
Consulting Engineers
Denver, Colorado
AUGUST 1972



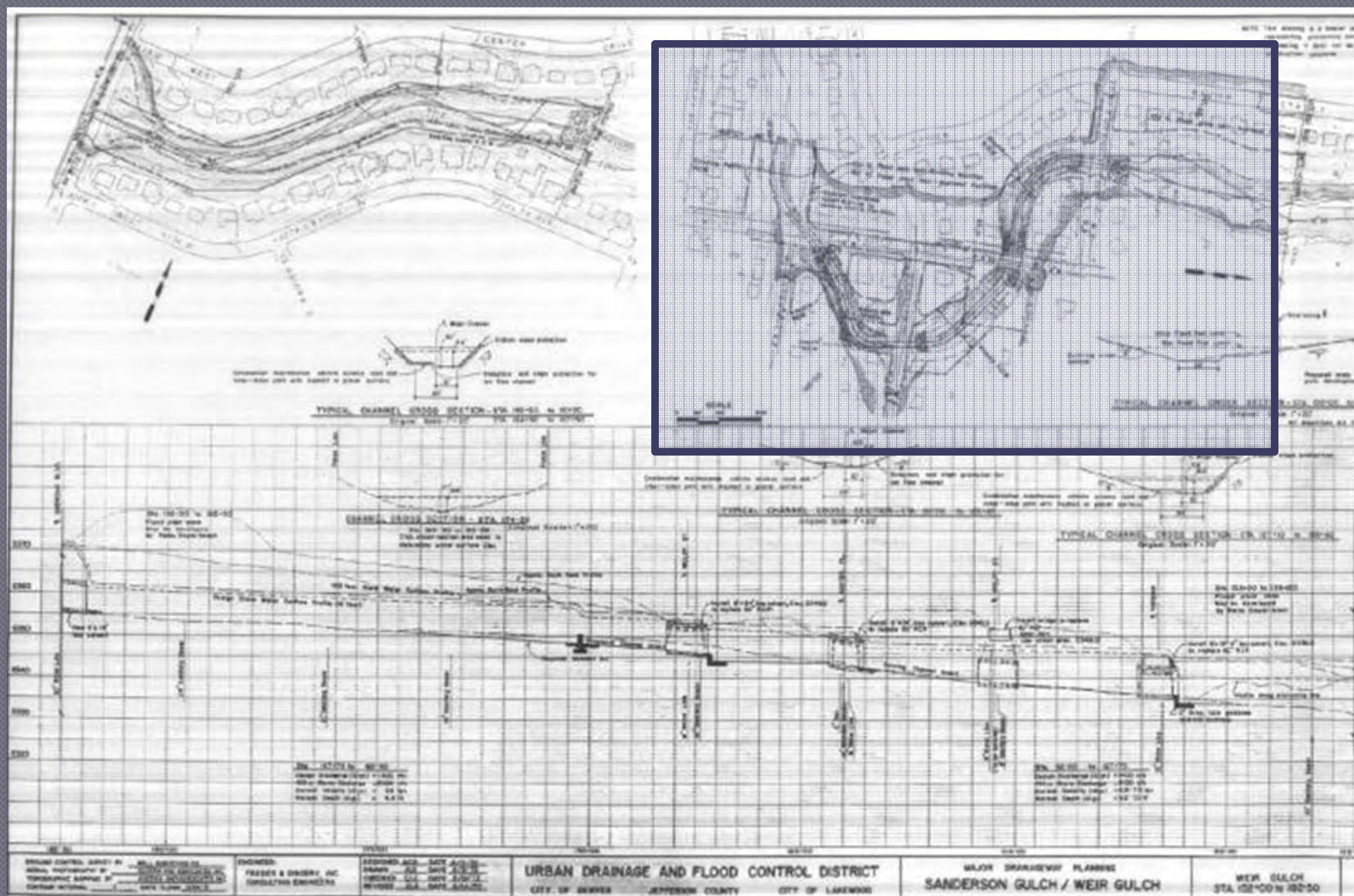
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

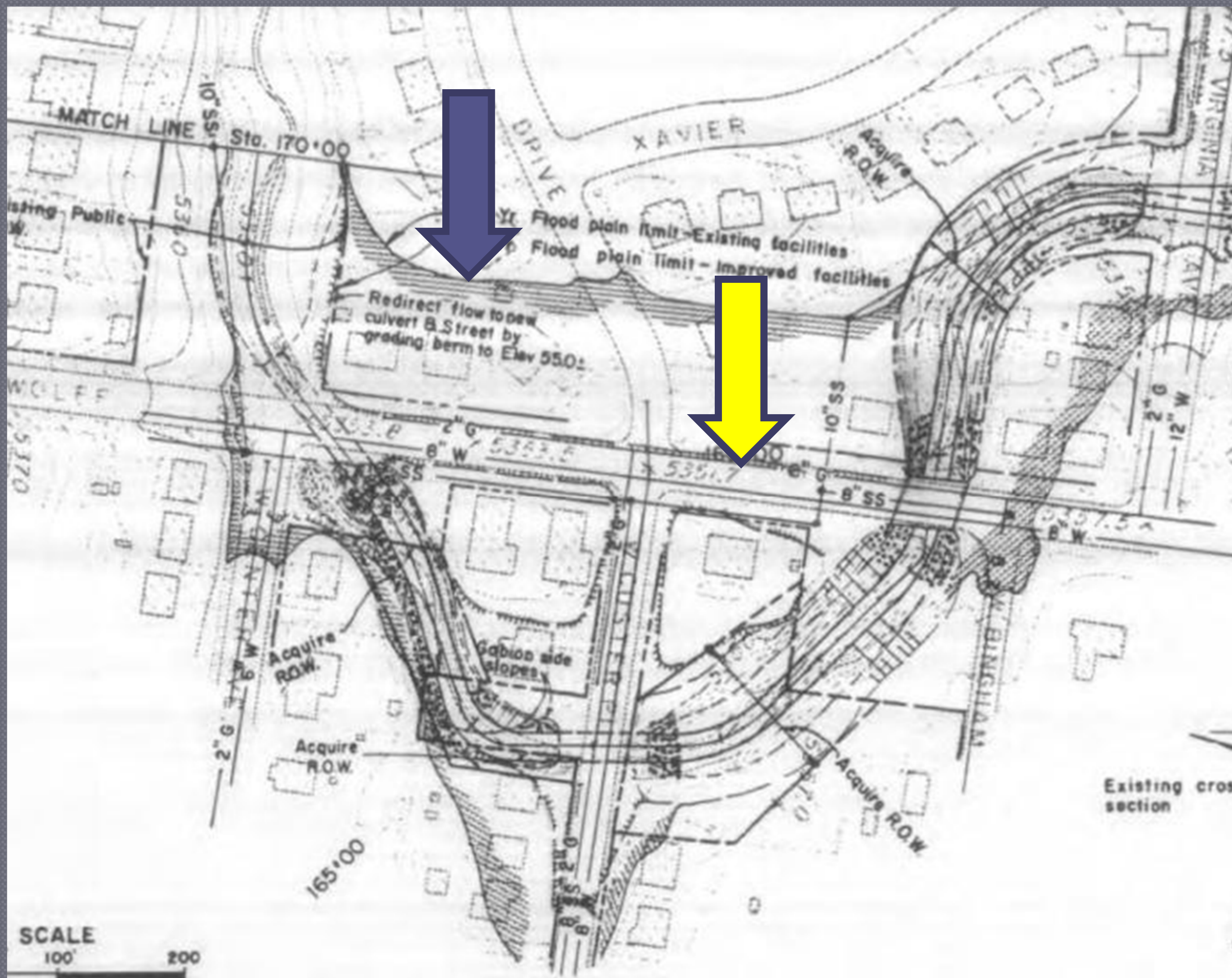
City of Denver Jefferson County City of Lakewood

MAJOR DRAINAGEWAY PLANNING SANDERSON GULCH/WEIR GULCH

Volume 2 Drawings

FRASIER & GINGERY, INC.
Consulting Engineers
Denver, Colorado
AUGUST 1972


URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
SANDERSON GULCH / WEIR GULCH
WEIR GULCH



MATCH LINE Sta. 170+00
XAVIER
DRIVE
Acquire R.O.W.
Yr. Flood plain limit - Existing facilities
Flood plain limit - improved facilities
Redirect flow to new culvert B Street by grading berm to Elev 55.0±
WOLFF
Gabion side slopes
Acquire R.O.W.
Acquire R.O.W.
Acquire R.O.W.
BINGHAM
VIRGINIA
Existing cross section
165+00
SCALE
100'
200

1971

- Project REUSE (Renewing the Environment through Urban Systems Engineering) was begun
  - Sponsored by HUD ($200,000), DRCOG ($60,000) and the District ($40,000)
  - Dual program directed at metropolitan urban drainage and metropolitan solid waste disposal problems

- Purposes of the project were:
  - Analyze the existing situation
  - Develop recommendations for immediate projects
  - Establish priorities for future planning
  - To prepare a 20-year planning and implementation program for urban drainage and solid waste management
- Most important to the District was the opportunity to identify drainage and flood control problems, and identify strategies to address those problems

1972

- Project REUSE results:
  - Inventory of drainage basins
    - Drainage basins divided into sub-basins of 1000 to 3000 acres
    - A numbering system was developed which is still used today
  - A master planning methodology
  - An understanding of the existing situation on the ground

DRAINAGE
BASIN
DESCRIPTIONS

St. Vrain
Boulder Creek
Big Dry
First Creek
Clear Creek
Sand Creek
Central Denver
Cherry Creek
Bear Creek
South Side

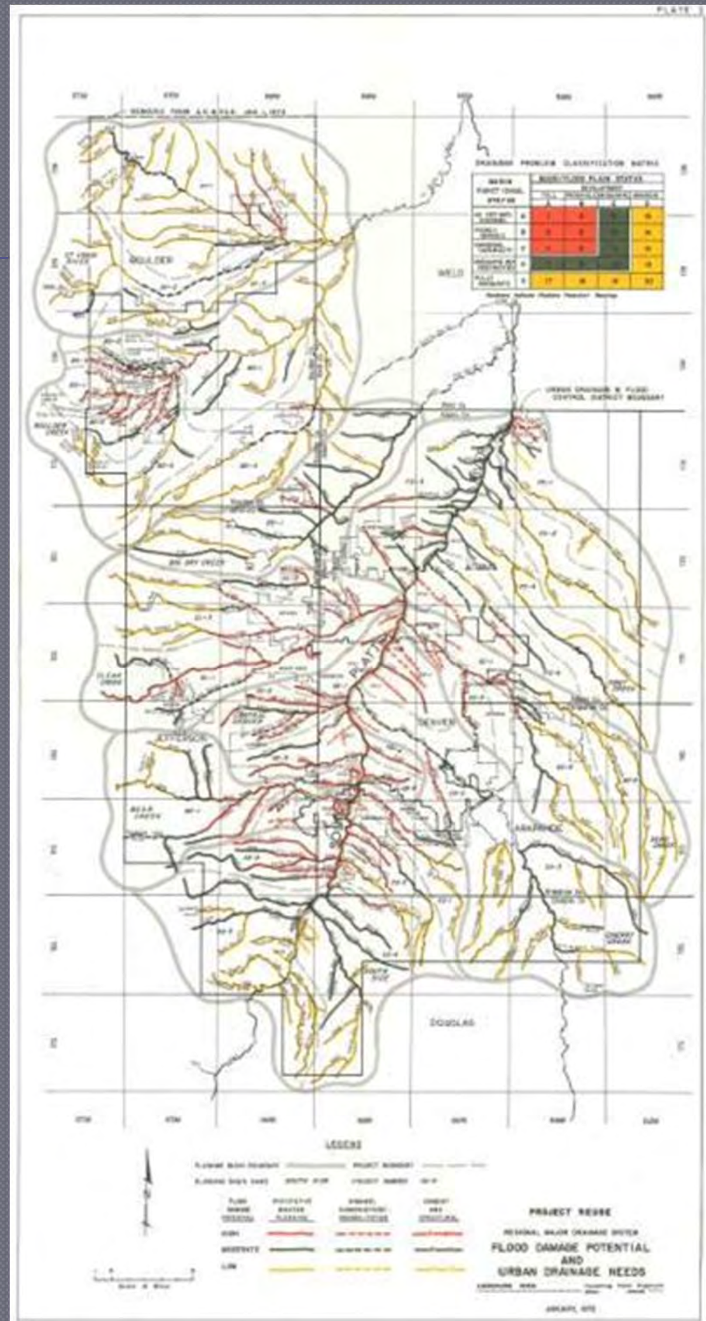
DRAINAGE BASIN DESCRIPTIONS
SUBBASIN DELINEATION AND SUMMARIES

PROJECT REUSE
Final Report – Supplemental Publication

DENVER REGIONAL COUNCIL OF GOVERNMENTS
AND
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

Project REUSE

In 1969, the Colorado General Assembly created the Urban Drainage and Flood Control District to develop and implement a drainage and runoff control program for the urbanized and urbanizing areas of the Denver region. The St. Vrain Basin was later deleted from the UD&FCD by the General Assembly, effective January 1, 1971. Through Project REUSE, it has been determined that, other than the St Vrain Basin, approximately 26% of the channel miles require some form of construction to provide one hundred year storm protection. The other 74% of channel miles lend themselves to nonconstruction measures, which will preserve them as flood plains, preventing future loss of human life and property damage. In both of these situations, the region faces the problem of initiating adequate preventive measures, completing master plans for the entire region, and developing financial resources for the necessary planning and construction activities.

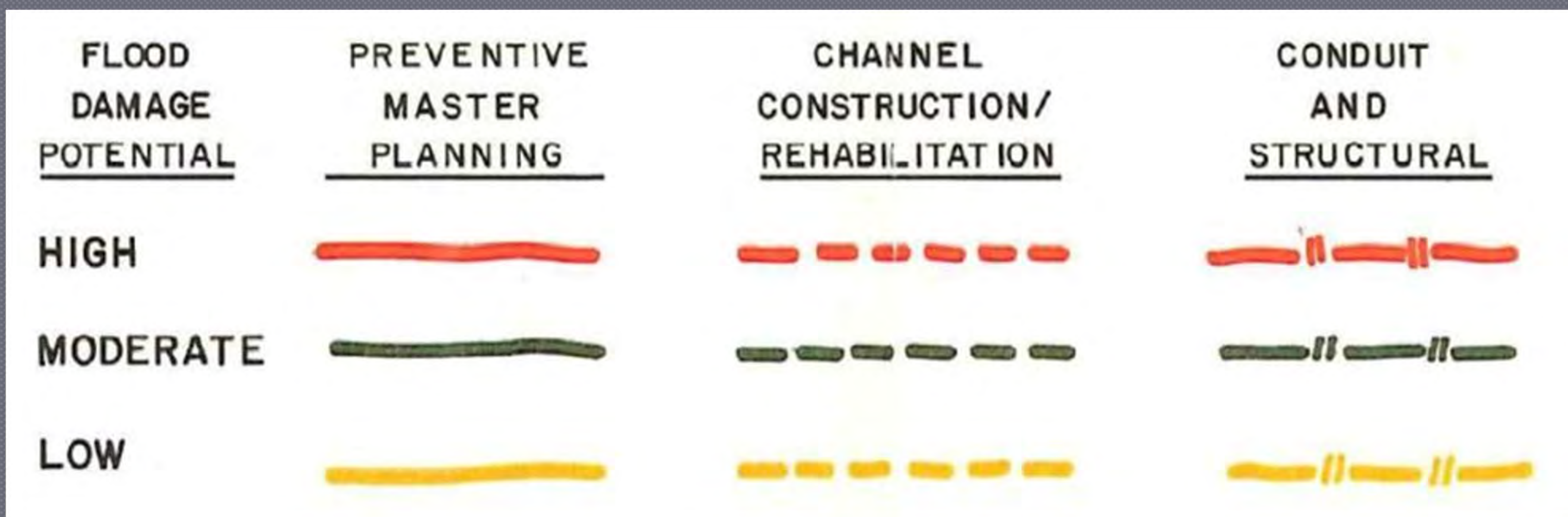


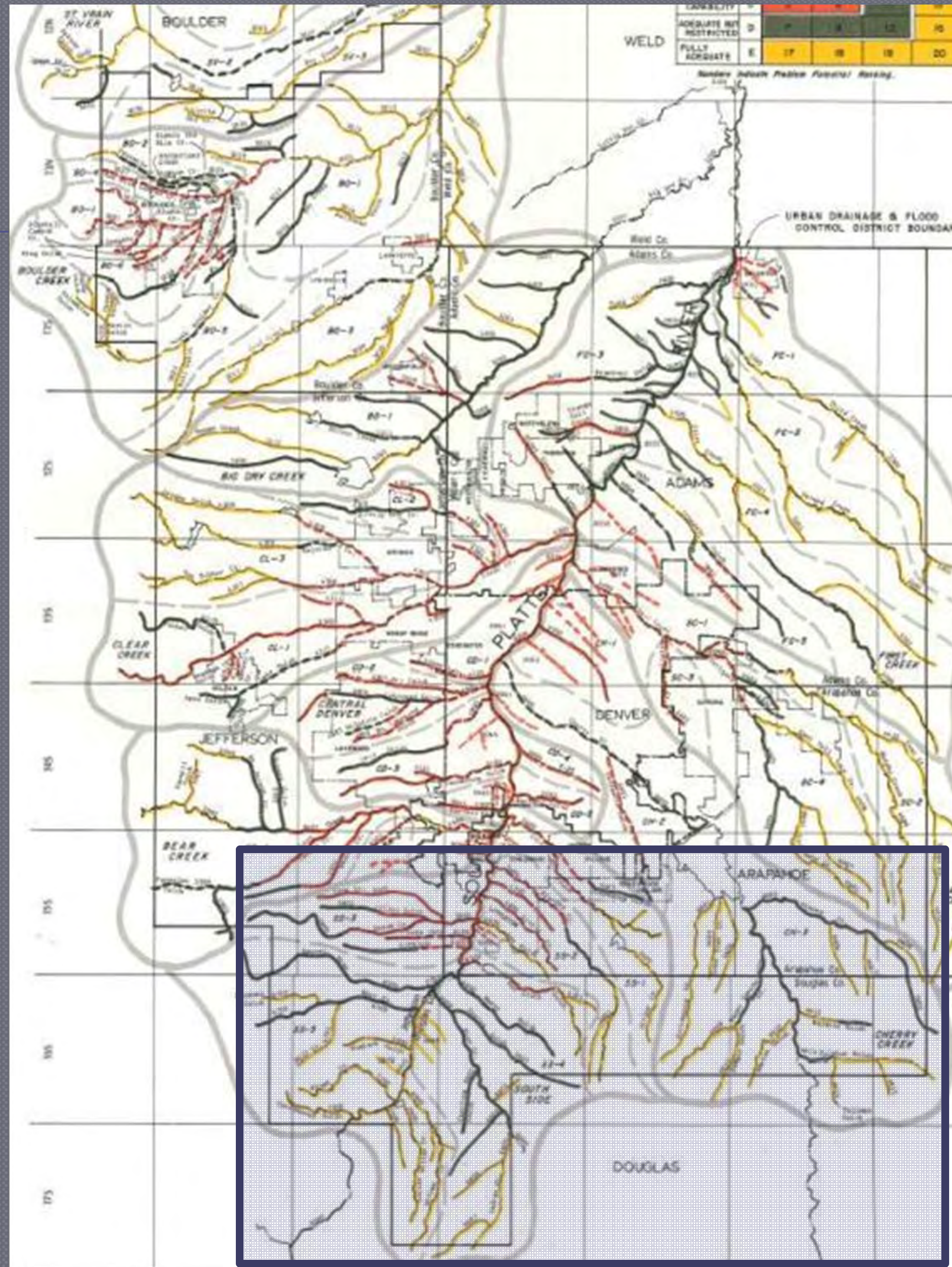
BOULDER
WELD
DENVER
ARAPAHOE
JEFFERSON
DOUGLAS
LEGEND
PROJECT REUSE
REGIONAL MAJOR DRAINAGE SYSTEM
FLOOD DAMAGE POTENTIAL
AND
URBAN DRAINAGE NEEDS

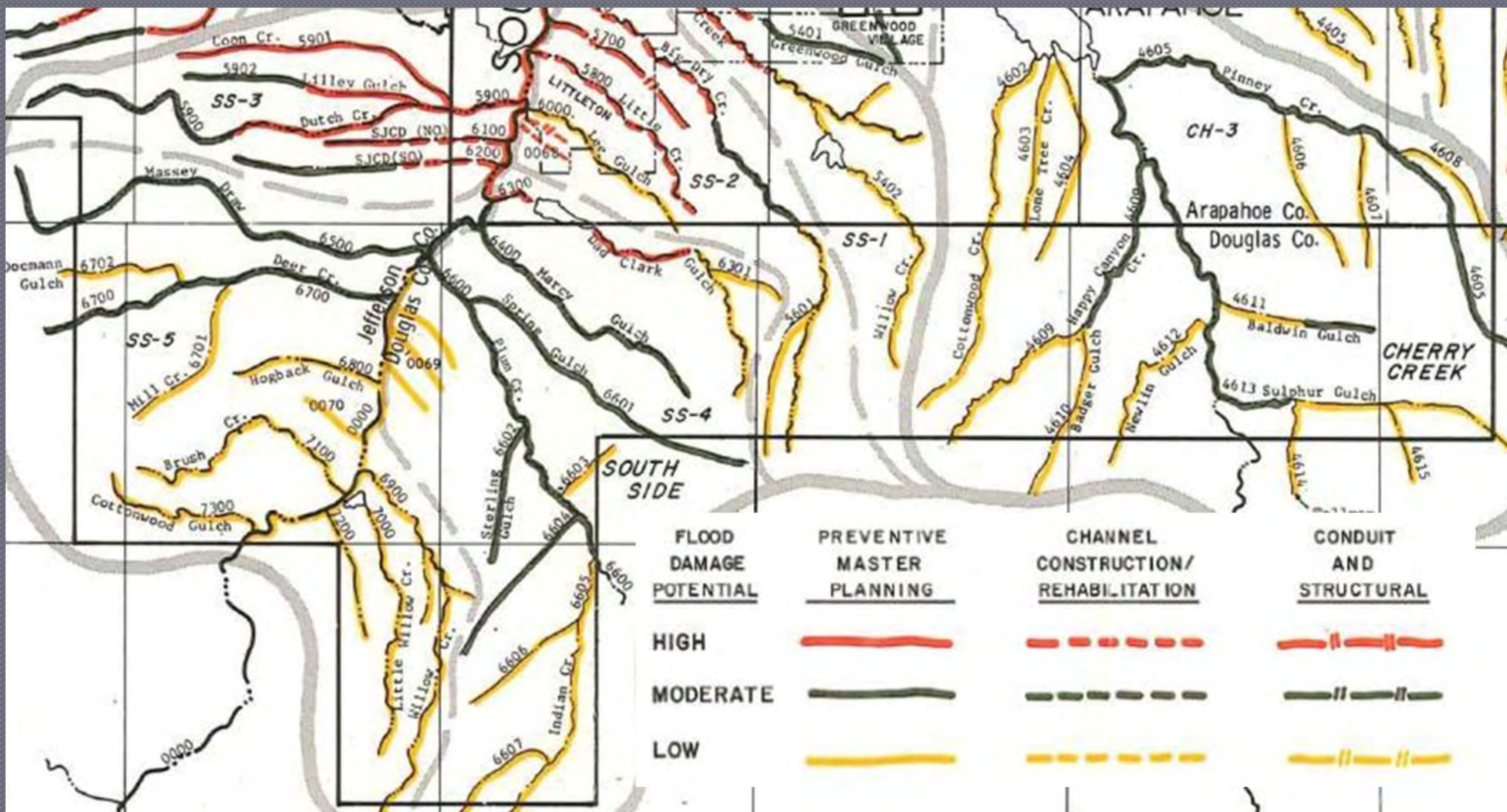
DRAINAGE PROBLEM CLASSIFICATION MATRIX

BASIN FUNCTIONAL STATUS		BASIN/FLOOD PLAIN STATUS			
		DEVELOPMENT			
		FULL	PROBABLE	MODERATE	MINIMUM
		A	B	C	D
NO DEFINED CHANNEL	A	1	4	9	13
POORLY DEFINED	B	2	5	10	14
MARGINAL CAPABILITY	C	3	6	11	15
ADEQUATE BUT RESTRICTED	D	7	8	12	16
FULLY ADEQUATE	E	17	18	19	20

Numbers Indicate Problem Potential Ranking.


FLOOD DAMAGE POTENTIAL
PREVENTIVE MASTER PLANNING
CHANNEL CONSTRUCTION/ REHABILITATION
CONDUIT AND STRUCTURAL
HIGH
MODERATE
LOW

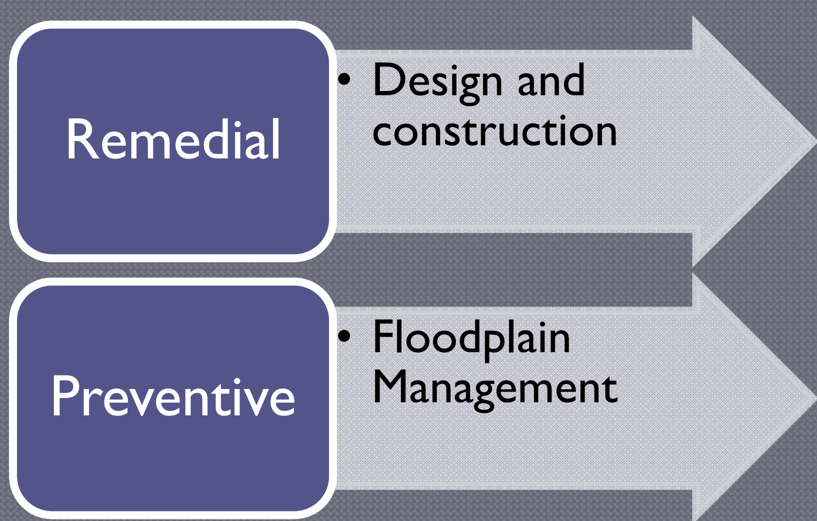

ST. VRAIN RIVER
BOULDER
WELD
URBAN DRAINAGE & FLOOD CONTROL DISTRICT BOUNDARY
BOULDER CREEK
BIG DRY CREEK
ADAMS
PLATTE
CLEAR CREEK
CENTRAL DENVER
DENVER
JEFFERSON
FIRST CREEK
BEAR CREEK
ARAPAHOE
CHERRY CREEK
SOUTH SIDE
DOUGLAS



Coon Cr.
Lilley Gulch
Dutch Cr.
SS-3
SJCD (NO)
SJCD(SO)
Massey Draw
LITTLETON
Little Cr.
Lee Gulch
Big Dry Cr.
GREENWOOD VILLAGE
Greenwood Gulch
SS-2
SS-1
CH-3
Pinney Cr.
Lone Tree Cr.
Willow Cr.
Cottonwood Cr.
Happy Canyon Cr.
Arapahoe Co.
Douglas Co.
Baldwin Gulch
CHERRY CREEK
Sulphur Gulch
Badger Gulch
Newlin Gulch
Dad Clark Gulch
Marcy Gulch
Spring Gulch
Plum Cr.
SS-4
SOUTH SIDE
Jefferson Co.
Douglas Co.
Deer Cr.
SS-5
Mill Cr.
Hogback Gulch
Brush Cr.
Cottonwood Gulch
Sterling Gulch
Little Willow Cr.
Willow Cr.
Indian Cr.
FLOOD DAMAGE POTENTIAL
PREVENTIVE MASTER PLANNING
CHANNEL CONSTRUCTION/ REHABILITATION
CONDUIT AND STRUCTURAL
HIGH
MODERATE
LOW

1973

- Based on the Project REUSE findings the District adopted a two-pronged approach of fixing existing problems while working to prevent new ones from being created.



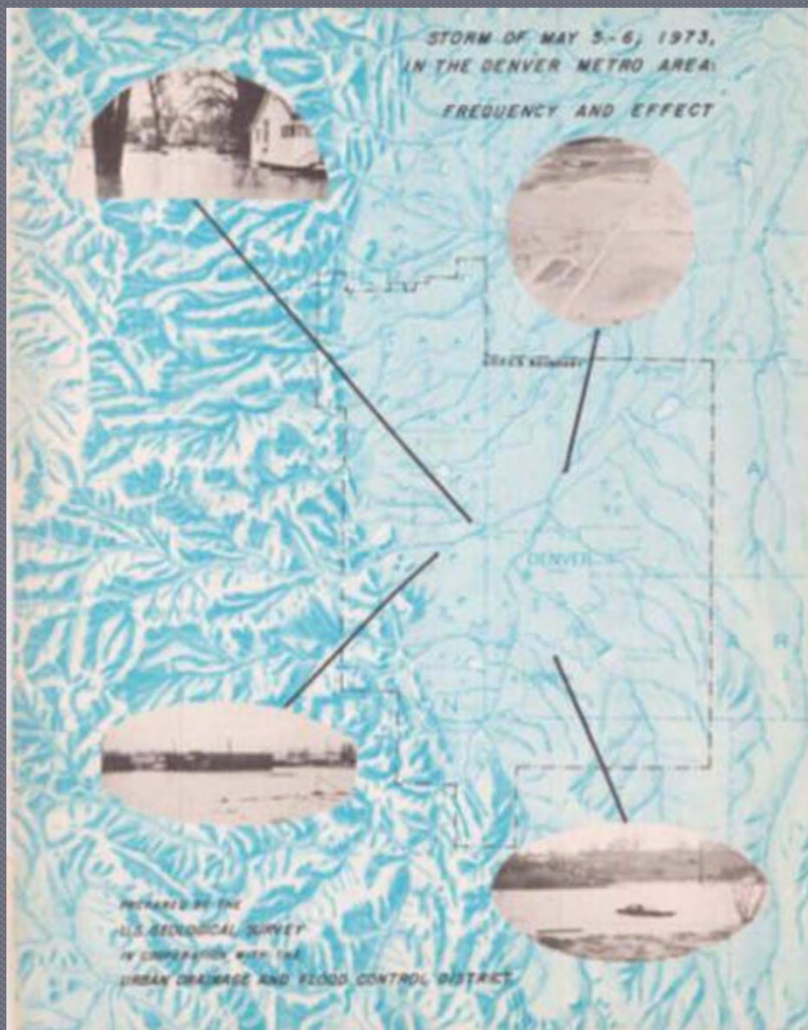
1973

- The District requested that the legislature authorize 0.4 mill for design and construction projects, which it did, effective in 1974
- The Floodplain Management Program was authorized to begin in 1974
  - Funded out of the existing 0.1 mill levy

1973

- After the legislature authorized the construction mill levy, the Board of Directors established the
- "Capital Improvements Expenditure Policy"
  - The proposed improvements must be requested by local public bodies
  - The proposed improvements must have been master planned
  - The local public bodies must share 50% of the cost of the project
  - The local public bodies must agree to own and maintain the completed facilities
  - Revenues received from each county will be spent for improvements benefitting that county over a period from 1974 to five years in the future
  - The District will not develop a public works department but will rely on existing local government public works departments

1973


STORM OF MAY 5-6, 1973,
IN THE DENVER METRO AREA:
FREQUENCY AND EFFECT
DENVER

Miller's Law:

You can't tell how deep a puddle is until you step in it

1974

- Floodplain Management Program
  - National Flood Insurance Program
  - Floodplain Regulation
  - Flood Hazard Area Delineation (FHAD)
  - Flood Warning
  - Flood Damage Surveys
  - Reviews of Proposed Developments
  - Public Information

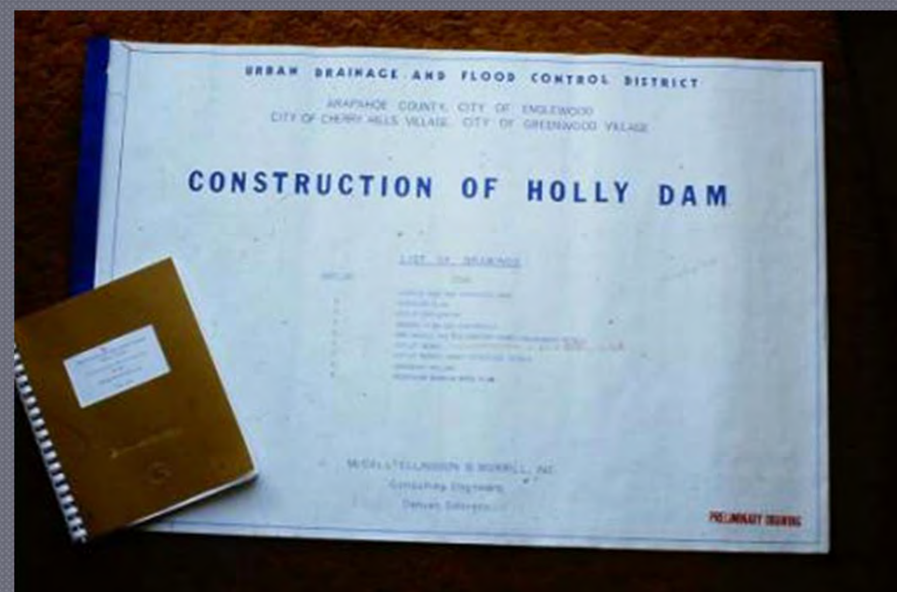
1974

- The Board authorized design and construction projects for
  - Englewood and Holly Dams
  - Niver Creek
  - Viele Channel
- Authorized design for Weir Gulch

Niver Creek

Viele Channel

Englewood and Holly Dams



Weir Gulch

1974

- FPM began a concerted effort to complete FHAD studies of undeveloped floodplains
- Cooperative efforts with Colorado Water Conservation Board, Corps of Engineers and Soil Conservation Service.

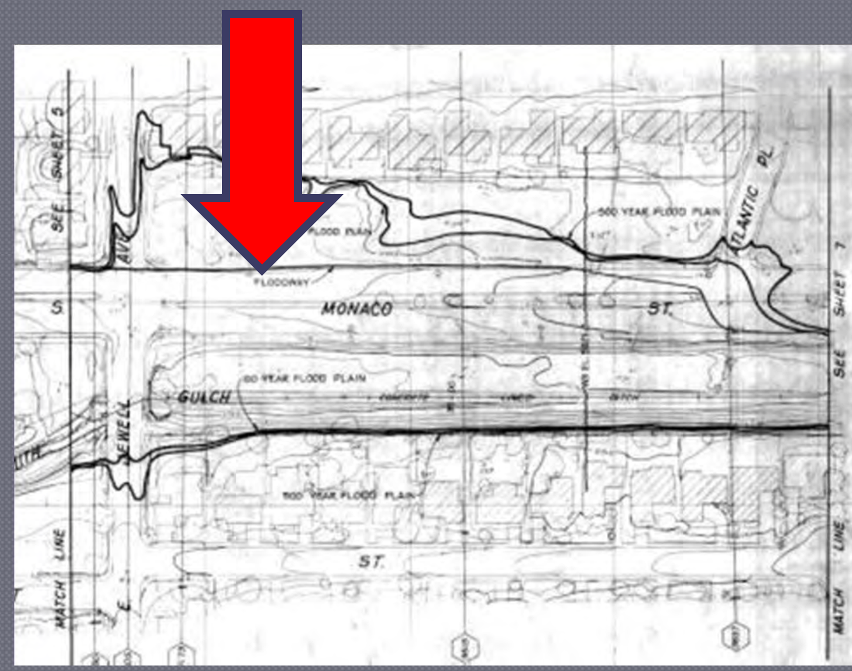
1974

- Decision was made to publish separate Master Planning and Flood Hazard Area Delineation reports
- Decision was made to not show floodways on the FHAD maps but to put them in a table instead

Floodway decisions

- 0.5 ft. rise in WSEL
- Don't show floodway on the maps
- Put in table in report

- Reasoning: To put a floodway on the map is to send the message "Fill to this line."



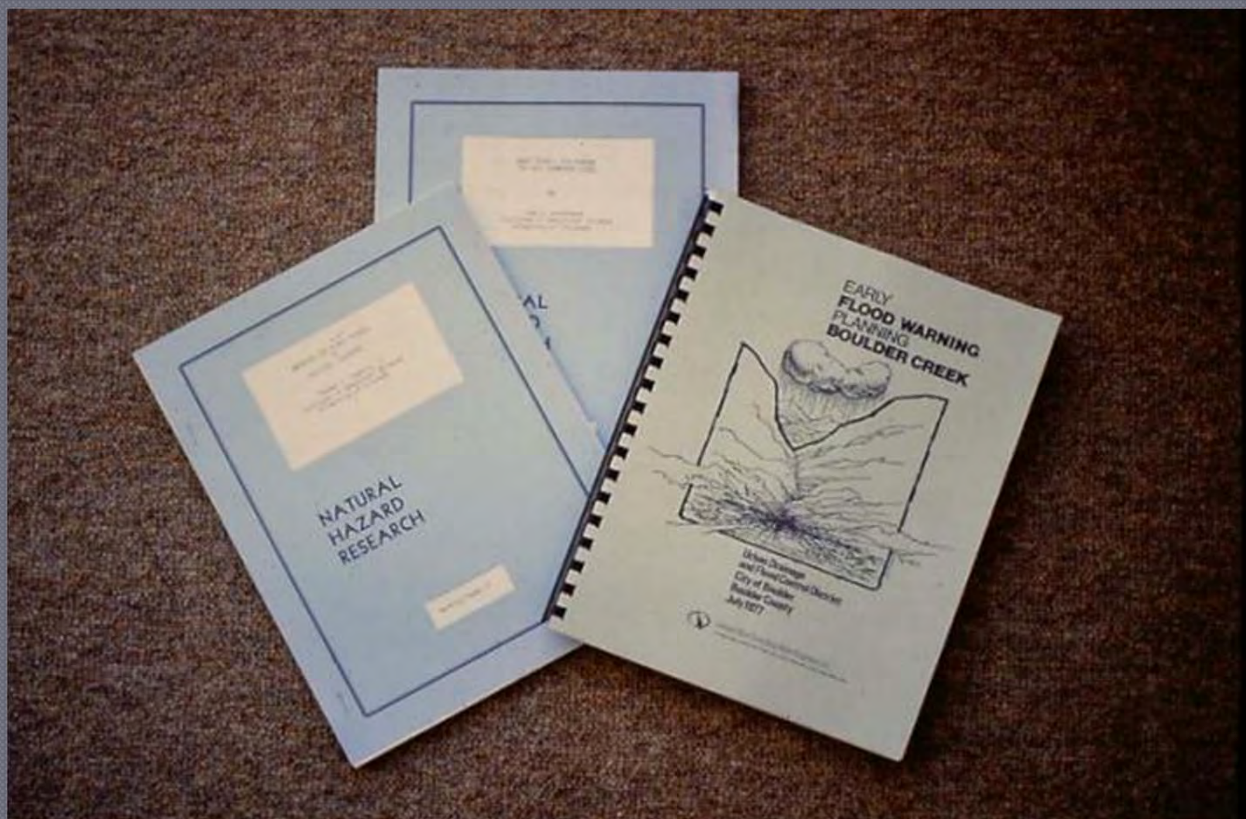
1975-1976

- Teamed with the Federal Insurance Administration (FIA) to work with local governments with defined floodplains to adopt adequate floodplain regulations
- All local governments with FIA published Flood Insurance Maps were in compliance with National Flood Insurance Program requirements.

Big Thompson Flood 1976

1976

- Began a planning study for a flood warning system for Boulder Creek



1976

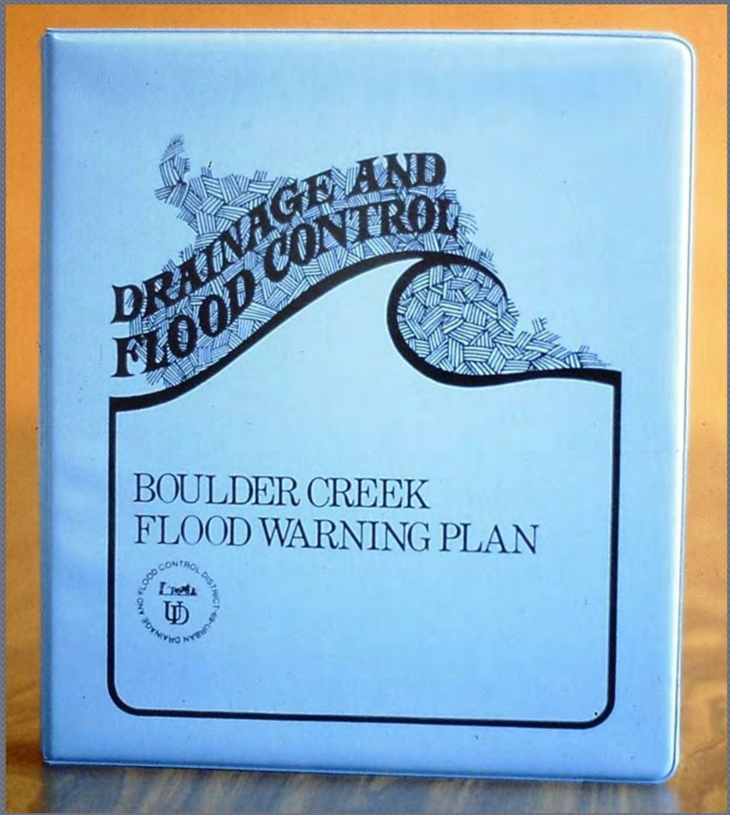
- Board of Directors decided to make a special effort to notify occupants of floodplains of the flood potential they faced

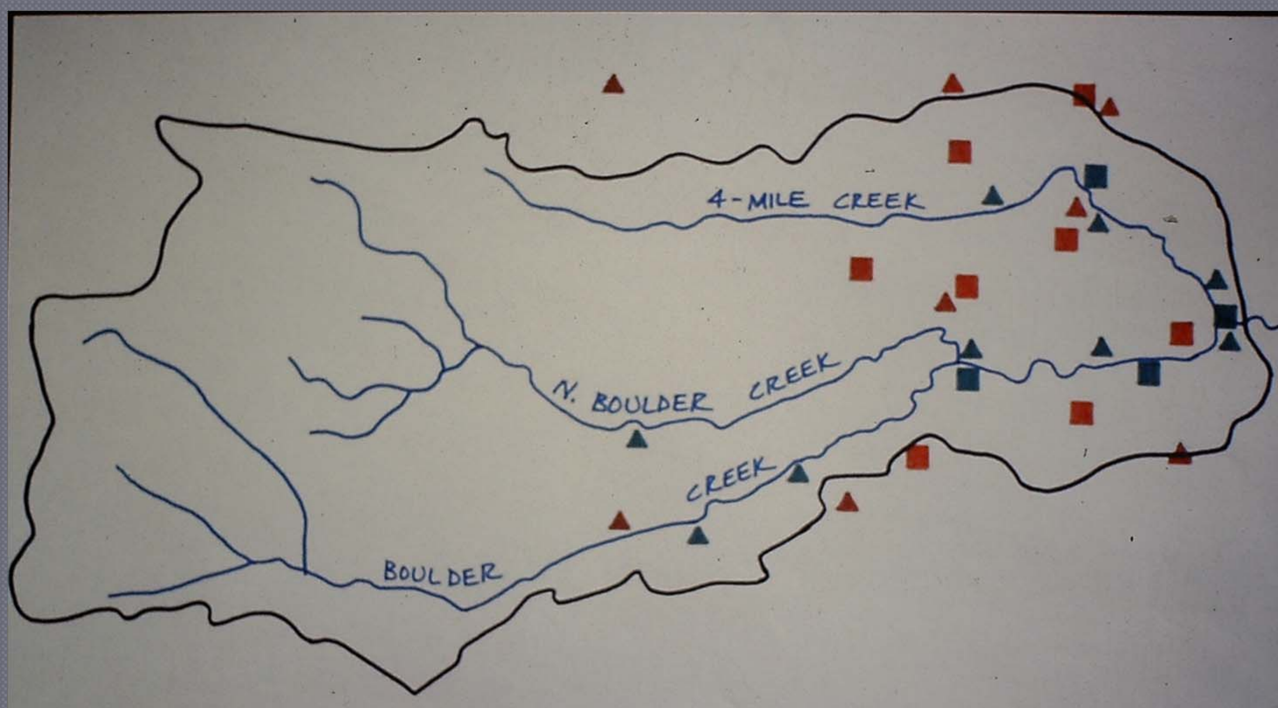
1976

- Board decided to request maintenance funding from the 1977 legislature

1978

- The initial flood warning system was implemented in the Boulder Creek watershed




4-MILE CREEK
N. BOULDER CREEK
CREEK
BOULDER

1978

- Legislature refused to authorize maintenance funding

1978

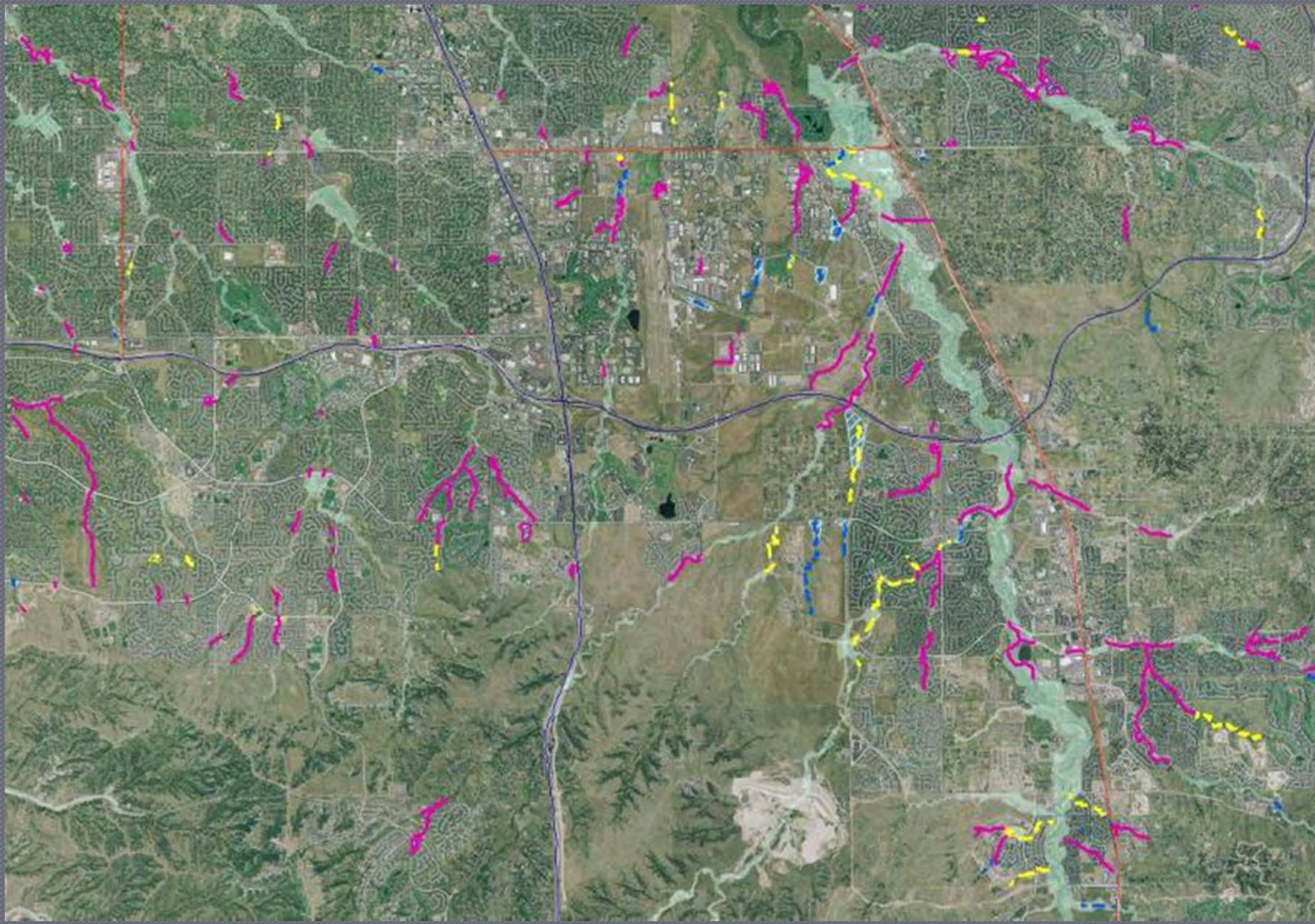
- Board of Directors authorized funds from the Capital Improvements Budget to assist local governments with maintenance of District funded facilities with the following policy decisions
  - Revenues received from each county will be spent for maintenance in that county
  - Local governments will not be required to match District funds
  - Contract for maintenance activities (no public works department)
- Decided to again request maintenance mill levy from the legislature

1979

- Maintenance Program was started
- Legislature approves 0.4 mill levy for maintenance and preservation of floodplains and floodways
  - Limited to three years (1981-1983)

1981

- Maintenance Eligibility Program started for facilities constructed by or approved for construction by local governments
- Requirements
  - Approve construction plans
  - Observe construction
  - Accept construction
  - Approve the project for maintenance eligibility



1986

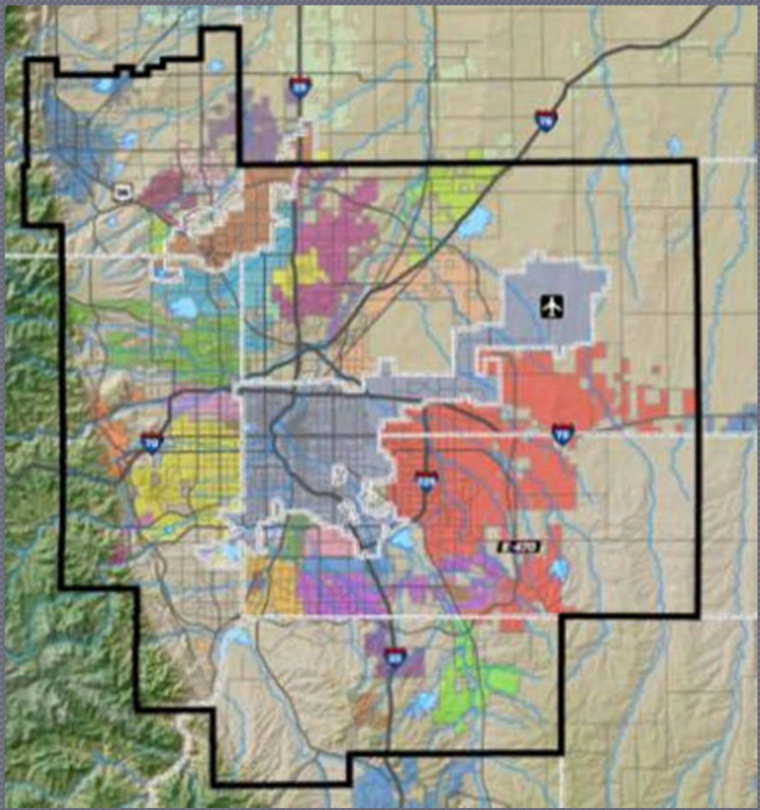
- Legislature authorized 0.1 mill levy for South Platte River (excluding Boulder County, and later, Broomfield)

1986

- District began its involvement in stormwater quality activities (in the Master Planning Program) in response to CWA amendments
  - Coordinated Phase I communities for consistency of NPDES permit applications.
  - Later did the same for Phase II communities
  - Also, stormwater quality research and BMP's

1989

- District adds approximately 400 square miles to the east and southeast

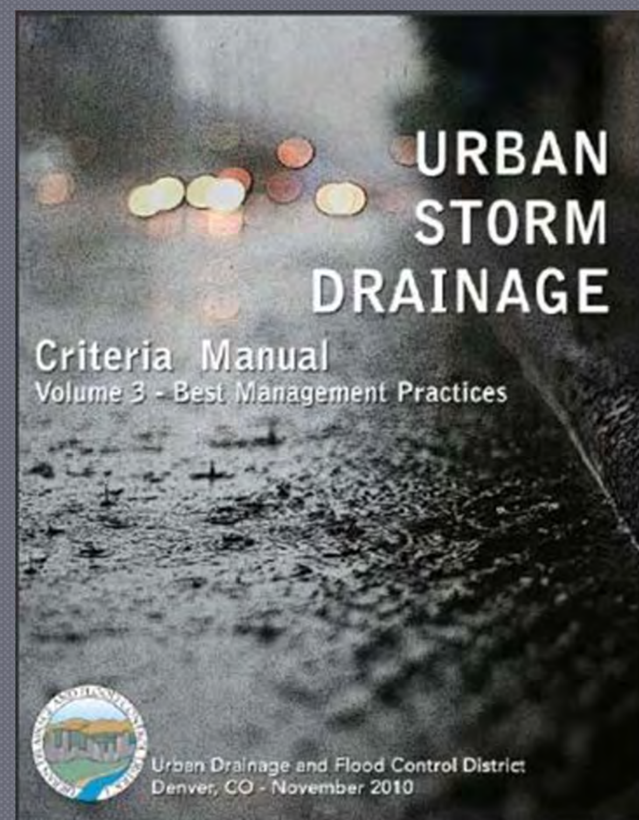


1991

- Taxpayer's Bill of Rights (TABOR) adopted by the voters
- This freezes District revenues at inflation plus growth
- Effectively ends future additions to service area by the legislature

1992

- *Urban Storm Drainage Criteria Manual Volume 3, Best Management Practices* is published for the first time



Leo Miser's First Computer Axiom:
When putting it into memory, remember where you put it.

1999

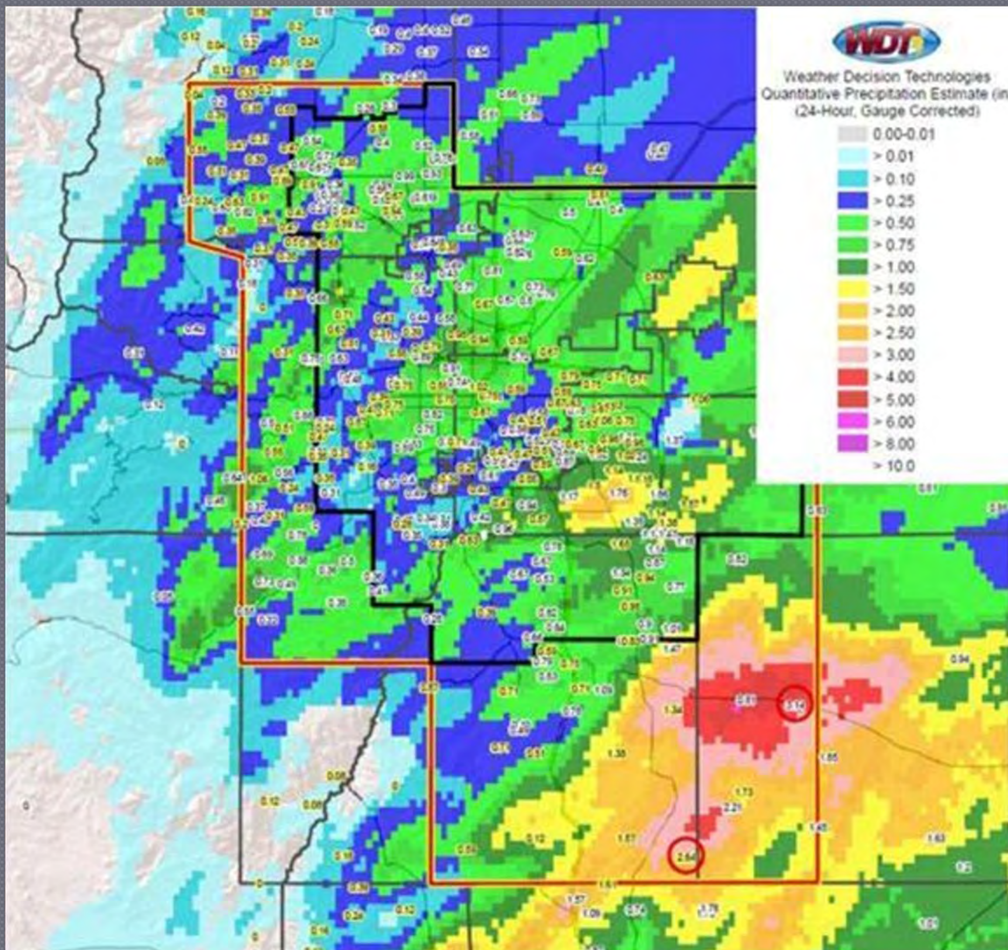
- District becomes FEMA's first Cooperating Technical Partner (CTP)

2005

- Information Services and Flood Warning Program was spun off from Floodplain Management Program
  - Manages all District internal and external information services
  - Manages the District's Flash Flood Prediction Program

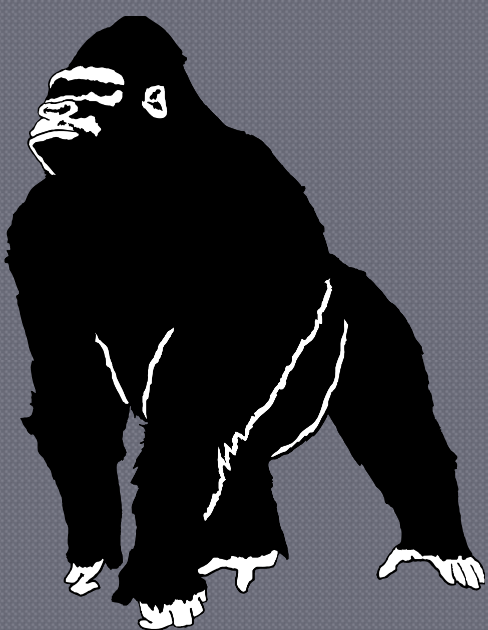

Urban Drainage and Flood Control District
Home Current Projects Downloads Calendar Resources & Links About Us FAQ's Mission Statement
Working with you since 1969
Flood Information
Floodplain Map
Flood Safety Information
ALERT System
Board Meetings
Flood Control Facilities
Maintenance Eligibility
Design, Construction and Maintenance
Recent News
Stormwater Quality
Stormwater Quality


SOUTH PLATTE RIVER


WDT
Weather Decision Technologies
Quantitative Precipitation Estimate (in)
(24-Hour, Gauge Corrected)
0.00-0.01
> 0.01
> 0.10
> 0.25
> 0.50
> 0.75
> 1.00
> 1.50
> 2.00
> 2.50
> 3.00
> 4.00
> 5.00
> 6.00
> 8.00
> 10.0

2006

- Design and Construction, Maintenance and South Platte River Programs combined into the Design, Construction and Maintenance Program



Board of Directors

1969	2011
Mayor and 3 council members from Denver	Mayor or Deputy Mayor and 3 council members from Denver
One county commissioner from each of Adams, Arapahoe, Boulder, Douglas and Jefferson Counties	Same
One mayor from an incorporated area in each of Adams, Arapahoe, Boulder and Jefferson Counties appointed by the Governor	Same
Two PE's selected by the Board	Same
	Mayor or Deputy Mayor of Broomfield
	Mayor or Deputy Mayor of each city with population > 100,000 people
Total 15	Total 22

2011

Urban Drainage and Flood Control District

ACTIVITY SUMMARY

March, 2011

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 2.3 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."

Goldsmith Gulch in a Denver Park

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 23 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; Design, Construction and Maintenance; Floodplain Management; and Information Services and Flood Warning. A brief description of each program is given in the following sections.

POPULATION GROWTH

YEAR	POPULATION	POPULATION INCREASE	PERCENTAGE INCREASE
1960	**934,253**	**318,618**	**51.8**
1970	**1,238,273**	**304,020**	**32.5**
1980	**1,618,461**	**380,188**	**30.7**
1990	**1,848,319**	**229,858**	**14.2**
2000	**2,302,650**	**454,331**	**24.6**
2007	**2,760,000** (est.)	**457,350**	**19.9**

1969 – District created

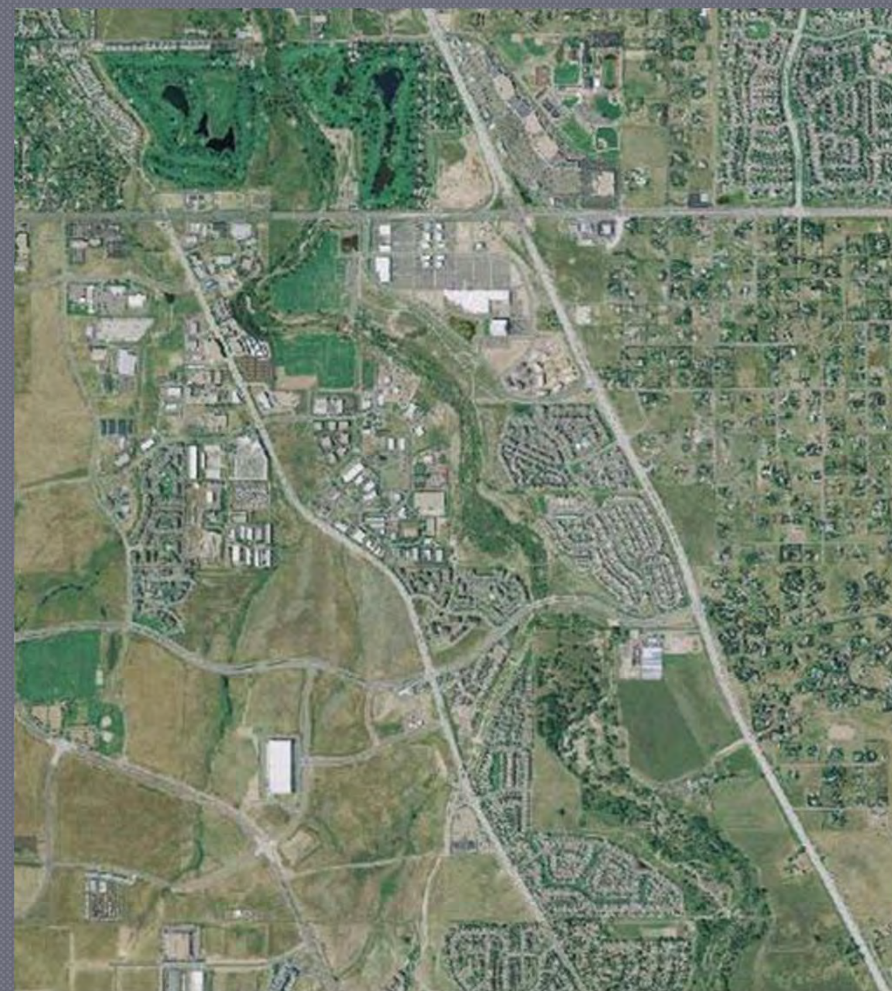
Source: Denver Regional Council of Governments

Results

- Through planning, design, construction, maintenance, and floodplain management by the District and its local government partners we have reduced the number of units in defined 100-year floodplains by about 5000 units while our population has tripled.

Cherry Creek (Arapahoe County) Upstream from Cherry Creek Dam

1974 Photo



2009 Photo

1978 Floodplain
UDFCD
USACE
CWCB

2009 Floodplain

Both floodplains

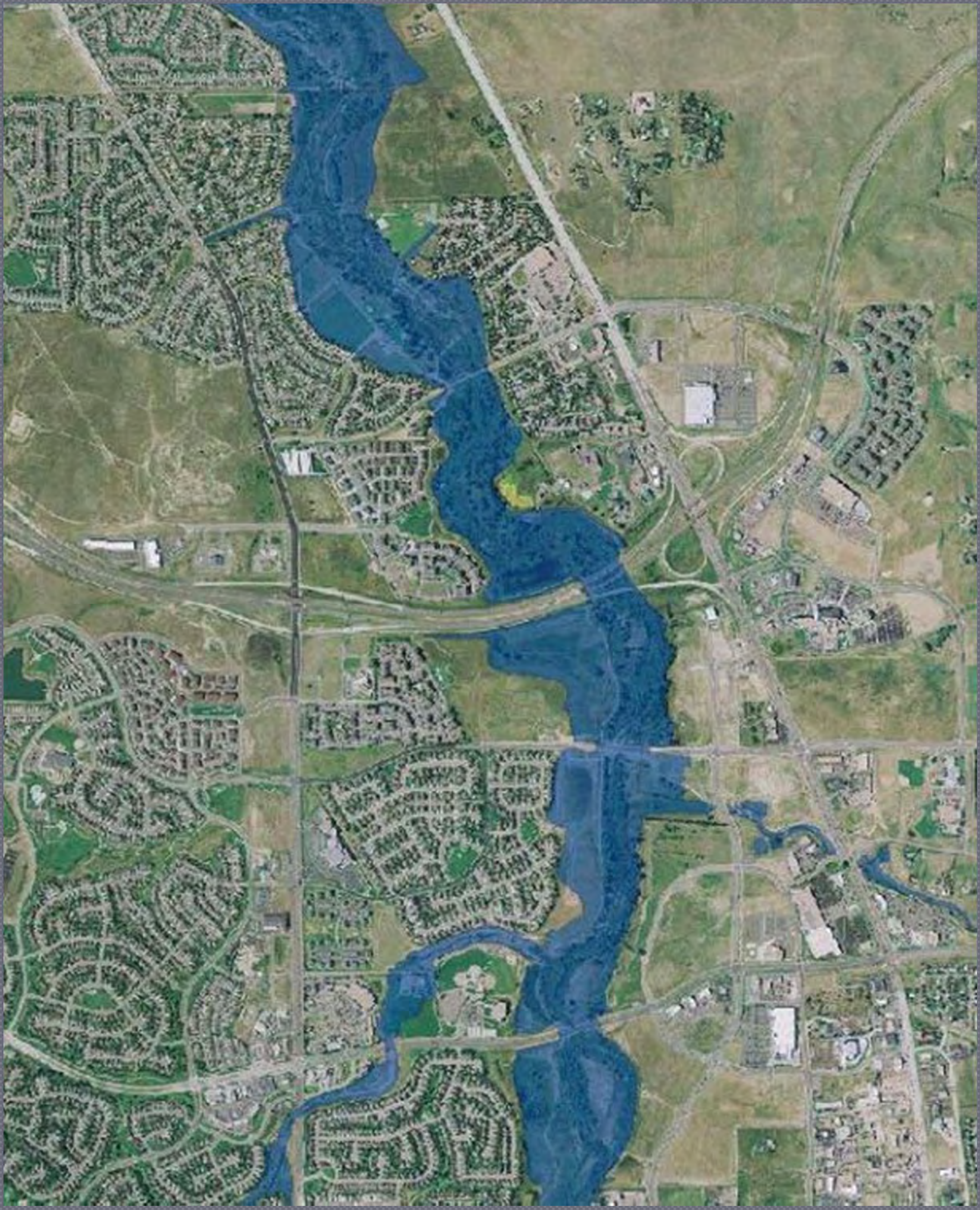
Cherry Creek (Douglas County) Upstream from Arapahoe County

1974 Photo

2009 Photo

1978 Floodplain

2009 Floodplain



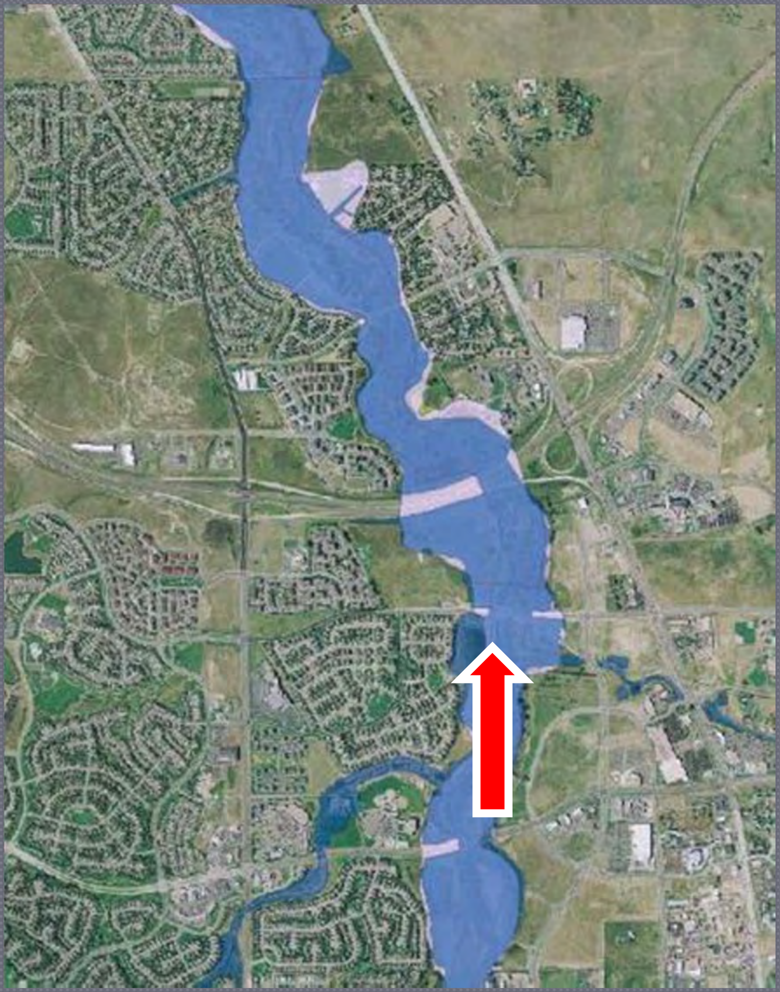
Both floodplains

Excavated floodway & fill the fringe

Fill the fringe

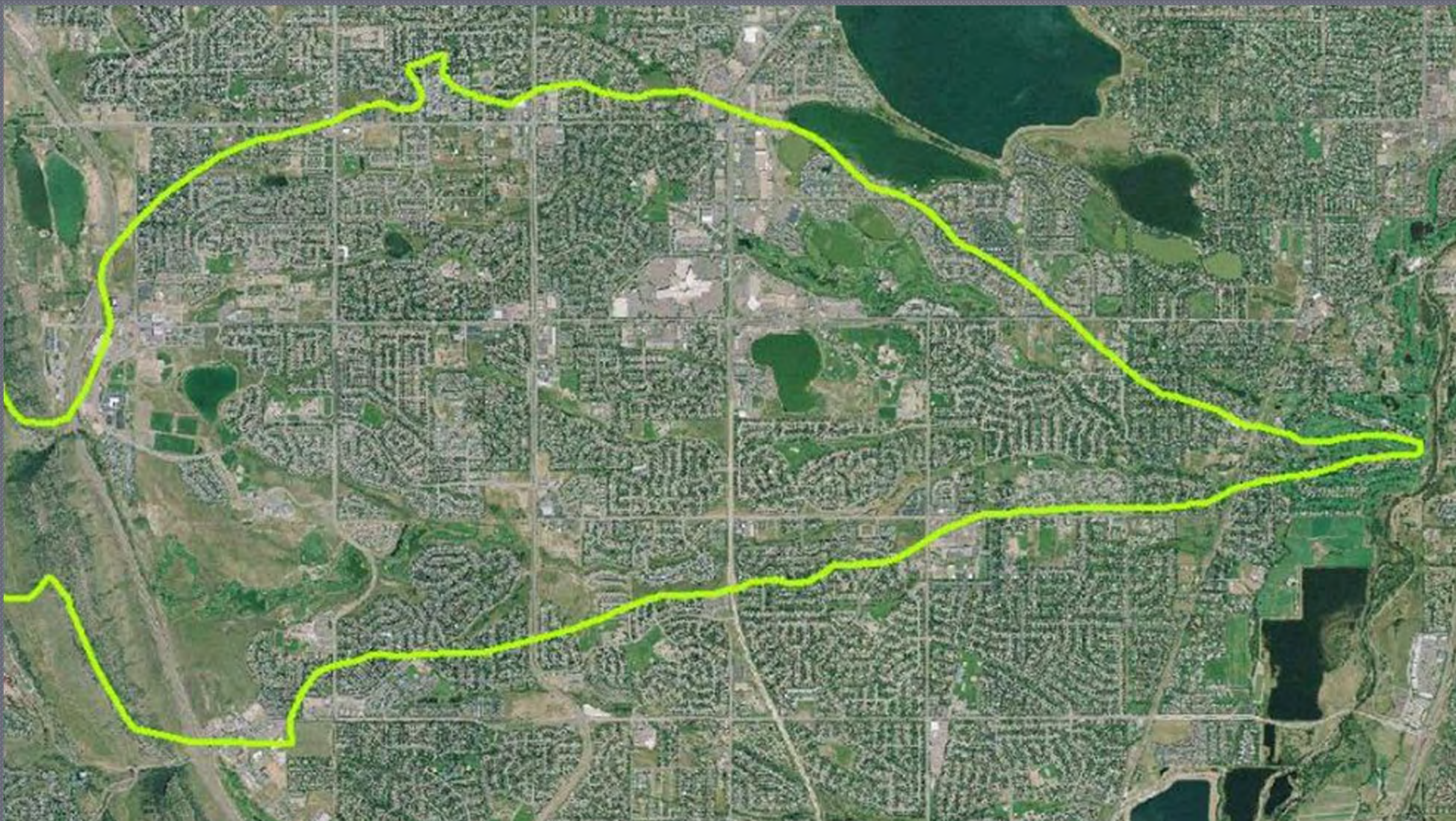
Fill the fringe and preservation

Preservation



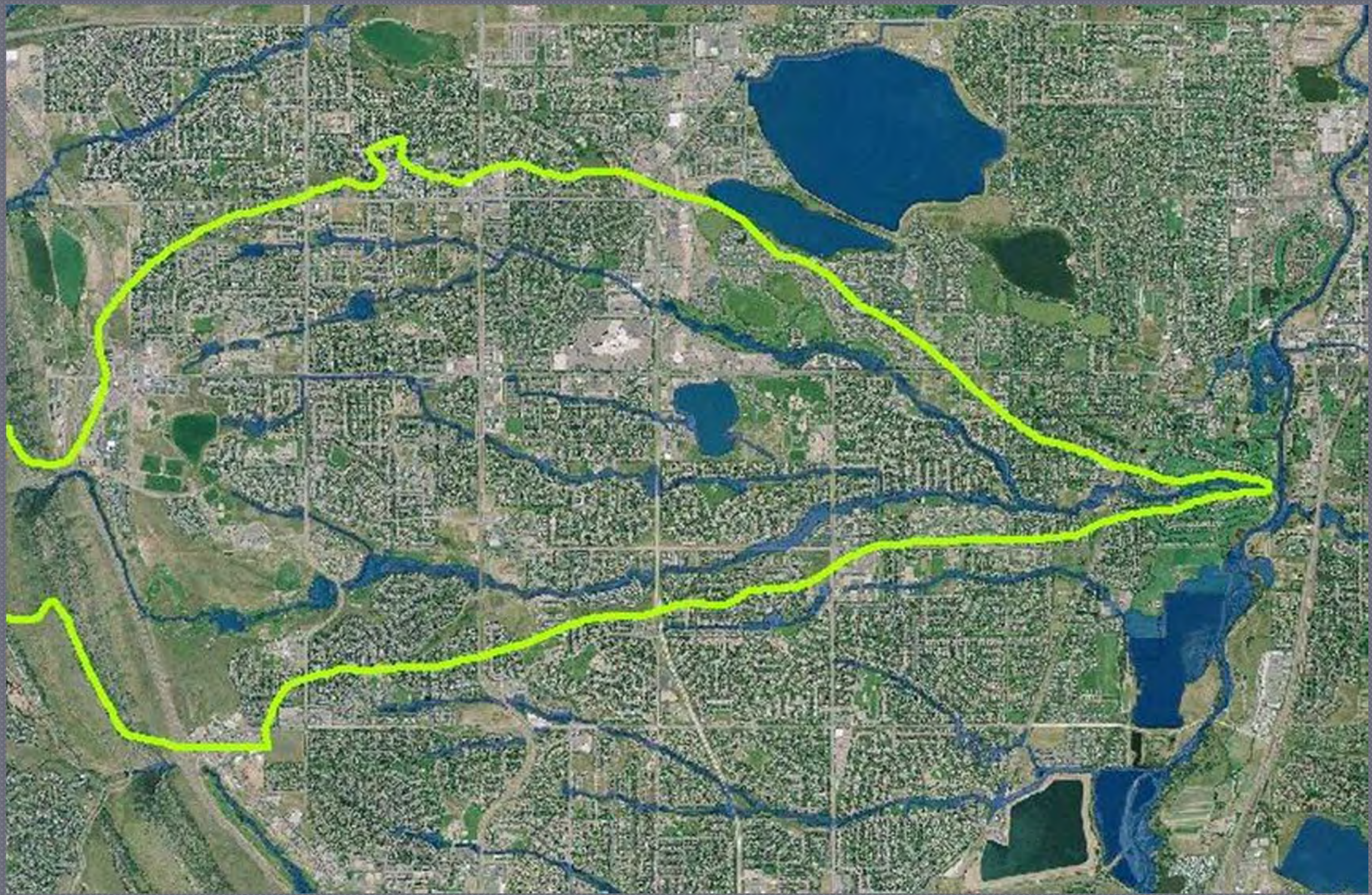

Dutch Creek Watershed 1980

Dutch Creek Watershed 2009



1977 floodplains on 1980 photo

2008 floodplains on 2009 photo



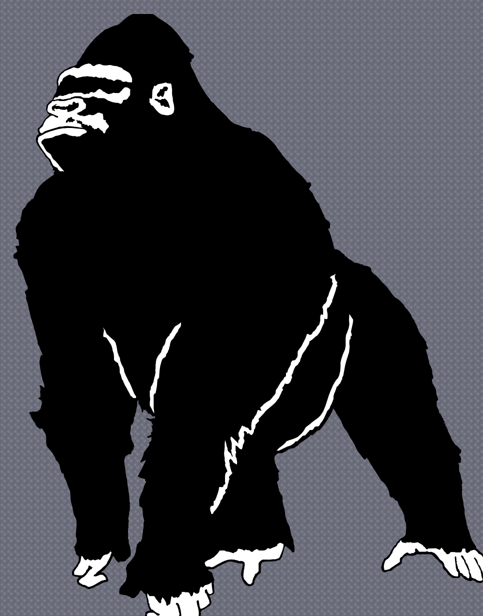
•Meadowood Golf Course

•Left half of photo is '80's channelization philosophy

•Right half of photo is basically a preservation option with trail

Preservation

Now some DCM projects



Naeser's Law:

You can make it foolproof, but you can't make it damnfoolproof

- Columbine Country Club
- Dutch Creek Capital Improvements

•Columbine Country Club

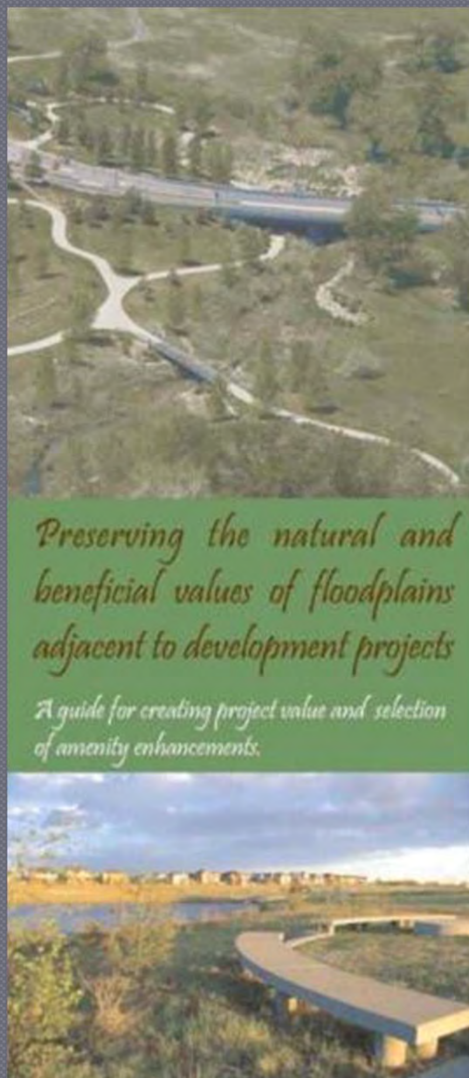
•Three Lakes Tributary Capital Improvements

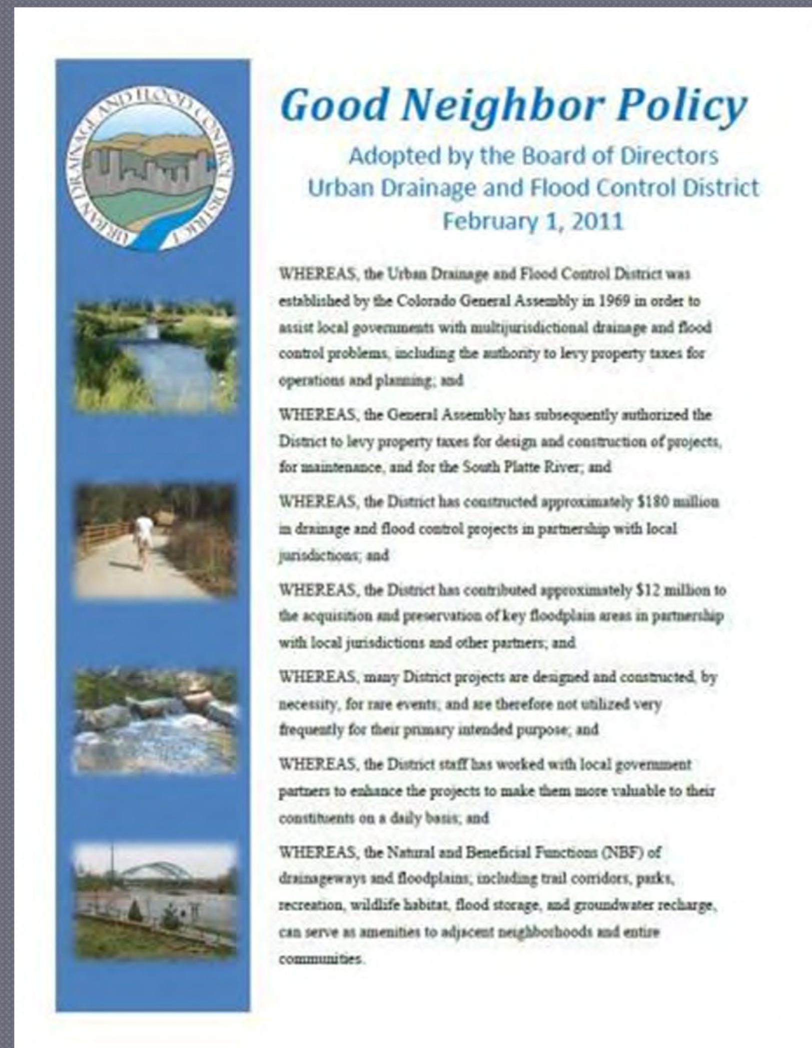
Local sponsor for COE project

Biggest project to date

We are a lot greener now

Recommended Reading





Good Neighbor Policy

Adopted by the Board of Directors
Urban Drainage and Flood Control District
February 1, 2011

WHEREAS, the Urban Drainage and Flood Control District was established by the Colorado General Assembly in 1969 in order to assist local governments with multijurisdictional drainage and flood control problems, including the authority to levy property taxes for operations and planning; and

WHEREAS, the General Assembly has subsequently authorized the District to levy property taxes for design and construction of projects, for maintenance, and for the South Platte River; and

WHEREAS, the District has constructed approximately $180 million in drainage and flood control projects in partnership with local jurisdictions; and

WHEREAS, the District has contributed approximately $12 million to the acquisition and preservation of key floodplain areas in partnership with local jurisdictions and other partners; and

WHEREAS, many District projects are designed and constructed, by necessity, for rare events; and are therefore not utilized very frequently for their primary intended purpose; and

WHEREAS, the District staff has worked with local government partners to enhance the projects to make them more valuable to their constituents on a daily basis; and

WHEREAS, the Natural and Beneficial Functions (NBF) of drainageways and floodplains, including trail corridors, parks, recreation, wildlife habitat, flood storage, and groundwater recharge, can serve as amenities to adjacent neighborhoods and entire communities.

Urban Drainage and Flood Control District

SUSTAINABILITY ON A LARGE SCALE

Action: In 1972 the Board of Directors of the Urban Drainage and Flood Control District decided to pursue a two-pronged approach of remedial and preventive actions to contain flood losses.

Outcome: The population of the District has tripled since the action described above but there are 5000 fewer structures (units) in the mapped 100-year floodplains than there were in 1970.

April, 2010

Introduction
In 1965 the Denver metropolitan area was hit with a devastating flood on the South Platte River. Following the flood an organization of county engineers began meeting to find ways to address drainage problems that crossed jurisdictional boundaries. By 1969, they had enlisted an influential state senator to draft and introduce the Urban Drainage and Flood Control Act in the Colorado General Assembly. The story goes that the act was stuck in a committee and likely headed for defeat when the 1969 South Boulder Creek flood occurred in Boulder. Following that event the legislation passed.

The legislation established the Urban Drainage and Flood Control District for the purpose of assisting local governments in the Denver metropolitan area with multi-jurisdictional drainage and flood control problems. The District boundaries have changed since the original legislation, and it now covers an area of 1608 square miles and includes Denver, parts of the 6 surrounding counties, and all or parts of 33 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.

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Flood Hazard News

An annual publication of the Urban Drainage and Flood Control District

Vol. 40, No. 1 December, 2010

Inside this issue

Elmer's Twomile Greenways Project

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

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

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

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

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

North of Valmont Road - Before

North of Valmont Road - After

In Conclusion

Matz's Maxim:

A conclusion is the place where you got tired of thinking.

Questions?

EPA's Proposed Rulemaking to Strengthen the Stormwater Program

US Environmental Protection Agency

Region 8

Agenda

- Stormwater Program Background
  - History of Stormwater Program
  - Green Infrastructure Approaches
- Proposed Stormwater Rulemaking
  - Key Stormwater Rulemaking Activities
  - Rulemaking Options Under Considerations
- Potential Impacts on State and Local Governments
- Questions

Background on Permit Program

- The National Pollutant Discharge Elimination System (NPDES) permit program, authorized under the Clean Water Act (CWA), regulates point sources that discharge pollutants into waters of the United States
- Certain sources of stormwater discharges, including those from municipal separate storm sewer systems (MS4s), construction activities, and industrial activities are regulated under the NPDES permit program
- Most states are authorized to provide oversight and issue NPDES stormwater permits
- EPA Region 8 remains the NPDES permitting authority at Federal Facilities in CO and all Indian Country in CO, MT, ND, SD, UT, WY

Stormwater Regulatory Background: Phase I Stormwater Regulations

- Finalized in 1990

- Regulates stormwater discharges from:
  - 11 categories of industrial operations, including construction activity disturbing 5 acres or more
  - Medium and large municipal separate storm sewer systems (MS4s) that serve 100,000 or more people

- Established:
  - Permit application requirements and deadlines
  - Requirements for a municipal stormwater management plan
  - Permit exclusion for industrial activities that are not exposed to stormwater

- 761 Phase I MS4s Nationally

Stormwater Regulatory Background: Phase II Stormwater Regulations

- Finalized in 1999
- Regulates stormwater discharges from:
  - Small MS4s, defined as:
    - An MS4 not already covered by an MS4 permit and
    - Located in an "urbanized area" as defined by the Bureau of Census, or
    - Designated by the NPDES permitting authority on a case-by-case basis.
  - Construction activities disturbing between one and five acres
- Established six minimum control measures for small MS4 permits:
  1. Public Education & Outreach
  2. Public Participation/Involvement
  3. Illicit Discharge Detection & Elimination
  4. Construction Site Runoff Control
  5. Post-Construction Runoff Control
  6. Pollution Prevention/Good Housekeeping
- Approximately 6,675 Phase II MS4s Nationally

Current Status of Stormwater Program

Much progress has been made; however, significant challenges remain to protect waterbodies from the impact of stormwater discharges.

According to EPA's 2004 Water Quality Inventory, urban stormwater discharge is the source of impairment in:

•22,559 miles, or 9.2% of all impaired rivers and streams
•701,024 acres, or 6.7% of all impaired lakes
•867 square miles, or 11.3% of all impaired estuaries

Stormwater Management Issues

1. Increased amounts of stormwater and pollutants…

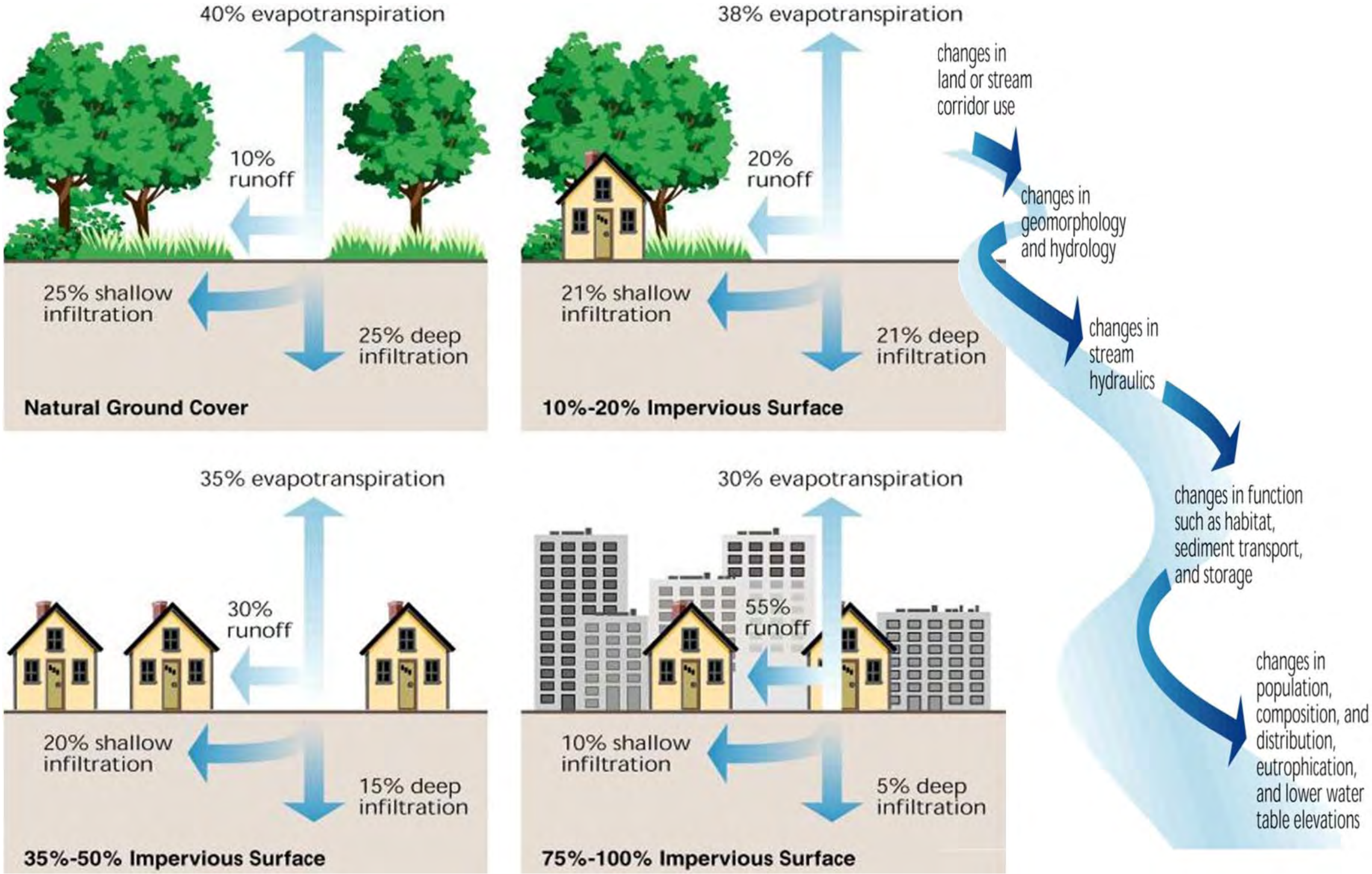
2. Enter the municipal separate storm sewer system (MS4) or is directly discharged to a nearby waterbody…

3. Which can lead to stream degradation and increased pollutants entering waterbodies

NRC Report *Urban Stormwater Management in the United States* (Oct. 08)

- Findings:
  - Current approach unlikely to produce an accurate picture of the problem and unlikely to adequately control stormwater's contribution to waterbody impairment
  - Requirements leave a great deal of discretion to dischargers to ensure compliance
  - Poor accountability and uncertain effectiveness
  - A more straightforward way to regulate stormwater would be to use flow or a surrogate, like impervious cover, as a measure of stormwater loading
- Recommendation:
  - Stormwater control measures that harvest, infiltrate, and evapotranspirate stormwater are critical to reducing the volume and pollutant loading of small storms.
- The NRC Report confirmed EPA's beliefs that current stormwater control efforts are not adequate

Impacts of Urbanization on Stormwater Discharges



New Approach to Stormwater Management

- Shift from the concept of moving stormwater as far away as quickly as possible in large, buried collection, storage & conveyance systems.

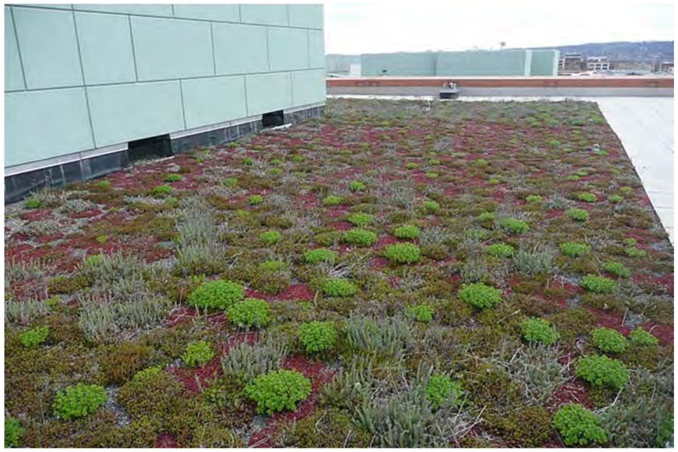
- Shift towards the concept of managing stormwater where it falls; using infiltration, evapotranspiration, and harvesting/use.

Green Infrastructure Approaches
Mimic Natural Hydrologic Site Conditions

Infiltration ~ Evapotranspiration ~ Capture & Use

- Bioretention
- Permeable pavements
- Green roofs
- Cisterns & rain barrels
- Trees & expanded tree boxes
- Reforestation & restoration
- Parking & street designs
- Water Conservation

Green Infrastructure Approaches



Green roof, Washington, DC

Rain garden, Philadelphia

Bioretention, Portland

Vegetated swale, Lenexa, KS

Parking lot swale
Santa Monica, CA

Disconnected downspout
Emeryville, CA

Green Infrastructure Approaches

Open swale, Portland, OR

Terraced open swale, Washington, DC

Permeable pavement, Seattle

Porous pavers, Philadelphia

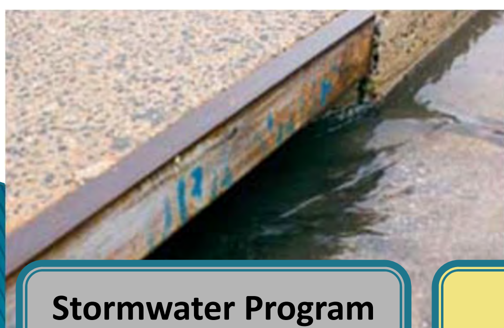
Large cistern, Chicago

Examples of Green Infrastructure Implementation in State and Local Stormwater Programs

- States are integrating green infrastructure principles into their permits
  - North Carolina - Montana - Maryland
  - New Jersey - Oregon - Wisconsin
  - Ohio - Connecticut - Colorado
  - West Virginia - Maine - Washington
  - California - Vermont - Kansas
  - Massachusetts - New York

- Communities are adopting green infrastructure approaches
  - Philadelphia, PA - Portland, OR - Washington, DC
  - Kansas City, MO - Chicago, IL - Richmond, VA
  - Milwaukee, WI - Louisville, KY - Seattle, WA

Stormwater Rulemaking



- EPA is considering developing performance standards for discharges from new and redevelopment that promote green infrastructure practices that mimic natural processes to infiltrate and recharge, evapotranspire, and/or harvest and use precipitation.

- As part of this effort, EPA is also:
  - Exploring options for expanding the universe of federally regulated municipal separate storm sewer system (MS4s),
  - Exploring the desirability of establishing different requirements for transportation facilities,
  - Evaluating options for establishing retrofit requirements on MS4s,
  - Evaluating additional provisions specific to the Chesapeake Bay

- EPA intends to propose a rule in September 2011 and to take final action by November 2012.

Benefits of Stormwater Rule

- Proactively Protects Local Water Quality
  - Development and sprawl are increasing at a rate faster than population growth. Increased impervious cover associated with this development impacts water quality by increasing pollutant loadings and stormwater discharges that cause stream erosion.
  - EPA's rule seeks protect water quality from these adverse water quality impacts.
- Helps to Restore Impaired Waters
  - Stormwater discharges are a primary cause of water quality impairment.
  - One goal of EPA's rule is to restore these impaired waters by establishing standards that must be met as redevelopment occurs and by promoting retrofits of stormwater practices that have not been effective in protecting streams from stream erosion and pollutant loading.
- Green infrastructure provides a cost-effective means of protecting water quality from stormwater discharges

Benefits of Stormwater Rule

- Cities should also realize other benefits from a rule that promotes green infrastructure. Green infrastructure:
  - Reduces the amount of rainwater that enters sewer systems, thereby **reducing overflows** of raw or partially treated wastewater
  - Increases job diversity by creating a demand for certified installers, operations and maintenance staff, and landscape architects
  - Creates more liveable communities by providing more trees, vegetation and open space
  - Mitigates urban **heat island effects**
  - Reduces energy usage
  - **Recharges groundwater** and restores depleting groundwater supplies
  - Creates more habitat for wildlife
  - Improves air quality

- Green infrastructure offers cities a holistic approach to solving many problems.

- EPA's stormwater rule aims to provide standards with appropriate flexibility so that states and cities can tailor solutions and take advantage of the benefits of green infrastructure in a way that best meets their needs.

MS4 Expansion Regulatory Options

- No change – 2010 Urbanized Area defined by Census.
- Extend coverage to jurisdiction boundaries of the Phase II MS4s rather than urbanized area boundary
- Extend coverage to urbanized area plus the urbanized clusters defined by Census*
- Extend coverage to regulate all MS4s in HUC 12 watershed which overlap with currently regulated area*

* May include a provision that excludes places with a minimum population (for example, less than 5,000 people)

Possible Requirement for New Development

- Natural hydrology with regard to discharge volume, rate and duration must be maintained or restored for discharges from newly developed sites using practices that infiltrate, evapotranspire, or harvest and use the discharge volume.
- This could be based on the hydrology of the land before construction (e.g., forest, prairie, meadow).

Regulatory Options for New Development Standard to Meet Requirement

1. Permitting authorities must, in their permits or state rule, establish specific numeric standards that ensure compliance with the requirement

Note: EPA plans to provide guidance to states to assist them in developing the numeric standard.

2. Permitting authorities must, in their permits or state rule, comply with the requirement by either:

a. Adopting the numeric criteria in the federal rule, or
b. Developing State-specific numeric criteria that are as protective as the criteria in the federal rule

Exceptions

- For all options, there could be exceptions if the numeric standard cannot be met. For example,
  - groundwater pollution concern for source water protection
  - conflict with water rights
  - site constraints, especially for new transportation projects

- Permitting authority could develop offsite mitigation or payment in lieu programs, develop an alternative standard or develop another mitigation measure

Additional Regulatory Considerations

- EPA could apply the requirement to sites discharging to the MS4 AND sites outside regulated MS4s
- EPA expects to establish a size threshold of sites
- EPA could allow states to approve a numeric standard developed for a specific site with unique conditions using an EPA calculator as an alternative to meeting state's numeric standard

Current Volumetric Retention Standards for Discharges from New Development

State or Locality (date enacted)	Size Threshold	Standard
Vermont (2003, draft 2010)	1 acre	Capture 90 percent of the annual storm events
New Hampshire (2009)	1 acre/ 100,000 sq ft outside MS4	Infiltrate, evapotranspire or capture first 1.0 inch from 24-hr storm
Wisconsin (2010)	1 acre	Infiltrate runoff to achieve 60% -90% of predevelopment volume based on impervious cover level
West Virginia (2009)	1 acre	Keep and manage on site 1” rainfall from 24-hour storm preceded by 48 hours of no rain
Montana (2009)	1 acre	Infiltrate, evapotranspire, or capture for reuse runoff from first 0.5” of rain
Portland, OR (1990)	500 sq ft of impervious cover	Infiltrate 10-yr, 24-hr storm
Anchorage, AK (2009)	10,000 sq ft	Keep and manage the runoff generated from the first 0.52 inches of rainfall from a 24 hour event preceded by 48 hours of no measureable precipitation.

Regulatory Options for Redevelopment Standard

1. Redevelopment standard is the same as the standard for new development, however additional exceptions are provided
2. Same as Option 1, except that credits are given for developing in certain areas (e.g., brownfields)
3. Redeveloped sites must be designed and constructed to reduce by 20% (or other percent reduction) the impervious cover from the preconstruction condition
4. Combination of (1) and (3) – some states already have this

Current Volumetric Standards for Onsite Retention of Discharges from Redevelopment

State or Locality (date enacted)	Size Threshold	Redevelopment Standard
Vermont (2003, draft 2010)	1 acre	Reduce impervious cover by 20% or treat 20% of WQ volume
New Hampshire (2009)	1 acre/ 100,000 sq ft outside MS4	Same as new development
Wisconsin (2010)	1 acre	40% TSS reduction from parking areas and roads or MEP
West Virginia (2009)	1 acre	0.2" reduction of 1" on site retention standard and additional 0.2" reductions exist
Montana (2009)	1 acre	Same as new development
Portland, OR (1990)	500 sq ft of impervious cover	Same as new development
Anchorage, AK (2009)	10,000 sq ft	Same as new development

Possible Regulatory Approach for Municipal Reduction of Existing Discharges (Retrofits)

- Proactive performance standards for new and redevelopment will prevent future stormwater and reduce some impacts as development occurs but does not address existing development which is the largest source of stormwater impacts

- To meet water quality goals addressing stormwater discharges from existing development is necessary

- What could a municipal retrofit plan look like?
  - Identification of sensitive waters
  - Identification of stormwater contribution to degradation or impairment
  - Development of goals and milestones for reducing stormwater contributions
  - Identification of priority projects and initiatives to meet permit-term milestones including retrofits for public sites undergoing redevelopment or routine repair and maintenance
  - Development of incentives for retrofits on private property

Industrial Program Options

- Replace the SIC code system with the NAICS system to modernize the identification of industrial discharges covered by NPDES stormwater regulations.
- Phase II MS4 carry out industrial program as described in Phase I requirements.
- Clarify that stormwater discharges from government owned/operated maintenance yards are industrial stormwater discharges.
  - Vehicle and equipment maintenance is a regulated industrial activity, except for municipal maintenance yards
  - These facilities often are given public administration SIC codes or some other non-regulated code not representative of their industrial nature
  - Other industrial activities that are federally, state, or municipally owned that meet the description of industrial stormwater must obtain permits

Key Rulemaking Activities

- Conducted listening sessions and national webcasts
- Distributed questionnaires to regulated MS4s, transportation-related MS4, unregulated MS4s, NPDES permitting authorities and owners/developers of developed sites to gather information - Summer and Fall 2010)
- HQ had sites visits to collect data
- HQ has monthly meetings with States
- Developing models to analyze the costs and pollutant reductions associated with stormwater control options; to evaluate the impacts of stormwater under baseline conditions and each control option; and to assess the financial impact of each control option
- Rulemaking is still being formulated, no decisions have been made at this time.

www.epa.gov/npdes/stormwater/rulemaking

How This Rule Could Impact State and Local Governments

- Benefits
  - Water Quality
  - Many others

- Costs
  - Increased number of MS4 permits
  - New requirements for direct discharges to waters of the U.S. and direct discharges to MS4s
  - Retrofits

- EPA is conducting a thorough analysis of the costs and benefits of all of the rulemaking options

Thank you and Questions ????

Amy Clark
USEPA Region 8
clark.amy@epa.gov
303-312-7014

Fourmile Canyon Post-Fire Flood Risk Assesment

Urban Drainage & Flood Control District Flood Warning Program

Kevin Stewart, P.E.
Information Services &
Flood Warning Program

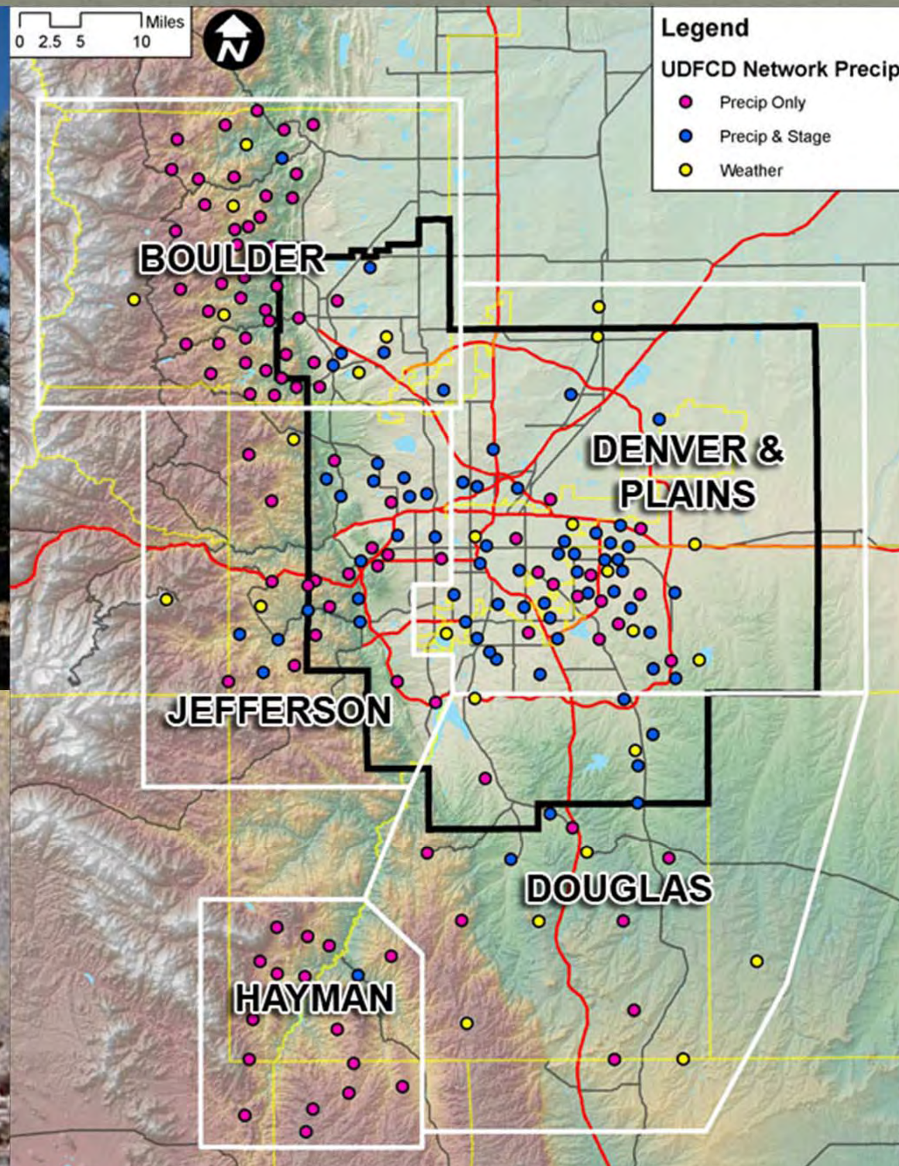
Serving the greater Denver/Boulder metropolitan area since 1979 in cooperation with NOAA's National Weather Service

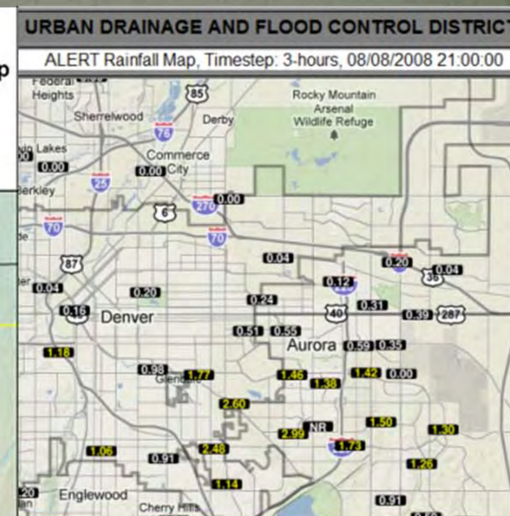
Flood Warning Program Primary Mission

Provide local governments with early notifications of potential and imminent flood threats *(primarily flash flood threats)* in time to take appropriate defensive actions.

Saving lives and property

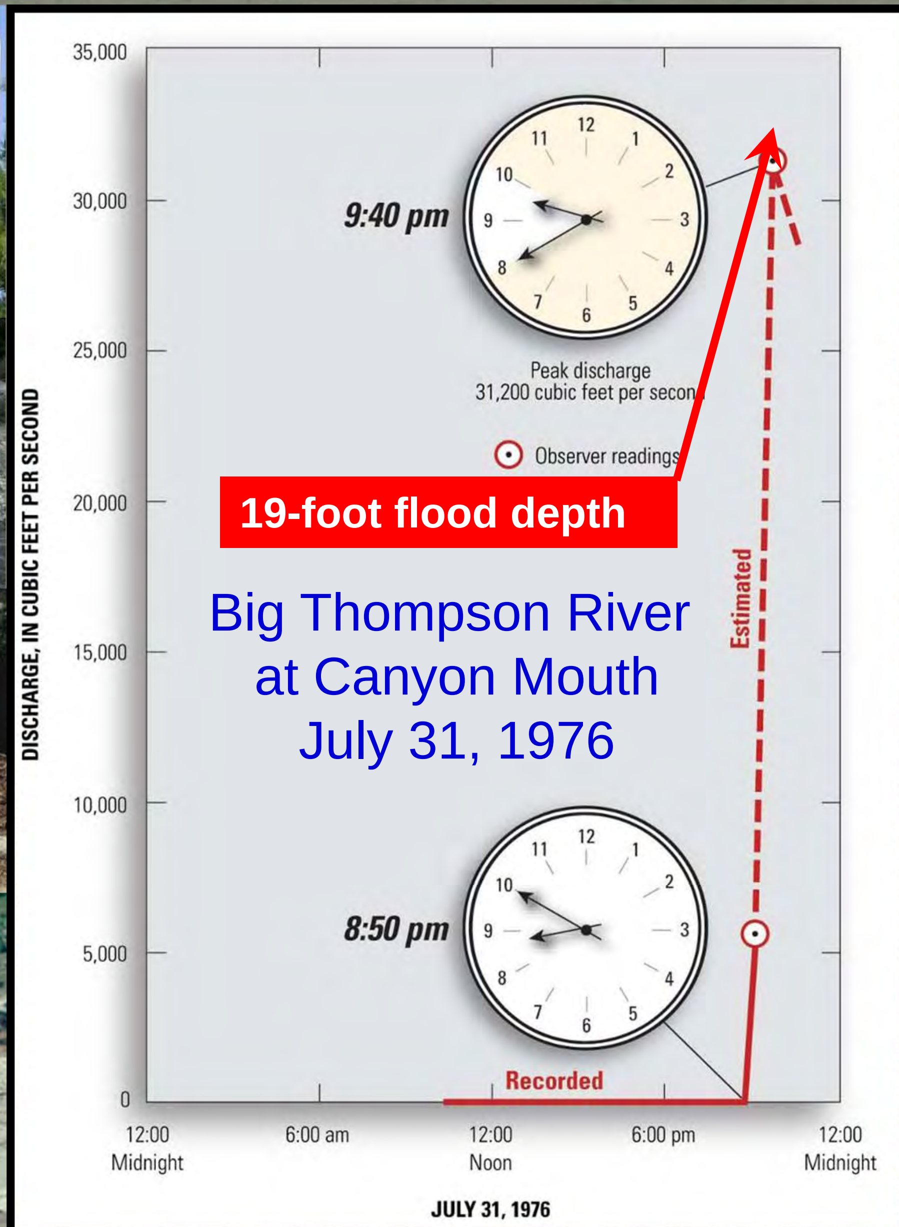
Early Flood Detection – The ALERT System





MOTIVATION FOR F2P2

1976 Big Thompson Canyon Flash Flood




A NEW CHALLENGE
The Fourmile Canyon Fire
Labor Day
September 6, 2010

THE FIRE

September 6, 2010

Conditions

10 am, September 6, 2010

Temperature:	63 degrees
Humidity:	7%
Wind:	12-15 mph WSW gusts to 35 mph
Fire danger rating:	High
Red Flag Warning:	Yes
Haines Index:	4
Probability of Ignition:	80%
Rainfall since Aug 1:	1.3” (avg 2.5”)

Fire Behavior

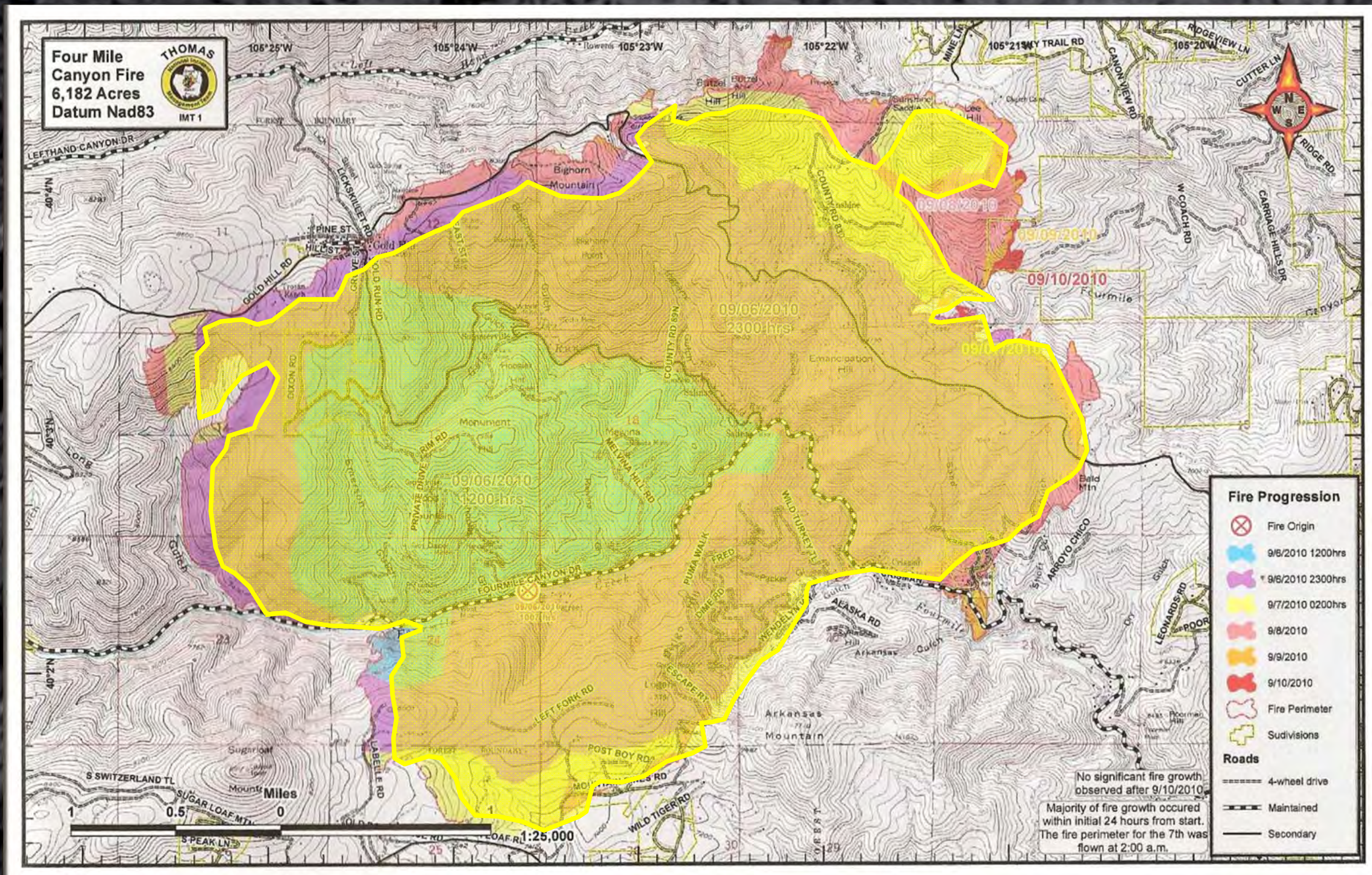
- ✓ Unstable air masses
- ✓Wind driven
- ✓ Creeping, backing surface fires
- ✓ Running surface fires with occasional torching
- ✓ Running crown fires (360º)
- ✓ Intense
- ✓ Fire Whirls
- ✓ Extreme Fire Behavior

Response

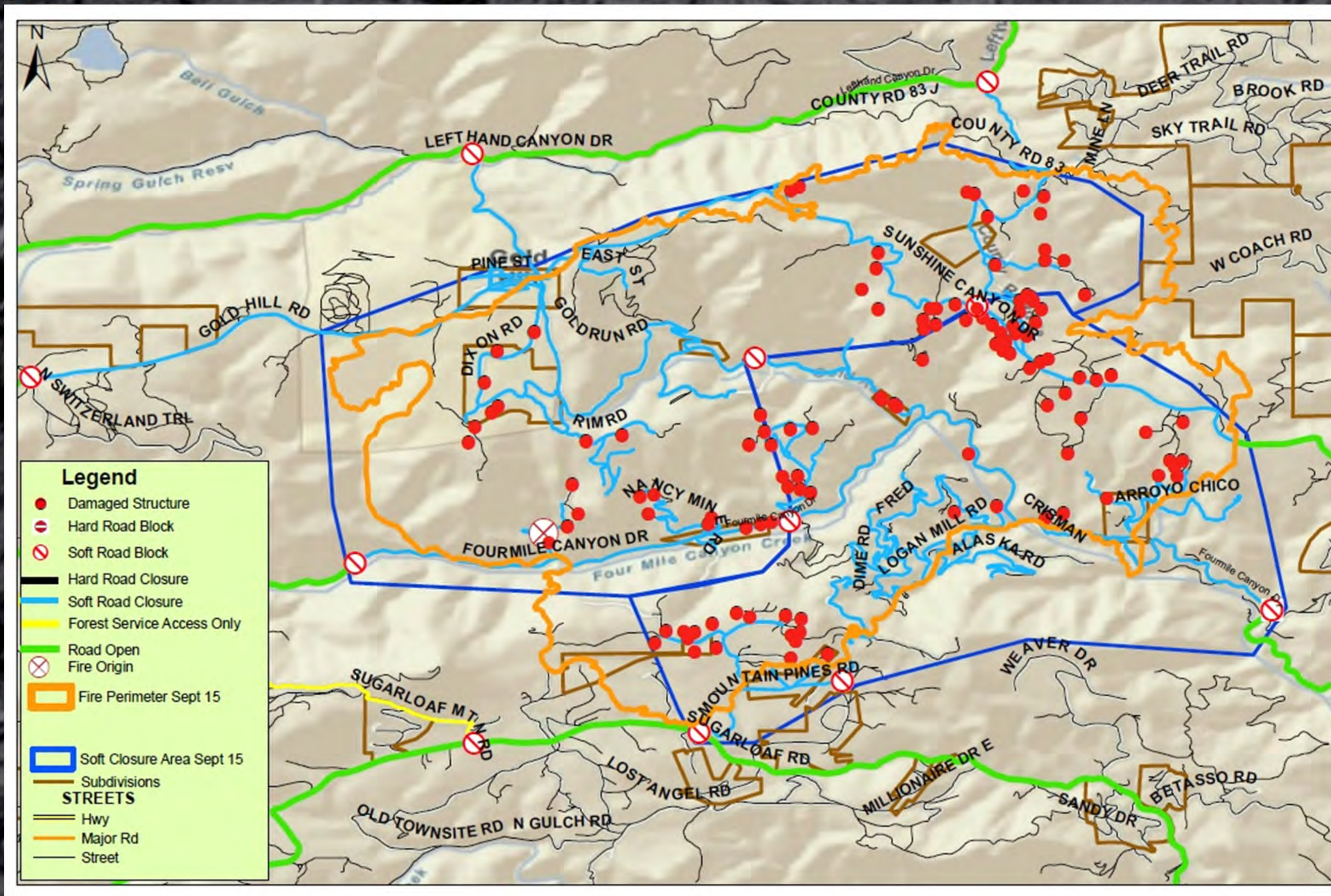
- ◆ 4 Fire Protection Districts mutual IA response
- ◆ 30 Fire agencies within 48 hours

- ➢ Within 2 hours
  - ✓ 50 firefighters
  - ✓ 20 fire trucks
- ➢ Within 6 hours
  - ✓ 150-200 firefighters
  - ✓ 75+ fire trucks
- ➢ Within 72 hours
  - ✓ 1000+ firefighters
  - ✓ 400 fire trucks

Fire Progression September 6-10



Incident Overview



Final Tally

Acres burned:

Total: 6,181

First 14 hours: ~6000 (~429 acres per hour)

Structures threatened: 500

Structures lost: 167

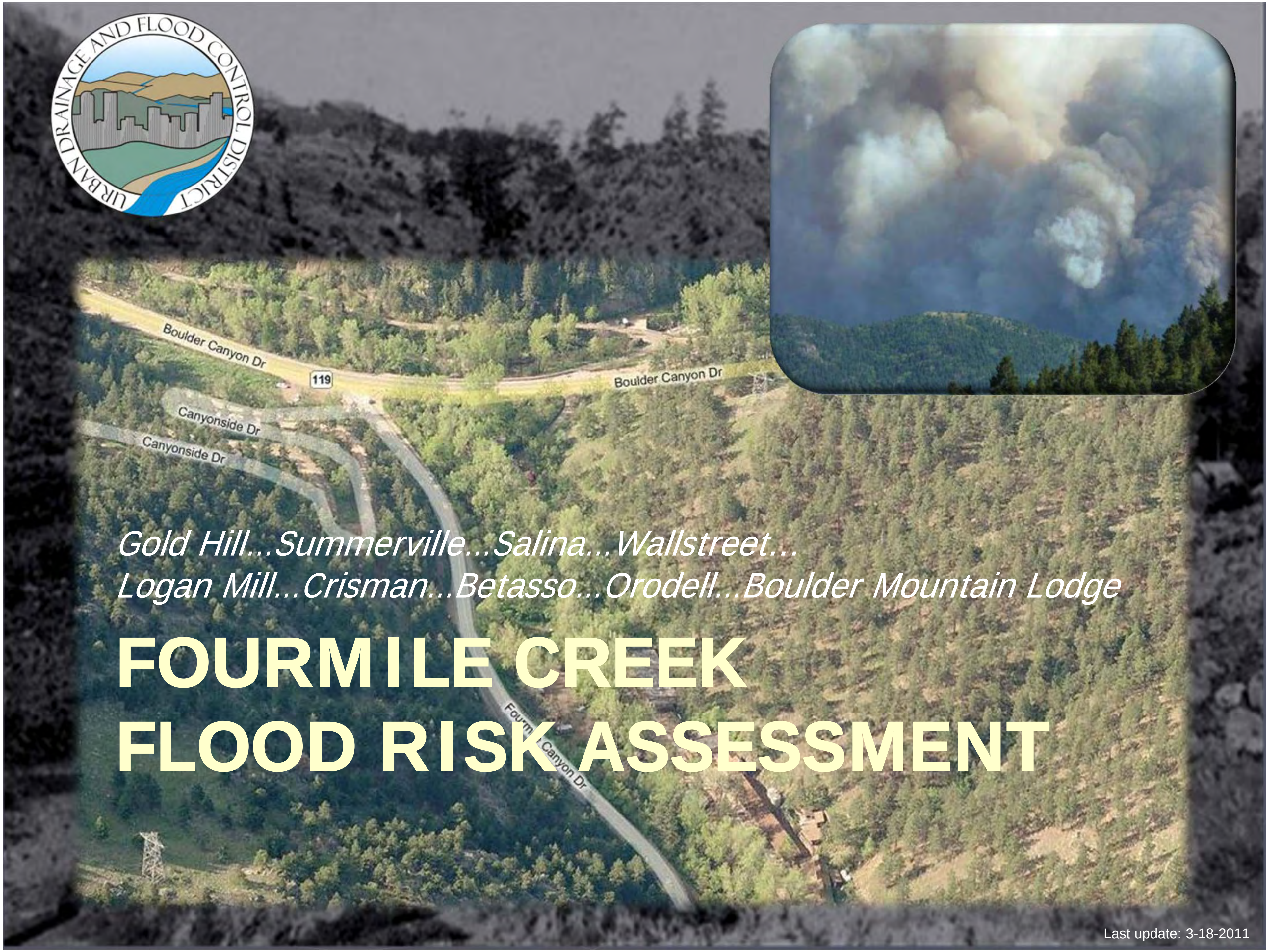
Structures damaged: 14

People evacuated: 3000

Cost: $10.8 million

Firefighter injuries: 7 (all minor)

Fatalities: 0



Gold Hill...Summerville...Salina...Wallstreet...
Logan Mill...Crisman...Betasso...Orodell...Boulder Mountain Lodge

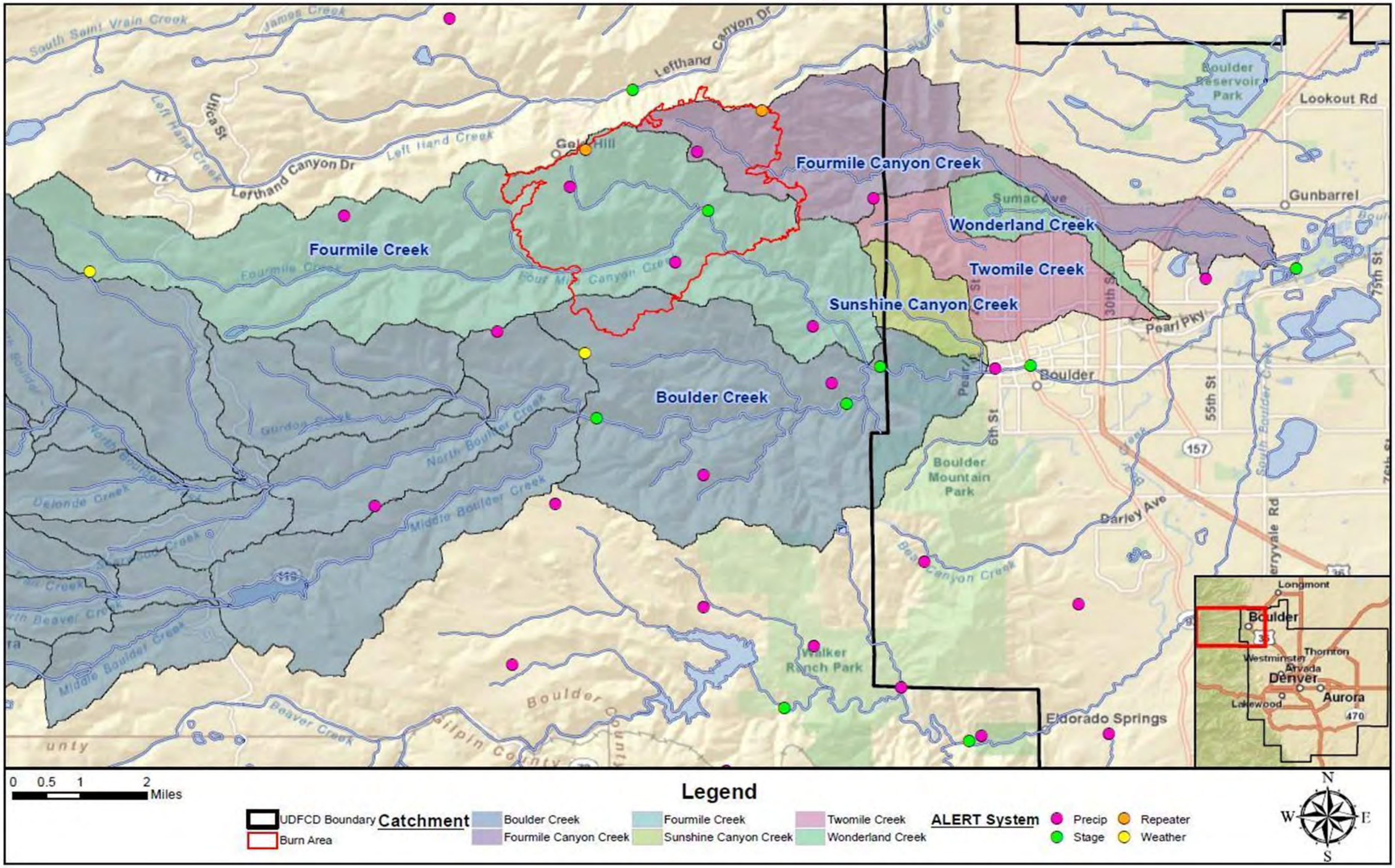
FOURMILE CREEK
FLOOD RISK ASSESSMENT

Last update: 3-18-2011

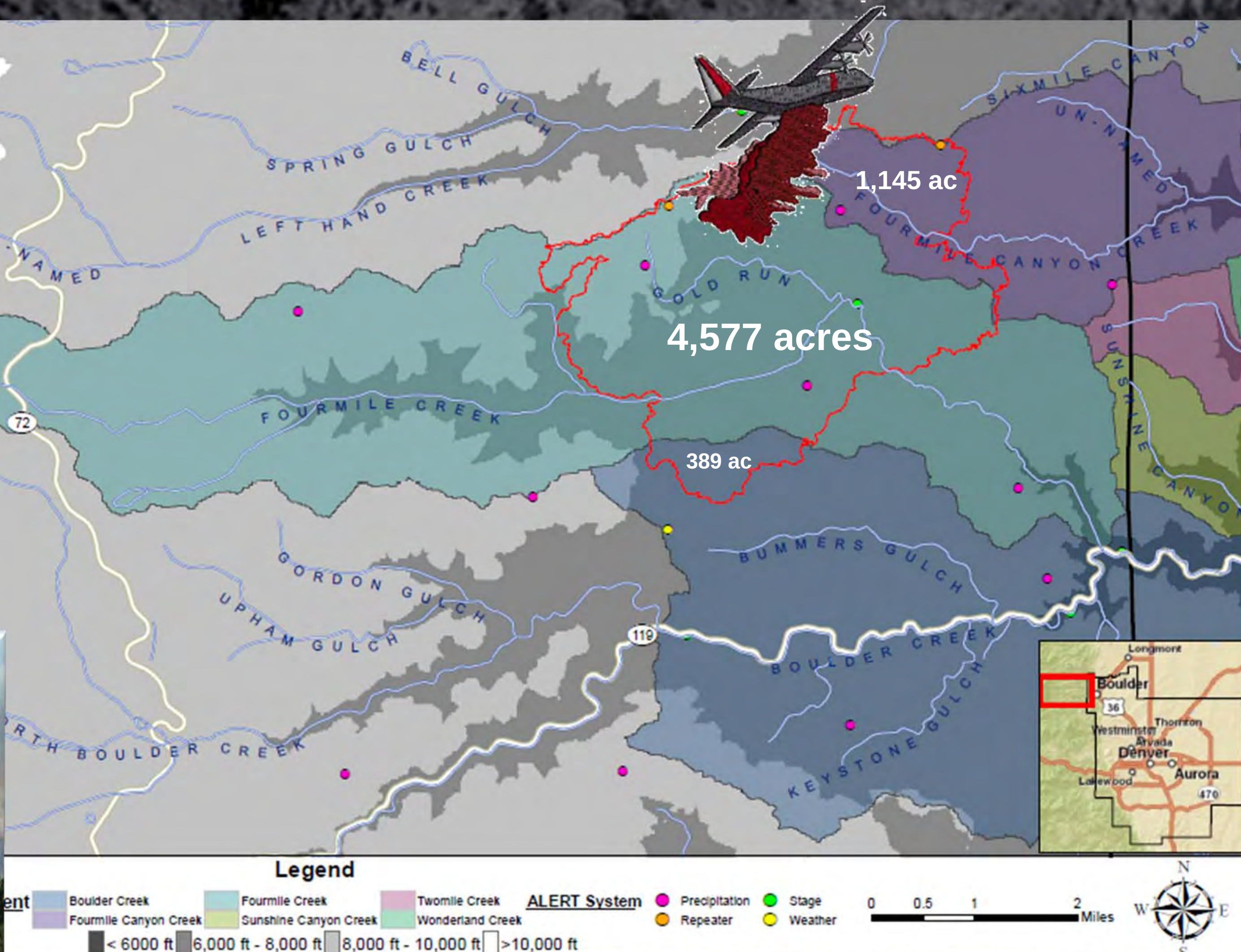
Urban Drainage and Flood Control District

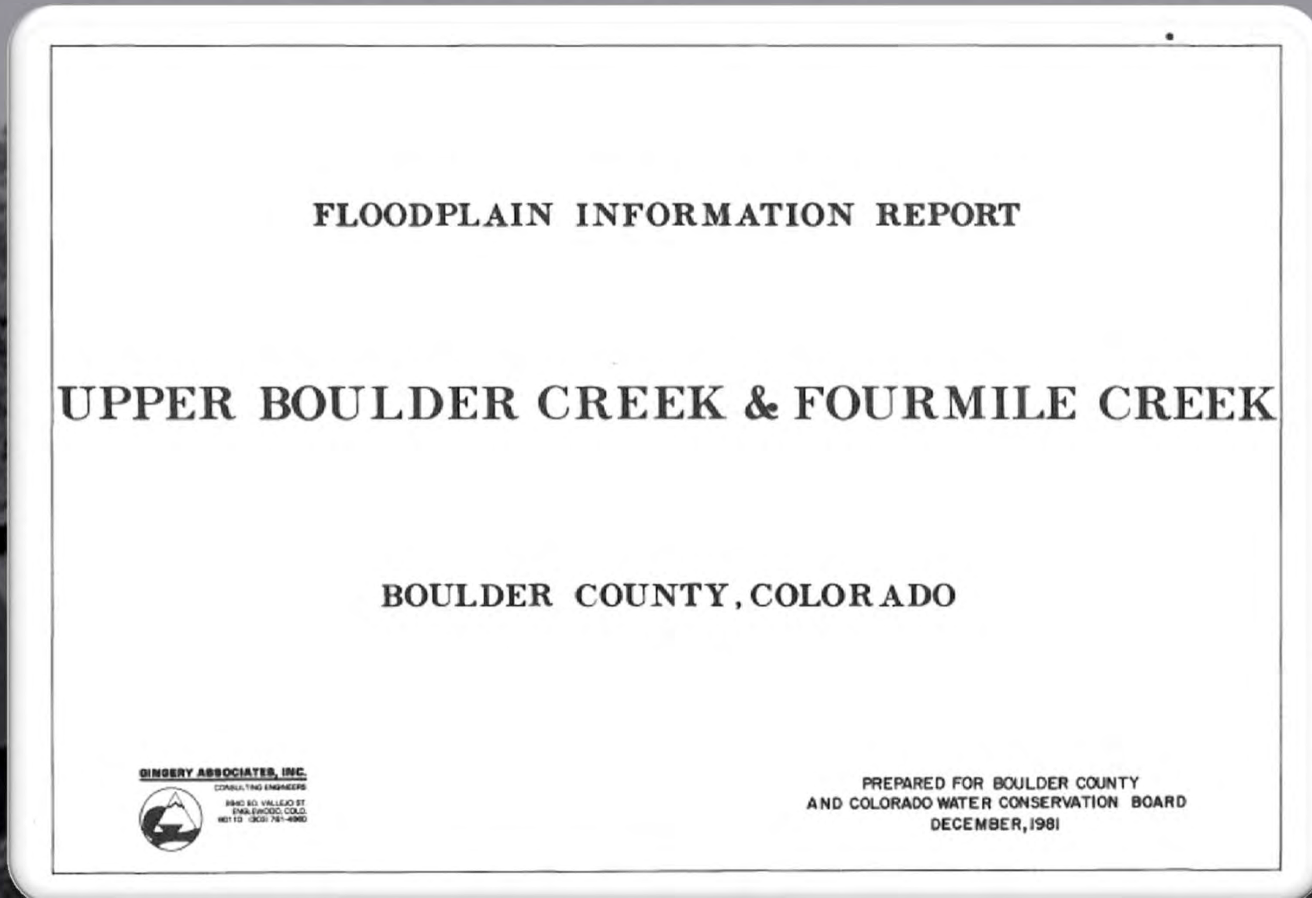
Flood Warning Program

September 2010 Fourmile Canyon Wildfire Watersheds



FMC Burn Area & Boulder Creek Watershed





FLOODPLAIN INFORMATION REPORT

UPPER BOULDER CREEK & FOURMILE CREEK

BOULDER COUNTY, COLORADO

GINGERY ASSOCIATES, INC.
CONSULTING ENGINEERS
ENGLEWOOD, COLO.

PREPARED FOR BOULDER COUNTY
AND COLORADO WATER CONSERVATION BOARD
DECEMBER, 1981

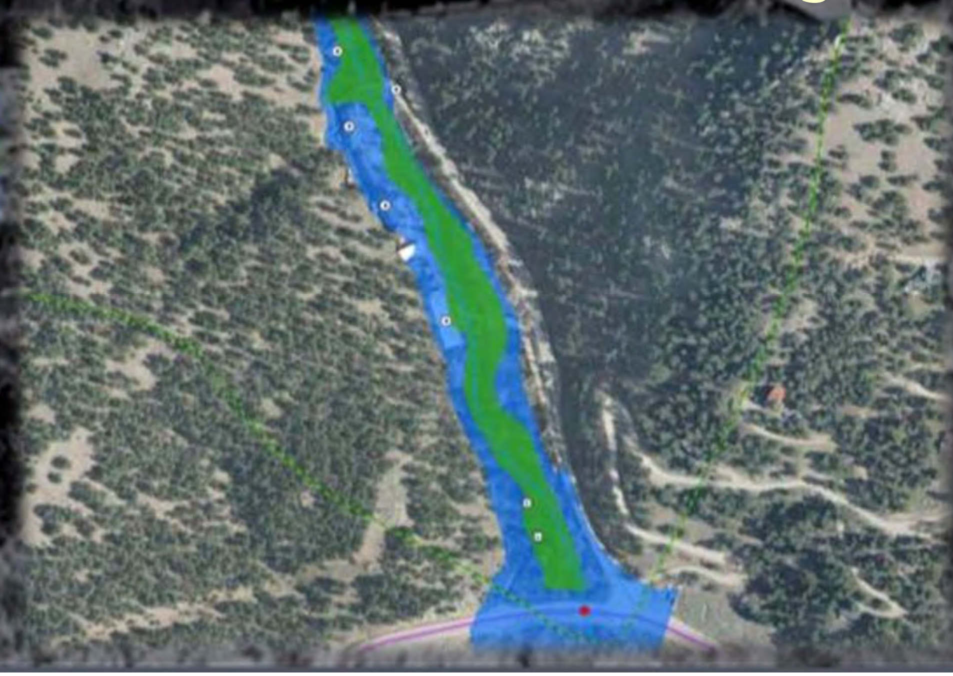
UNDERSTANDING THE THREAT

Flood Profiles & Extents

Salina

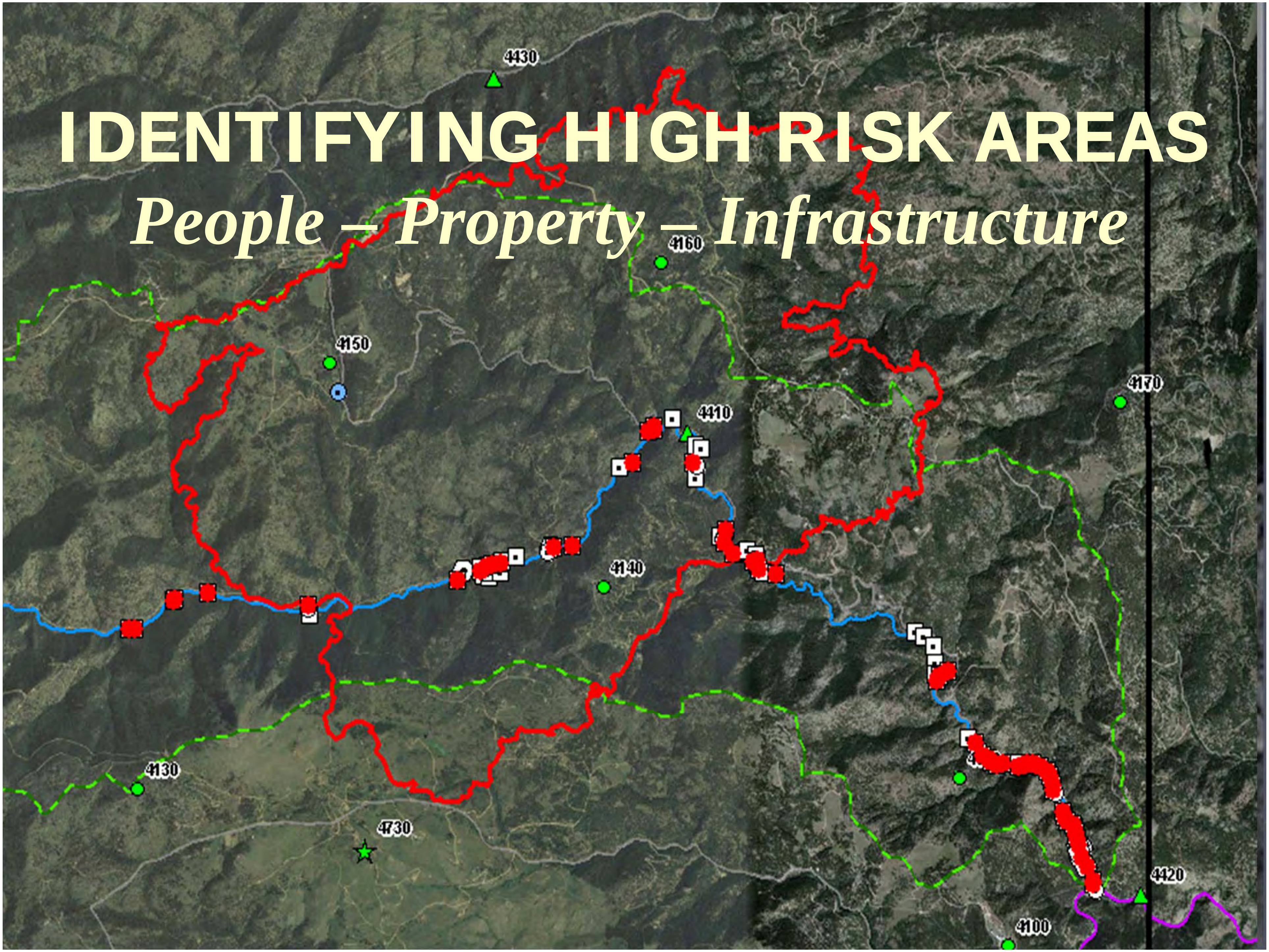
Orodell

Boulder Mountain Lodge



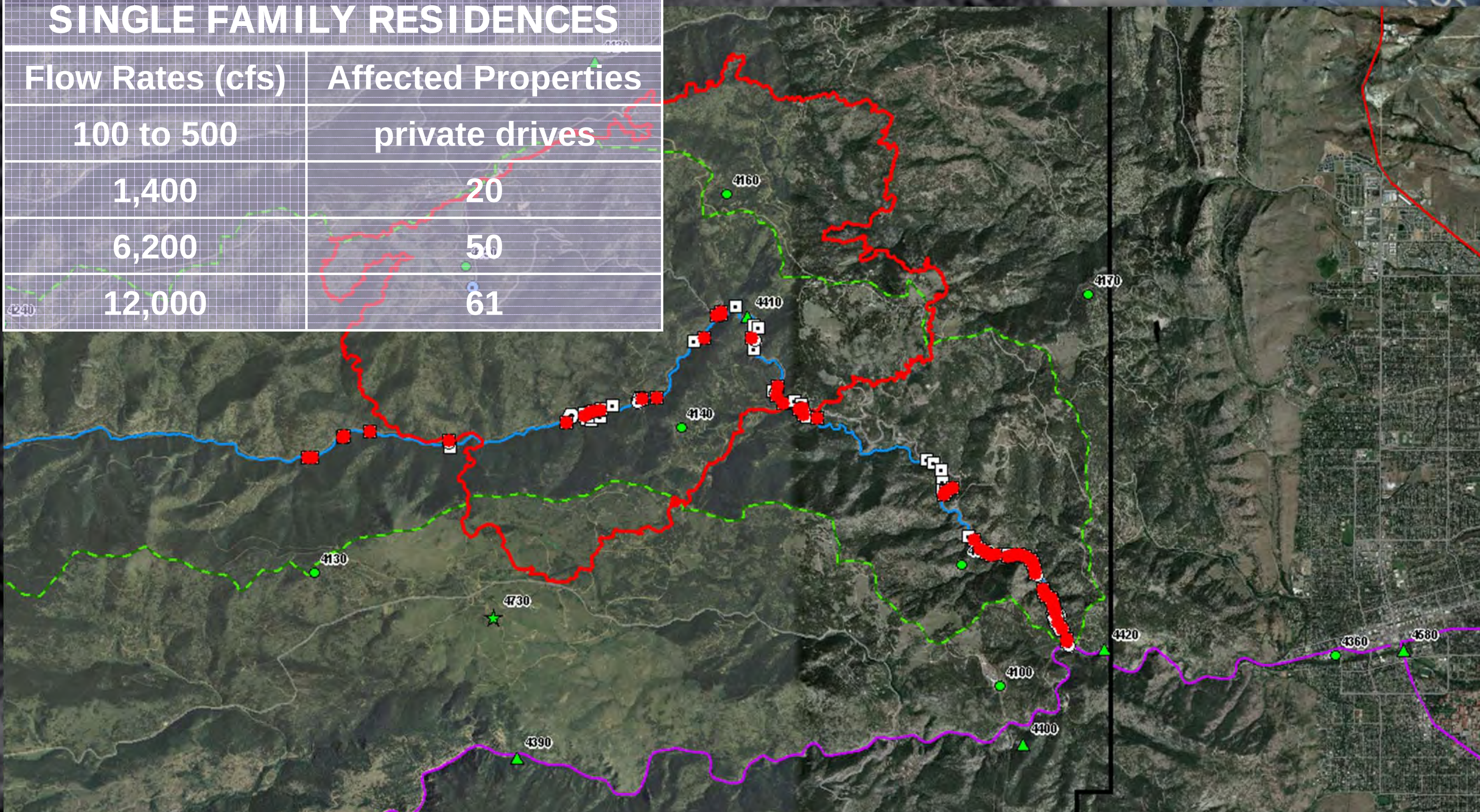
IDENTIFYING HIGH RISK AREAS

People – Property – Infrastructure



Private Properties along Fourmile Creek

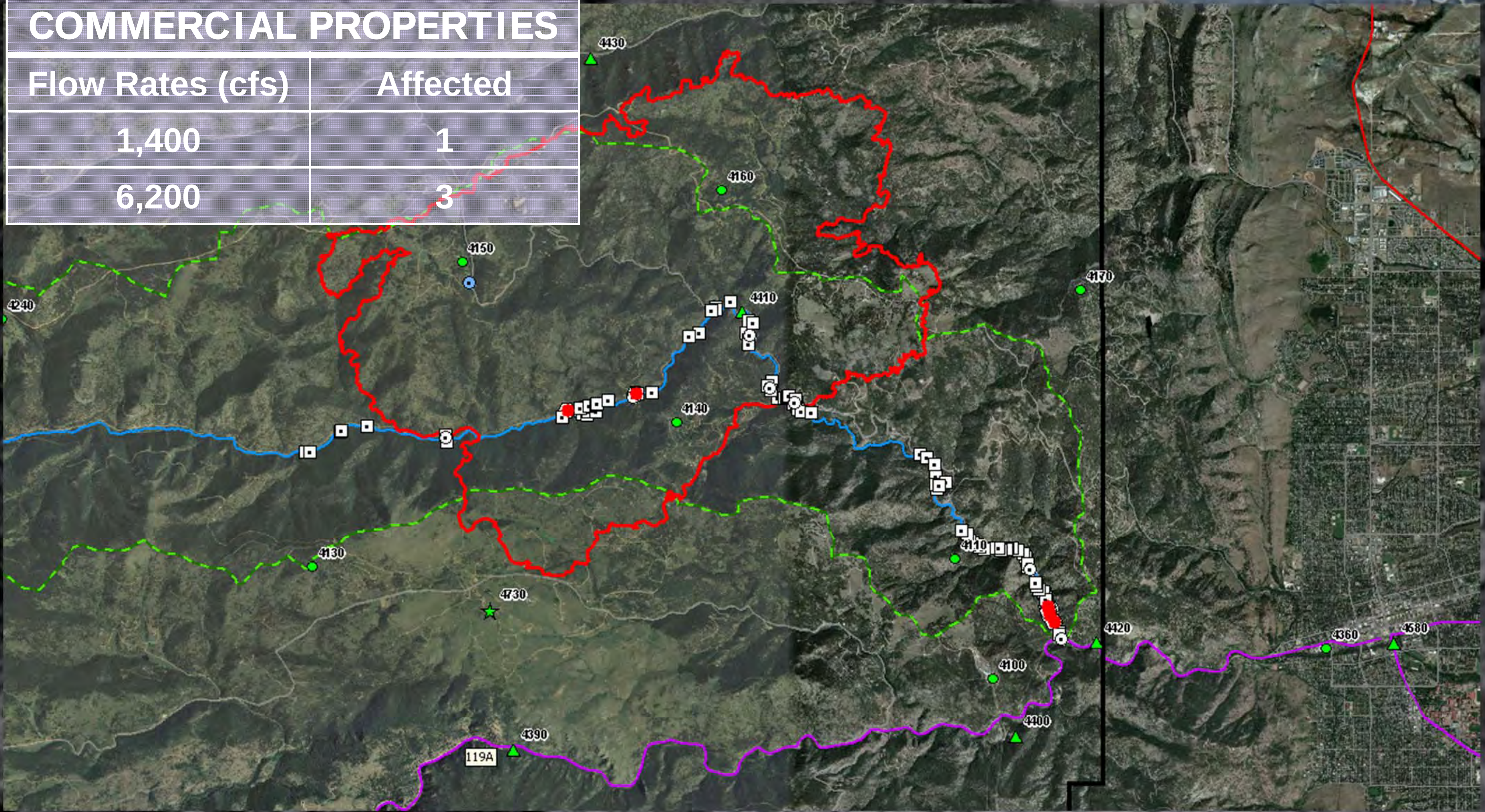
SINGLE FAMILY RESIDENCES	
Flow Rates (cfs)	**Affected Properties**
100 to 500	private drives
1,400	20
6,200	50
12,000	61



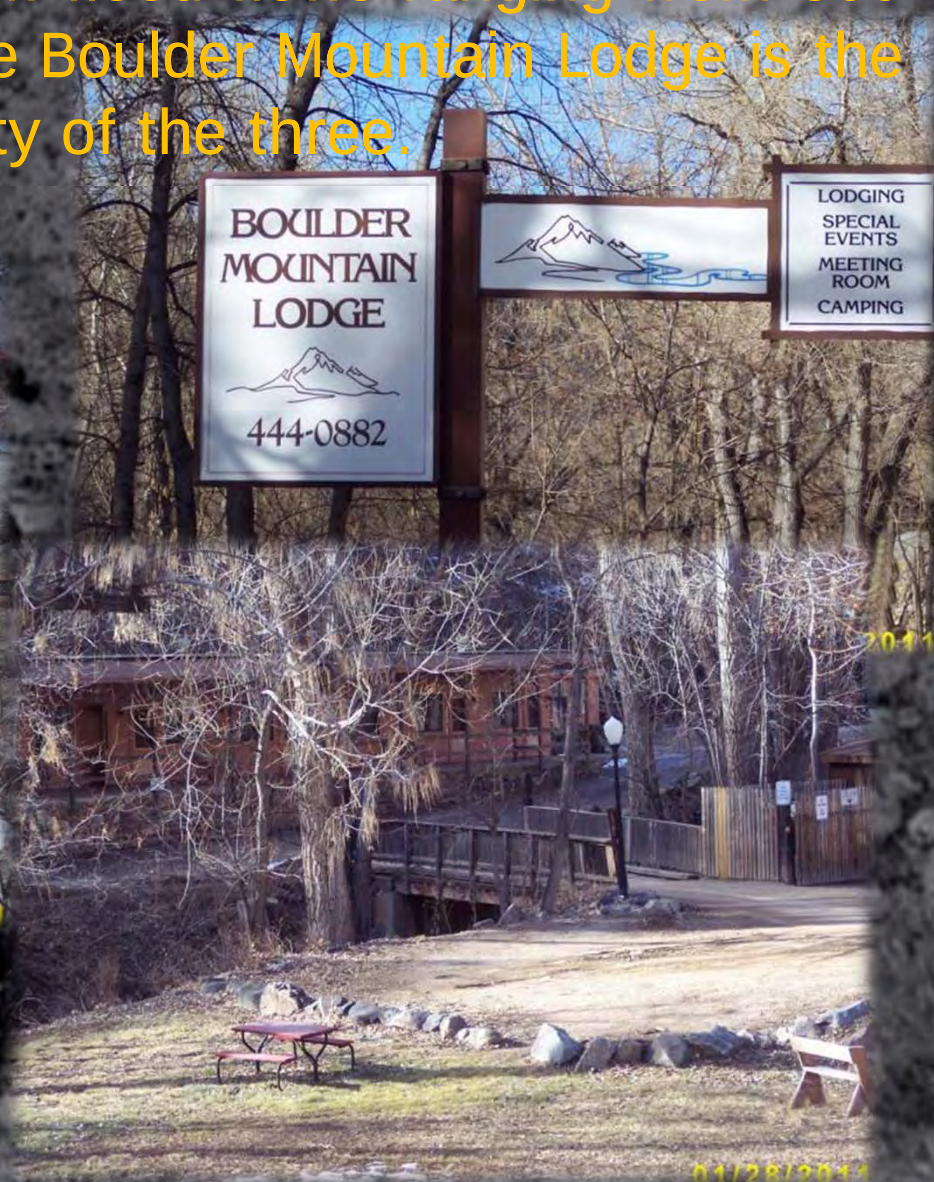
Twenty homes along Fourmile Creek are at risk from flood flows ranging from 500 to 1,500 cfs—a highly likely event. An additional 30 homes are at risk of flooding from larger floods (1,500 to 6,000 cfs) and 11 more from less likely, but possible events approaching 10,000 cfs. This brings the total to 61 homes threatened. An additional 10 to 15 homes adjacent to Gold Run are also at high risk from flooding and debris flows.

More Private Properties along Fourmile Creek

COMMERCIAL PROPERTIES	
Flow Rates (cfs)	Affected
1,400	1
6,200	3



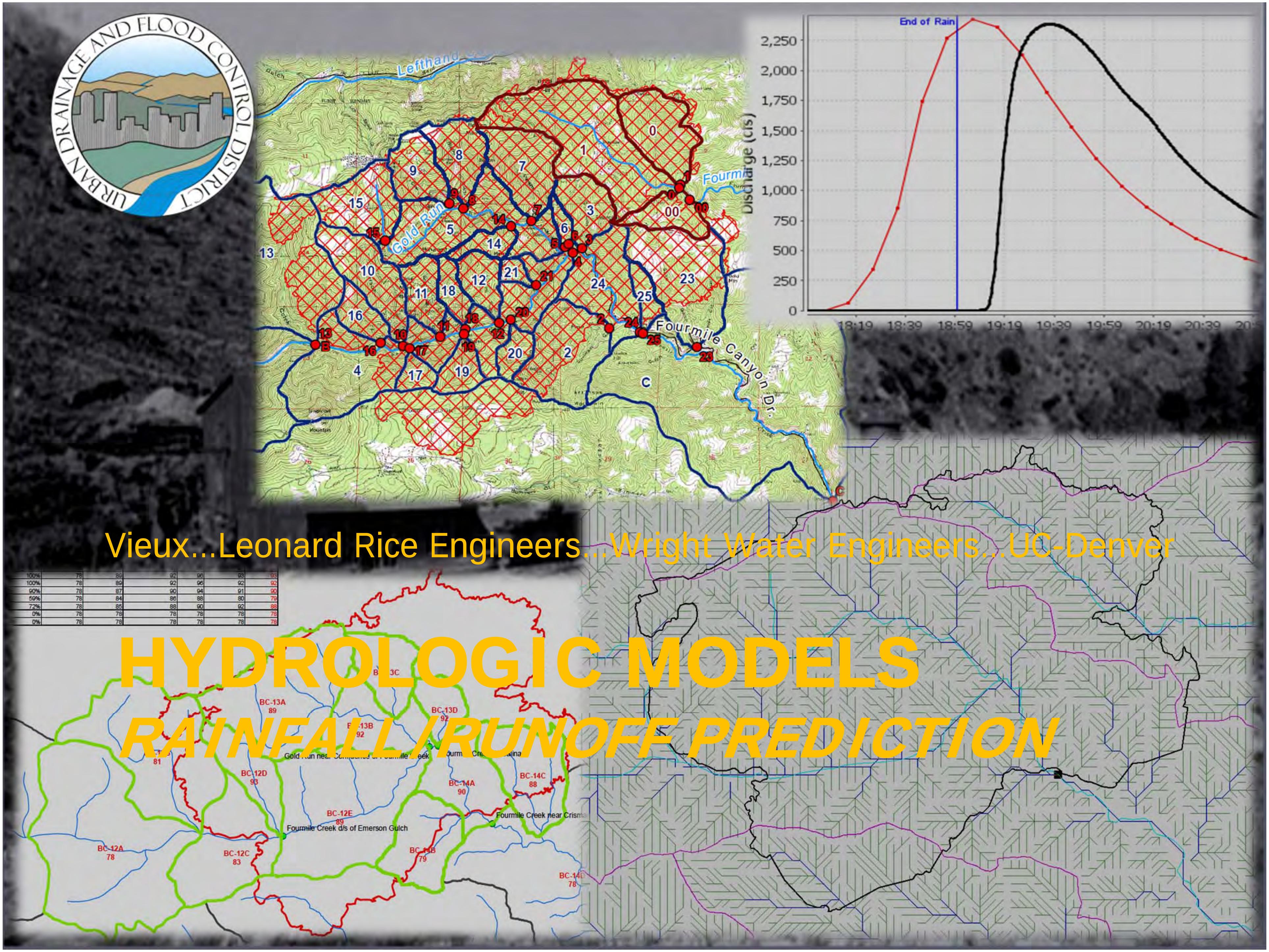
Three commercial properties along Fourmile Creek at risk from flood flows ranging from 500 to 6,000 cfs. The Boulder Mountain Lodge is the highest risk facility of the three.



Infrastructure along Fourmile Creek

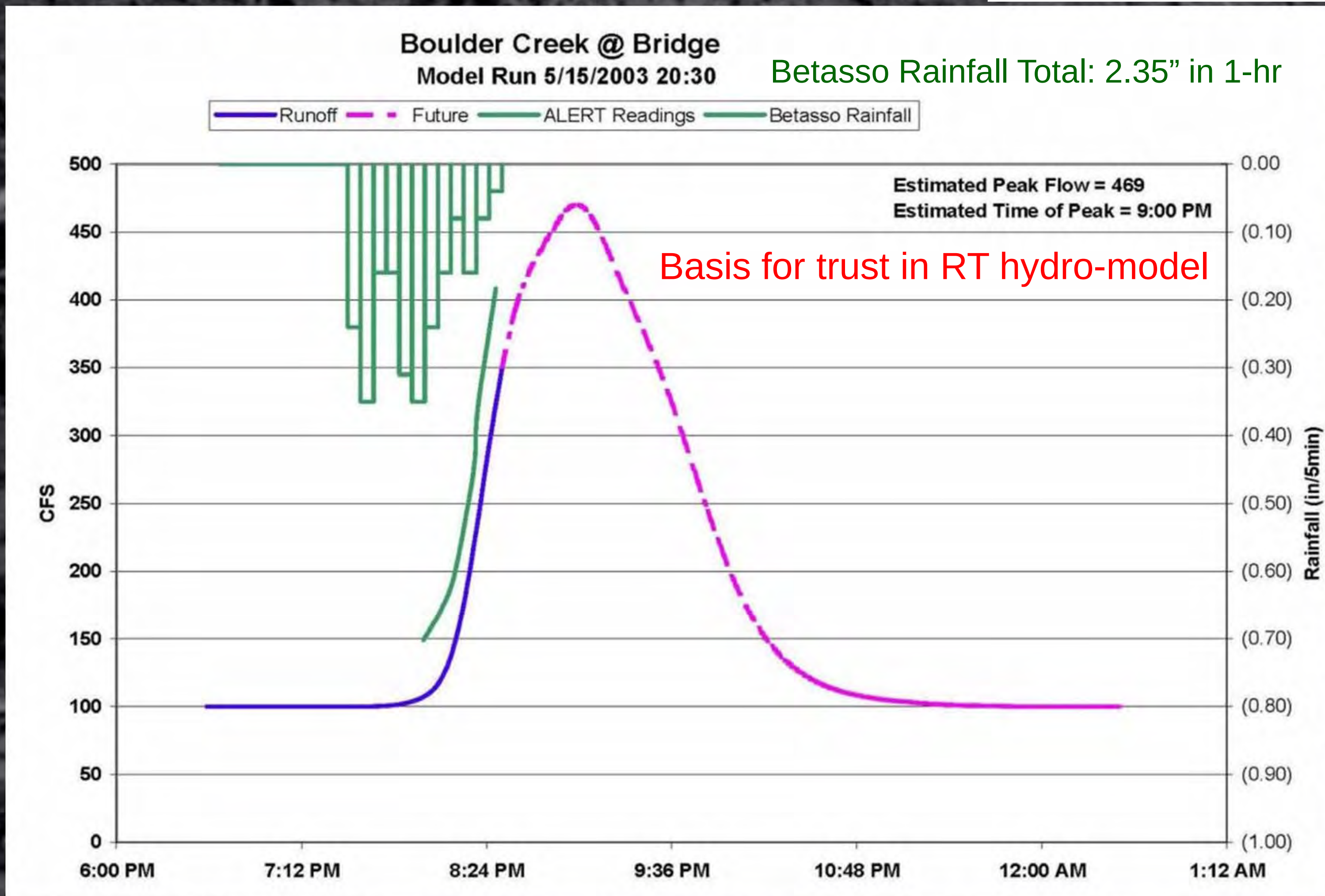
High debris flows will further increase flood risk by reducing the capacity of the channel and road crossings to convey floodwater.

ROAD CROSSINGS	
Location	Qcap (cfs)
Colorado Hwy 119	1,700
Crisman Rd	1,200
Logan Mill Rd	1,500
Private at Salina	2,000
many private drives	< 500

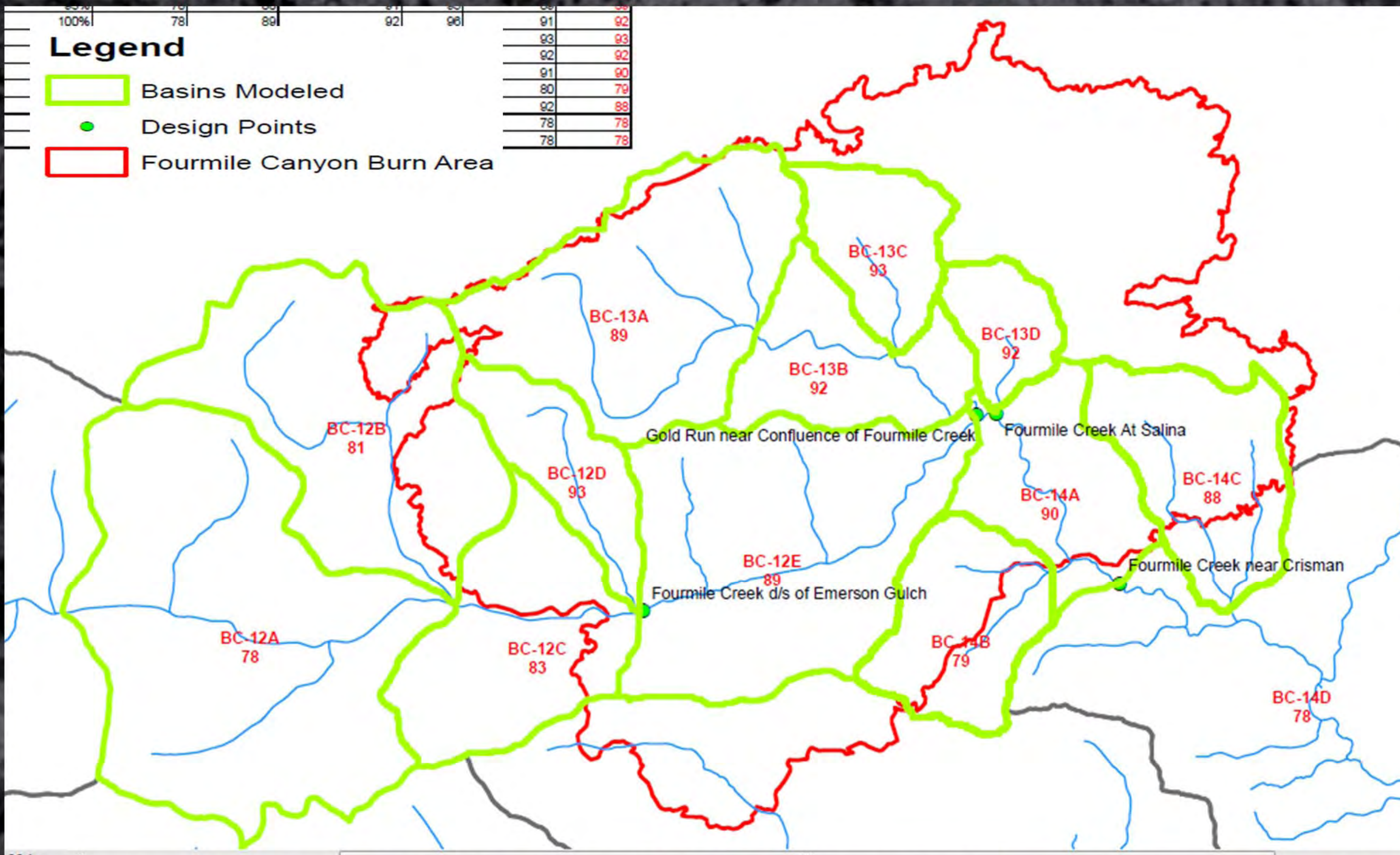

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
HYDROLOGIC MODELS
RAINFALL/RUNOFF PREDICTION
Vieux...Leonard Rice Engineers...Wright Water Engineers...UC-Denver
End of Rain
Discharge (cfs)
Fourmile Canyon Dr.
Gold Run
Fourmile Creek d/s of Emerson Gulch
Fourmile Creek near Crisman

LRE Model Run
May 15, 2003

Measured Peak
Qp = 508 cfs
@ 20:57

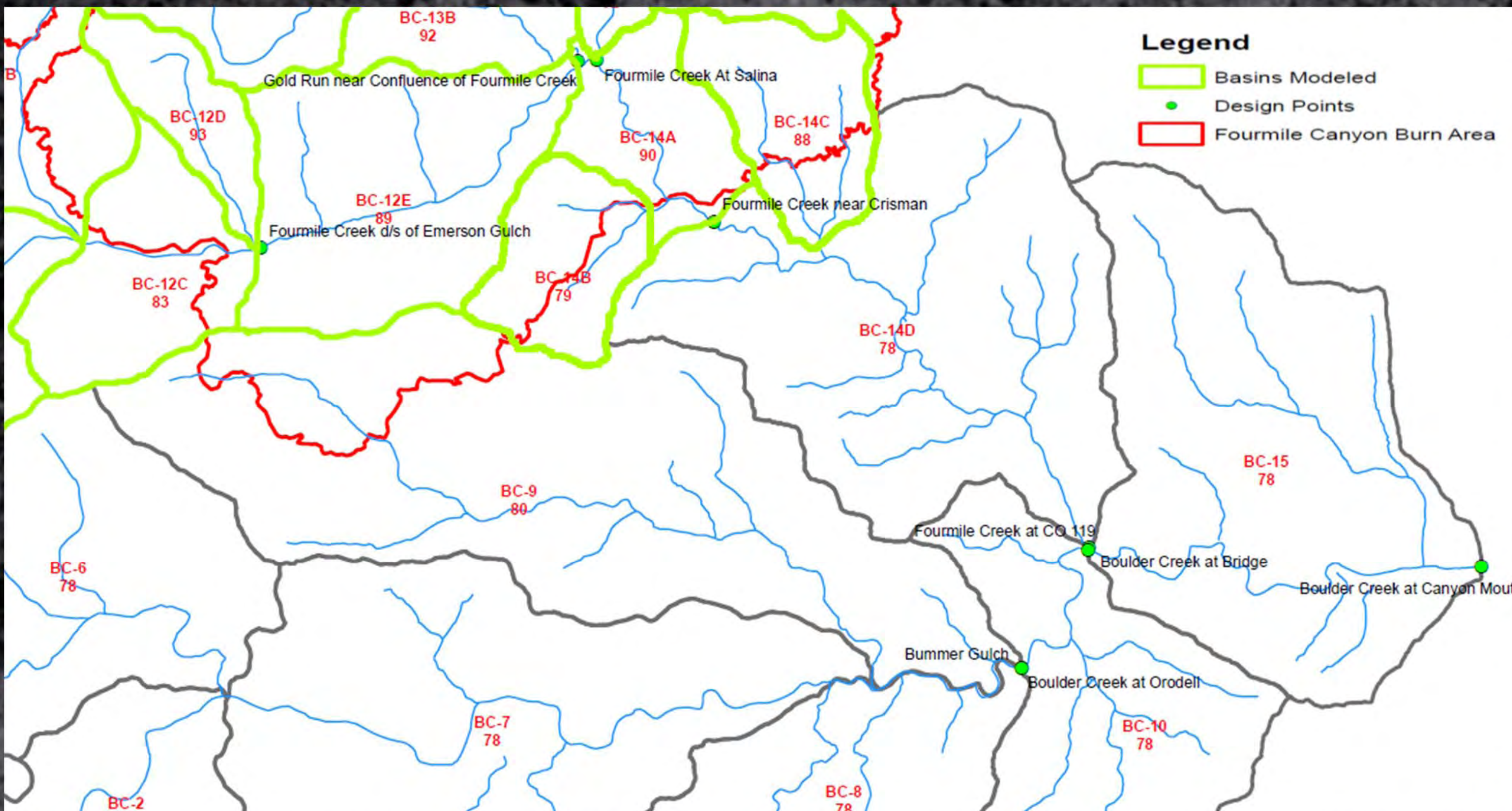


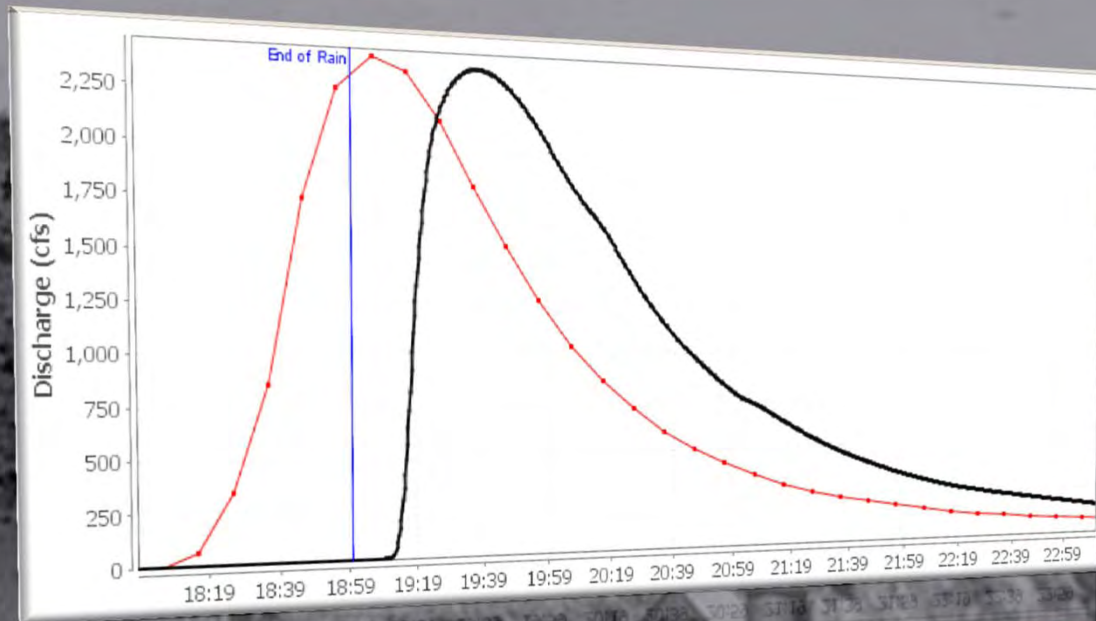
LRE Sub-basins & Design Points



LRE Model Looking Downstream

Runoff hydrographs routed to mouth of Boulder Canyon





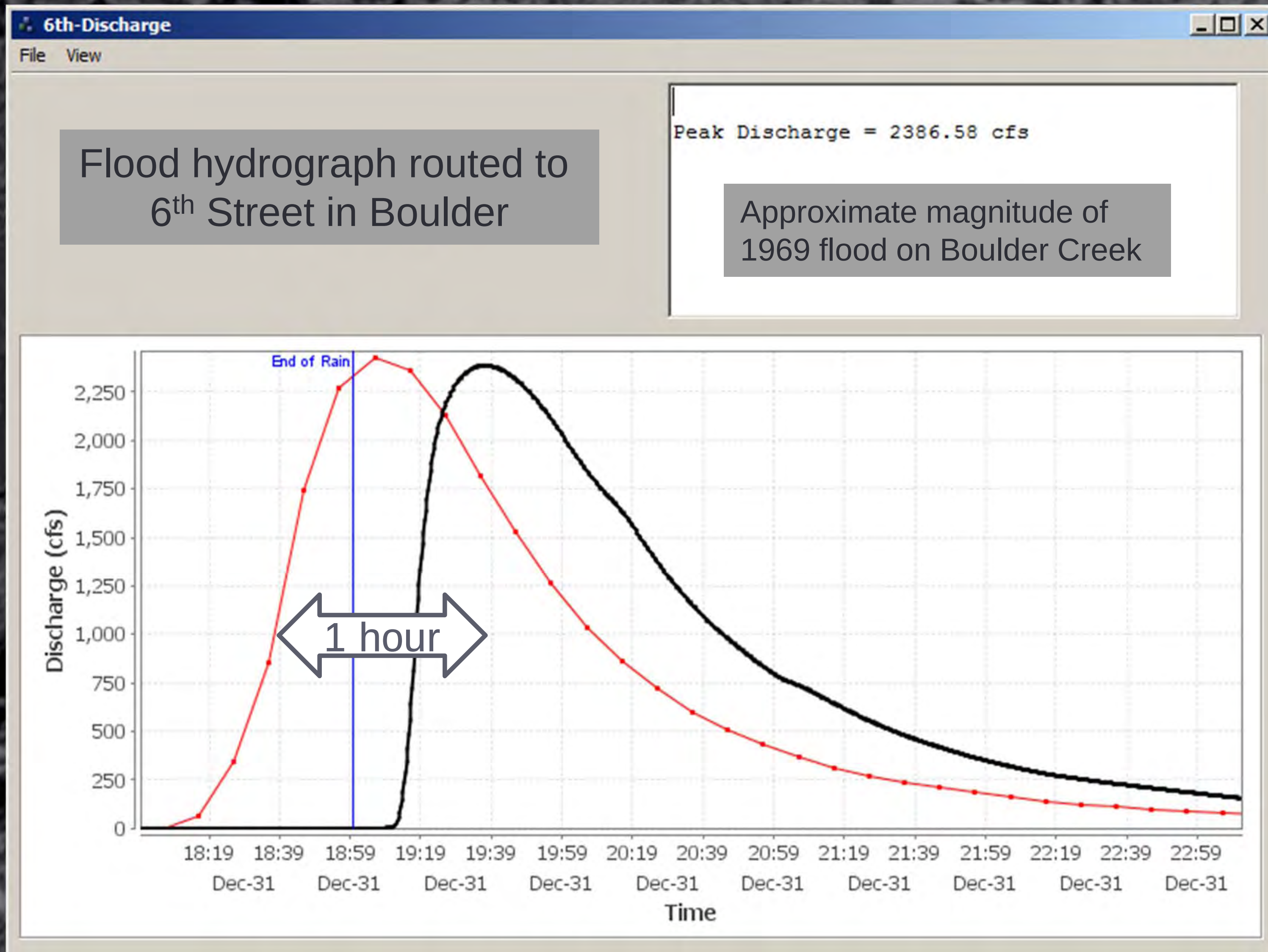
FLOOD ROUTING & TRAVEL TIMES

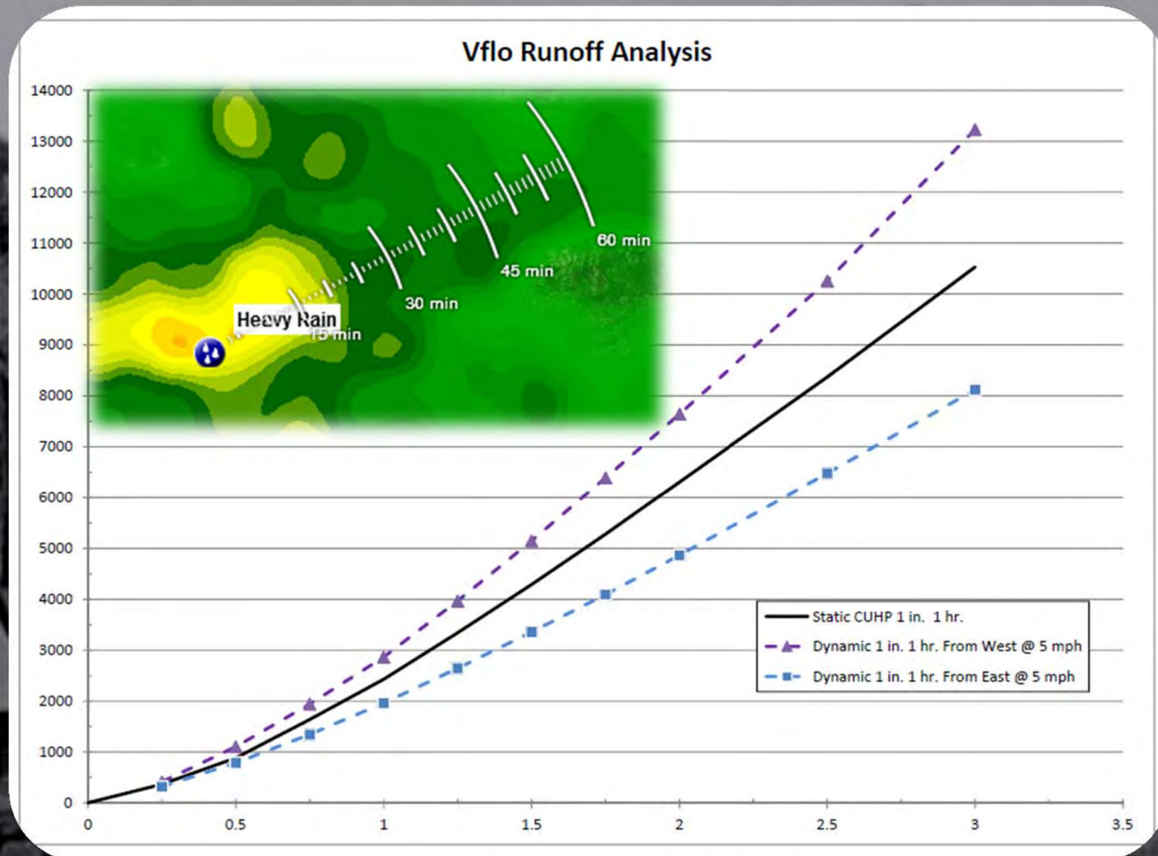
Stream Channel Distances

- ~3.2 miles from FMC-BA outfall to confluence w/Boulder Creek at SH 119
- ~2 miles from FMC confluence to Boulder Creek canyon mouth

Short Travel Time/Minimal Attenuation

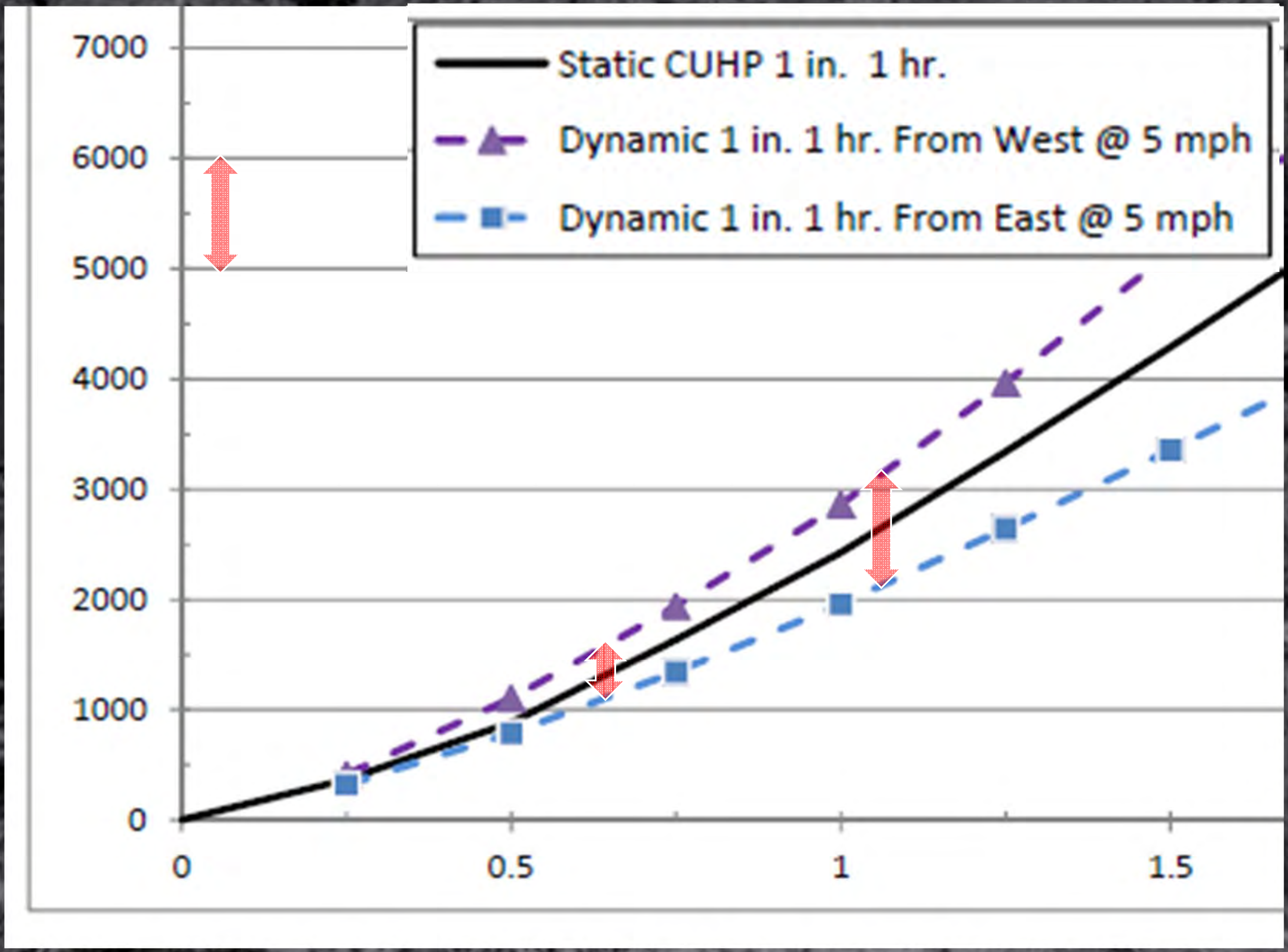
Hydrograph routed 5 miles from FMC-BA to western Boulder city limit at canyon mouth

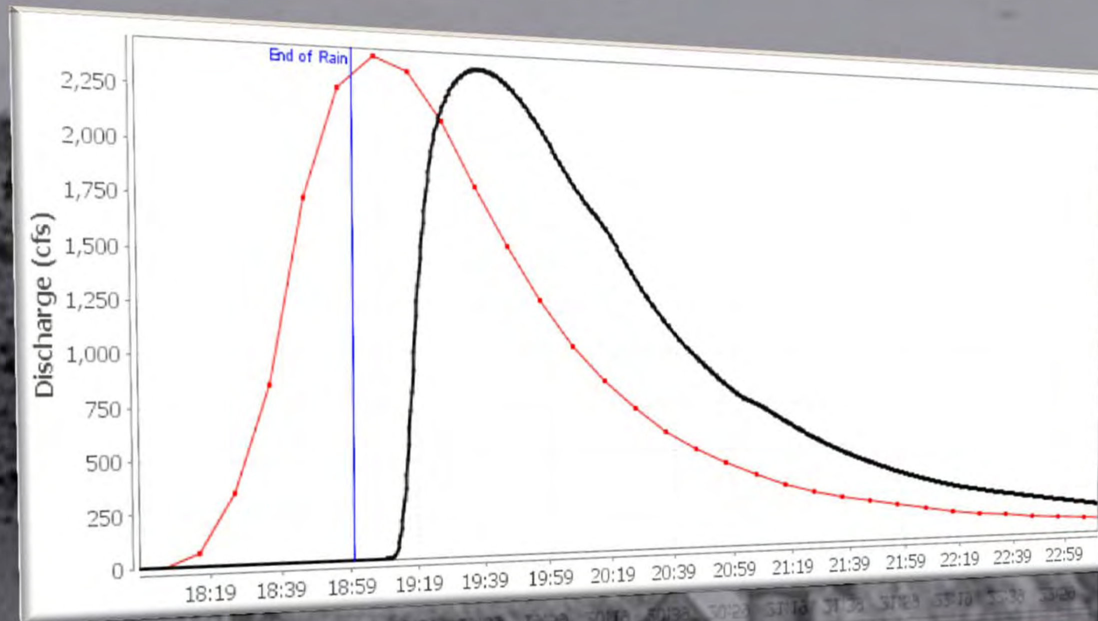




HOW STORM TRACKING AFFECTS PEAK RUNOFF

Runoff peaks are also affected by the storm track

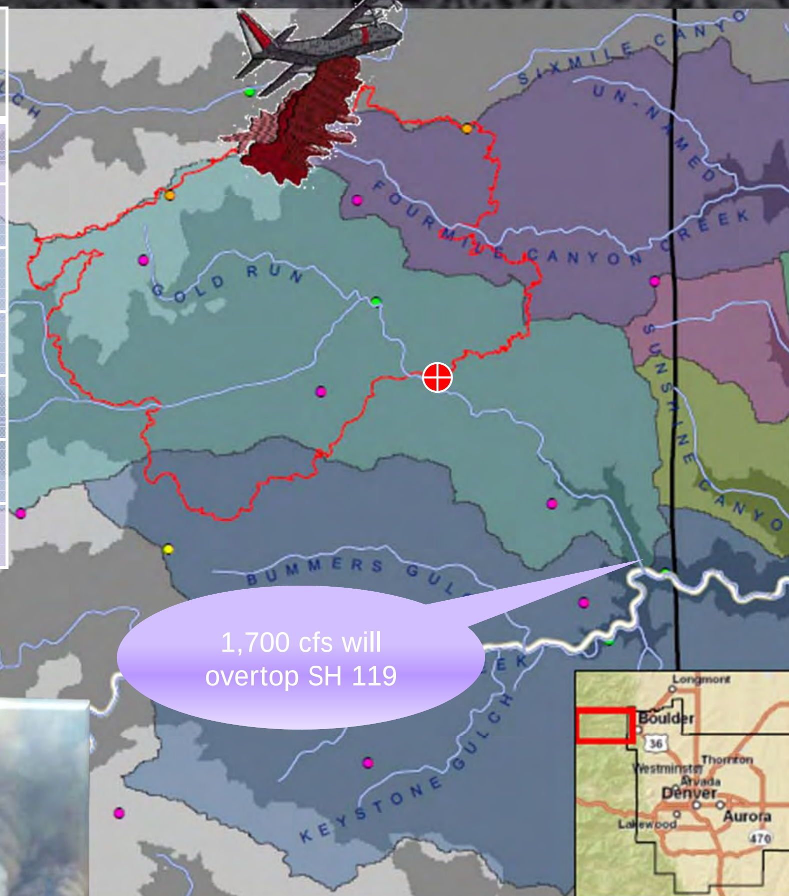




COMPARING MODEL RESULTS

Fourmile Creek
Peak Runoff Estimates

R.I. @ SH 119	CWCB 1981
2-yr	450
5-yr	850
10-yr	1,420
25-yr	2,700
50-yr	4,440
100-yr	6,230
500-yr	11,640



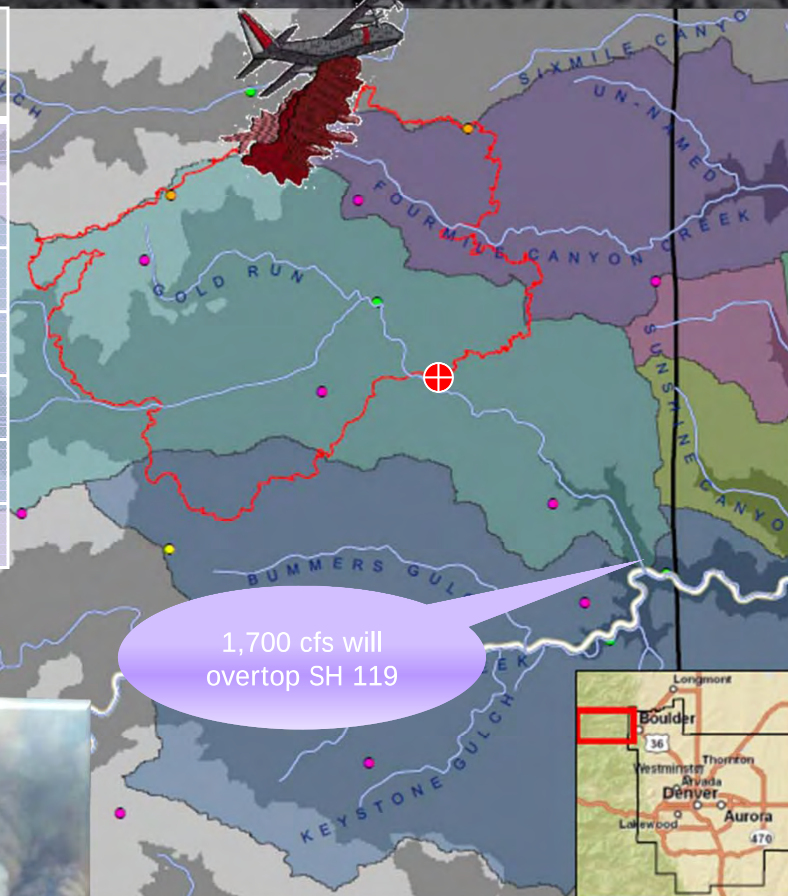
1-HR PCP	Vieux	LRE	WWE	UCD
0.5”	880	150	200	550
0.75”	1,600	460	470	900
1.0”	2,400	890	820	1,400
1.25”	3,300	1,400	1,200	1,800
1.5”	4,300	2,000	1,800	2,200
1.75”	5,300	2,600	2,800	2,700
2.0”	6,300	3,300	3,800	3,200
2.5”	8,400	4,600	5,900	4,300
3.0”	10,500	6,100	7,500	5,600

NOTES:
1. Vieux peaks assume saturated BA at start of rain, i.e. worst case scenario
2. Burn area outfall located ~5 miles upstream from Boulder city limit (canyon mouth).
3. Fourmile Creek confluence w/Boulder Creek located ~2 miles upstream of Boulder.

Peak discharge estimates in cfs relate only to runoff from the FMC Burn Area.

Fourmile Creek
Saturated Watershed – Worst Case

R.I. @ SH 119	CWCB 1981
2-yr	450
5-yr	850
10-yr	1,420
25-yr	2,700
50-yr	4,440
100-yr	6,230
500-yr	11,640



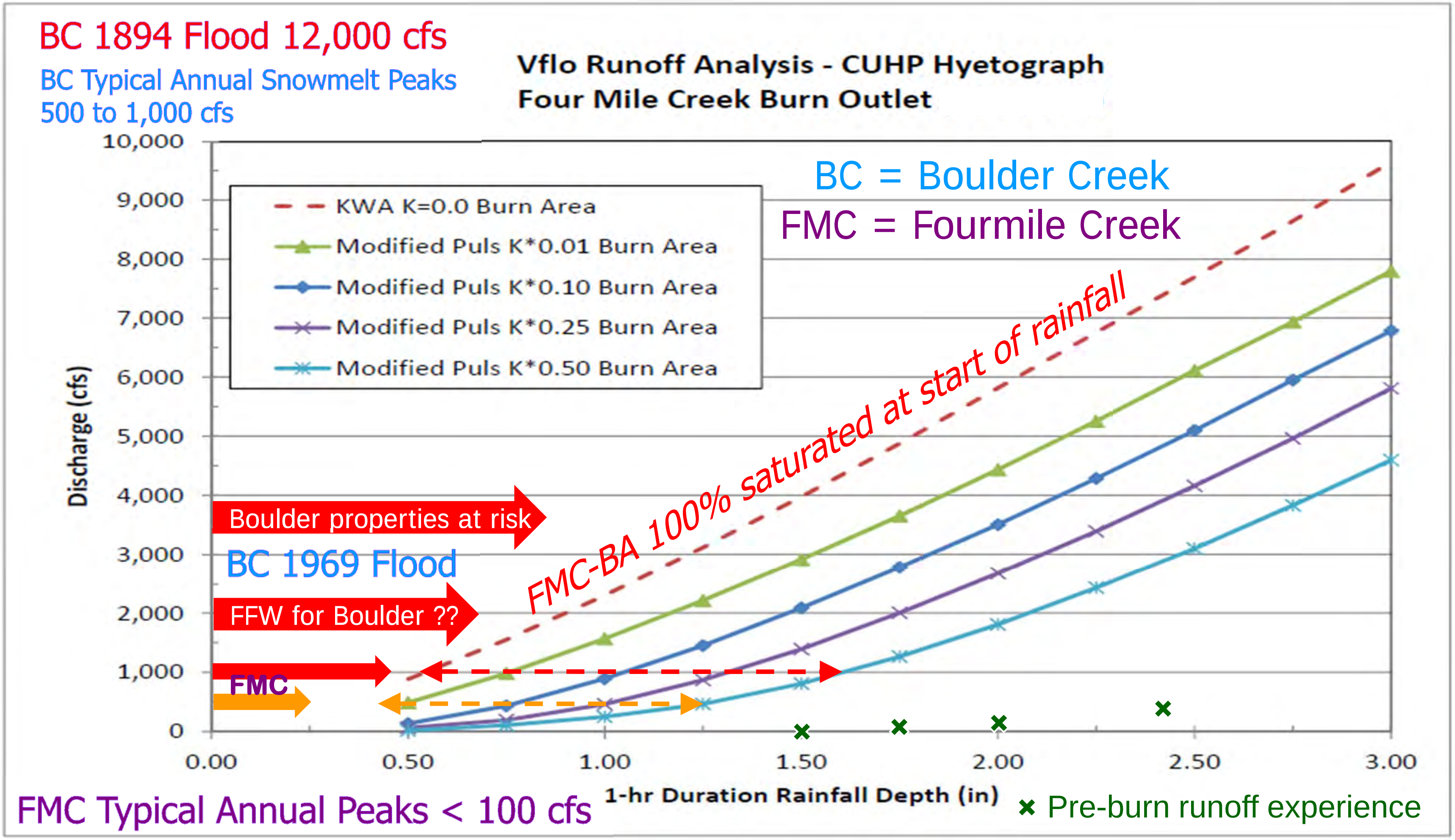
1-HR PCP	Vieux	LRE	WWE	UCD
0.5”	880	520	170	550
0.75”	1,600	1,100	880	
1.0”	2,400	1,800	1,700	1,300
1.25”	3,300	2,500	2,600	
1.5”	4,300	3,200	3,600	2,200
1.75”	5,300	4,000	4,700	
2.0”	6,300	4,800	5,800	3,400
2.5”	8,400	6,400	8,500	4,600
3.0”	10,500	8,200	11,500	6,000

Peak discharge estimates in cfs relate only to runoff from the FMC Burn Area.
Last update: 3/18/2011

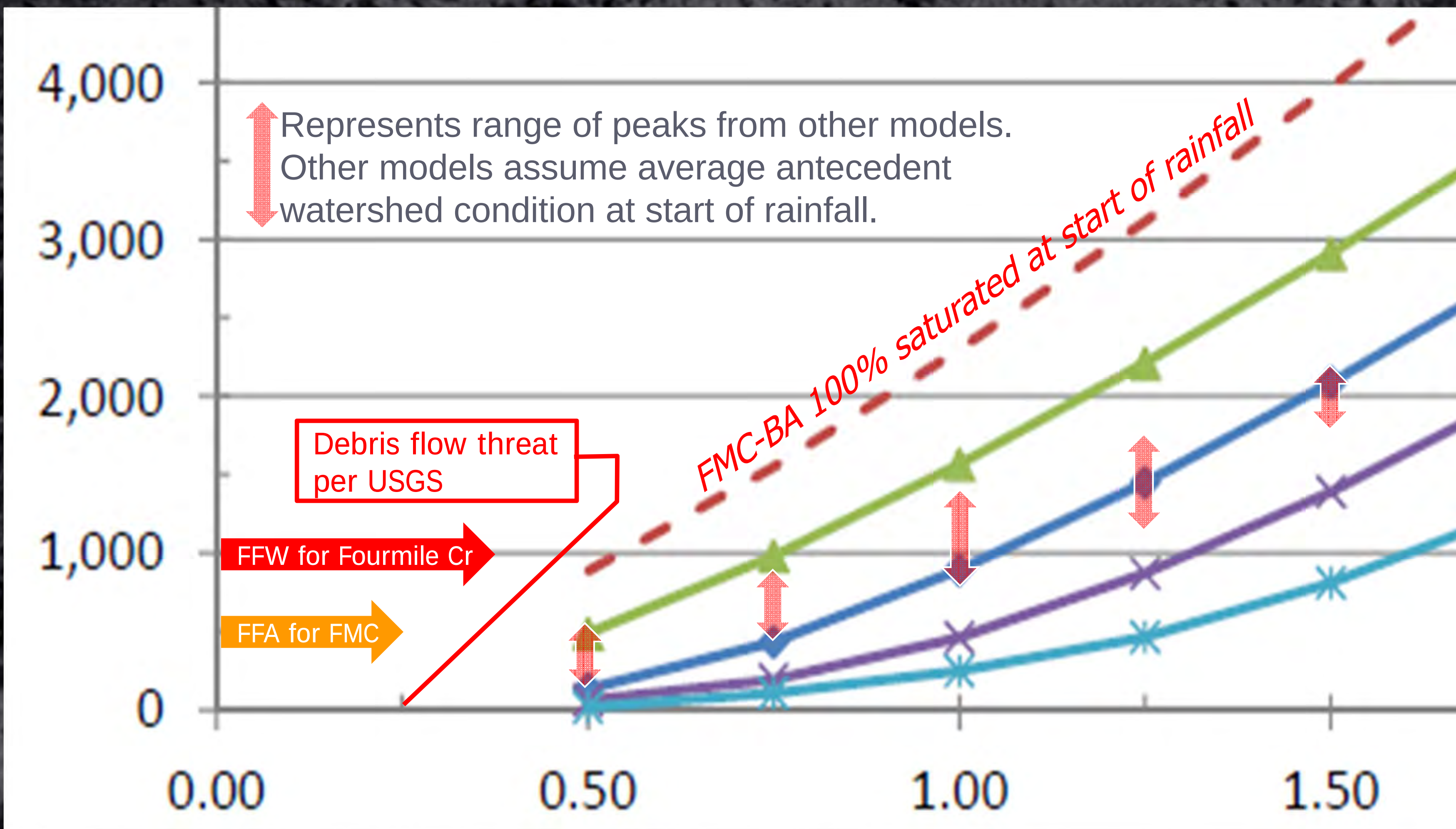
NOTES:
1. All models assume saturated BA at start of rain, i.e. worst case scenario
2. WWE adjusted slightly to best fit data plot.
3. ⊕ Burn area outfall near Crisman located ~5 miles upstream from Boulder city limit (canyon mouth).
4. Fourmile Creek confluence w/Boulder Creek located ~2 miles upstream of Boulder.

Hydrologic Models

High flood threat from commonly occurring rainfall

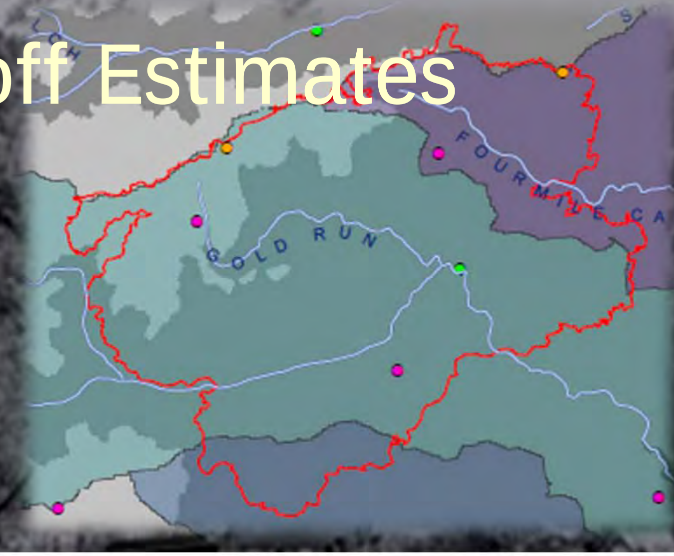


Significant damages and life-threatening conditions expected from flood peaks ranging for 500 to 1,000 cfs on Fourmile Cr.



Gold Run

LRE Peak Runoff Estimates

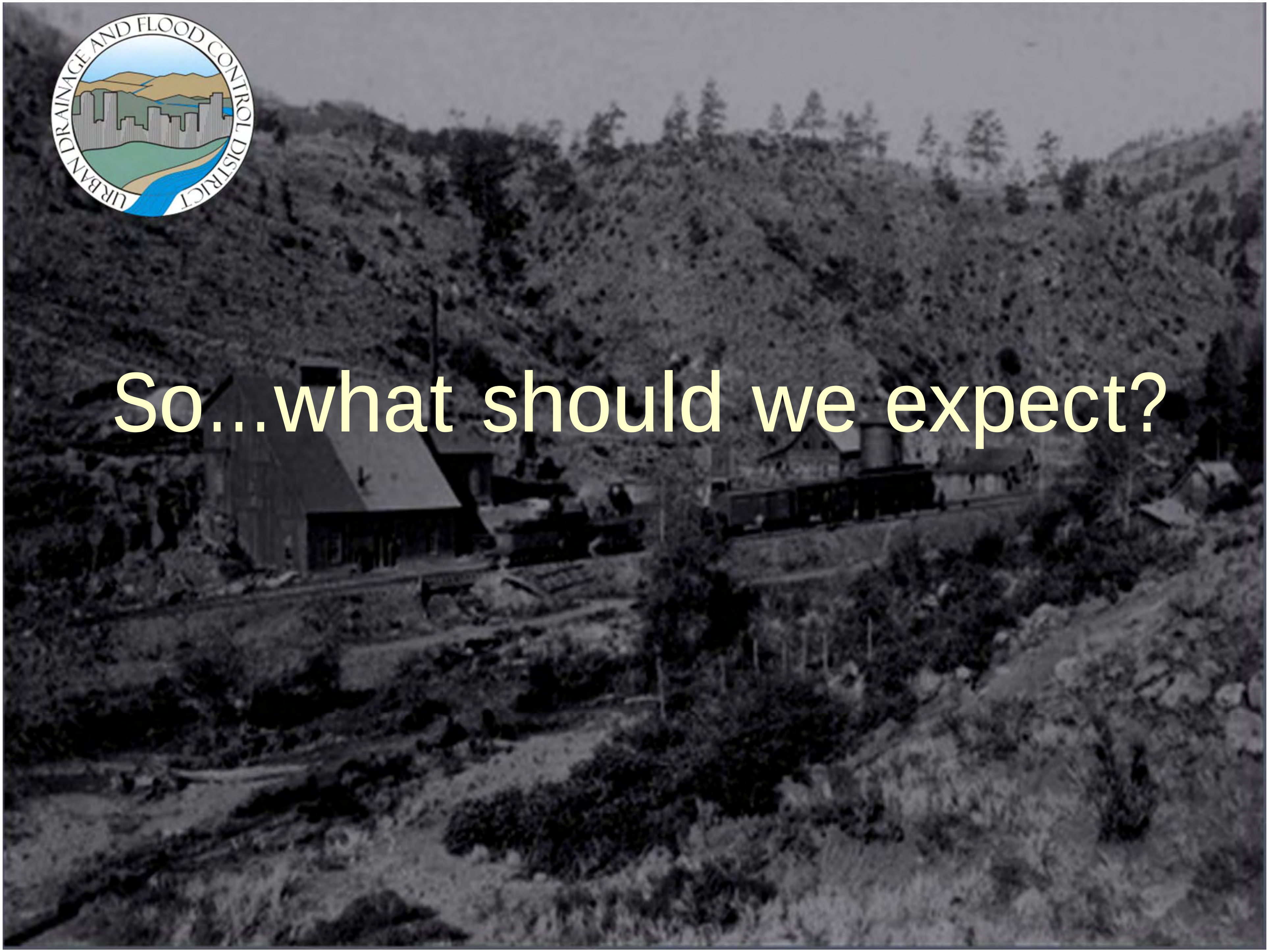


PRIVATE RESIDENCES

An additional 10 to 15 homes are also at risk along Gold Run, a left bank tributary to Fourmile Creek at Salina.

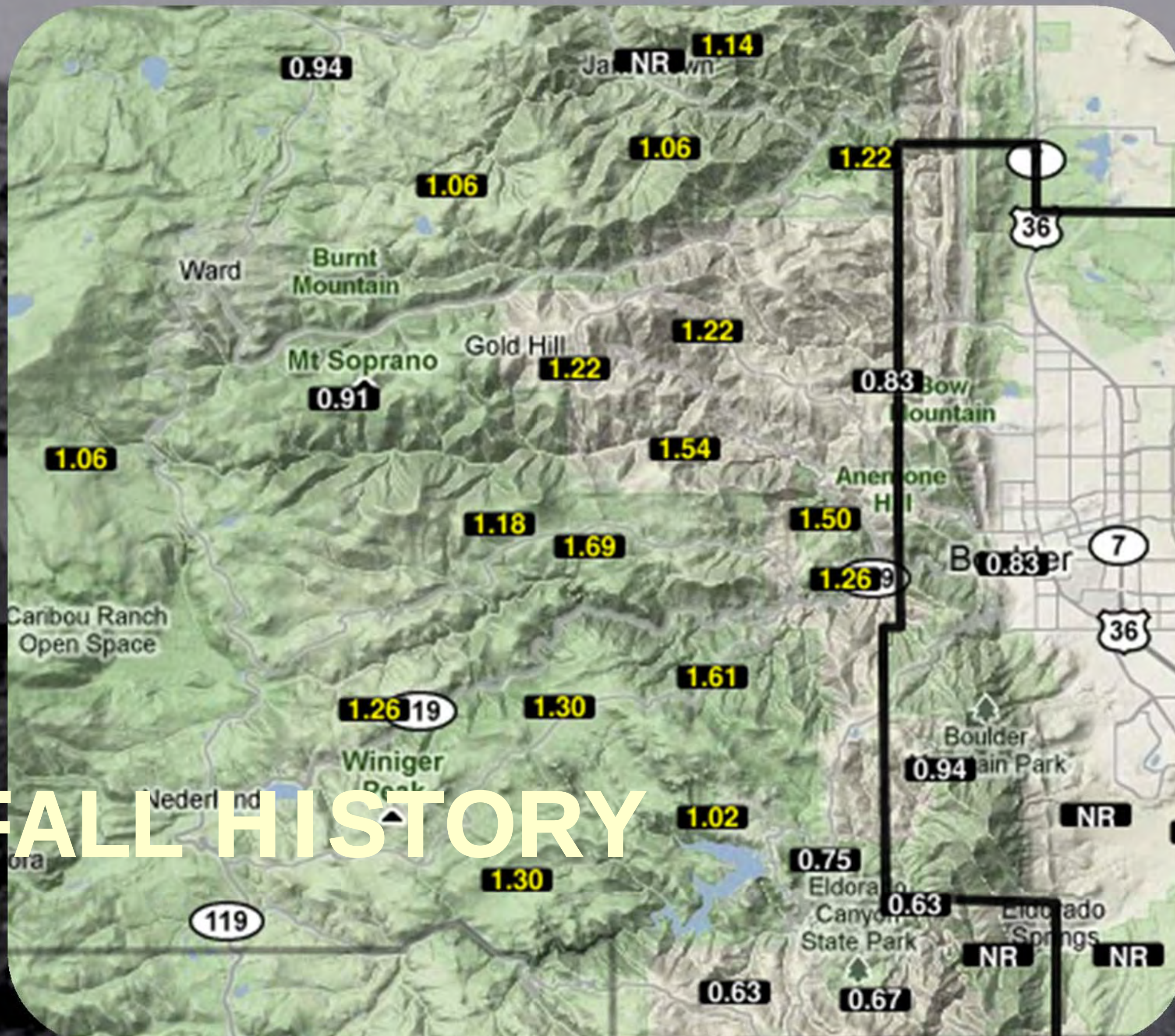
Gold Run at Fourmile Creek

Rainfall	Unburned	Moderate	Moderate/High	High	Anticipated
0.25, 1-hr	0	0	6	48	5
0.50, 1-hr	0	49	99	227	84
0.75, 1-hr	17	167	261	462	231
1.0, 1-hr	79	329	463	723	420
1.25, 1-hr	173	523	689	997	634
1.50, 1-hr	296	737	936	1282	870
1.75, 1-hr	440	967	1194	1575	1120
2.0, 1-hr	601	1212	1461	1872	1378
2.50, 1-hr	972	1728	2012	2472	1916
3.00, 1-hr	1386	2266	2585	3079	2476


So…what should we expect?

June 3, 2002

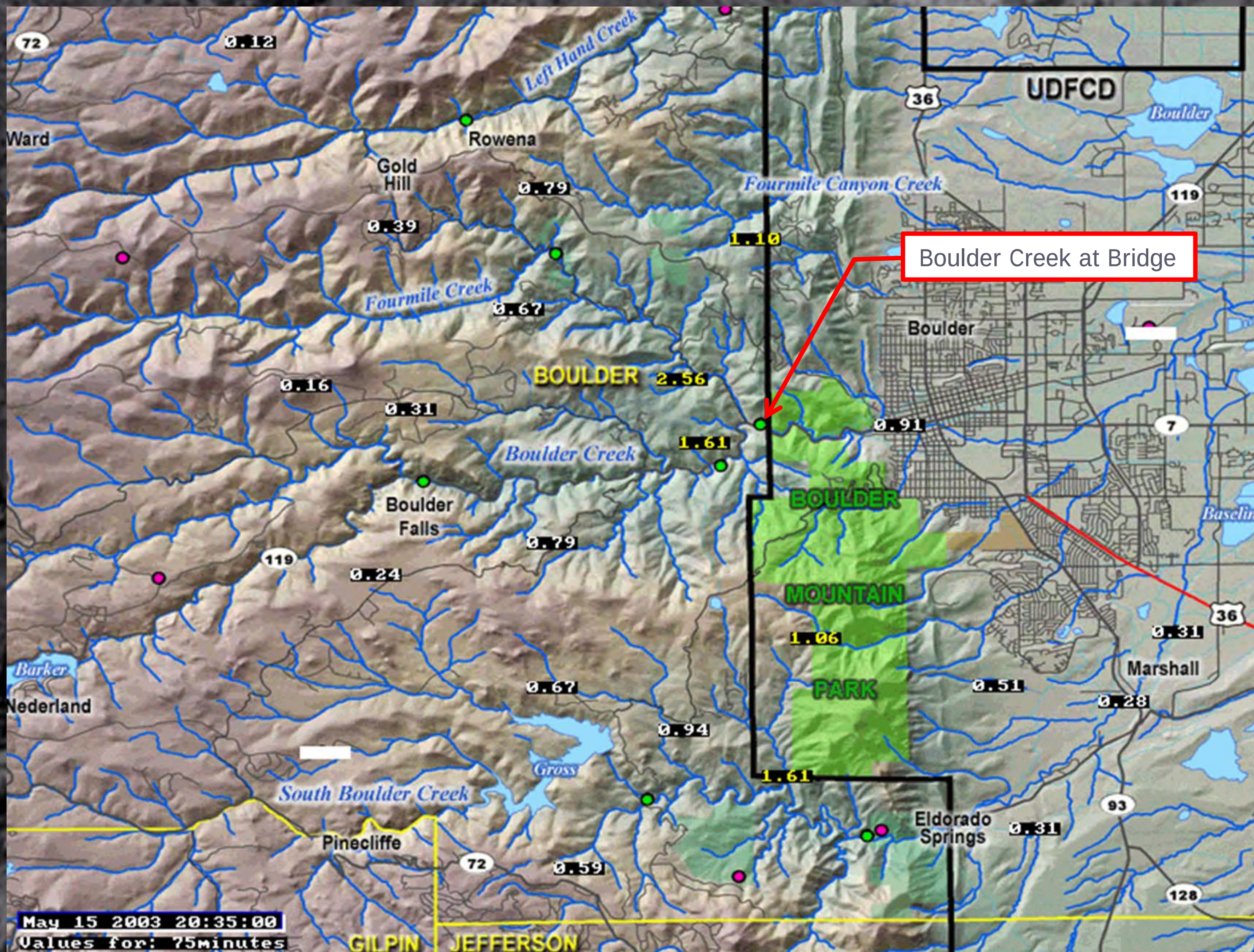
RAINFALL HISTORY



Most intense rainfall measurement 1990 – 2010 (21 years)

May 15, 2003
75-minute rainfall totals ending at 8:35 PM

Peak 1-hour at Betasso 2.35”



Intense Rain Events in Boulder County 1990-2010

10 Minute

Station	Date	Tips	Inches	in/hr
4010	5/18/95 1:39 PM	34	1.339	8.031
4040	8/7/89 9:22 PM	25	0.984	5.906
4060	7/4/90 6:14 PM	23	0.906	5.433
4030	7/8/98 9:12 PM	23	0.906	5.433
4290	7/19/99 3:26 PM	23	0.906	5.433
4230	7/31/99 3:12 PM	23	0.906	5.433
4840	8/15/07 5:12 PM	23	0.906	5.433
4010	7/22/91 1:08 PM	22	0.866	5.197
4330	7/31/99 3:22 PM	22	0.866	5.197
4350	8/11/97 2:22 PM	21	0.827	4.961
4250	7/19/99 3:26 PM	21	0.827	4.961
4840	8/16/10 5:47 PM	21	0.827	4.961
4250	7/31/99 3:37 PM	20	0.787	4.724
4250	9/2/99 4:40 PM	20	0.787	4.724
4070	7/22/91 1:17 PM	19	0.748	4.488
4130	7/25/98 5:09 PM	19	0.748	4.488
4470	7/17/00 2:13 PM	19	0.748	4.488
4020	8/18/03 3:26 PM	19	0.748	4.488
4830	8/15/07 5:13 PM	19	0.748	4.488
4510	9/8/89 10:15 AM	18	0.709	4.252
4530	7/30/97 2:31 PM	18	0.709	4.252
4270	7/25/98 5:01 PM	18	0.709	4.252
4290	7/31/99 3:33 PM	18	0.709	4.252
4090	7/4/90 6:15 PM	17	0.669	4.016
4490	7/19/97 2:34 PM	17	0.669	4.016
4340	7/25/98 4:46 PM	17	0.669	4.016
4790	7/26/98 1:20 PM	17	0.669	4.016

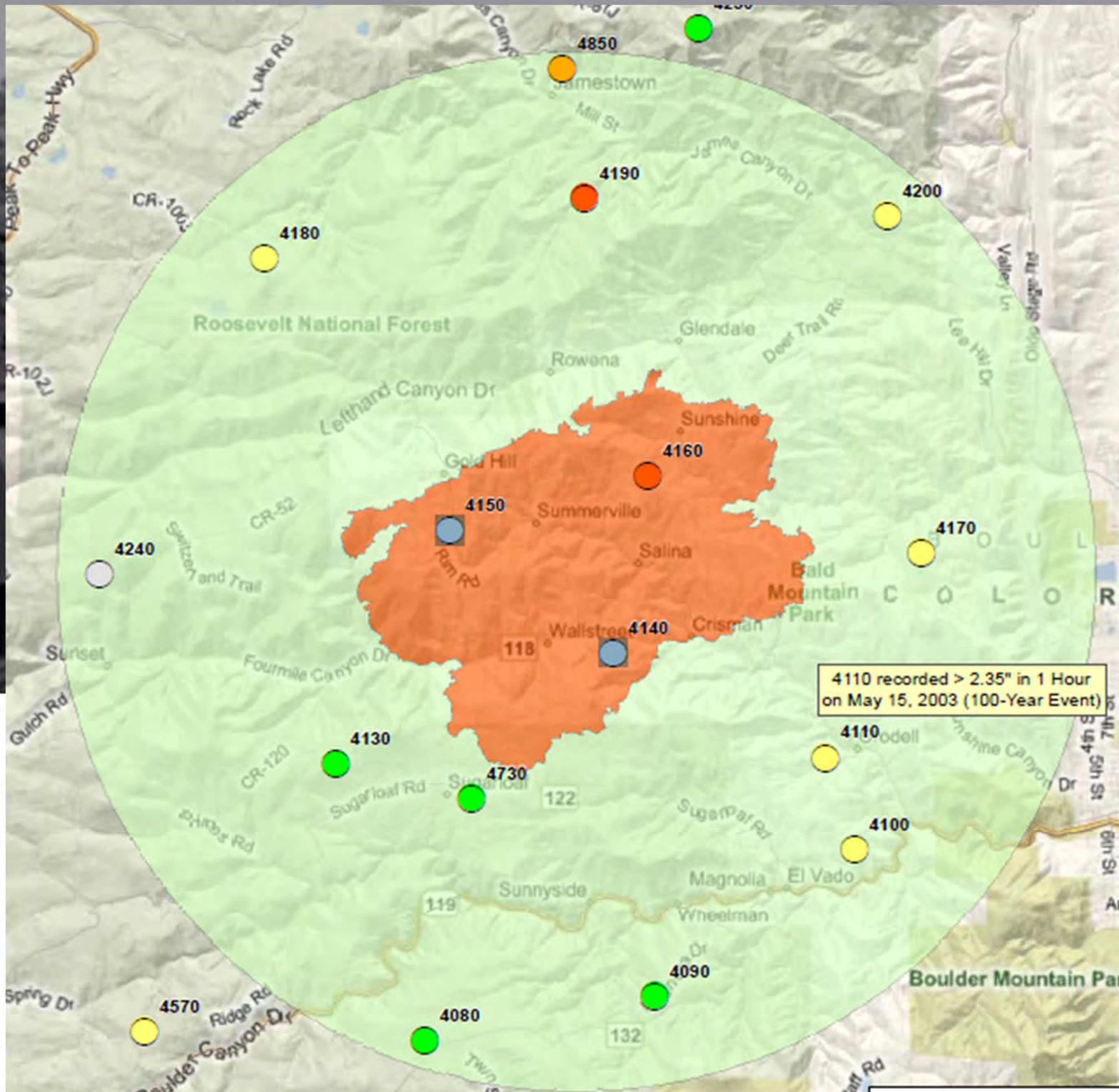
1 Hour

Station	Date	Tips	Inches
4030	7/8/98 9:27 PM	62	2.441
4110	5/15/03 8:20 PM	60	2.362
4010	7/22/91 1:57 PM	56	2.205
4470	6/3/05 2:07 PM	48	1.890
4710	7/30/99 4:40 PM	47	1.850
4040	7/8/98 10:03 PM	42	1.654
4270	7/25/98 5:38 PM	39	1.535
4290	7/19/99 4:10 PM	39	1.535
4040	5/15/03 8:17 PM	39	1.535
4010	5/18/95 1:40 PM	38	1.496
4250	7/19/99 3:44 PM	38	1.496
4330	7/31/99 3:28 PM	38	1.496
4260	6/3/02 6:56 PM	38	1.496
4250	7/31/99 3:47 PM	37	1.457
4020	8/18/03 4:12 PM	37	1.457
4070	7/22/91 1:55 PM	36	1.417
4060	7/22/91 1:58 PM	36	1.417
4290	7/31/99 3:55 PM	36	1.417
4220	7/25/05 4:58 PM	36	1.417
4040	8/7/89 9:30 PM	35	1.378
4040	8/10/94 10:03 PM	35	1.378
4830	8/18/03 4:07 PM	35	1.378
4340	7/25/98 5:28 PM	34	1.339
4180	7/31/99 2:49 PM	34	1.339
4010	8/4/99 5:03 PM	34	1.339
4100	5/15/03 8:26 PM	34	1.339
4300	7/16/00 10:18 PM	33	1.299

6 Hour

Station	Date	Tips	Inches
4070	8/4/99 7:43 PM	81	3.189
4040	8/4/99 8:44 PM	78	3.071
4030	8/4/99 8:32 PM	77	3.031
4090	8/4/99 8:54 PM	76	2.992
4010	8/4/99 8:57 PM	76	2.992
4030	7/8/98 11:59 PM	72	2.835
4050	8/4/99 9:06 PM	72	2.835
4110	5/15/03 11:33 PM	66	2.598
4020	8/4/99 9:00 PM	64	2.520
4010	7/22/91 3:29 PM	63	2.480
4080	8/9/01 11:39 AM	62	2.441
4190	8/30/03 1:06 AM	61	2.402
4730	8/9/01 11:43 AM	59	2.323
4470	6/3/05 6:51 PM	58	2.283
4360	8/4/99 7:48 PM	57	2.244
4100	8/4/99 8:35 PM	56	2.205
4130	8/4/99 9:05 PM	56	2.205
4190	8/29/03 11:42 PM	56	2.205
4150	5/31/91 11:45 PM	55	2.165
4080	8/4/99 8:49 PM	55	2.165
4180	8/30/03 1:03 AM	54	2.126
4770	8/30/03 1:15 AM	54	2.126
4550	8/18/04 9:41 PM	54	2.126
4710	7/30/99 6:58 PM	53	2.087
4750	8/18/04 10:18 PM	52	2.047
4200	8/4/99 8:25 PM	51	2.008
4070	7/22/91 3:06 PM	50	1.969

ALERT System Rainfall Record Analysis by Water & Earth Technologies, Inc.



> 1" in 1 Hour Count (1990-2010)

- 0
- 1
- 2
- 3
- 4

24 days exceeded 0.98" in 1 hour

1 day exceeded 100-year event of 2.35" in 1 hour

- 5-mile Radius from Center of Fire
- Fourmile Canyon Fire Boundary

Measured Rainfall Events > 0.9" in 1-hour

37 days between 1990 & 2010

YEAR	DATES & TIMES
1990	Jul-4@1828, Aug-17@1300
1991	May-31@2101, Jun-1@1413, Jul-22@1358, Aug-3@1051
1996	Jul-28@1918, Sep-14@1834
1997	Jun-6@1548, Jul-30@1559
1998	Jul-8@2352, Jul-24@1915, Jul-25@1814
1999	Jul-19@1556, Jul-28@1738, Jul-30@1618, Jul-31@1536, Aug-4@1614, Aug-7@1531, Aug-27@1449
2000	Jul-16@2101
2001	Aug-9@1931, Aug-30@1912
2002	Jun-3@1954
2003	May-15@2047, Jun-18@2328, Jul-29@1352, Aug-29@2146
2004	Jul-16@1431, Aug-18@1617
2005	Jul-25@1708
2006	Jun-24@1841, Jul-20@1544, Aug-14@1510
2007	Jul-26@2316, Jul-29@1559
2010	Jul-4@2032

2 days in May
5 days in June
20 days in July
9 days in August
1 day in September

Measured Rainfall >0.5” & < 0.9” in 1-hr

151 days between 1990 & 2010

15 days in April
18 days in May
29 days in June
31 days in July
34 days in August
24 days in September

YEAR	DATES	YEAR	DATES
1990	5-28,30 7-11,16,19,20 8-5,11,16 9-2,5,6	2000	8-16
1991	5-15,16,22 6-13 7-25,26 9-9,11	2001	4-11 7-8,11 8-5,7,8,11,15
1992	6-27 9-24,29	2002	5-24 8-5 9-10,12
1993	4-22 6-7,11,17 7-13 9-14,17	2003	4-24 6-17,19 7-27 8-30
1994	4-30 5-11 6-2,18,20,21 7-31 8-10,11,13 9-13	2004	4-4,5 5-1 6-8,9,27,29 7-19,23,28 9-19,30
1995	5-18,29 6-17 7-14 8-19,24 9-14	2005	4-11 6-3 8-10,22,23 9-14
1996	4-8, 5-23, 6-12,16,21 7-9 9-18	2006	4-26 7-2,25 8-13
1997	4-13,25 6-7,10,12,13 8-3,4,5 9-11	2007	5-5,6 6-12 7-7,27,30 8-15,17,24 9-5,24
1998	4-3,26 7-22,26,30 8-1,4	2008	8-6,9
1999	5-11,20,24 7-8,16,17,24,29 8-5,10 9-2,24,29	2009	4-19 5-23 6-24,26 7-27 9-8
		2010	4-21 5-14 6-23,26 7-7 8-6,9

What do streamflow records tell us?

Suspected largest peak flow rate on Fourmile Creek at Salina since ALERT gauges were first installed in 1979.

Paleo-flood evidence tells us that Fourmile Creek was the primary source of the 1894 flood.

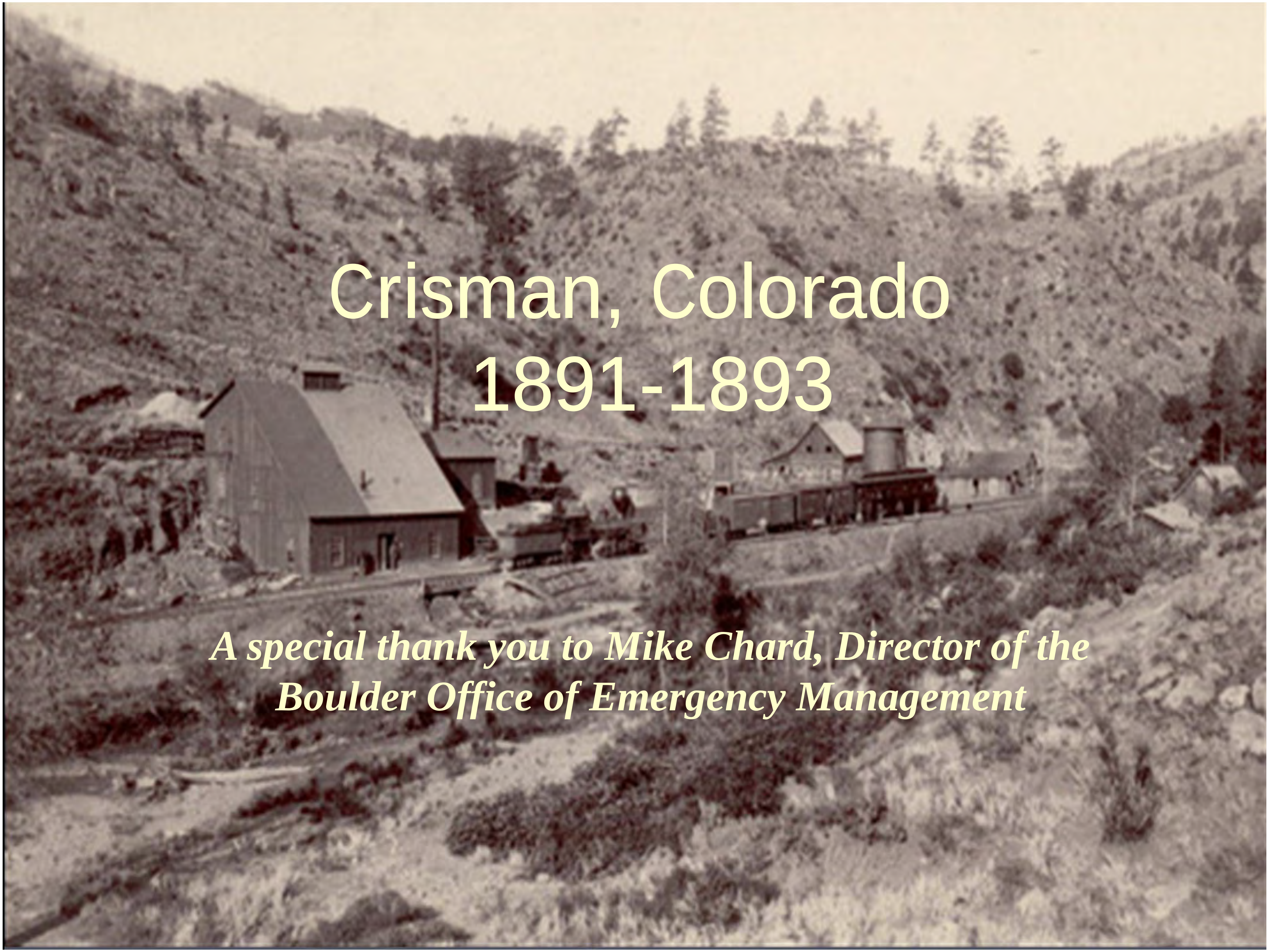
41 Fourmile

Water Level PT

Date	Time	feet	cubic feet/second	Alarm
6/5/1995	5:00:30	2.75	150	
6/4/1995	21:46:36	2.75	150	
6/4/1995	5:01:55	3	190	
6/3/1995	19:44:01	3	190	
6/3/1995	5:03:06	3.25	225	
6/2/1995	6:12:36	3.25	225	
6/1/1995	5:04:43	3.75	310	alarm
6/1/1995	3:14:17	3.75	310	alarm
5/31/1995	21:37:02	4	350	alarm
5/31/1995	5:05:14	4.25	400	alarm
5/31/1995	1:32:19	4.25	400	alarm
5/30/1995	20:56:24	4.5	460	alarm
5/30/1995	17:35:53	4.25	400	alarm
5/30/1995	16:54:48	4.5	460	alarm
5/30/1995	7:04:13	4.25	400	alarm
5/30/1995	5:05:32	4	350	alarm
5/30/1995	1:49:19	4	350	alarm
5/30/1995	1:37:44	3.75	310	alarm
5/30/1995	1:26:45	4	350	alarm
5/29/1995	18:01:35	3.75	310	alarm
5/29/1995	5:05:50	3.5	265	
5/28/1995	5:06:04	3.5	265	
5/27/1995	10:43:03	3.5	265	
5/27/1995	5:06:24	3.25	225	
5/27/1995	1:09:08	3.25	225	
5/26/1995	13:17:11	3	190	

Some Facts & Opinions

- One-hour rainfall measurements from the ALERT System exceeded 0.9” on 37 days in the past 21 years at one or more locations within a 6-mile radius from the center of the FMC-BA.
- 0.75” to 1.25” of rainfall over the FMC-BA is capable of producing flood peaks on Fourmile Creek that could overtop SH 119 (Qcap ~1,700 cfs unobstructed)
- As little as 500 cfs will threaten existing private drive crossings along Fourmile Creek, which is highly likely from 1-hour rainfalls exceeding 0.5”
- The number of private homes and other habitable structures at risk from flooding in the FMC-BA and along Fourmile Creek downstream is large (60-75).
- The Boulder Mountain Lodge is at very high risk of inundation due to its location being a short distance upstream of SH 119, which can backup floodwaters to a depth of 19-feet or more when flow rates exceed 1,000 cfs.
- Liquid propane tanks pose a significant threat that could impact Boulder.
- The May 30, 1995 estimated peak flow of 400-500 cfs on Fourmile Creek was likely the largest in recent memory.
- The May 15, 2003 storm…a 100-year rainfall at the Betasso...produced an estimated peak flow of only 400 cfs in Fourmile Creek. That would look much different today.


Crisman, Colorado
1891-1893
A special thank you to Mike Chard, Director of the
Boulder Office of Emergency Management

Why You Need An iPad

A Tale of Two eProducts

By Shea Thomas

2011 Urban Drainage Seminar

What is an ePlan?

An ePlan is:

- An electronic version of a traditional master plan
- A pdf *showing* information
- One continuous plan and one continuous profile

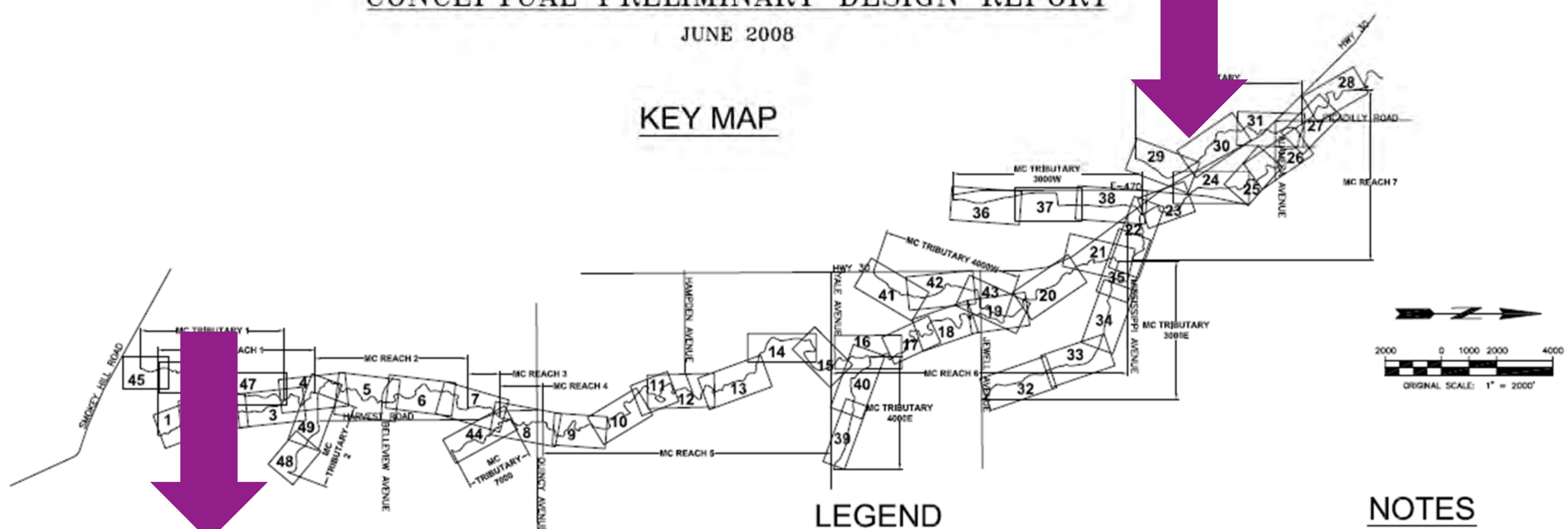
An ePlan is not:

- More work for the consultant
- A tree killer
- 'Smart'…yet

of pages

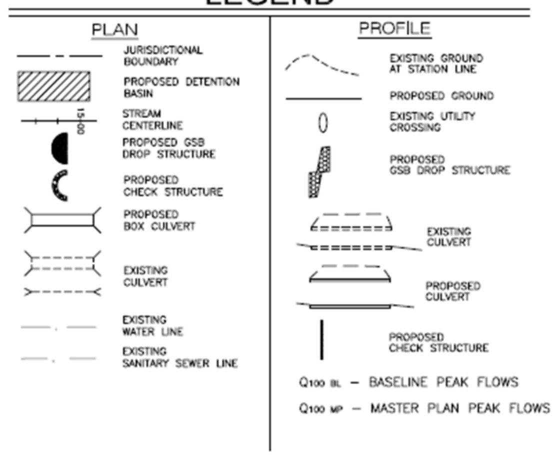
MURPHY CREEK AND TRIBUTARIES WATERSHEDS
CONCEPTUAL PRELIMINARY DESIGN REPORT
JUNE 2008

KEY MAP



SHEET	REACH	LOCATION MURPHY CREEK PLAN AND PROFILE,
1	MAINSTEM	STA. 675+00 TO STA. 687+43
2	MAINSTEM	STA. 650+00 TO STA. 675+00
3	MAINSTEM	STA. 623+00 TO STA. 650+00
4	MAINSTEM	STA. 598+00 TO STA. 623+00
5	MAINSTEM	STA. 572+00 TO STA. 598+00
6	MAINSTEM	STA. 546+00 TO STA. 572+00
7	MAINSTEM	STA. 520+00 TO STA. 546+00
8	MAINSTEM	STA. 494+00 TO STA. 520+00
9	MAINSTEM	STA. 468+00 TO STA. 494+00
10	MAINSTEM	STA. 442+00 TO STA. 468+00
11	MAINSTEM	STA. 416+00 TO STA. 442+00
12	MAINSTEM	STA. 390+00 TO STA. 416+00
13	MAINSTEM	STA. 364+00 TO STA. 390+00
14	MAINSTEM	STA. 337+00 TO STA. 364+00
15	MAINSTEM	STA. 312+00 TO STA. 337+00
16	MAINSTEM	STA. 286+00 TO STA. 312+00
17	MAINSTEM	STA. 260+00 TO STA. 286+00
18	MAINSTEM	STA. 233+00 TO STA. 260+00
19	MAINSTEM	STA. 208+00 TO STA. 233+00
20	MAINSTEM	STA. 181+00 TO STA. 208+00
21	MAINSTEM	STA. 159+00 TO STA. 181+00
22	MAINSTEM	STA. 134+00 TO STA. 159+00
23	MAINSTEM	STA. 114+00 TO STA. 134+00
24	MAINSTEM	STA. 94+00 TO STA. 114+00
25	MAINSTEM	STA. 73+00 TO STA. 94+00
26	MAINSTEM	STA. 57+00 TO STA. 73+00
27	MAINSTEM	STA. 37+00 TO STA. 57+00
28	MAINSTEM	STA. 19+47 TO STA. 37+00
29	TRIB 2000	STA. 50+00 TO STA. 74+39
30	TRIB 2000	STA. 26+00 TO STA. 50+00
31	TRIB 2000	STA. 5+00 TO STA. 26+00
32	TRIB 3000E	STA. 55+00 TO STA. 79+60
33	TRIB 3000E	STA. 31+00 TO STA. 55+00
34	TRIB 3000E	STA. 11+00 TO STA. 31+00
35	TRIB 3000E	STA. 0+61 TO STA. 11+00
36	TRIB 3000W	STA. 50+00 TO STA. 73+82
37	TRIB 3000W	STA. 24+00 TO STA. 50+00
38	TRIB 3000W	STA. 2+12 TO STA. 24+00
39	TRIB 4000E	STA. 24+00 TO STA. 43+85
40	TRIB 4000E	STA. 2+46 TO STA. 24+00
41	TRIB 4000W	STA. 42+00 TO STA. 60+27
42	TRIB 4000W	STA. 21+00 TO STA. 42+00
43	TRIB 4000W	STA. 8+29 TO STA. 21+00
44	TRIB 7000	STA. 6+54 TO STA. 29+48
45	TRIB 1	STA. 48+00 TO STA. 57+60.34
46	TRIB 1	STA. 27+00 TO STA. 48+00
47	TRIB 1	STA. 0+00 TO STA. 27+00
48	TRIB 2	STA. 20+00 TO STA. 34+36.46
49	TRIB 2	STA. 0+00 TO 20+00
DTL-1	TYPICAL DETAILS	
DTL-2	TYPICAL DETAILS	
DTL-3	TYPICAL DETAILS	

LEGEND



NOTES

THIS DRAWING IS FOR MASTER PLANNING PURPOSES AND REPRESENTS PRELIMINARY AND CONCEPTUAL ENGINEERING. ALTERNATIVES TO THIS OUTFALL SYSTEM WILL BE CONSIDERED BY LOCAL AGENCIES AND THE URBAN DRAINAGE AND FLOOD CONTROL DISTRICT PROVIDED THE ALTERNATIVE OFFERS AN EQUIVALENT INTENT OF THE PLAN, INCLUDING HYDRAULIC CAPACITY, WATER QUALITY, STREAM STABILITY AND NATURAL WATERWAY FEATURES. THE ALTERNATIVE MUST COMPLY WITH ALL REQUIREMENTS OF THE LOCAL JURISDICTION AND THE URBAN DRAINAGE AND FLOOD CONTROL DISTRICT. IN ADDITION, THERE MAY BE STATE AND FEDERAL REQUIREMENTS THAT WILL NEED TO BE CONSIDERED AND MET. THIS DRAWING DOES NOT PROVIDE A FINAL DESIGN AND SHALL NOT BE USED FOR CONSTRUCTION PURPOSES.

LOCAL CITIES, TOWNS, AND COUNTIES MANAGE AND REGULATE ALL LAND USE CHANGE, DEVELOPMENT AND REDEVELOPMENT ACTIVITIES WITHIN AND ADJACENT TO THE 100-YEAR FLOODPLAINS IN ORDER TO PREVENT, TO A MAXIMUM EXTENT POSSIBLE, FUTURE FLOOD DAMAGES TO BUILDINGS AND STRUCTURES FROM THE 100-YEAR FLOOD AND TO MINIMIZE DAMAGES FROM LARGER FLOODS. THE RECOMMENDATIONS OF THIS PLAN PROVIDE A SET OF OPTIONS SUBSCRIBED TO BY CITIES, TOWNS, AND COUNTIES IN CARRYING OUT THEIR FLOOD PLAIN MANAGEMENT AND REGULATORY RESPONSIBILITIES AND OBLIGATIONS.

MANY ACTIVITIES THAT OCCUR OR AFFECT DITCHES, DRAINAGE, CREEKS, PONDS OR WETLANDS REQUIRE A SECTION 404 PERMIT AUTHORIZATION FROM THE US ARMY CORPS OF ENGINEERS. DURING PRELIMINARY DESIGN, AND PRIOR TO FINAL DESIGN OR STARTING WORK, CONTACT THE CORPS' DENVER REGULATORY OFFICE AT 303-979-4120 FOR APPROPRIATE PERMIT AUTHORITY TO AVOID COMPROMISING AND DELAYING THE COMPLETION OF THE PROJECT.

NAME: Z:\UDFCD PLANNING\Murphy Creek\OSP\CAD_MC_OSP\dwg\Prelim DGN PP\Keymap.dwg
PLOT DATE: Sep 25, 2008 11:43am

MOSER ENGINEERING
720 S. COLORADO BLVD. SUITE 410 S DENVER, CO 80246 PHONE: 303-757-8655 FAX: 303-300-1655

DESIGNED RCO DATE 02/04/08
DRAWN RWM DATE 02/04/08
CHECKED RCO DATE 02/04/08
REVISED DATE

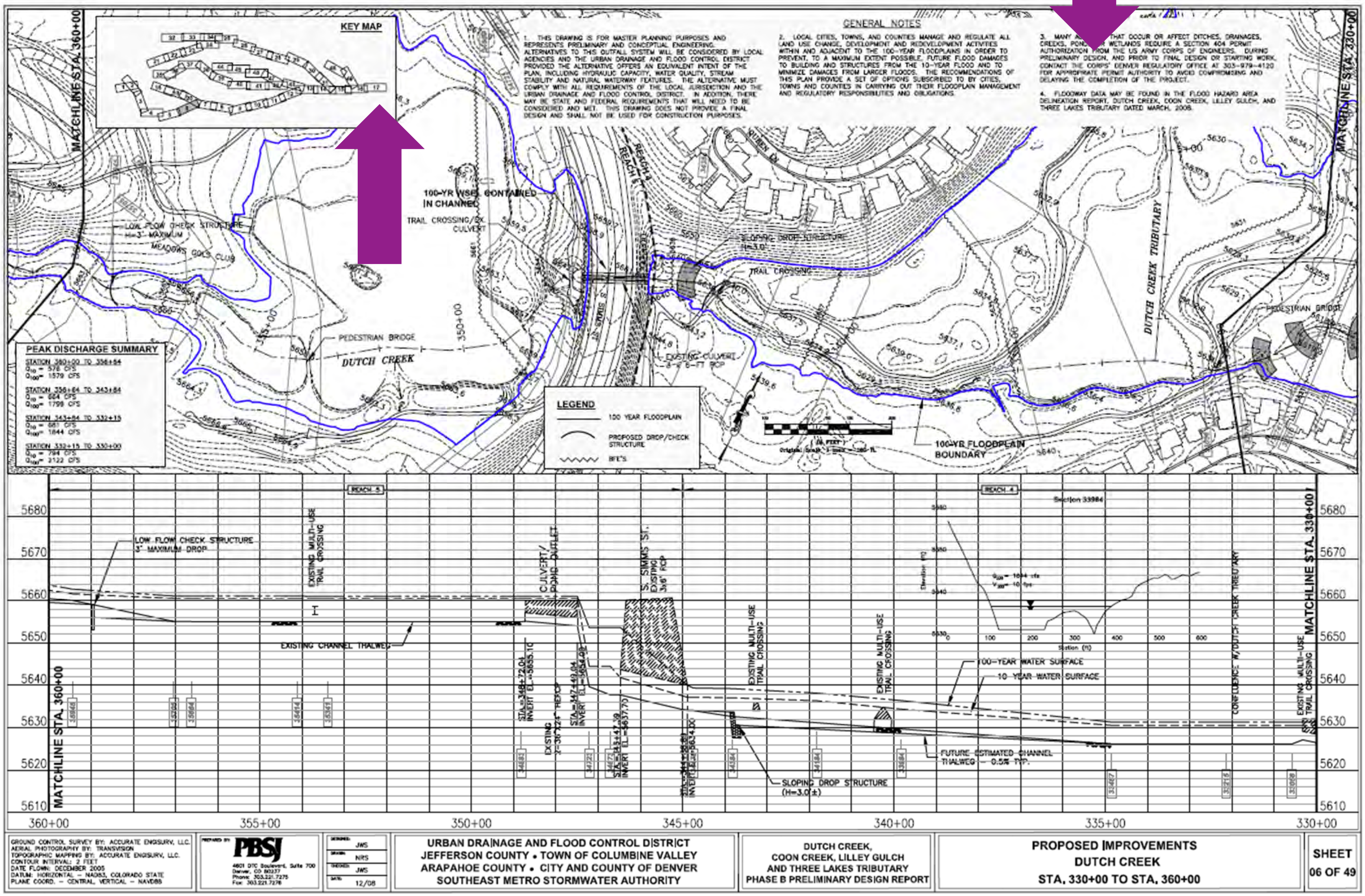
CITY OF AURORA
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

MURPHY CREEK OUTFALL SYSTEMS PLANNING STUDY

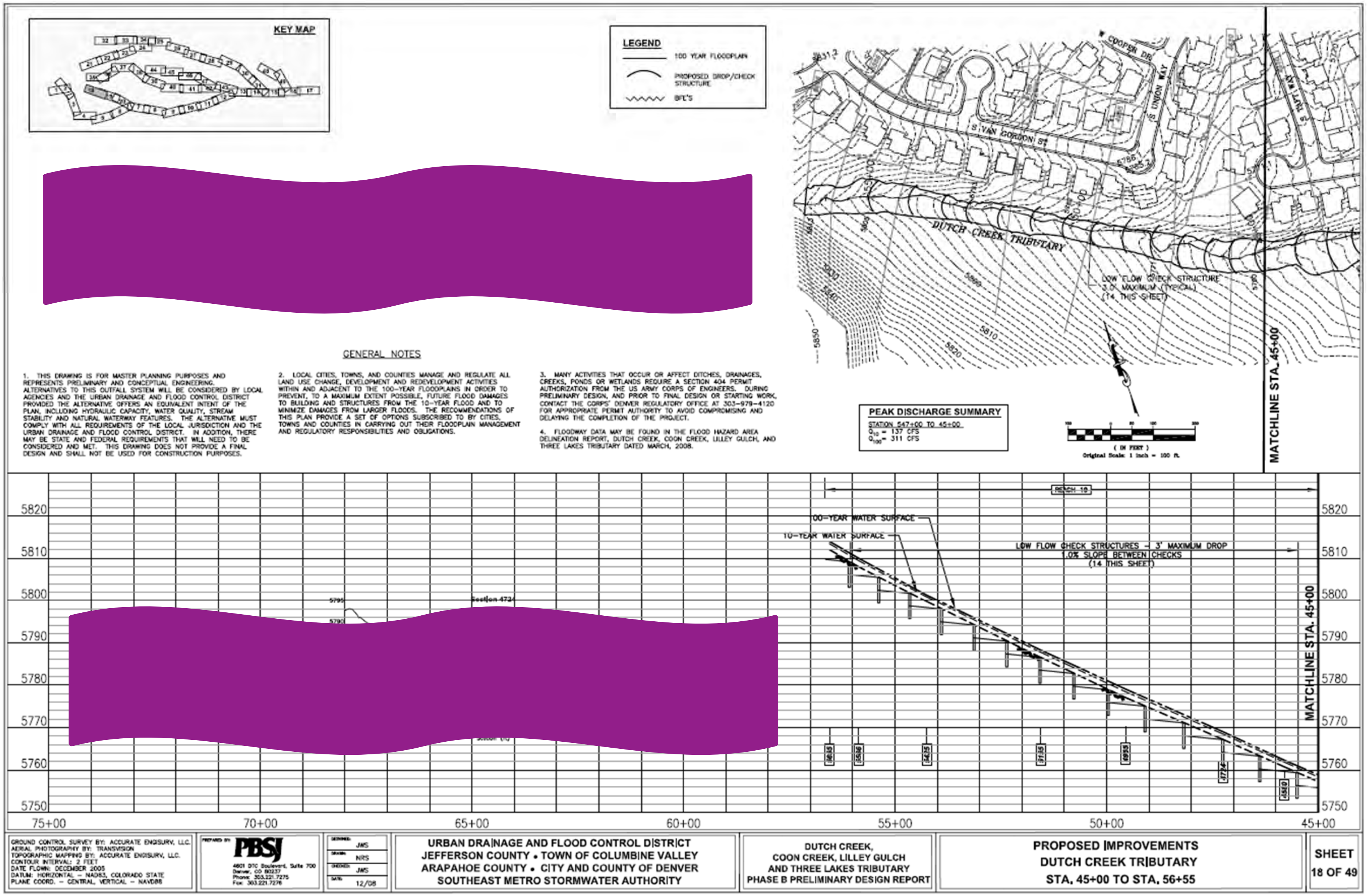
MURPHY CREEK PLAN AND PROFILE SHEET KEY MAP

INDEX-1

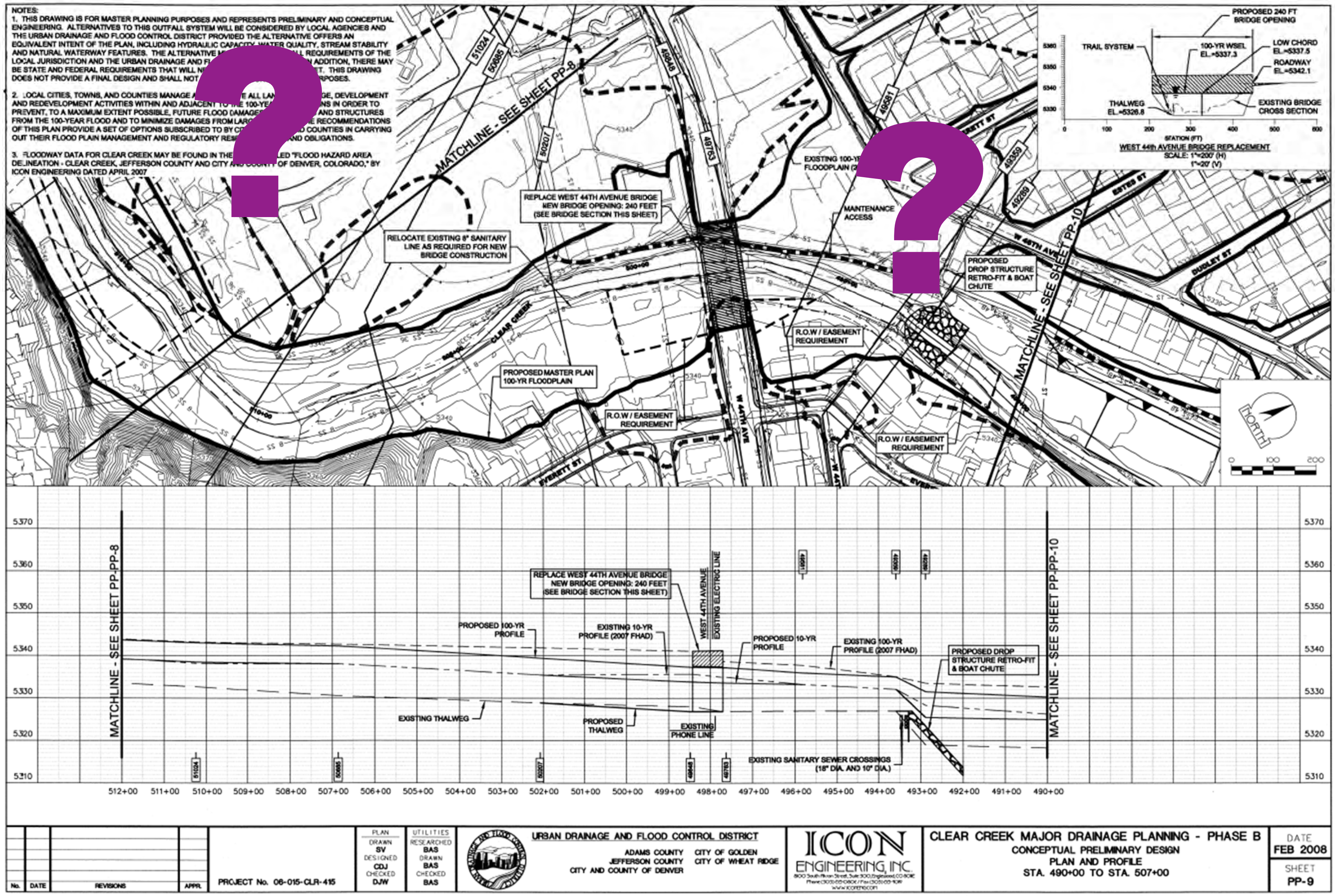
Incomplete Floodplain



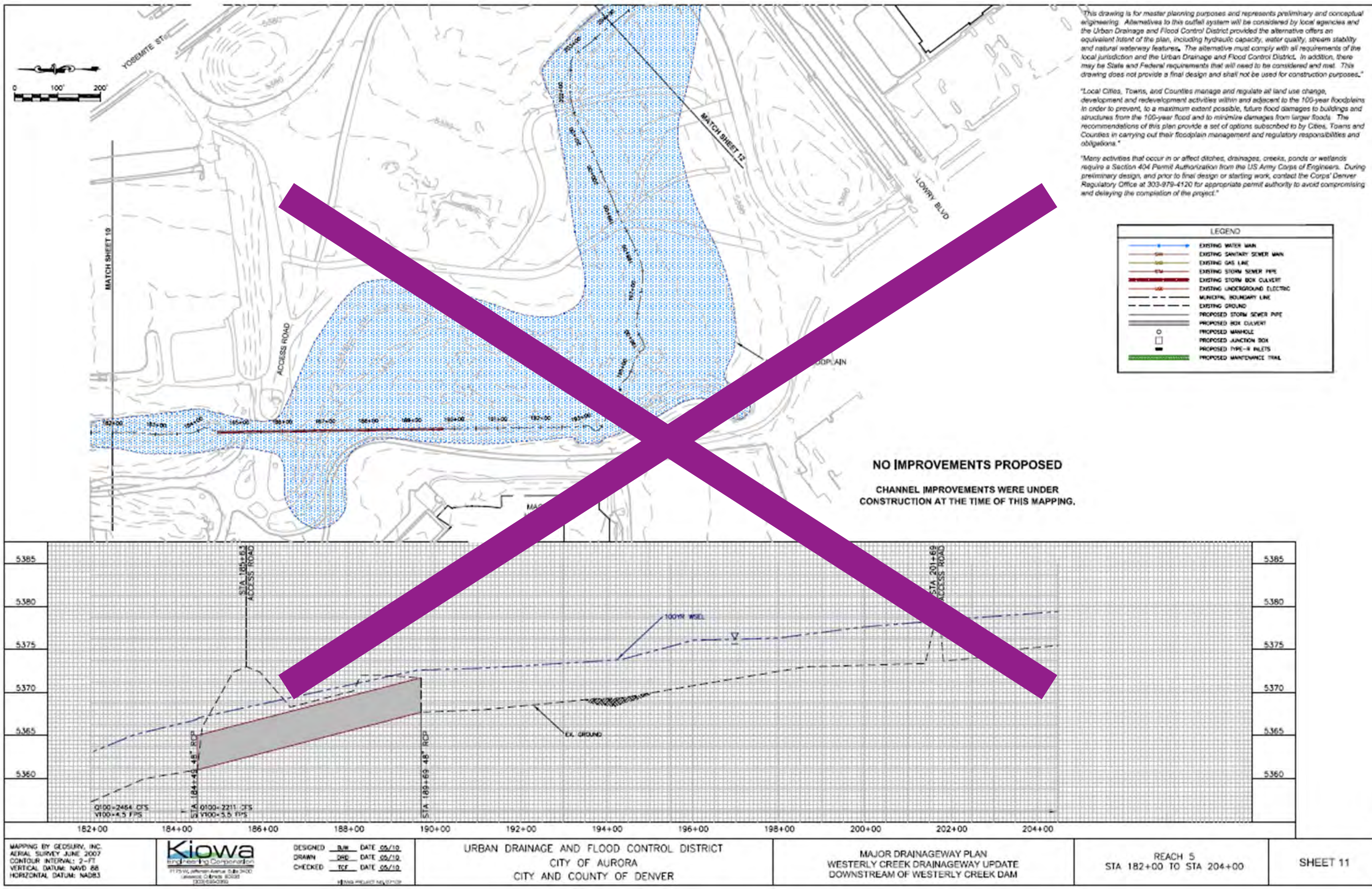
Partial Pages



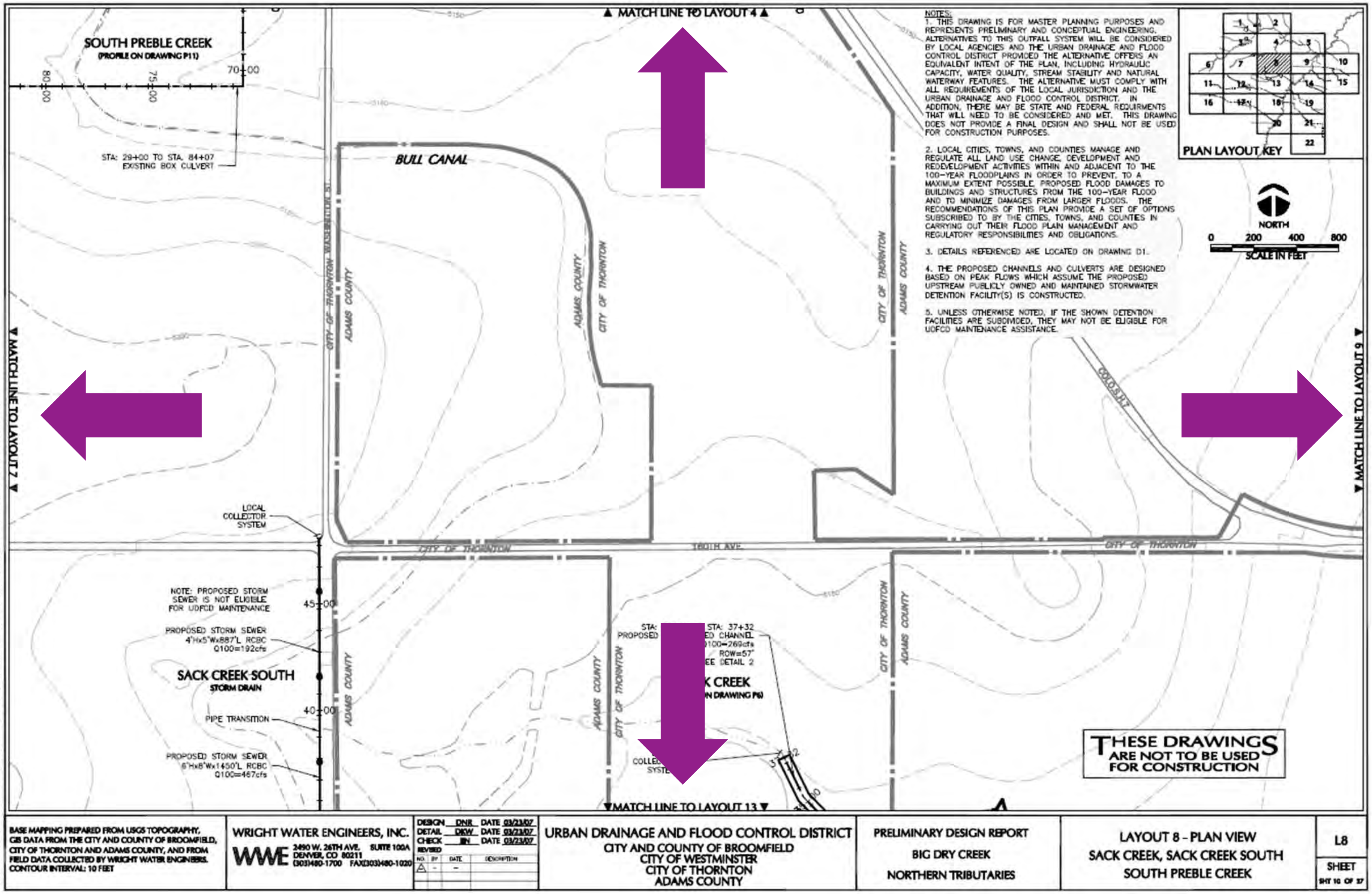
Confusing Linework



Useless Sheets

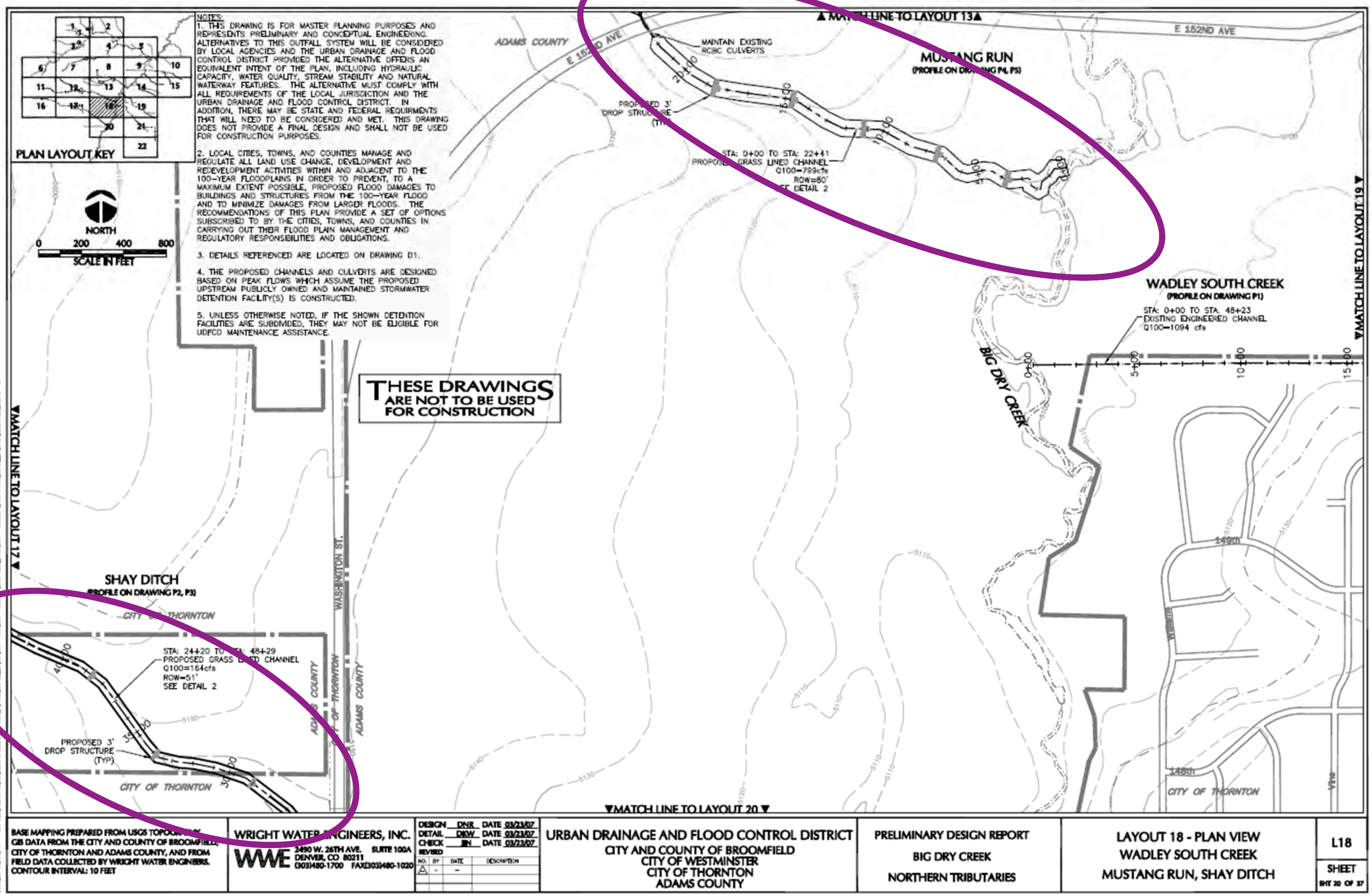


Matchlines

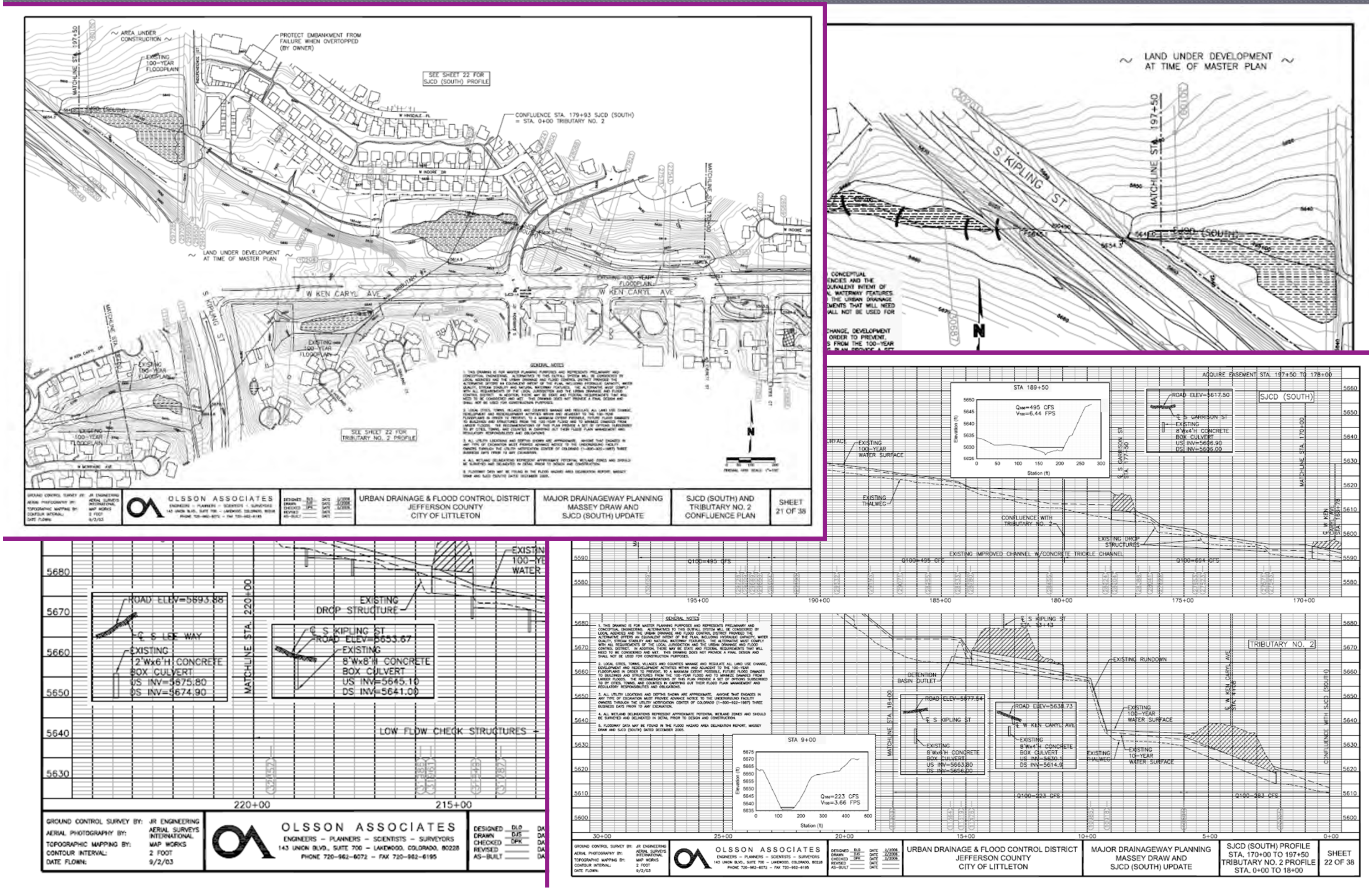


▲ MATCH LINE TO LAYOUT 4 ▲
▼ MATCH LINE TO LAYOUT 7 ▼
▼ MATCH LINE TO LAYOUT 9 ▼
▼MATCH LINE TO LAYOUT 13 ▼
SOUTH PREBLE CREEK
(PROFILE ON DRAWING P11)
BULL CANAL
SACK CREEK SOUTH
STORM DRAIN
160TH AVE.
CITY OF THORNTON
ADAMS COUNTY
PLAN LAYOUT KEY
NORTH
SCALE IN FEET
THESE DRAWINGS ARE NOT TO BE USED FOR CONSTRUCTION
BASE MAPPING PREPARED FROM USGS TOPOGRAPHY, GIS DATA FROM THE CITY AND COUNTY OF BROOMFIELD, CITY OF THORNTON AND ADAMS COUNTY, AND FROM FIELD DATA COLLECTED BY WRIGHT WATER ENGINEERS. CONTOUR INTERVAL: 10 FEET
WRIGHT WATER ENGINEERS, INC.
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
CITY AND COUNTY OF BROOMFIELD
CITY OF WESTMINSTER
CITY OF THORNTON
ADAMS COUNTY
PRELIMINARY DESIGN REPORT
BIG DRY CREEK
NORTHERN TRIBUTARIES
LAYOUT 8 - PLAN VIEW
SACK CREEK, SACK CREEK SOUTH
SOUTH PREBLE CREEK
L8
SHEET

Bits and Pieces



Schizophrenia



Report Content Stays the Same

- Executive Summary
- Introduction
- Study Area Description
- Hydrologic Analysis
- Hydraulic Analysis
- Alternative Analysis
- Recommended Plan
- Conceptual Design*
- Appendices

What's Different

- Plan Drawings

Sheet 19 Commentary: Murphy Creek Station 208+00 to 233+00

Murphy Creek between stations 208+00 to 233+00 is within the Murphy Creek development. According to the 2006 FHAD Study, there are no structures within the 100-year floodplain boundary. The existing 3-10' x 10' CBC crossing at Jewell Avenue will be overtopped during the 100-year event. The existing 2-10' x 10' CBC crossing at Old Tom Morris Road is adequate to convey the 100-year event.

The existing channel slope is approximately 0.7% and will likely experience degradation in the future.

2 check structures are proposed within the reach and will halt future erosion allowing the channel to stabilize at a predicted slope of 0.40%. Channel improvements were implemented within this reach of Murphy Creek during the construction of the Murphy Creek development. Discussions with the City of Aurora have determined that check structures were installed at that time. Once the channel invert begins to "flatten" the channel should be evaluated to determine if an existing structure will protect the channel or if an additional check structure is required. While the existing 3-10' x 10' CBC at Jewell Avenue is inadequate to convey the baseline peak flows, once the existing detention basins in the DADS are recognized the existing structure will be adequate.

Jewell Avenue CBC

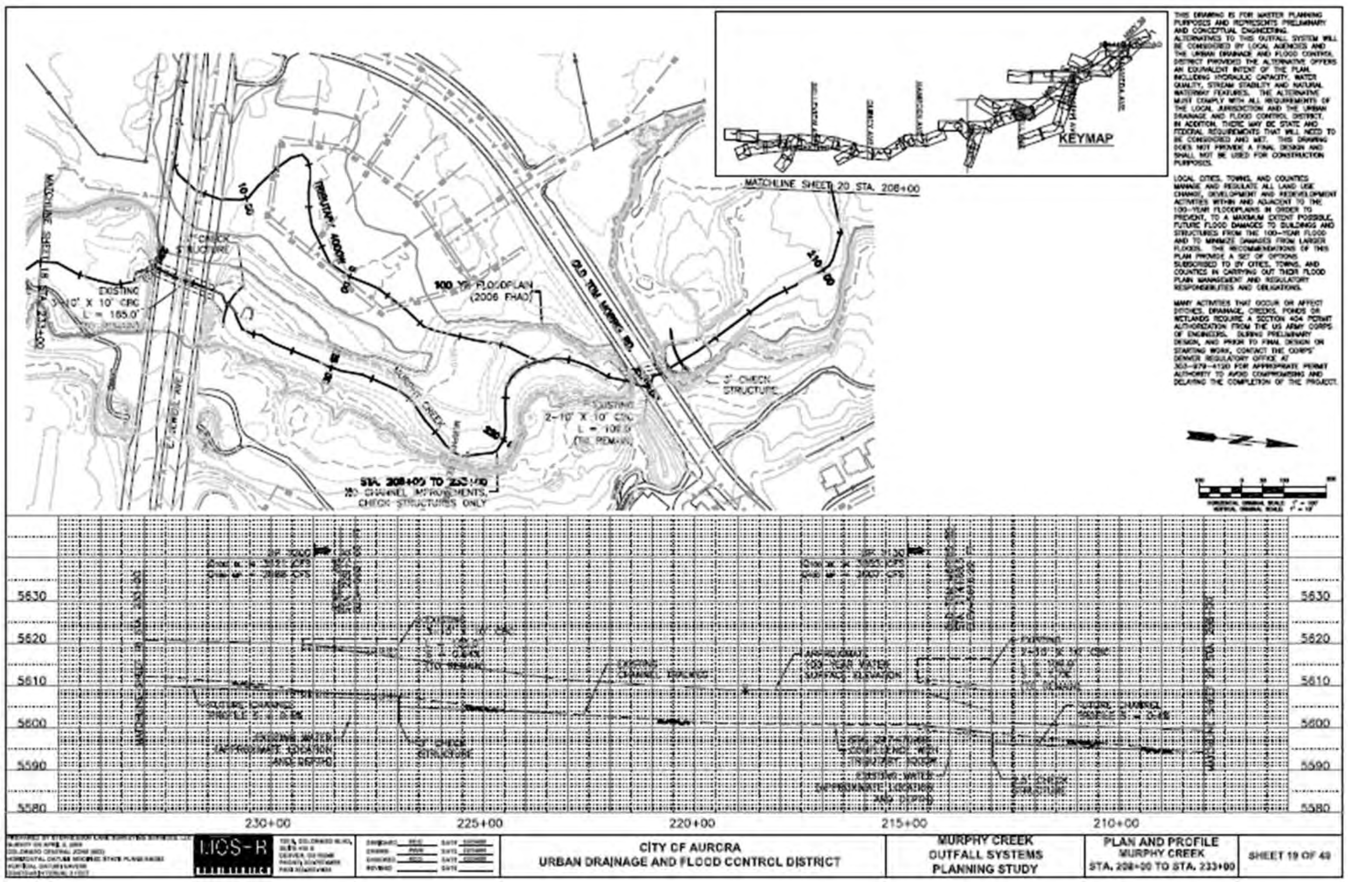
Sheet 19 Cost Estimate

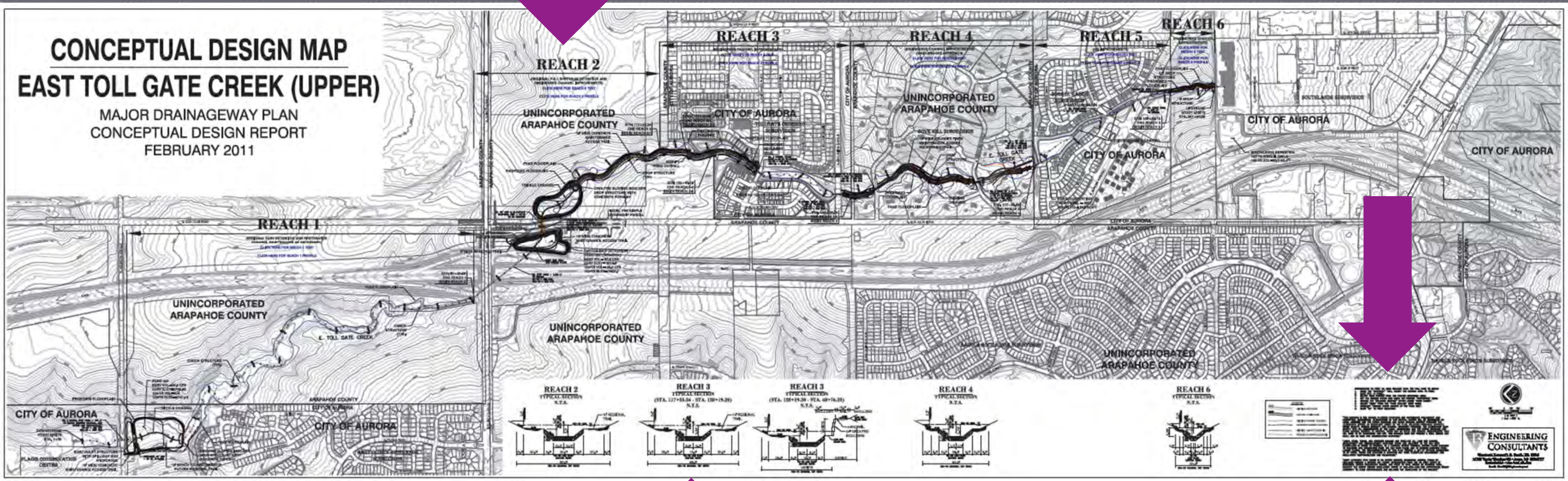
SHEET 19

Murphy Creek: Mainstem - Reach 6				From Sta. 208+00		To Sta. 233+00	
Characteristics							
Channel Length				2500		ft	
Average Floodplain Width				300		ft	
SELECTED IMPROVEMENT: FLOODPLAIN PRESERVATION							
Description	**Height (ft)**	**Avg. Width (ft)**	**Avg. Vol (ft^3)**	**Unit Price**	**Unit**	**Quantity**	**Subtotal**
Construction							
Check Structure*	3	115	690	$ 20,444	CY	2	$ 40,889
Mobilization				$ 20,000	each	2	$ 40,000
Toe Protection				$ 22	LF	2,500	$ 55,000
Maintenance							
Debris Removal				$ 1.00	LF	2,500	$ 2,500
Maintenance Trail (Gravel)				$ 20	LF	2,500	$ 50,000
Land Value							
ROW and easements				$ 2	SF	750,000	$ 1,500,000

Subtotals	**Present Day Cost Estimate**	**50-Year Cost Estimate (PV)****
Construction	$ 135,889	$ 131,294
Maintenance	$ 425,000	$ 224,979
Land Value	$ 1,500,000	$ 1,449,275
Contingencies, Engineering, and Admin. Costs (55% of Construction Costs)	$ 74,739	$ 72,211
Total	$ 2,135,628	$ 1,877,759

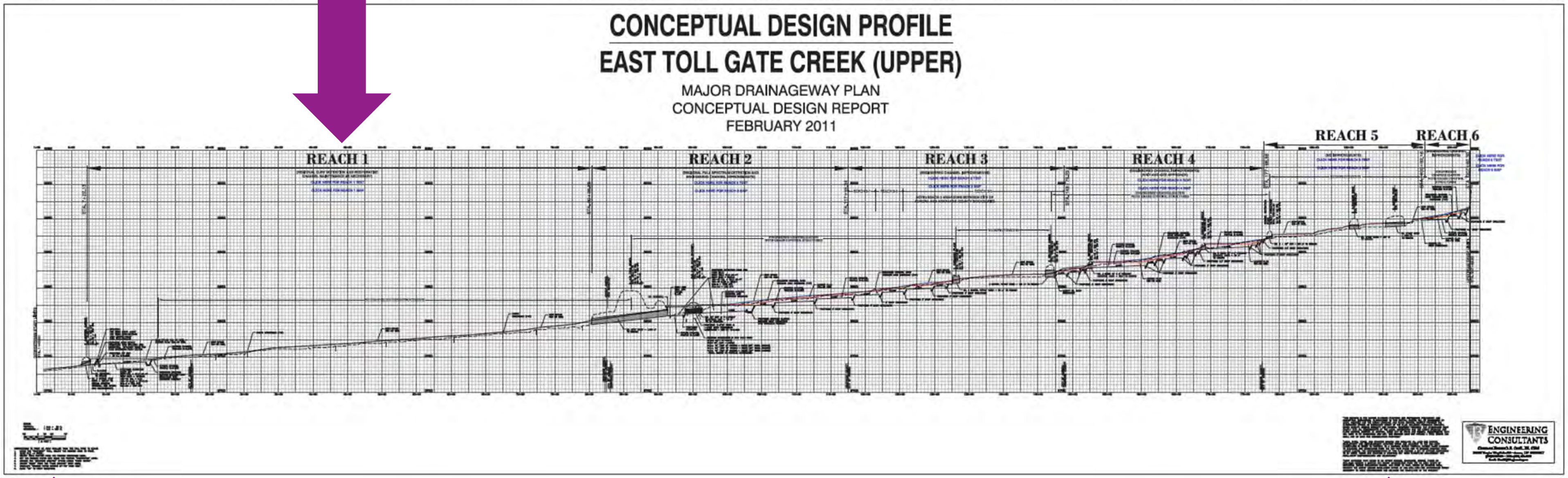
(*) The height shown in the Table reflects the above ground height not the total installed quantity.
(**) The 50-year cost estimate refers to the total amount that a series of future payments is worth now. For these calculations, it was assumed that the effective rate of return was 3.5% (see Cost discussion in Section 6.4).




CONCEPTUAL DESIGN MAP
EAST TOLL GATE CREEK (UPPER)
MAJOR DRAINAGEWAY PLAN
CONCEPTUAL DESIGN REPORT
FEBRUARY 2011
REACH 1
REACH 2
REACH 3
REACH 4
REACH 5
REACH 6
UNINCORPORATED ARAPAHOE COUNTY
CITY OF AURORA
E. TOLL GATE CREEK
ENGINEERING CONSULTANTS

What's Different

- Plan Drawings
- Profile Drawings


CONCEPTUAL DESIGN PROFILE
EAST TOLL GATE CREEK (UPPER)
MAJOR DRAINAGEWAY PLAN
CONCEPTUAL DESIGN REPORT
FEBRUARY 2011
REACH 1
REACH 2
REACH 3
REACH 4
REACH 5
REACH 6
ENGINEERING CONSULTANTS

What's Different

- Plan Drawings
- Profile Drawings
- Conceptual Design Section

6.1 MASTER PLAN OVERVIEW

The notice to proceed for the conceptual design phase of the project was issued on April 23, 2007. The

- Tributary 4000E – Varies from the Selected Plan since the limits of the channel improvements begin at the confluence with Murphy Creek and extend upstream at the limits of proposed development site.

Tributary 2000 – FSD within the BAFB will aid in reducing the potential for erosion from the basin as it develops. In addition, detention just upstream of Highway 30 will remove the risk of roadway overtopping and improve the overall safety of the road. By defining the floodplain within the improved channel geometry and improving the roadway crossings, there is an increase to public safety.

6.8 MASTER PLAN DRAWINGS

The recommendations contained in this report are further described in Appendix G, Plan and Profile Drawings for the Master Plan improvements.

ponds on the DADS site will reduce downstream peak flows and remove structures from the floodplain.

Murphy Creek Reach 6 – Yale to Mississippi. The check dams and bank stabilization will help create a stable channel that will result in an increase in safety to the public and prevent excessive erosion.

Tributary 3000W – The FSD recommended upstream of the closed Aurora landfill will reduce the chance that the clay cap will be disturbed. Defining the floodplain within the improved channel geometry downstream of the landfill and improving the roadway crossings will improve the safety to the public.

8.4.2 First Creek (Upper) Reach F2: 56th Avenue to Tower Road

Engineered Trapezoidal Channel

Reach F2 of First Creek (Upper) is between stations 60+70 to 82+40 and is within the City and County of Denver. The downstream reach limit is located at 56th Avenue and the upstream limit is located at Tower Road.

Structures

There are three road crossings and associated structures within this reach. The existing 56th Avenue Eastbound and Westbound Bridges share a peak flow of 4,160 cfs and have adequate capacity to convey the 100-year event. The existing Tower Road dual Conspan Bridge has a 100-year Conceptual Design peak flow of 5,220 cfs, and has adequate capacity to convey the 100-year event.

Existing Channel

The existing channel is 2,170 feet long and has a well-defined low flow channel with dense vegetation. The existing slope is 0.54%. The average 100-year DFHAD floodplain is extremely wide at 1,379 feet and contains a significant flow split. Due to this extremely wide 100-year floodplain upstream of 56th Avenue and because 56th Avenue's lowest point is west of the bridges, the floodplain overtops 56th Avenue on the west side of the floodplain.

Proposed Channel

The approach to Reach F2 has also changed during the Conceptual Design Phase to accommodate for planned pedestrian below-grade crossings under the Tower Road Bridge and 56th Avenue. The below-grade crossing elevations require the invert of the channel to be dropped approximately three feet. When the Tower Road Bridge was constructed, the channel downstream was not lowered to provide positive slope which is causing severe ponding issues around the bridge. To address the ponding issues, this Conceptual Design is recommending an engineered trapezoidal channel to create drainage from the bridge and per the request of the City and County of Denver. The engineered trapezoidal channel will be cut into the existing channel to allow for lowering of the invert. The top width of the channel including one-foot of freeboard is 223 feet, the top width of the low flow channel is 79 feet, and the combined depth is 7.5 feet. The engineered trapezoidal channel will be grass lined and will contain the 100-year event. Please note that Reach F2 channel improvements work in conjunction with improvements on Reach F1 to eliminate overtopping of 56th Avenue. Due to the natural topography, the area west of the defined trapezoidal channel is below the 100-year flood elevation and is separated by an uncertified levee. The western area has the potential to be breached and is therefore still within a flood risk zone. Because of this, the land acquisition cost in Table 8.4.2 includes the entire area of the regulatory floodplain. There is one existing check structure just downstream of Tower Road. Additionally, one drop structure is proposed so that if future erosion occurs, both the high flow and low flow channels will stabilize at a slope of 0.35%. Please refer to Typical Section 1 on Figure 8-1 at the end of Section 8.

Detention Facilities

There are no existing or proposed detention facilities within this reach.

Maintenance Trail

A permanent 10 foot wide maintenance trail will be built within the overbanks during trapezoidal channel construction to provide construction and maintenance access. Figure 8-1, Typical Section I, illustrates the maintenance trail incorporation into the channel overbanks.

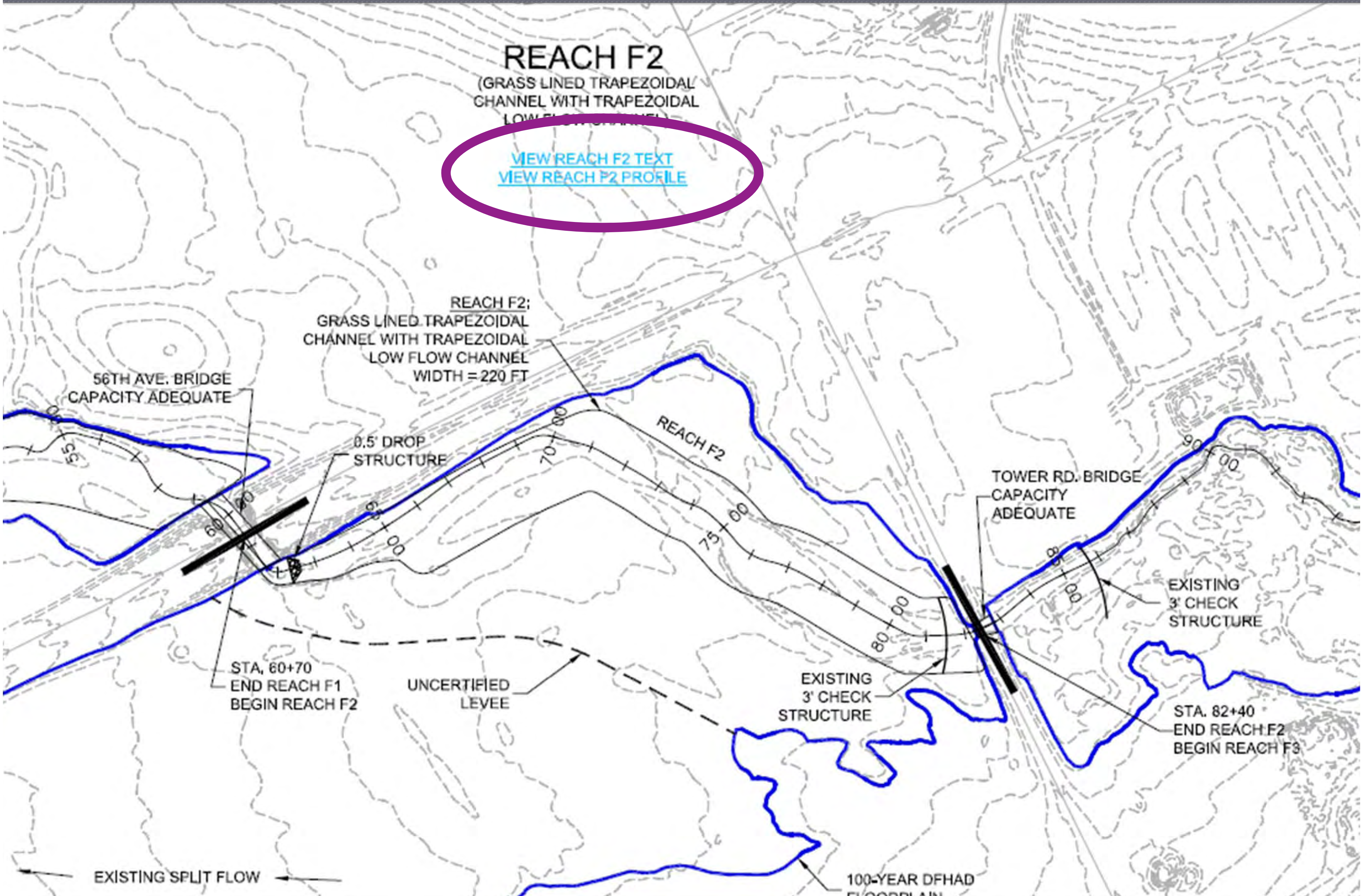
CLICK HERE TO VIEW REACH F2 MAP
CLICK HERE TO VIEW REACH F2 PROFILE

Table 8.4.2 Reach F2: Denver Cost Estimate

PROJECT :	First Creek (Upper) Major Drainageway Plan: Conceptual Design				
DRAINAGEWAY :	First Creek (Upper)				
REACH :	F2				
STATIONING:	Sta 60+70 to 82+40				
JURISDICTION :	City and County of Denver				
PLAN SHEET :	1	ESTIMATED BY :	AGC	DATE :	7/20/2010

CONSTRUCTION COSTS					
DESCRIPTION		QUANTITY	UNIT	UNIT COST	COST
Channel Improvements					
Excavation, High Range		71000	C.Y.	$25.75	$1,828,250.00
Landscaping and Recreation Improvements					
Reclamation & seeding (native grasses)		11	ACRE	$1,030.00	$11,330.00
Trail/Path, Crusher Fines (10' Width)		2170	FT	$10.30	$22,351.00
Land Acquisition					
Easement/ROW Acquisition		69	ACRE	$87,120.00	$6,011,280.00
Subtotals					
Subtotal Capital Improvement Costs					$1,861,931.00
Subtotal Additional Construction Costs (Dewatering, Mobilization, Traffic Control, Utilities, Stormwater Management)					$316,640.00
Subtotal Land Acquistion					$6,011,280.00
Subtotal Other Costs (Engineering, Legal, Construction Management, & Contingency)					$2,700,879.06
Grand Total					**$10,890,730.05**

ANNUAL OPERATION AND MAINTENANCE COSTS						
DESCRIPTION			QUANTITY	UNIT	UNIT COST	COST
Channel Operations and Maintenance						
Mowing			11	ACRE	$150.00	$1,650.00
Debris Removal			2170	L.F.	$3.00	$6,510.00
Restorative Maintenance and Rehabilitation			0.4	MI	$5,000.00	$2,054.92
Grand Total						**$10,214.92**

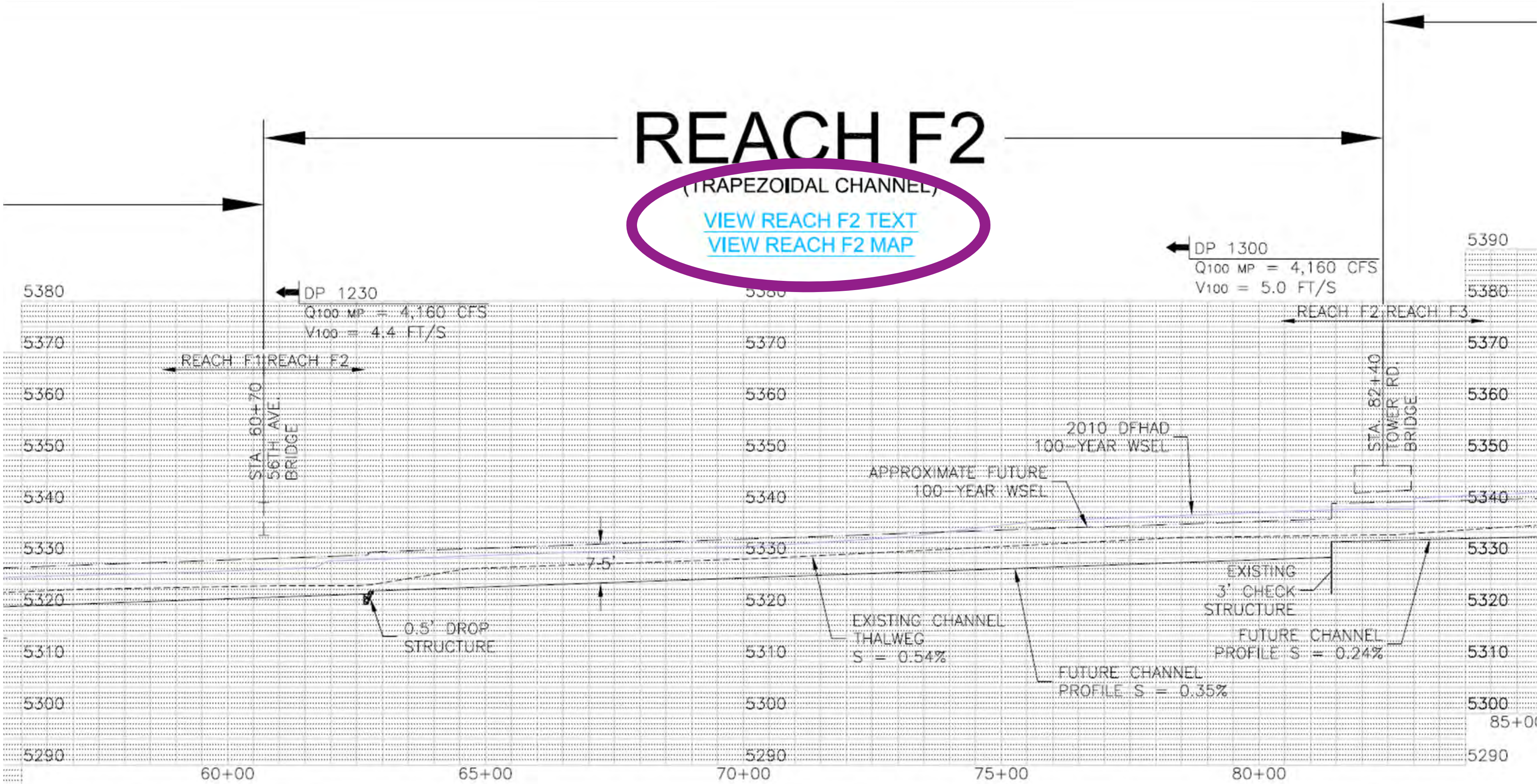

REACH F2
(GRASS LINED TRAPEZOIDAL
CHANNEL WITH TRAPEZOIDAL
VIEW REACH F2 TEXT
VIEW REACH F2 PROFILE
REACH F2:
GRASS LINED TRAPEZOIDAL
CHANNEL WITH TRAPEZOIDAL
LOW FLOW CHANNEL
WIDTH = 220 FT
56TH AVE. BRIDGE
CAPACITY ADEQUATE
0.5' DROP
STRUCTURE
REACH F2
TOWER RD. BRIDGE
CAPACITY
ADEQUATE
EXISTING
3' CHECK
STRUCTURE
STA. 60+70
END REACH F1
BEGIN REACH F2
UNCERTIFIED
LEVEE
EXISTING
3' CHECK
STRUCTURE
STA. 82+40
END REACH F2
BEGIN REACH F3
EXISTING SPLIT FLOW
100-YEAR DFHAD

REACH F2

(TRAPEZOIDAL CHANNEL)

VIEW REACH F2 TEXT

VIEW REACH F2 MAP



8.4.2 First Creek (Upper) Reach F2: 56th Avenue to Tower Road

Engineered Trapezoidal Channel

Reach F2 of First Creek (Upper) is between stations 60+70 to 82+40 and is within the City and County of Denver. The downstream reach limit is located at 56th Avenue and the upstream limit is located at Tower Road.

Structures

There are three road crossings and associated structures within this reach. The existing 56th Avenue Eastbound and Westbound Bridges share a peak flow of 4,160 cfs and have adequate capacity to convey the 100-year event. The existing Tower Road dual Conspan Bridge has a 100-year Conceptual Design peak flow of 5,220 cfs, and has adequate capacity to convey the 100-year event.

Existing Channel

The existing channel is 2,170 feet long and has a well-defined low flow channel with dense vegetation. The existing slope is 0.54%. The average 100-year DFHAD floodplain is extremely wide at 1,379 feet and contains a significant flow split. Due to this extremely wide 100-year floodplain upstream of 56th Avenue and because 56th Avenue's lowest point is west of the bridges, the floodplain overtops 56th Avenue on the west side of the floodplain.

Proposed Channel

The approach to Reach F2 has also changed during the Conceptual Design Phase to accommodate for planned pedestrian below-grade crossings under the Tower Road Bridge and 56th Avenue. The below-grade crossing elevations require the invert of the channel to be dropped approximately three feet. When the Tower Road Bridge was constructed, the channel downstream was not lowered to provide positive slope which is causing severe ponding issues around the bridge. To address the ponding issues, this Conceptual Design is recommending an engineered trapezoidal channel to create drainage from the bridge and per the request of the City and County of Denver. The engineered trapezoidal channel will be cut into the existing channel to allow for lowering of the invert. The top width of the channel including one-foot of freeboard is 223 feet, the top width of the low flow channel is 79 feet, and the combined depth is 7.5 feet. The engineered trapezoidal channel will be grass lined and will contain the 100-year event. Please note that Reach F2 channel improvements work in conjunction with improvements on Reach F1 to eliminate overtopping of 56th Avenue. Due to the natural topography, the area west of the defined trapezoidal channel is below the 100-year flood elevation and is separated by an uncertified levee. The western area has the potential to be breached and is therefore still within a flood risk zone. Because of this, the land acqusition cost in Table 8.4.2 includes the entire area of the regulatory floodplain. There is one existing check structure just downstream of Tower Road. Additionally, one drop structure is proposed so that if future erosion occurs, both the high flow and low flow channels will stabilize at a slope of 0.35%. Please refer to Typical Section 1 on Figure 8-1 at the end of Section 8.

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CLICK HERE TO VIEW REACH F2 MAP
CLICK HERE TO VIEW REACH F2 PROFILE

Table 8.4.2 Reach F2: Denver Cost Estimate

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DRAINAGEWAY :	First Creek (Upper)				
REACH :	F2				
STATIONING:	Sta 60+70 to 82+40				
JURISDICTION :	City and County of Denver				
PLAN SHEET :	1	ESTIMATED BY :	[illegible]	DATE :	[illegible]

CONSTRUCTION COSTS					
DESCRIPTION		QUANTITY	UNIT	UNIT COST	COST
Channel Improvements					
Excavation, High Range		71000	C.Y.	$25.75	$1,828,250.00
Landscaping and Recreation Improvements					
Reclamation & seeding (native grasses)		11	ACRE	$1,030.00	$11,330.00
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Subtotals					
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Subtotal Additional Construction Costs (Dewatering, Mobilization, Traffic Control, Utilities, Stormwater Management)					$316,640.00
Subtotal Land Acquistion					$6,011,280.00
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Grand Total					**$10,890,730.05**

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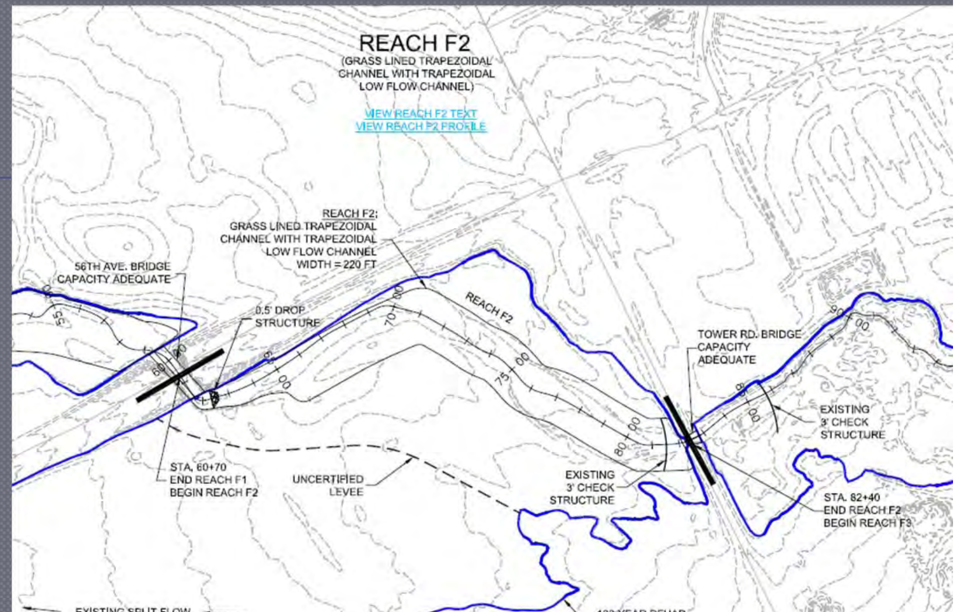
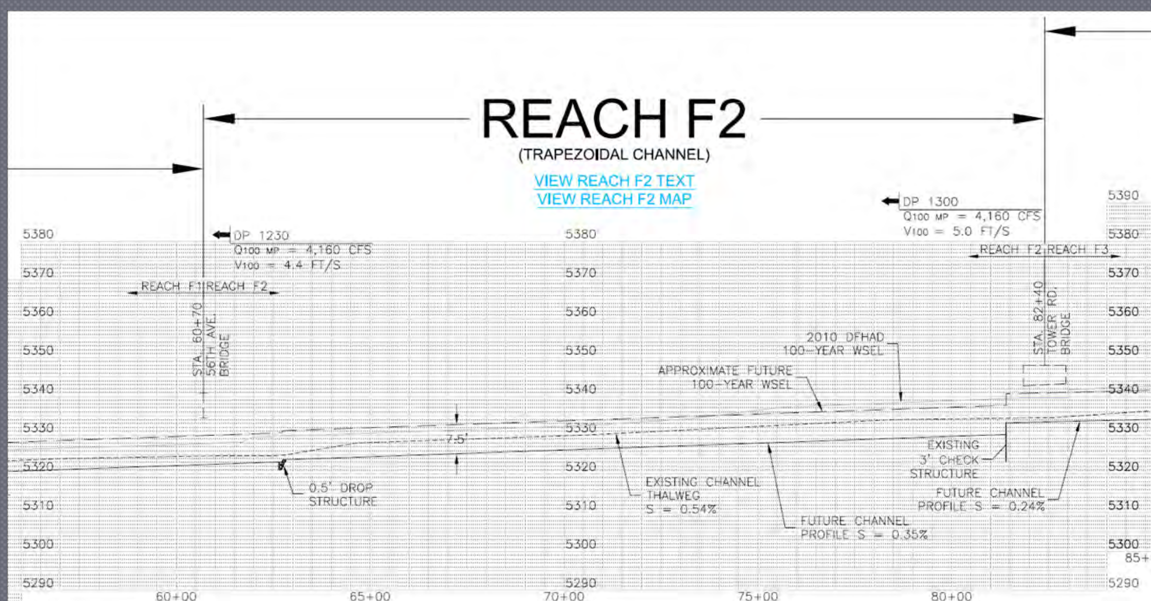
Restorative Maintenance and Rehabilitation		0.4	MI	[illegible]	$2,054.92
Grand Total					**$10,214.92**

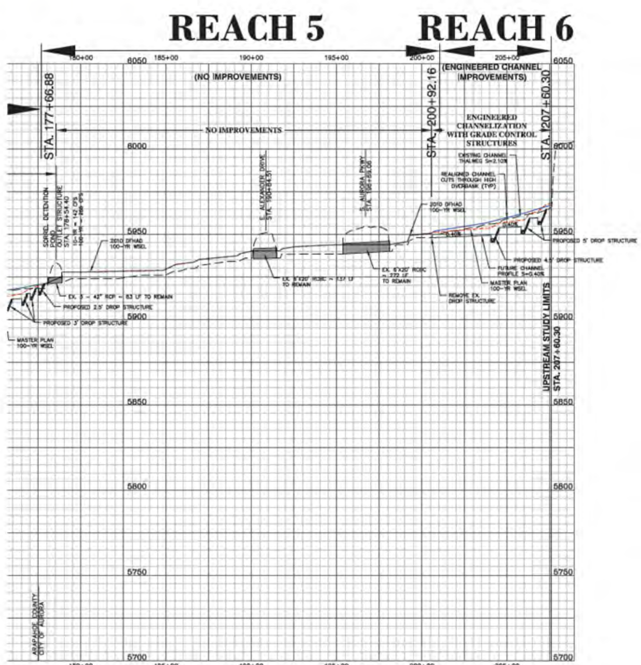




APPENDIX E:
CONCEPTUAL DESIGN MAPS

CLICK HERE TO VIEW FULL-SIZE MAP

CLICK HERE TO VIEW PRESET 11 X 17 PRINTABLE MAPS


REACH 5
REACH 6
(NO IMPROVEMENTS)
(ENGINEERED CHANNEL IMPROVEMENTS)
NO IMPROVEMENTS
ENGINEERED CHANNELIZATION WITH GRADE CONTROL STRUCTURES
STA. 177+66.88
STA. 200+92.16
STA. 207+60.30
UPSTREAM STUDY LIMITS
STA. 207+60.30

ePlan Guidelines

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

Electronic Planning Study (EPlan) Guidelines

for Outfall Systems Planning and Major Drainageway Planning Studies

December 2010

Prepared by

MOSER & associates ENGINEERING
720 South Colorado Boulevard
Suite 410 S
Denver, Colorado 80246
phone (303) 757-3655
fax (303) 300-1635

TABLE 3.1
Conceptual Design Map Feature Appearance and Layer Conventions

FEATURE	LAYER NAME	APPEARANCE	LABEL
CONCEPTUAL DESIGN ELEMENTS			
Channelization Limits	CHANNEL	Black, solid line	Average channel top width
Grade Control Structures	DROP, CHECK, etc.	Black, solid line ; hatch if necessary	Grade control height
Bank Stabilization	BANK-STABL	Black, solid outline; hatch if necessary	
Detention Basin	DETENTION	Black, solid line; Hatch footprint	Volume, Q_{IN}, Q_{OUT}, max. depth
Storm Sewer	INLET, MANHOLE, PIPE	Black, solid line	Flow, Existing & Proposed Size if applicable
Study Limits	LIMITSTUDY	Black, solid line	Label study limit
Watershed Boundary	WATERSHED	Black, thick solid line	Label watershed boundary
STRUCTURE ELEMENTS			
Stream Centerline	CHANNEL	Black, solid line	
Centerline Stationing	CHSTATION	Black	
Culverts	CULVERT	Black, solid line	Flow, Existing size and Proposed Size
Bridges	BRIDGE	Black, solid line	Flow, Existing size and Proposed Size
Foot Bridges	FOOTBRIDGE	Black, solid line	Flow, Existing size and Proposed Size
	OTHER_STRUCT	Black, solid line	Flow, Existing size and Proposed Size
	STRUCTEXT	Black	
	100-YEAR FLOOD	Blue, solid line	Label line with source of delineation
	100-YEAR FLOOD FUTURE	Light blue, dashed line	"Approximate 100-Year Floodplain with Improvements"
	ROAD	Thin gray line	

3.5.1 About Attachments and Links

Acrobat lets the user attach PDF files to an Adobe PDF document so that the reader can open them for viewing. If the PDF document is moved to a new location, the attachments automatically go with it. Attachments are added by using the Attach A File tool and linked from the parent document. In the case of the EPlan PDF, the parent document is the Master PDF and the attachments are the Map, Profile, and Easy-to-Print PDF files. A reader can click on links within the Text to jump to the Map or Profile zoomed to the corresponding reach. Likewise, links on the Map and Profile provide similar functionality.

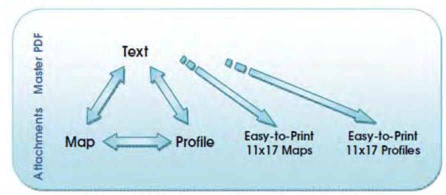


TABLE 3.2
Conceptual Design Map Recommended Text Sizes

DESCRIPTION	PRINTED HEIGHT
Map Title	1.0 inch
Map Subtitle	0.50 inch
Reach Identifier	0.30 inch
Links (to Text and Profile below Reach Identifier)	0.14 inch
Street Names	0.30 inch
General Feature Labels	0.14 inch
Centerline Stationing	0.14 inch
Matchline	0.20 inch

3.4.4 Reach Labels

The reaches must be clearly labeled on the profile in a manner that allows them to be identified easily when the PDF sheet is zoomed out. Beneath the reach identifier, include the following text:

CLICK HERE TO VIEW REACH (reach identifier) TEXT
CLICK HERE TO VIEW REACH (reach identifier) PROFILE
Substitute "(reach identifier)" with the name of the reach.

This text will be used in the final PDF to link between the Text, Maps, and Profiles. Each reach label should be accompanied by links to the Text and the Map. This functionality is intended to replace the traditional plan and profile sheets and therefore is an essential component of a useful EPlan PDF document.

New Checklists

EXHIBIT D

MAJOR DRAINAGEWAY PLANNING STUDIES
REPORT CHECKLIST

Instructions:

1. Engineer shall submit a completed copy of this checklist with all draft and final reports for each milestone.
2. For the Baseline Hydrology and Alternatives Analysis submittals, include placeholders for all of the report sections that will be populated in future submittals.
3. For deviations from checklist, include a separate sheet with numbered comments and write the corresponding number in the "Note #" column.
4. Clearly label Sections and Subsections (bold items in checklist) in report.

	REPORT SECTIONS	Baseline Hydrology	Alternatives Analysis	Conceptual Design	Note #
PRELIMINARIES	**Cover Sheet**	☐	☐	☐	
	Project Title (from Agreement)	☐	☐	☐	
	Project Sponsors List, including logos	☐	☐	☐	
	Engineer's Name/Address	☐	☐	☐	
	Date (Month & Year)	☐	☐	☐	
	"DRAFT" stamp (on all except final Conceptual Design Report)	☐	☐	☐	
	Transmittal Letter	☐	☐	☐	
	Signed and sealed by Engineer transmitting report to District	☐	☐	☐	
	Table of Contents	☐	☐	☐	
	Section titles and page numbers	☐	☐	☐	
	List of Tables (number, title, and location in report)	☐	☐	☐	
	List of Figures (number, title, and location in report)	☐	☐	☐	
	List of Appendices	☐	☐	☐	
EXECUTIVE SUMMARY	**Purpose and Objective**	N/A	N/A	☐	
	Describe reasons for investigation of drainage and flood control problems	N/A	N/A	☐	
	Planning Process	N/A	N/A	☐	
	Brief overview of planning process including public meetings	N/A	N/A	☐	
	Project Area Description	N/A	N/A	☐	
	General Project Area description	N/A	N/A	☐	
	Reference to Vicinity Map and Watershed Map	N/A	N/A	☐	
	Brief summary of Project Area hydrology: Compare existing and future land use conditions peak flows for both existing infrastructure and proposed improvements	N/A	N/A	☐	
	Brief summary of Project Area hydraulics: Compare existing and future land use conditions and existing infrastructure floodplains	N/A	N/A	☐	
	Alternative Analysis	N/A	N/A	☐	
	Brief summary of categories and alternatives considered	N/A	N/A	☐	
	Master Plan	N/A	N/A	☐	
	Brief summary of the plan on a reach-by-reach basis	N/A	N/A	☐	
	Explanation of costs and benefits of Master Plan	N/A	N/A	☐	
	Implementation priorities	N/A	N/A	☐	
	Tables	N/A	N/A	☐	
	Project participants and their affiliations	N/A	N/A	☐	
	Hydrology reconciliation with previous studies showing peak flows at key locations from all studies	N/A	N/A	☐	
	Master Plan Cost Estimate Summary – detailed cost estimate of master plan by reach with costs split out by jurisdiction	N/A	N/A	☐	

Page 1 of 8

EXHIBIT D

OUTFALL SYSTEMS PLANNING STUDIES
REPORT CHECKLIST

Instructions:

1. Engineer shall submit a completed copy of this checklist with all draft and final reports for each milestone.
2. For the Baseline Hydrology and Alternatives Analysis submittals, include placeholders for all of the report sections that will be populated in future submittals.
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4. Clearly label Sections and Subsections (bold items in checklist) in report.

	REPORT SECTIONS	Baseline Hydrology	Alternatives Analysis	Conceptual Design	Note #
PRELIMINARIES	**Cover Sheet**	⍰	⍰	⍰	
	Project Title (from Agreement)	⍰	⍰	⍰	
	Project Sponsors List, including logos	⍰	⍰	⍰	
	Engineer's Name/Address	⍰	⍰	⍰	
	Date (Month & Year)	⍰	⍰	⍰	
	"DRAFT" stamp (on all except final Conceptual Design Report)	⍰	⍰	⍰	
	Transmittal Letter	⍰	⍰	⍰	
	Signed and sealed by Engineer transmitting report to District	⍰	⍰	⍰	
	Table of Contents	⍰	⍰	⍰	
	Section titles and page numbers	⍰	⍰	⍰	
	List of Tables (number, title, and location in report)	⍰	⍰	⍰	
	List of Figures (number, title, and location in report)	⍰	⍰	⍰	
	List of Appendices	⍰	⍰	⍰	
EXECUTIVE SUMMARY	**Purpose and Objective**	N/A	N/A	⍰	
	Describe reasons for investigation of drainage and flood control problems	N/A	N/A	⍰	
	Planning Process	N/A	N/A	⍰	
	Brief overview of planning process including public meetings	N/A	N/A	⍰	
	Project Area Description	N/A	N/A	⍰	
	General Project Area description	N/A	N/A	⍰	
	Reference to Vicinity Map and Watershed Map	N/A	N/A	⍰	
	Brief summary of Project Area hydrology: Compare existing and future land use conditions peak flows for both existing infrastructure and proposed improvements	N/A	N/A	⍰	
	Brief summary of Project Area hydraulics: Compare existing and future land use conditions and existing infrastructure floodplains	N/A	N/A	⍰	
	Alternative Analysis	N/A	N/A	⍰	
	Brief summary of categories and alternatives considered	N/A	N/A	⍰	
	Master Plan	N/A	N/A	⍰	
	Brief summary of the plan on an outfall-by-outfall basis	N/A	N/A	⍰	
	Explanation of costs and benefits of Master Plan	N/A	N/A	⍰	
	Implementation priorities	N/A	N/A	⍰	
	Tables	N/A	N/A	⍰	
	Project participants and their affiliations	N/A	N/A	⍰	
	Hydrology reconciliation with previous studies showing peak flows at key locations from all studies	N/A	N/A	⍰	
	Master Plan Cost Estimate Summary – detailed cost estimate of master plan by outfall with costs split out by jurisdiction	N/A	N/A	⍰	

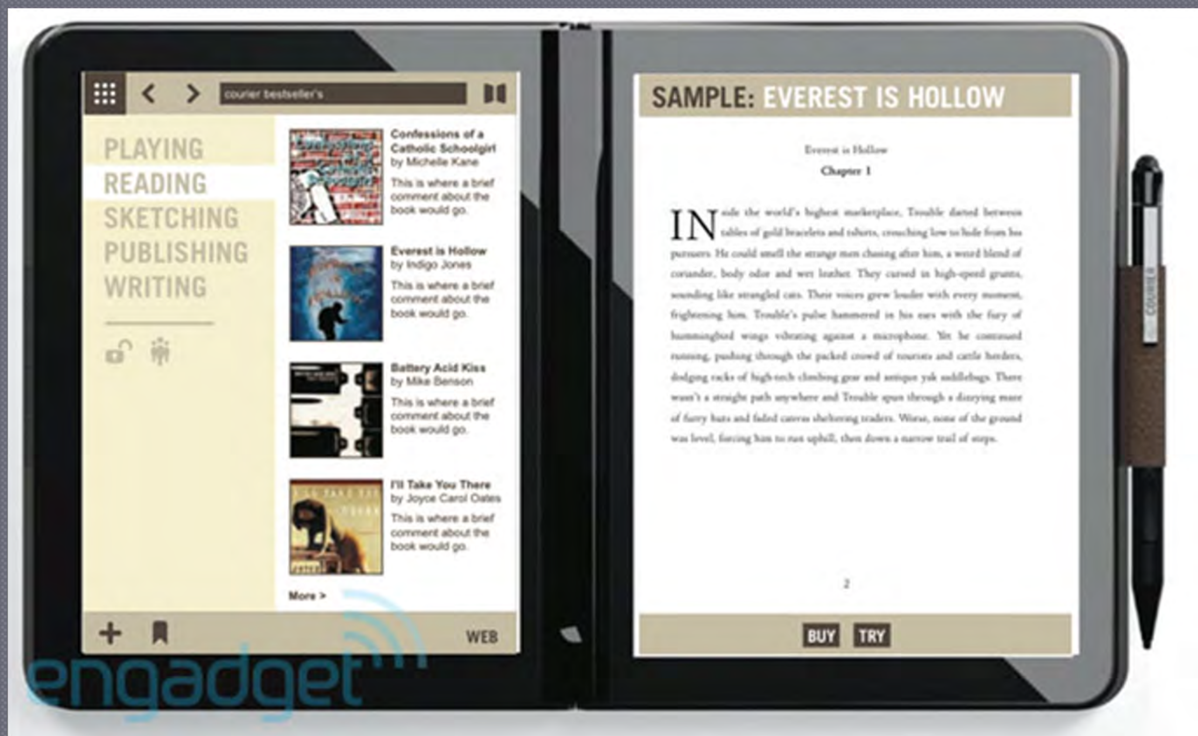
Page 1 of 8

Completed ePlans

- First Creek (Upper) Major Drainageway Plan
- East Toll Gate Creek (Upstream of Hampden Avenue) Major Drainageway Plan

Order Now!!

But wait…

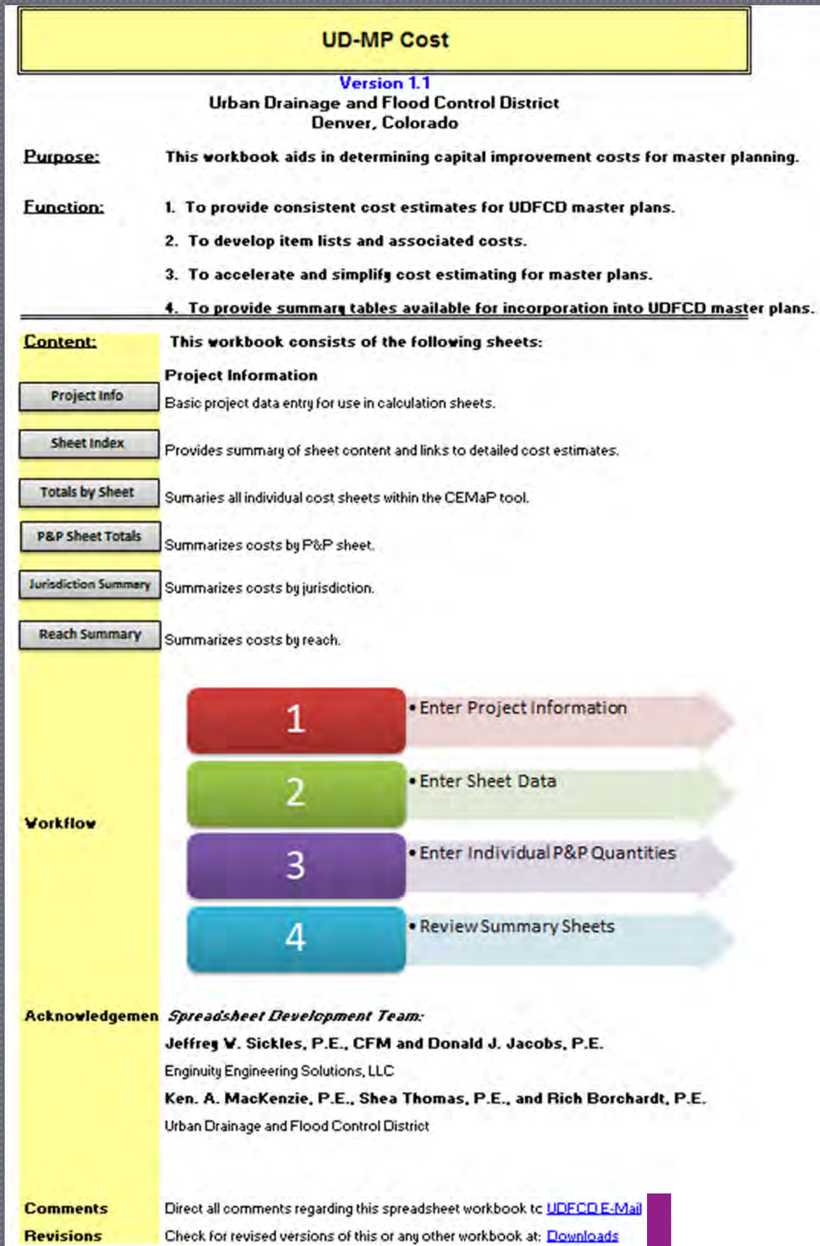

courier bestseller's
PLAYING
READING
SKETCHING
PUBLISHING
WRITING
Confessions of a Catholic Schoolgirl
by Michelle Kane
This is where a brief comment about the book would go.
Everest is Hollow
by Indigo Jones
This is where a brief comment about the book would go.
Battery Acid Kiss
by Mike Benson
This is where a brief comment about the book would go.
I'll Take You There
by Joyce Carol Oates
This is where a brief comment about the book would go.
More >
WEB
SAMPLE: EVEREST IS HOLLOW
Everest is Hollow
Chapter 1
BUY
TRY
engadget

UD-MP Cost

Reasons for developing tool:

- To provide consistent cost estimates for UDFCD master plans
- To develop item lists and associated costs
- To accelerate and simplify cost estimating for master plans
- To provide summary tables for incorporation into UDFCD master plans

Intro



UD-MP Cost

Version 1.1
Urban Drainage and Flood Control District
Denver, Colorado

Purpose: This workbook aids in determining capital improvement costs for master planning.

Function:
1. To provide consistent cost estimates for UDFCD master plans.
2. To develop item lists and associated costs.
3. To accelerate and simplify cost estimating for master plans.
4. To provide summary tables available for incorporation into UDFCD master plans.

Content: This workbook consists of the following sheets:

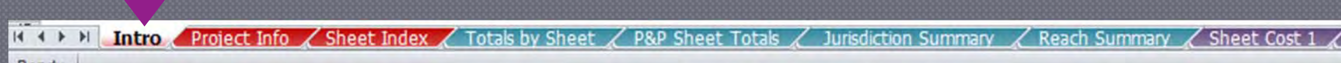
Project Information

Project Info	Basic project data entry for use in calculation sheets.
Sheet Index	Provides summary of sheet content and links to detailed cost estimates.
Totals by Sheet	Sumaries all individual cost sheets within the CEMaP tool.
P&P Sheet Totals	Summarizes costs by P&P sheet.
Jurisdiction Summary	Summarizes costs by jurisdiction.
Reach Summary	Summarizes costs by reach.

Workflow

Acknowledgemen *Spreadsheet Development Team:*
Jeffrey V. Sickles, P.E., CFM and Donald J. Jacobs, P.E.
Enginuity Engineering Solutions, LLC
Ken. A. MacKenzie, P.E., Shea Thomas, P.E., and Rich Borchardt, P.E.
Urban Drainage and Flood Control District

Comments Direct all comments regarding this spreadsheet workbook tc UDFCD E-Mail
Revisions Check for revised versions of this or any other workbook at: Downloads



Project Info

Project Info

Return to Intro

Project Name :	Dutch Creek - Phase B
Estimator :	S. Thomas
Date :	4/25/2011

Project Drainageways :

Drainageway Name	Length (mi)	No. of Reaches
Dutch Creek	0.95 mi	10
Coon Creek	0.00 mi	6
Lilley Creek	0.00 mi	3
	0.00 mi	
	0.00 mi	
	0.00 mi	
	0.00 mi	
	0.00 mi	
	0.00 mi	
	0.00 mi	
Totals :	0.95 mi	19

Jurisdictions/Sponsors :

Jurisdiction
Jefferson County
Arapahoe County
Denver

Unit Cost Index Year :	2009
Current Year :	2011
Years Since Index Year :	2
Annual Inflation Index :	3.00%

Intro | Project Info | Sheet Index | Totals by Sheet | P&P Sheet Totals | Jurisdiction Summary | Reach Summary | Sheet Cost 1

Ready

Blue requires input

Green calculates or pulls from elsewhere

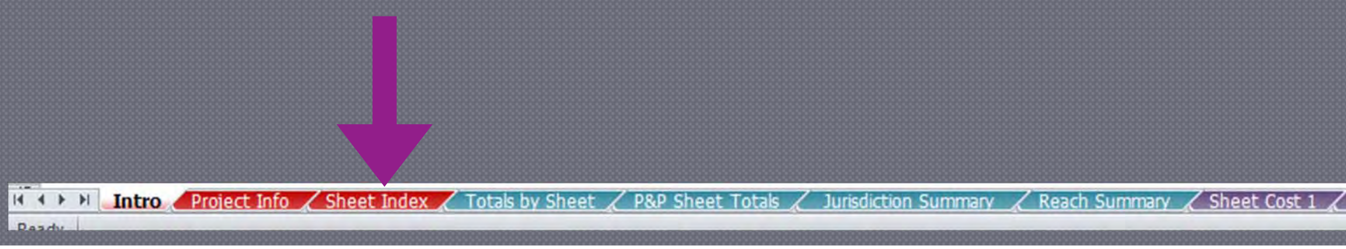
Sheet Index

Sheet Index

Project Name : Dutch Creek – Phase B
Estimator : S. Thomas
Date : 4/25/2011

Sheets :

Cost Sheet Number	P&P Sheet Number	Reach Number	Drainageway Name	Jurisdiction	Downstream Station	Upstream Station	Length
1	1	Reach 1	Dutch Creek	Arapahoe County	000+00	050+00	5000 ft
2							0 ft
3							0 ft
4							0 ft
5							0 ft
6							0 ft
7							0 ft
8							0 ft
9							0 ft
10							0 ft
11							0 ft
12							0 ft
13							0 ft
14							0 ft
15							0 ft
16							0 ft
17							0 ft
18							0 ft
19							0 ft
20							0 ft
21							0 ft
22							0 ft
23							0 ft
24							0 ft
25							0 ft



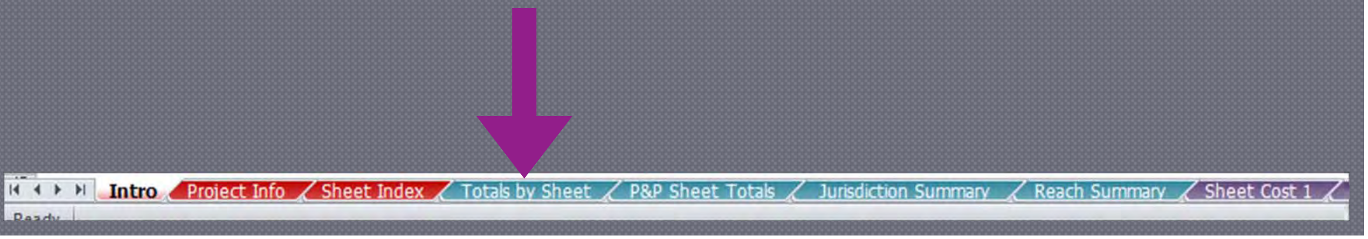
Totals by Sheet

SUMMARY ALL COST SHEETS

Project Name : Dutch Creek - Phase B
Estimator : S. Thomas
Date : 4/25/2011

Return to Intro

COST SHEET	P&P SHEET	REACH	JURISDICTION	CAPITAL	EASEMENT/ROW	ENGINEERING	LEGAL/ADMINISTRATIVE	CONTRACT ADMIN/CM	CONTINGENCY	SHEET COST
1	1	1	Arapahoe County	$4,770,199	$147,500	$715,530	$238,510	$477,020	$1,229,425	$7,578,183
2	0	0	0	$0	$0	$0	$0	$0	$0	$0
3	0	0	0	$0	$0	$0	$0	$0	$0	$0
4	0	0	0	$0	$0	$0	$0	$0	$0	$0
5	0	0	0	$0	$0	$0	$0	$0	$0	$0
6	0	0	0	$0	$0	$0	$0	$0	$0	$0
7	0	0	0	$0	$0	$0	$0	$0	$0	$0
8	0	0	0	$0	$0	$0	$0	$0	$0	$0
9	0	0	0	$0	$0	$0	$0	$0	$0	$0
10	0	0	0	$0	$0	$0	$0	$0	$0	$0
11	0	0	0	$0	$0	$0	$0	$0	$0	$0
12	0	0	0	$0	$0	$0	$0	$0	$0	$0
13	0	0	0	$0	$0	$0	$0	$0	$0	$0
14	0	0	0	$0	$0	$0	$0	$0	$0	$0
15	0	0	0	$0	$0	$0	$0	$0	$0	$0
16	0	0	0	$0	$0	$0	$0	$0	$0	$0
17	0	0	0	$0	$0	$0	$0	$0	$0	$0
18	0	0	0	$0	$0	$0	$0	$0	$0	$0
19	0	0	0	$0	$0	$0	$0	$0	$0	$0
20	0	0	0	$0	$0	$0	$0	$0	$0	$0
21	0	0	0	$0	$0	$0	$0	$0	$0	$0
22	0	0	0	$0	$0	$0	$0	$0	$0	$0
23	0	0	0	$0	$0	$0	$0	$0	$0	$0
24	0	0	0	$0	$0	$0	$0	$0	$0	$0
25	0	0	0	$0	$0	$0	$0	$0	$0	$0
26	0	0	0	$0	$0	$0	$0	$0	$0	$0



P&P Sheet Totals

SUMMARY BY PLAN AND PROFILE SHEET

Project Name : Dutch Creek - Phase B
Estimator : S. Thomas
Date : 4/25/2011

Return to Intro

P&P SHEET	CAPITAL	EASEMENT/ROW	ENGINEERING	LEGAL/ADMINISTRATIVE	CONTRACT ADMIN/CM	CONTINGENCY	SHEET COST
1	$4,770,199	$147,500	$715,530	$238,510	$477,020	$1,229,425	$7,578,183
2	$0	$0	$0	$0	$0	$0	$0
3	$0	$0	$0	$0	$0	$0	$0
4	$0	$0	$0	$0	$0	$0	$0
5	$0	$0	$0	$0	$0	$0	$0
6	$0	$0	$0	$0	$0	$0	$0
7	$0	$0	$0	$0	$0	$0	$0
8	$0	$0	$0	$0	$0	$0	$0
9	$0	$0	$0	$0	$0	$0	$0
10	$0	$0	$0	$0	$0	$0	$0
11	$0	$0	$0	$0	$0	$0	$0
12	$0	$0	$0	$0	$0	$0	$0
13	$0	$0	$0	$0	$0	$0	$0
14	$0	$0	$0	$0	$0	$0	$0
15	$0	$0	$0	$0	$0	$0	$0
16	$0	$0	$0	$0	$0	$0	$0
17	$0	$0	$0	$0	$0	$0	$0
18	$0	$0	$0	$0	$0	$0	$0
19	$0	$0	$0	$0	$0	$0	$0
20	$0	$0	$0	$0	$0	$0	$0
21	$0	$0	$0	$0	$0	$0	$0
22	$0	$0	$0	$0	$0	$0	$0
23	$0	$0	$0	$0	$0	$0	$0

Intro | Project Info | Sheet Index | Totals by Sheet | P&P Sheet Totals | Jurisdiction Summary | Reach Summary | Sheet Cost 1

Jurisdiction Summary

SUMMARY BY JURISDICTION

Project Name : Dutch Creek - Phase B
Estimator : S. Thomas
Date : 4/25/2011

Return to Intro

JURISDICTION	CAPITAL	EASEMENT/ROW	ENGINEERING	LEGAL/ADMINISTRATIVE	CONTRACT ADMIN/CM	CONTINGENCY	TOTAL
Jefferson County	$0	$0	$0	$0	$0	$0	$0
Arapahoe County	$4,770,199	$147,500	$715,530	$238,510	$477,020	$1,229,425	$7,578,183
Denver	$0	$0	$0	$0	$0	$0	$0
0	$0	$0	$0	$0	$0	$0	$0
0	$0	$0	$0	$0	$0	$0	$0
0	$0	$0	$0	$0	$0	$0	$0
0	$0	$0	$0	$0	$0	$0	$0
0	$0	$0	$0	$0	$0	$0	$0
0	$0	$0	$0	$0	$0	$0	$0
0	$0	$0	$0	$0	$0	$0	$0
Totals	**$4,770,199**	**$147,500**	**$715,530**	**$238,510**	**$477,020**	**$1,229,425**	**$7,578,183**

Intro | Project Info | Sheet Index | Totals by Sheet | P&P Sheet Totals | Jurisdiction Summary | Reach Summary | Sheet Cost 1

Reach Summary

SUMMARY BY REACH

Project Name : Dutch Creek - Phase B
Estimator : S. Thomas
Data : 4/25/2011

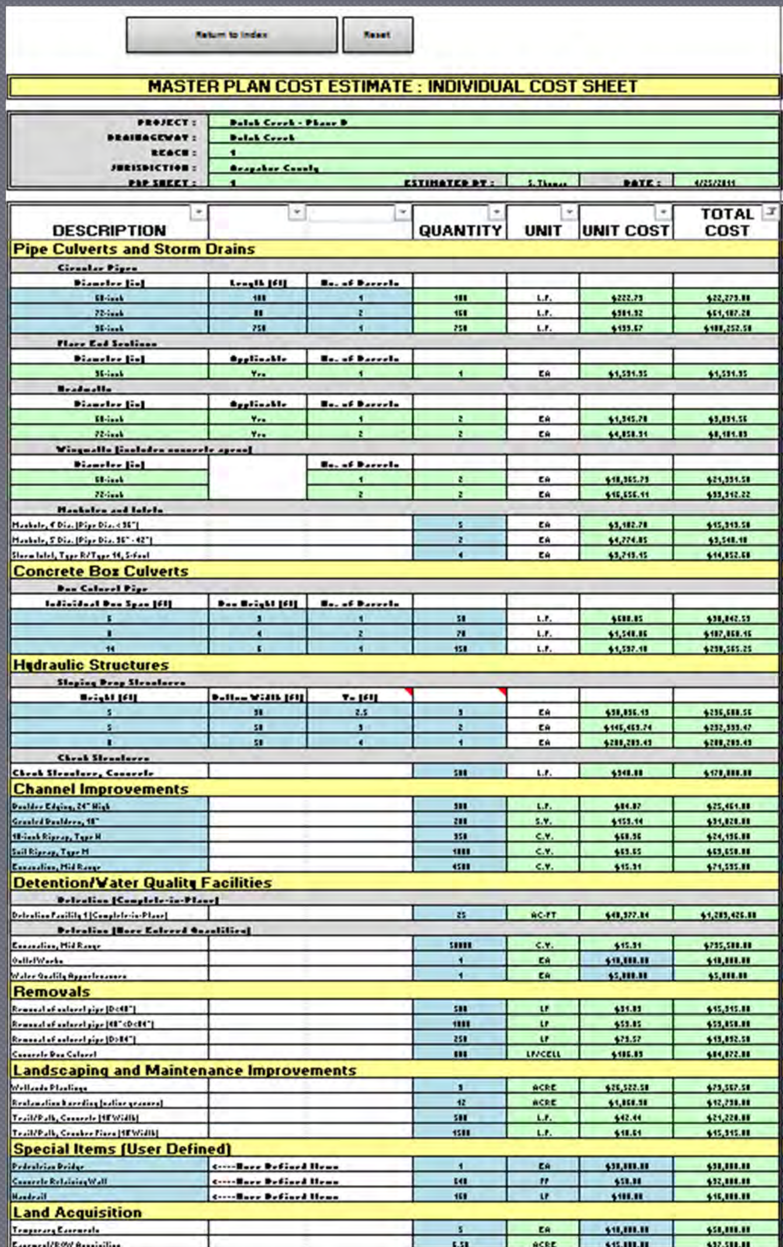
Return to Intro

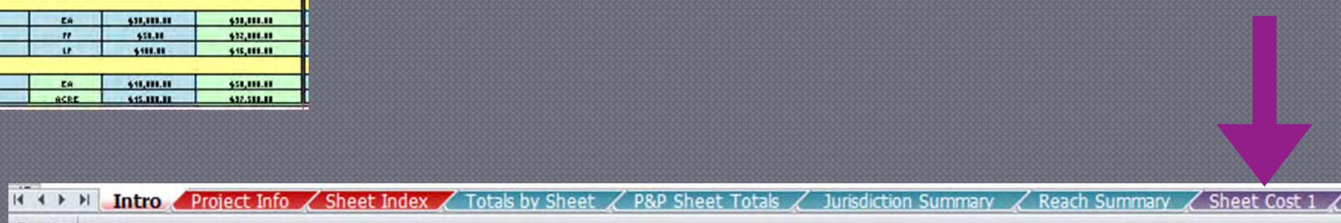
REACH	CAPITAL	EASEMENT/ROW	ENGINEERING	LEGAL/ADMINISTRATIVE	CONTRACT ADMIN/CM	CONTINGENCY	REACH COST
1	$4,770,199.01	$147,500.00	$715,529.85	$238,509.95	$477,019.90	$1,229,424.75	$7,578,183.46
2	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
3	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
4	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
5	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
6	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
7	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
8	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
9	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
10	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
11	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
12	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
13	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
14	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
15	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
16	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
17	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
18	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
19	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
20	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
21	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
22	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
23	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
24	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
25	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
26	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
27	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
28	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
29	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
30	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Totals	**$4,770,199**	**$147,500**	**$715,530**	**$238,510**	**$477,020**	**$1,229,42**	**$7,578,183**

Intro | Project Info | Sheet Index | Totals by Sheet | P&P Sheet Totals | Jurisdiction Summary | Reach Summary | Sheet Cost 1

Ready

Sheet Cost


Return to Index
Reset
MASTER PLAN COST ESTIMATE : INDIVIDUAL COST SHEET
PROJECT :
DRAINAGEWAY :
REACH :
JURISDICTION :
P&P SHEET :
ESTIMATED BY :
DATE :
DESCRIPTION
QUANTITY
UNIT
UNIT COST
TOTAL COST
Pipe Culverts and Storm Drains
Concrete Box Culverts
Hydraulic Structures
Channel Improvements
Detention/Water Quality Facilities
Removals
Landscaping and Maintenance Improvements
Special Items (User Defined)
Land Acquisition


Intro
Project Info
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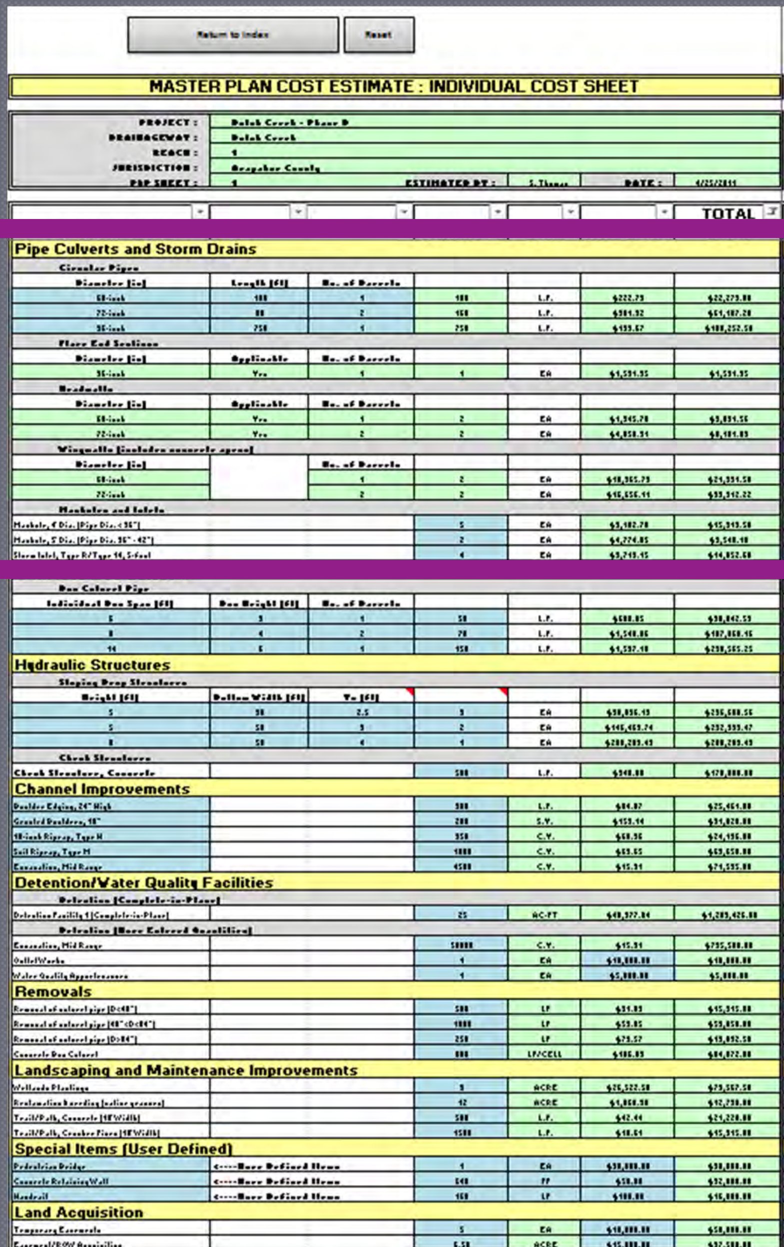
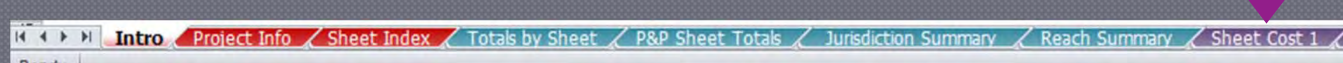
Jurisdiction Summary
Reach Summary
Sheet Cost 1
Ready

Pipe Culverts and Storm Drains





Pipe Culverts and Storm Drains

Diameter (in)
60-inch
72-inch

72-inch
78-inch
84-inch
90-inch
96-inch
102-inch
108-inch
120-inch

U/S FES	D/S FES
Yes	

Yes
No

Length (ft)	No. of Barrels

Entering Pipe Length
User must enter the length of the pipe section from upstream to downstream. Do not enter total linear feet of pipe for multiple barrels.

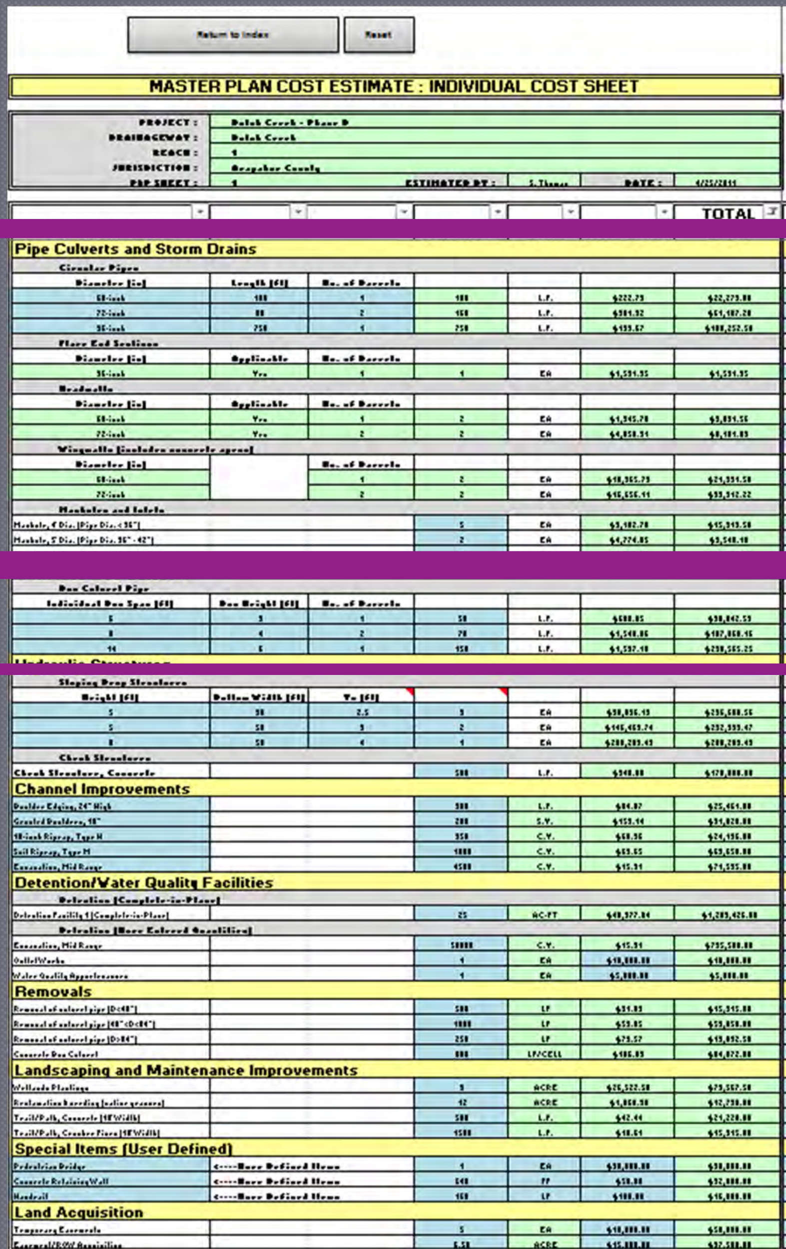
Barrels	U/S Headwall
0	No
0	

Yes
No

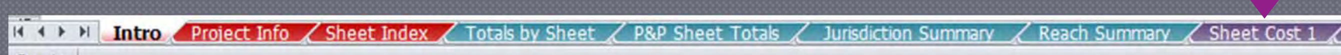
DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST
Pipe Culverts and Storm Drains						
Circular Pipes						
Diameter (in)	**Length (ft)**	**No. of Barrels**				
60-inch	100	1	100	L.F.	$222.79	$22,279.00
72-inch	80	2	160	L.F.	$381.92	$61,107.20
36-inch	750	1	750	L.F.	$133.67	$100,252.50
Flare End Sections						
Diameter (in)	**Applicable**	**No. of Barrels**				
36-inch	Yes	1	1	EA	$1,591.35	$1,591.35
Headwalls						
Diameter (in)	**Applicable**	**No. of Barrels**				
60-inch	Yes	1	2	EA	$1,945.78	$3,891.56
72-inch	Yes	2	2	EA	$4,050.91	$8,101.83
Wingwalls (includes concrete apron)						
Diameter (in)		**No. of Barrels**				
60-inch		1	2	EA	$10,965.79	$21,931.58
72-inch		2	2	EA	$16,656.11	$33,312.22
Manholes and Inlets						
Manhole, 4' Dia. (Pipe Dia. < 36")			5	EA	$3,182.70	$15,913.50
Manhole, 5' Dia. (Pipe Dia. 36" - 42")			2	EA	$4,774.05	$9,548.10
Storm Inlet, Type R/Type 14, 5-foot			4	EA	$3,713.15	$14,852.60

Intro / Project Info / Sheet Index / Totals by Sheet / P&P Sheet Totals / Jurisdiction Summary / Reach Summary / Sheet Cost 1 / Sheet Cost 2 / Sheet Cost 3 / Sheet Co

Inlet Quantity Input
For 10-foot length enter quantity of 2; For 15-foot length enter quantity of 3; etc.



Concrete Box Culverts



Concrete Box Culverts

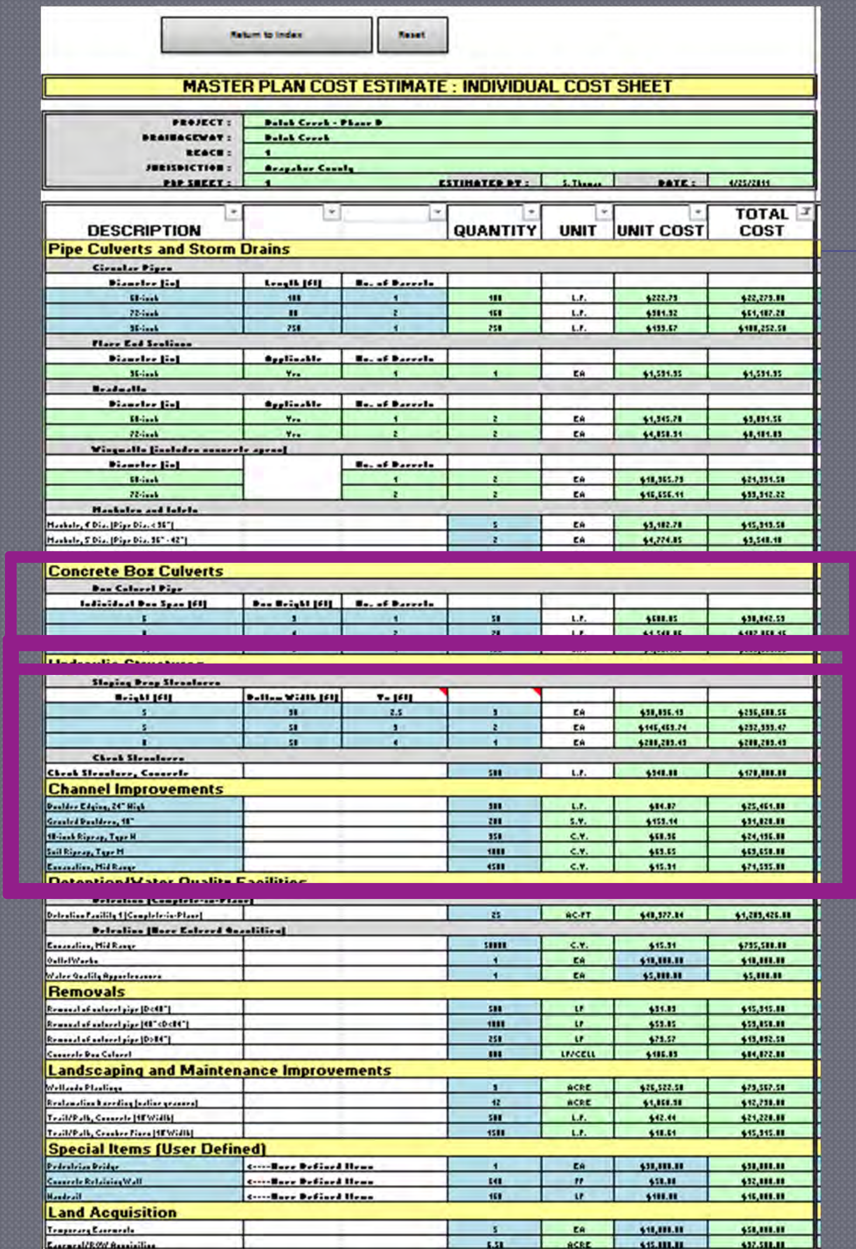
Table 3 : Available Box Culvert Sizes									
Span (feet)	Rise (feet)								
	2	3	4	5	6	7	8	9	10
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

Box Culvert Pipe	
Individual Box Span (ft)	Bo
4	
5	
6	
7	
8	
9	
10	
11	

Steel (lbs)	U/S Headwall	D/S Headwall
0.00	Yes	Yes
0.00		
	Yes	
	No	
0.00		

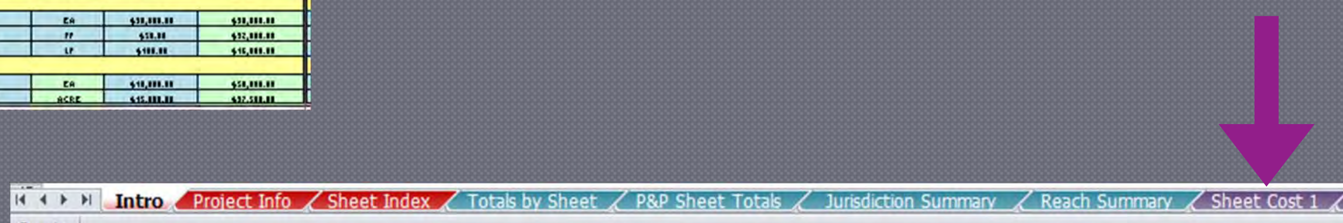
Concrete Box Culverts

Box Culvert Pipe										
Individual Box Span (ft)	**Box Height (ft)**	**No. of Barrels**								
6	3	1					50	L.F.	$566.20	$28,310.00
8	4	2					70	L.F.	$1,452.00	$101,640.00
14	6	1					150	L.F.	$1,448.40	$217,260.00
								L.F.	$0.00	$0.00
								L.F.	$0.00	$0.00
								L.F.	$0.00	$0.00
								L.F.	$0.00	$0.00
								L.F.	$0.00	$0.00
								L.F.	$0.00	$0.00
								L.F.	$0.00	$0.00
Headwall and Toewalls										
Individual Box Span (ft)	**No. of Barrels**	**Span (ft)**	**Concrete (C.Y.)**	**Steel (lbs)**	**U/S Headwall**	**D/S Headwall**				
6	1	8.00	0.68	176.80	Yes	Yes	2	EA	$617.44	$1,234.88
8	2	19.00	1.62	741.00	Yes	Yes	2	EA	$1,723.30	$3,446.60
14	1	16.00	1.36	544.00	Yes	Yes	2	EA	$1,387.20	$2,774.40
	0	0.00	0.00	0.00			0	EA	$0.00	$0.00
	0	0.00	0.00	0.00			0	EA	$0.00	$0.00
	0	0.00	0.00	0.00			0	EA	$0.00	$0.00
	0	0.00	0.00	0.00			0	EA	$0.00	$0.00
	0	0.00	0.00	0.00			0	EA	$0.00	$0.00
	0	0.00	0.00	0.00			0	EA	$0.00	$0.00
	0	0.00	0.00	0.00			0	EA	$0.00	$0.00
Wingwalls (includes wingwalls on either side of channel and concrete apron)										
Individual Box Span (ft)	**Box Rise (ft)**	**No. of Barrels**	**Total Interior Span (ft)**	**Length (ft)**	**Concrete (C.Y.)**	**Steel (lbs)**				
6	3	1	6.00	13	7.72	397.85	2	EA	$5,724.45	$11,448.89
8	4	2	17.00	14	12.79	624.78	2	EA	$9,451.14	$18,902.29
14	6	1	14.00	18	19.30	863.50	2	EA	$14,197.67	$28,395.33
0	0	0	-	0	-	-	0	EA	$0.00	$0.00
0	0	0	-	0	-	-	0	EA	$0.00	$0.00
0	0	0	-	0	-	-	0	EA	$0.00	$0.00
0	0	0	-	0	-	-	0	EA	$0.00	$0.00
0	0	0	-	0	-	-	0	EA	$0.00	$0.00
0	0	0	-	0	-	-	0	EA	$0.00	$0.00
0	0	0	-	0	-	-	0	EA	$0.00	$0.00



Hydraulic Structures

Channel Improvements



Yn (ft)
2.5
3
4

Input normal depth at upstream end of drop structure.

Hydraulic Structures

Hydraulic Structures

Sloping Drop Structures

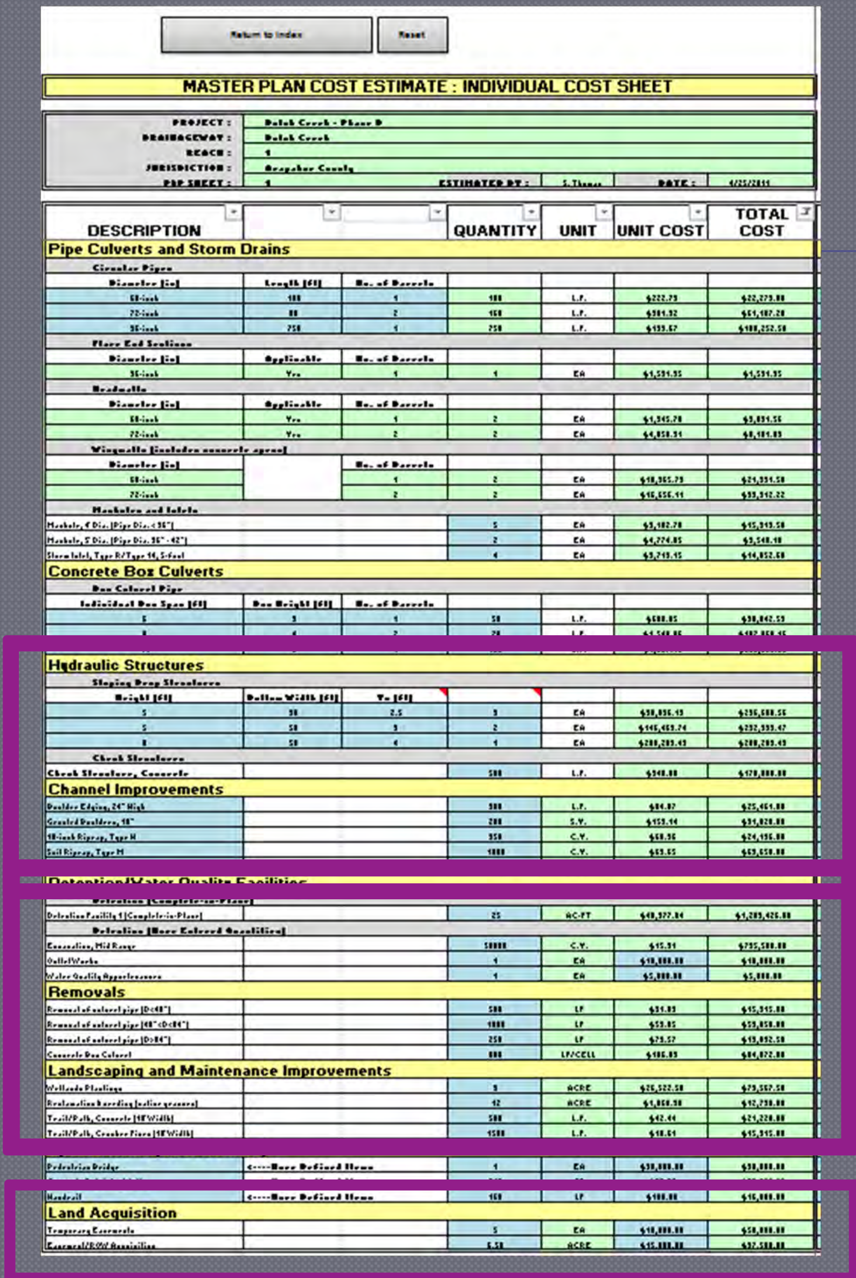
Height (ft)	Bottom Width (ft)	Yn (ft)		La (ft)	Hard Basin Length (ft)	Total Width (ft)				
5	30	2.5		5.00	56.00	50.00	3	EA	$93,217.72	$279,653.16
5	50	3		5.00	56.00	74.00	2	EA	$138,059.67	$276,119.34
8	50	4		8.00	71.00	82.00	1	EA	$196,254.37	$196,254.37
				5.00	0.00	0.00		EA	$0.00	$0.00
				5.00	0.00	0.00		EA	$0.00	$0.00
				5.00	0.00	0.00		EA	$0.00	$0.00
				5.00	0.00	0.00		EA	$0.00	$0.00
				5.00	0.00	0.00		EA	$0.00	$0.00
				5.00	0.00	0.00		EA	$0.00	$0.00
				5.00	0.00	0.00		EA	$0.00	$0.00
Check Structures										
Check Structure, Concrete							500	L.F.	$340.00	$170,000.00

- Boulder Edging, 36" High
- Concrete Low Flow Channel
- Grouted Boulders, 12"
- Grouted Boulders, 18"
- Grouted Boulders, 24"
- Grouted Boulders, 36"
- Grouted Boulders, 48"
- 6-inch Riprap, Type VL

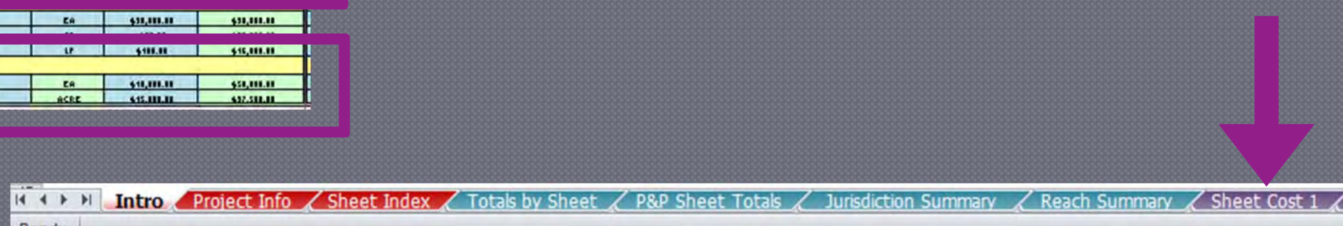
Channel Improvements

Channel Improvements

Boulder Edging, 24" High	300	L.F.	$80.00	$24,000.00
Grouted Boulders, 18"	200	S.Y.	$150.00	$30,000.00
18-inch Riprap, Type H	350	C.Y.	$65.00	$22,750.00
Soil Riprap, Type M	1000	C.Y.	$60.00	$60,000.00
Excavation, Mid Range	4500	C.Y.	$15.00	$67,500.00
				$0.00
				$0.00
				$0.00
				$0.00
				$0.00
				$0.00
				$0.00
				$0.00



- Detention/WQ
- Removals
- Landscaping
- Land Acquisition



Detention/WQ Facilities

Detention/Water Quality Facilities					
Detention (Complete-in-Place)					
Detention Facility 1 (Complete-in-Place)		25	AC-FT	$45,600.00	$1,140,000.00
Detention Facility 2 (Complete-in-Place)			AC-FT	$45,600.00	$0.00
Detention Facility 3 (Complete-in-Place)			AC-FT	$45,600.00	$0.00
Detention (User Entered Quantities)					
Excavation, Low Range			C.Y.	$12.00	$0.00
Excavation, Mid Range		50000	C.Y.	$15.00	$750,000.00
Excavation, High Range			C.Y.	$25.00	$0.00
Outlet Works	**User Defined Unit Cost ---->**	1	EA	$10,000.00	$10,000.00
Water Quality Appurtenances	**User Defined Unit Cost ---->**	1	EA	$5,000.00	$5,000.00

Removals

Removals					
Removal of culvert pipe (D<48")		500	LF	$30.00	$15,000.00
Removal of culvert pipe (48"<D<84")		1000	LF	$50.00	$50,000.00
Removal of culvert pipe (D>84")		250	LF	$75.00	$18,750.00
Concrete Box Culvert		800	LF/CELL	$100.00	$80,000.00

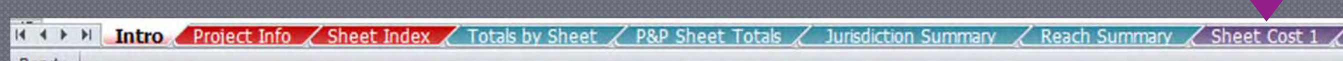
Landscaping/Maintenance

Landscaping and Maintenance Improvements					
Wetlands Plantings		3	ACRE	$25,000.00	$75,000.00
Reclamation & seeding (native grasses)		12	ACRE	$1,000.00	$12,000.00
Trail/Path, Concrete (10' Width)		500	L.F.	$40.00	$20,000.00
Trail/Path, Crusher Fines (10' Width)		1500	L.F.	$10.00	$15,000.00

Land Acquistion

Land Acquisition					
Temporary Easements		5	EA	$10,000.00	$50,000.00
Easement/ROW Acquisition		6.50	ACRE	$15,000.00	$97,500.00

Special Items



Special Items (User Defined)

Special Items (User Defined)						
Pedestrian Bridge	<----User Defined Items	User Defined Unit Cost ---->	1	EA	$30,000.00	$30,000.00
Concrete Retaining Wall	<----User Defined Items	User Defined Unit Cost ---->	640	FF	$50.00	$32,000.00
Handrail	<----User Defined Items	User Defined Unit Cost ---->	160	LF	$100.00	$16,000.00
	<----User Defined Items	User Defined Unit Cost ---->				$0.00
	<----User Defined Items	User Defined Unit Cost ---->				$0.00
	<----User Defined Items	User Defined Unit Cost ---->				$0.00
	<----User Defined Items	User Defined Unit Cost ---->				$0.00
	<----User Defined Items	User Defined Unit Cost ---->				$0.00
	<----User Defined Items	User Defined Unit Cost ---->				$0.00
	<----User Defined Items	User Defined Unit Cost ---->				$0.00

Additional Capital Costs

Additional Capital Construction Costs				
Dewatering	User Defined Lump Sum Cost ---->	$10,000.00	L.S.	$10,000.00
Mobilization		5%		$202,619.78
Traffic Control	User Defined Lump Sum Cost ---->	$25,000.00	L.S.	$25,000.00
Utility Coordination/Relocation	User Defined Lump Sum Cost ---->	$5,000.00	L.S.	$5,000.00
Stormwater Management/Erosion Control		5%		$202,619.78

Other Costs (percentage of Capital Improvement Costs)		
Engineering	15%	$674,645.26
Legal/Administrative	5%	$224,881.75
Contract Admin/Construction Management	10%	$449,763.51
Contingency	25%	$1,161,283.77

Cost Data

Item	Unit	Unit Cost 2009	Unit Cost Current Yr.
Circular Pipes			
12-inch	L.F.	$42.00	$42.00
18-inch	L.F.	$63.00	$63.00
24-inch	L.F.	$84.00	$84.00
30-inch	L.F.	$105.00	$105.00
36-inch	L.F.	$126.00	$126.00
42-inch	L.F.	$147.00	$147.00
48-inch	L.F.	$168.00	$168.00
54-inch	L.F.	$189.00	$189.00
60-inch	L.F.	$210.00	$210.00
66-inch	L.F.	$231.00	$231.00
72-inch	L.F.	$360.00	$360.00
78-inch	L.F.	$390.00	$390.00
84-inch	L.F.	$420.00	$420.00
90-inch	L.F.	$450.00	$450.00
96-inch	L.F.	$480.00	$480.00
102-inch	L.F.	$714.00	$714.00
108-inch	L.F.	$756.00	$756.00
120-inch	L.F.	$840.00	$840.00
Flared End Sections			
12-inch	EA	$650.00	$650.00
18-inch	EA	$750.00	$750.00
24-inch	EA	$850.00	$850.00
30-inch	EA	$1,050.00	$1,050.00
36-inch	EA	$1,500.00	$1,500.00
42-inch	EA	$1,950.00	$1,950.00
48-inch	EA	$2,000.00	$2,000.00
Manholes and Inlets			
Manhole, 4' Dia. (Pipe Dia. < 36"), Depth > 15-feet)	EA	$3,000.00	$3,000.00
Manhole, 5' Dia. (Pipe Dia. 36" - 42"), Depth > 15-feet)	EA	$4,500.00	$4,500.00
Manhole, 6' Dia. (Pipe Dia. , Depth > 15-feet)	EA	$5,250.00	$5,250.00
Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees)	EA	$10,000.00	$10,000.00
Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees)	EA	$15,000.00	$15,000.00
Storm Inlet, Type R/Type 14, 5-foot, 10-foot deep avg.	EA	$3,500.00	$3,500.00
Headwalls for Circular Pipes			
See Headwall Table			
Wingwalls for Circular Pipes			
See Wingwall Table			
Hydraulic Structures			
Grouted Boulders, 36-inch	C.Y.	$250.00	$250.00
Riprap, Type M	C.Y.	$60.00	$60.00
Soil Riprap, Type M	C.Y.	$65.00	$65.00
Excavation, Complete-in-Place	C.Y.	$12.00	$12.00
Bedding, Granular Type II	C.Y.	$50.00	$50.00
Grout	C.Y.	$275.00	$275.00
Check Structure, Concrete	L.F.	$220.00	$340.00

Cost Data

Sheet Cost 54 | Sheet Cost 55 | Sheet Cost 56 | Sheet Cost 57 | Sheet Cost 58 | Sheet Cost 59 | Sheet Cost 60 | Cost Data

Intro | Cost Index | UD-COST | Cost Data

LITE Version

UDFCD COST ESTIMATOR FOR MASTER PLANNING - LITE

LITE Version 1.1

Urban Drainage and Flood Control District

Denver, Colorado

Purpose: This workbook aids in determining capital improvement costs for master planning.

Function:

1. To provide consistent cost estimates for UDFCD master plans.
2. To develop item lists and associated costs.
3. To accelerate and simplify cost estimating for master plans.

Acknowledgements: ***Spreadsheet Development Team:***

Jeffrey W. Sickles, P.E., CFM and Donald J. Jacobs, P.E.

Enginuity Engineering Solutions, LLC

Ken. A. MacKenzie, P.E., Shea Thomas, P.E., and Rich Borchardt, P.E.

Urban Drainage and Flood Control District

Comments Direct all comments regarding this spreadsheet workbook to: UDFCD E-Mail

Revisions Check for revised versions of this or any other workbook at: Downloads

Summary Table in Report

3.8 Cost Estimator Tables

UDFCD has developed Cost Estimator Excel spreadsheets to assist consultants in developing budgetary cost estimates for the EPlan conceptual design improvements. The spreadsheets simplify the estimating process by standardizing the information required and the manner in which it is presented. The most updated version of the Cost Estimator spreadsheet should be obtained from UDFCD to ensure that the unit prices are up-to-date.

Each reach must have a detailed cost estimate comple
Cost Estimator. The following are brief instructions to ir
tables into the EPlan text. Consult the Cost Estimator help
information.

1. Fill out a Sheet Cost tab for each Reach.
2. Click on the Filter Summary Sheet button.
3. Copy the resulting table to the reach description ir

8.4.2 First Creek (Upper) Reach F2: 56th Avenue to Tower Road

Engineered Trapezoidal Channel

Reach F2 of First Creek (Upper) is between stations 60+70 to 82+40 and is within the City and County of Denver. The downstream reach limit is located at 56th Avenue and the upstream limit is located at Tower Road.

Structures

There are three road crossings and associated structures within this reach. The existing 56th Avenue Eastbound and Westbound Bridges share a peak flow of 4,160 cfs and have adequate capacity to convey the 100-year event. The existing Tower Road dual Conspan Bridge has a 100-year Conceptual Design peak flow of 5,220 cfs, and has adequate capacity to convey the 100-year event.

Existing Channel

The existing channel is 2,170 feet long and has a well-defined low flow channel with dense vegetation. The existing slope is 0.54%. The average 100-year DFHAD floodplain is extremely wide at 1,379 feet and contains a significant flow split. Due to this extremely wide 100-year floodplain upstream of 56th Avenue and because 56th Avenue's lowest point is west of the bridges, the floodplain overtops 56th Avenue on the west side of the floodplain.

Proposed Channel

The approach to Reach F2 has also changed during the Conceptual Design Phase to accommodate for planned pedestrian below-grade crossings under the Tower Road Bridge and 56th Avenue. The below-grade crossing elevations require the invert of the channel to be dropped approximately three feet. When the Tower Road Bridge was constructed, the channel downstream was not lowered to provide positive slope which is causing severe ponding issues around the bridge. To address the ponding issues, this Conceptual Design is recommending an engineered trapezoidal channel to create drainage from the bridge and per the request of the City and County of Denver. The engineered trapezoidal channel will be cut into the existing channel to allow for lowering of the invert. The top width of the channel including one-foot of freeboard is 223 feet, the top width of the low flow channel is 79 feet, and the combined depth is 7.5 feet. The engineered trapezoidal channel will be grass lined and will contain the 100-year event. Please note that Reach F2 channel improvements work in conjunction with improvements on Reach F1 to eliminate overtopping of 56th Avenue. Due to the natural topography, the area west of the defined trapezoidal channel is below the 100-year flood elevation and is separated by an uncertified levee. The western area has the potential to be breached and is therefore still within a flood risk zone. Because of this, the land acquisition cost in Table 8.4.2 includes the entire area of the regulatory floodplain. There is one existing check structure just downstream of Tower Road. Additionally, one drop structure is proposed so that if future erosion occurs, both the high flow and low flow channels will stabilize at a slope of 0.35%. Please refer to Typical Section 1 on Figure 8-1 at the end of Section 8.

Detention Facilities

There are no existing or proposed detention facilities within this reach.

Maintenance Trail

A permanent 10 foot wide maintenance trail will be built within the overbanks during trapezoidal channel construction to provide construction and maintenance access. Figure 8-1, Typical Section I, illustrates the maintenance trail incorporation into the channel overbanks.

CLICK HERE TO VIEW REACH F2 MAP
CLICK HERE TO VIEW REACH F2 PROFILE

Table 8.4.2 Reach F2: Denver Cost Estimate

PROJECT :	First Creek (Upper) Major Drainageway Plan: Conceptual Design				
DRAINAGEWAY :	First Creek (Upper)				
REACH :	F2				
STATIONING:	Sta 60+70 to 82+40				
JURISDICTION :	City and County of Denver				
PLAN SHEET :	1	ESTIMATED BY :	AGC	DATE :	7/20/2010

CONSTRUCTION COSTS					
DESCRIPTION		QUANTITY	UNIT	UNIT COST	COST
Channel Improvements					
Excavation, High Range		71000	C.Y.	$25.75	$1,828,250.00
Landscaping and Recreation Improvements					
Reclamation & seeding (native grasses)		11	ACRE	$1,030.00	$11,330.00
Trail/Path, Crusher Fines (10' Width)		2170	FT	$10.30	$22,351.00
Land Acquisition					
Easement/ROW Acquisition		69	ACRE	$87,120.00	$6,011,280.00
Subtotals					
Subtotal Capital Improvement Costs					$1,861,931.00
Subtotal Additional Construction Costs (Dewatering, Mobilization, Traffic Control, Utilities, Stormwater Management)					$316,640.00
Subtotal Land Acquistion					$6,011,280.00
Subtotal Other Costs (Engineering, Legal, Construction Management, & Contingency)					$2,700,879.05
Grand Total					**$10,890,730.05**

ANNUAL OPERATION AND MAINTENANCE COSTS					
DESCRIPTION		QUANTITY	UNIT	UNIT COST	COST
Channel Operations and Maintenance					
Mowing		11	ACRE	$150.00	$1,650.00
Debris Removal		2170	L.F.	$3.00	$6,510.00
Restorative Maintenance and Rehabilitation		0.4	MI	$5,000.00	$2,054.92
Grand Total					**$10,214.92**

User Manual

USER MANUAL

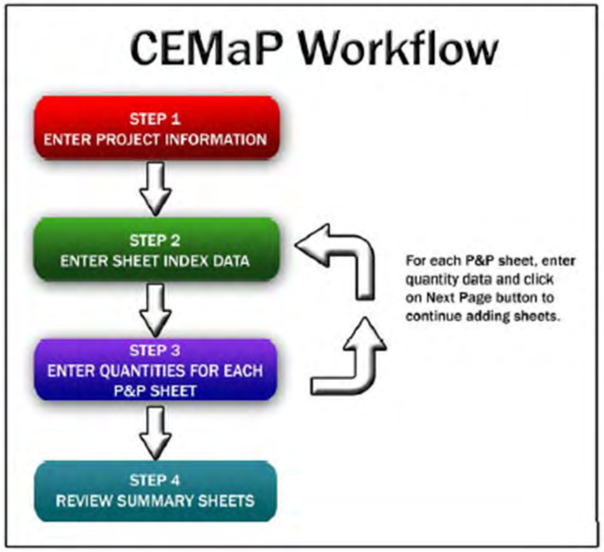
COST ESTIMATOR FOR MASTER PLANNING (UD-MP Cost)

Version 1.1

Urban Drainage and Flood Control District
2480 West 26th Avenue
Suite 156-B
Denver, Colorado 80211

PH : 303.455.6277
FX : 303.455.7880
Email: udfcd.org

December 2010



Step 2 : Enter Sheet Data

Sheet Index

The Sheet Index is meant to capture data regarding each plan and profile sheet including the reach, or reaches, on the sheet, jurisdictions, and upstream and downstream station limits (Note : Station limits are entered in feet – stationing format is handled by Excel formatting options). Station limits are used to calculate a length which then populates the length column on the Project Info tab. Stream stationing is an optional user input item. All of the data entered here is forwarded on to the Individual Cost Worksheets. In addition, hyperlinks are provided in the first column of the Index Sheet to take the user to the quantity/cost portion of the UD-MP Cost tool. Drainageway and Jurisdiction data is handled by pull-down menus populated by the Project Info tab.

USER TIP :

When P&P sheets have more than one reach, user must designate separate cost worksheets for each reach. For example, if P&P Sheet 1 has Reach 1 and Reach 2 within its boundaries, the user will input one row as P&P Sheet 1, Reach Number 1 and another row as P&P Sheet 1, Reach Number 2. Users should plan ahead accordingly when starting a cost estimate.

2.2 Before You Get Started

The UD-COST tool uses some of the advanced functionality of Excel. The user must have this advanced functionality active within the spreadsheet for all of the formulas to calculate correction. In general, if errors are shown in the calculation cells it is likely that the necessary add-ins are not loaded in Excel. To load these, the user must do the following in Excel:

1. Navigate to the "Excel Options" dialogue box. In Windows Office 2007 this can be found by clicking on the "Windows" icon in the upper left portion of Excel and clicking on the "Excel Options" button at the bottom of the dialogue box that appears.
2. Next, click on the "Add-Ins" option on the left side of the dialogue box. In this view you can see what add-ins are currently loaded in to Excel.

Circular Pipes

1. Circular pipes are entered by users selecting a pipe size with the pull-down menu under the Diameter column. Available pipe sizes range from 12-inches to 120-inches. When pipes larger than this are needed, the user should use a box culvert.
2. Once a pipe size is entered, the user must enter a total length of the pipe section.
3. User must enter number of barrel sections along the noted length.

   Example :

   Given : Roadway crossing shown on plan with 3 – 36" culverts with an upstream to downstream length of 100 feet.

   User Entry : Diameter = 36-inch
   Length = 100 ft
   No. of Barrels = 3

   Quantity : 300 lineal feet of 36-inch RCP

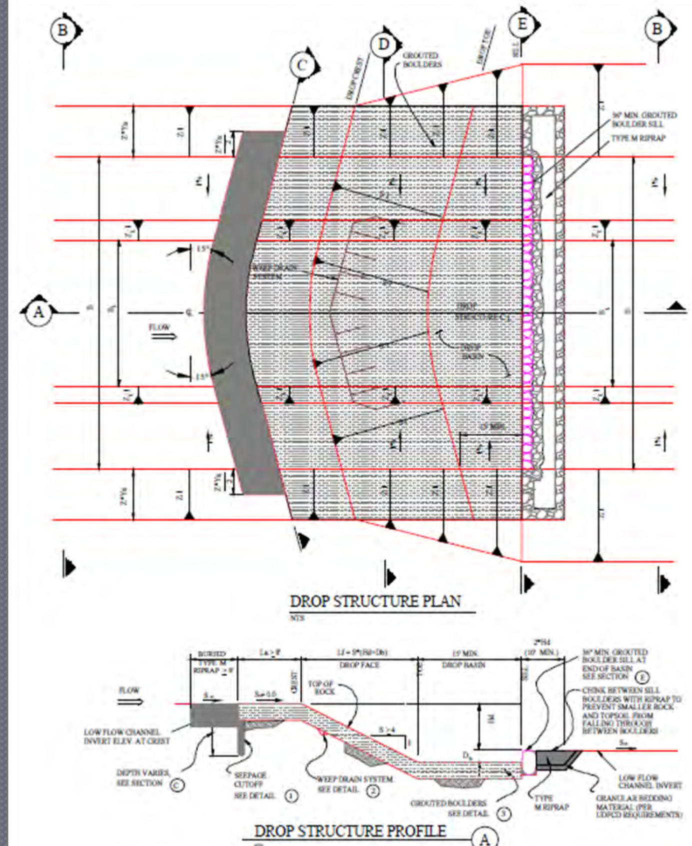


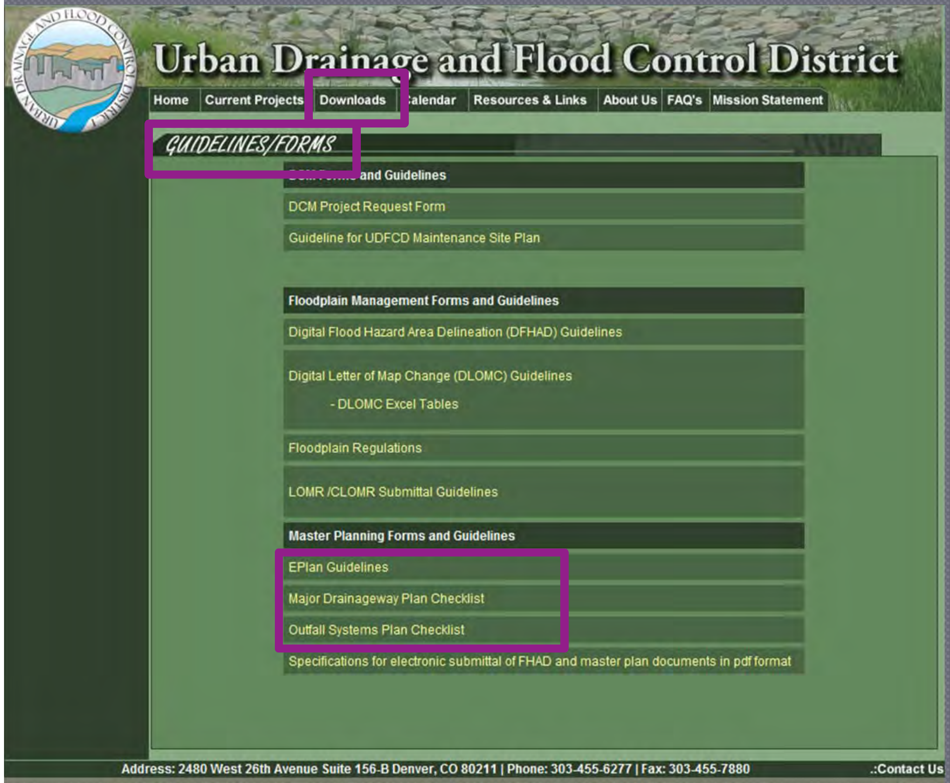
Figure HS-7B—Grouted Sloping Boulder Drop With Low-Flow Channel for Stabilized Channels in Erosion Resistant Soils (Figure 1 of 2)

Does it work?

Cost Comparison of Actual Projects			
Project Name	UD-MP Cost Total	Bid Total	Difference
Sable Detention	$2,271,799	$1,764,758	28% higher
Piney Creek	$1,580,195	$1,496,269	5% higher
Utah Junction	$1,204,052	$1,194,535	1% higher
McIntyre	$1,331,021	$798,730	66% higher

www.udfcd.org

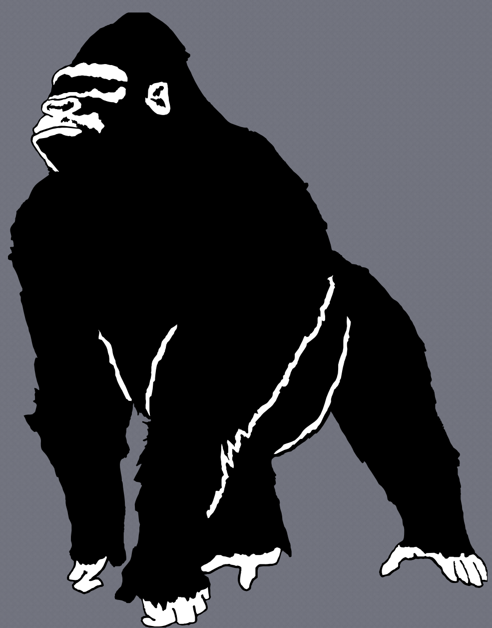
Download Now!!!



2011 Urban Drainage Seminar

DCM Program Update

By David Bennetts
Laura Kroeger
Barbara Chongtoua



DCM Program Update

- General Program Update - David
- Cloud/IPAD - Laura

- Denver SWDP Process - Barbara

DCM Program Update

- Program Changes

  Downsized staff – one less FTE

  Reorganized and shifted responsibilities

DCM Program Update

- EDM Update

  All District Documents

  Floodplain Information

  Routine Maintenance Program

DCM Program Update

- EDM Update – Future Enhancements

  Routine Maintenance –

  Schedule Information

  Linked Inspection Reports

  Generate Pay Quantities

DCM Program Update

- EDM Update – Future Enhancements

  Dam Layer –

  Boundary & Survey Information

  Utility Information

  EPP's

  Inundation Maps

  Monitoring Information

  Inspection Reports

DCM Program Update

- EDM Update – Future Enhancements
  Pond Layer -

    Maintenance Information

    Cost Information

    Maintenance Plans

DCM Program Update

- District Specifications Project

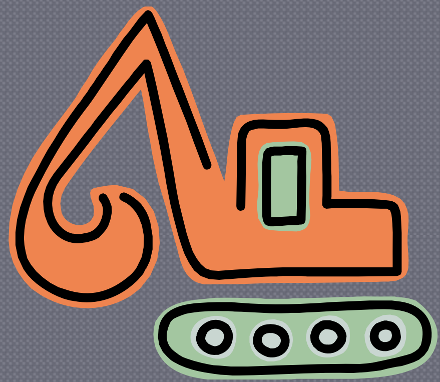
Updating our standard specifications

Put them on the website
in two phases

DCM Program Update

- Demonstration Projects Update

Demonstration Projects



Lead to Criteria Development

DCM Program Update

Void Filled Riprap/Riffle Drops

DCM Program Update

Log Drop Structures

DCM Program Update

GRFC Panel Drops

DCM Program Update

Floating Vegetated Islands

DCM Program Update

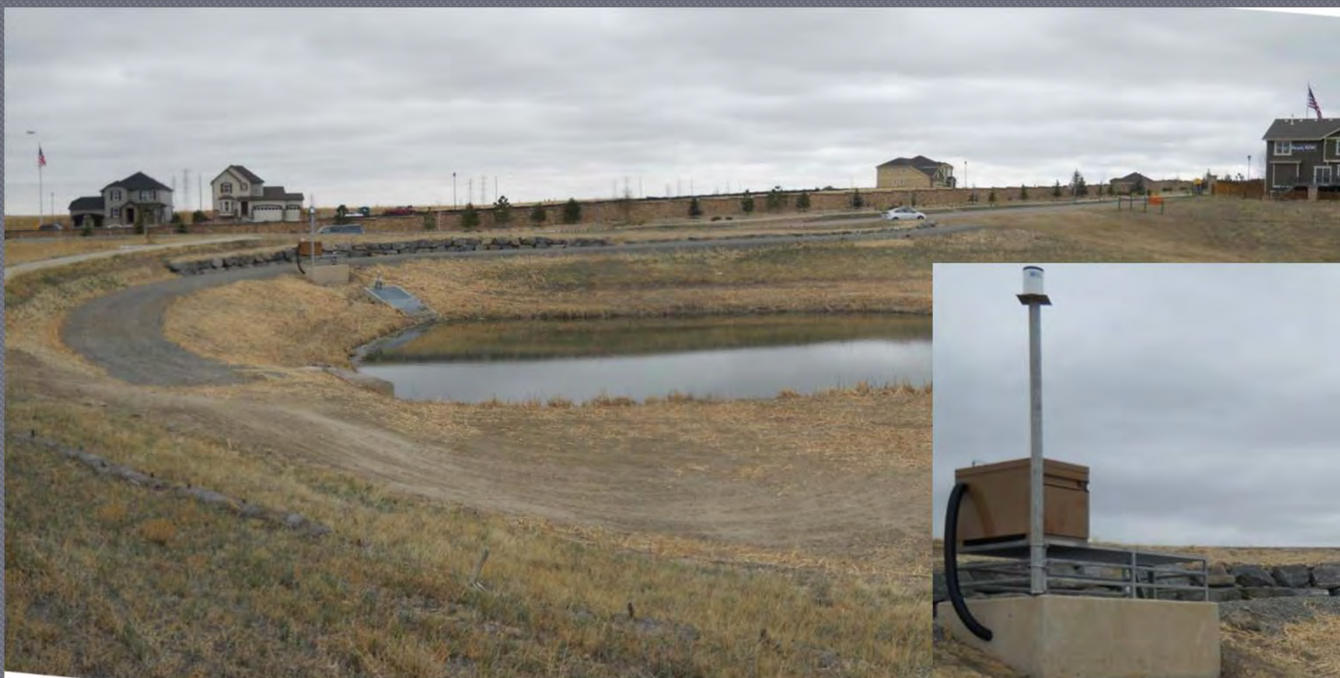
Floating Vegetated Islands

DCM Program Update

Floating Vegetated Islands

DCM Program Update

EDB Outlet Structures



DCM Program Update

Sculpted Concrete Drops

DCM Program Update

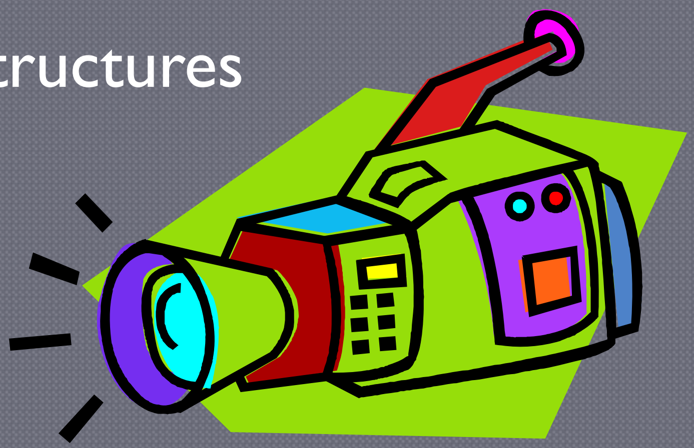
- Videos of construction techniques

  Sculpted Concrete Drop Structures

  Void Filled Riprap/Riffle Drop structures

  Sloping Grouted Boulder Drop structures

  Boulder Walls



DCM Program Update

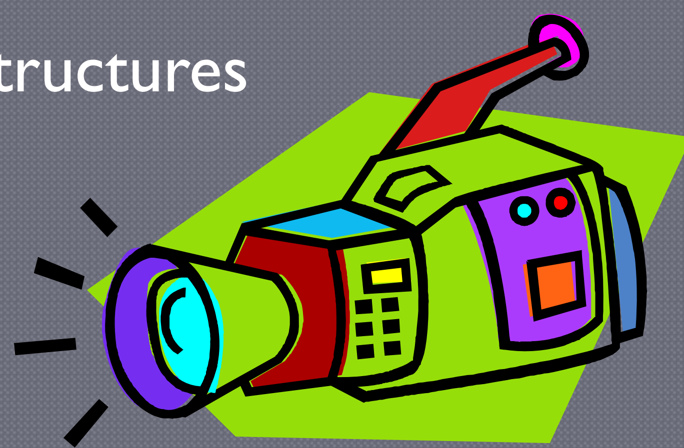
- Videos of construction techniques

  Sculpted Concrete Drop Structures

  Void Filled Riprap/Riffle Drop structures

  Sloping Grouted Boulder Drop structures

  Boulder Walls



In "The Cloud"

By Laura Kroeger

2011 Urban Drainage Seminar

Time

How can we make better use of our Time?

Smaller Staff

More Efficient

Information Management

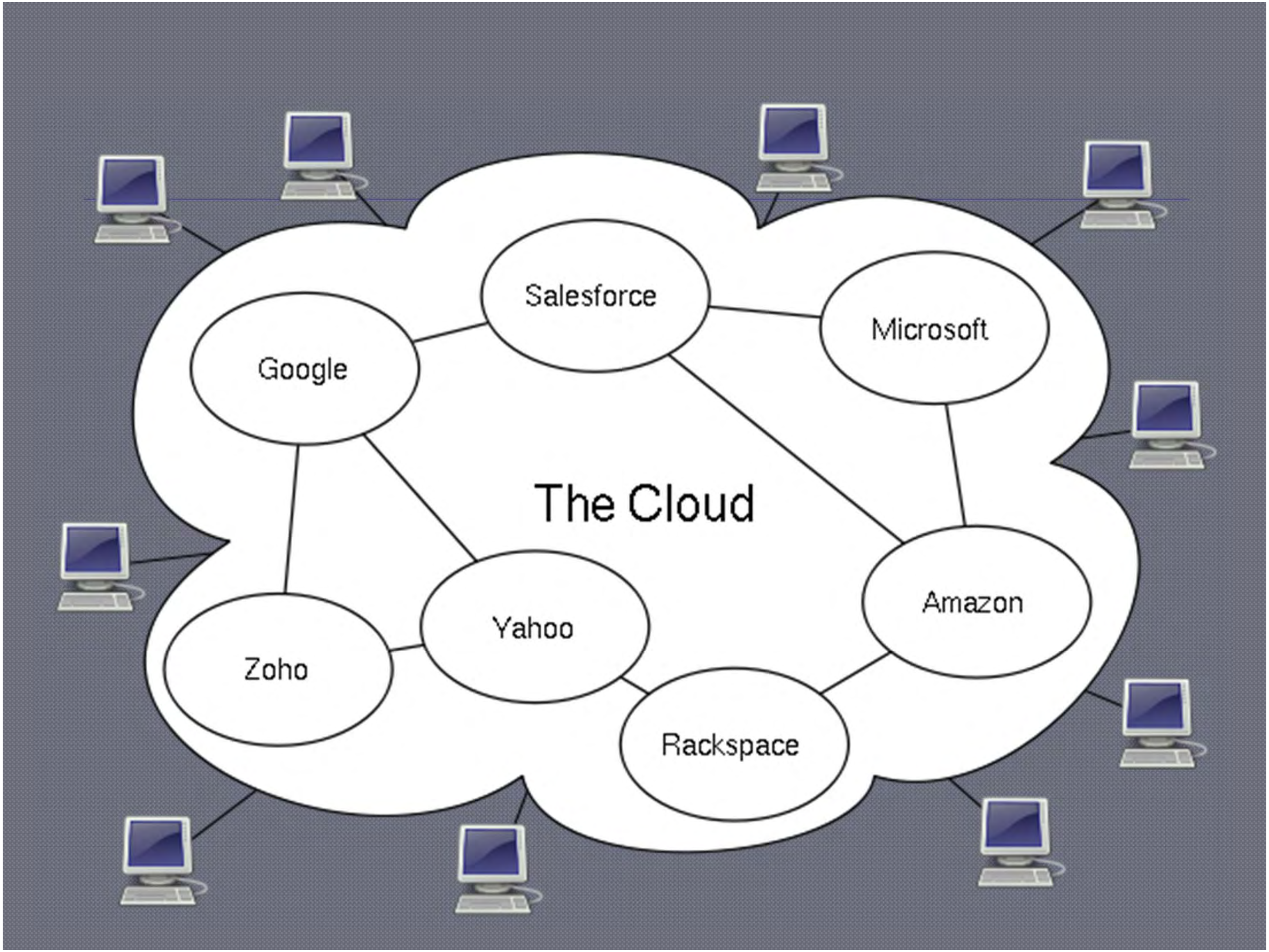
Information Management

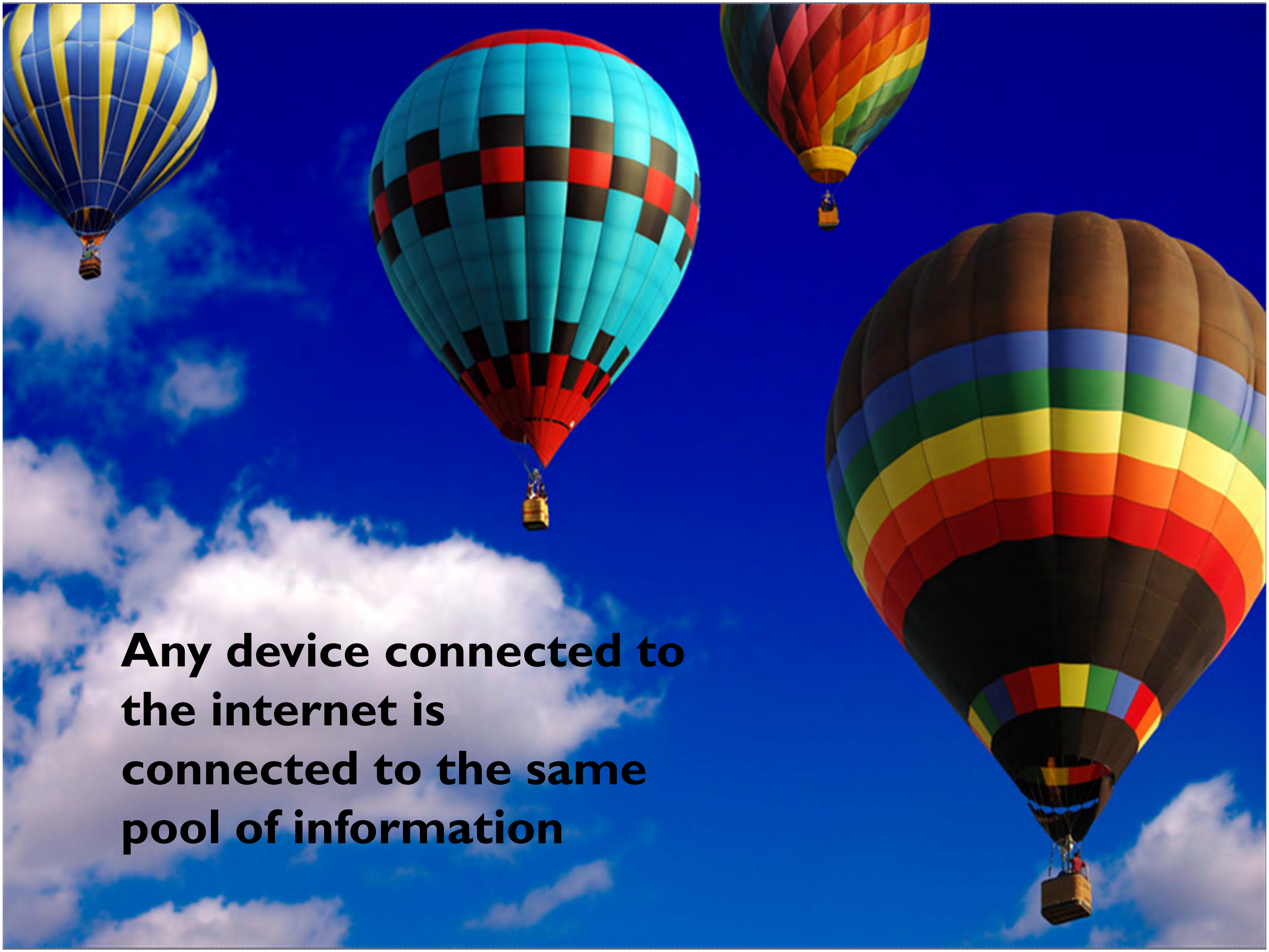
"The ability to quickly process and synthesize information and turn it into actions is one of the most emergent skills of the professional world today"

By Merlin Mann

"Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction"

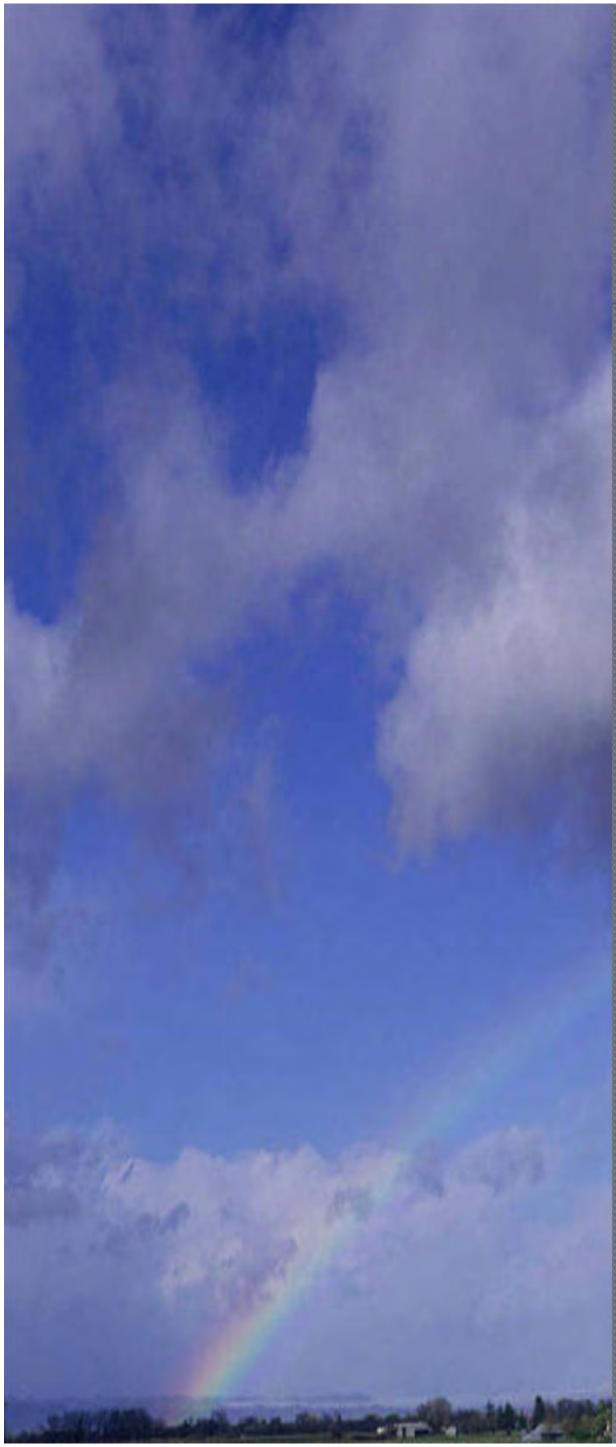
By National Institute of Standards and Technology (NIST)


The Cloud
Salesforce
Microsoft
Google
Amazon
Yahoo
Zoho
Rackspace


Any device connected to
the internet is
connected to the same
pool of information

The Vision

Project team, design through construction, utilizes a cloud based system to share and store information.



The Rainbow

Paperless
- agendas, meeting minutes
- drawings and specifications

Full access to documents no matter where you are

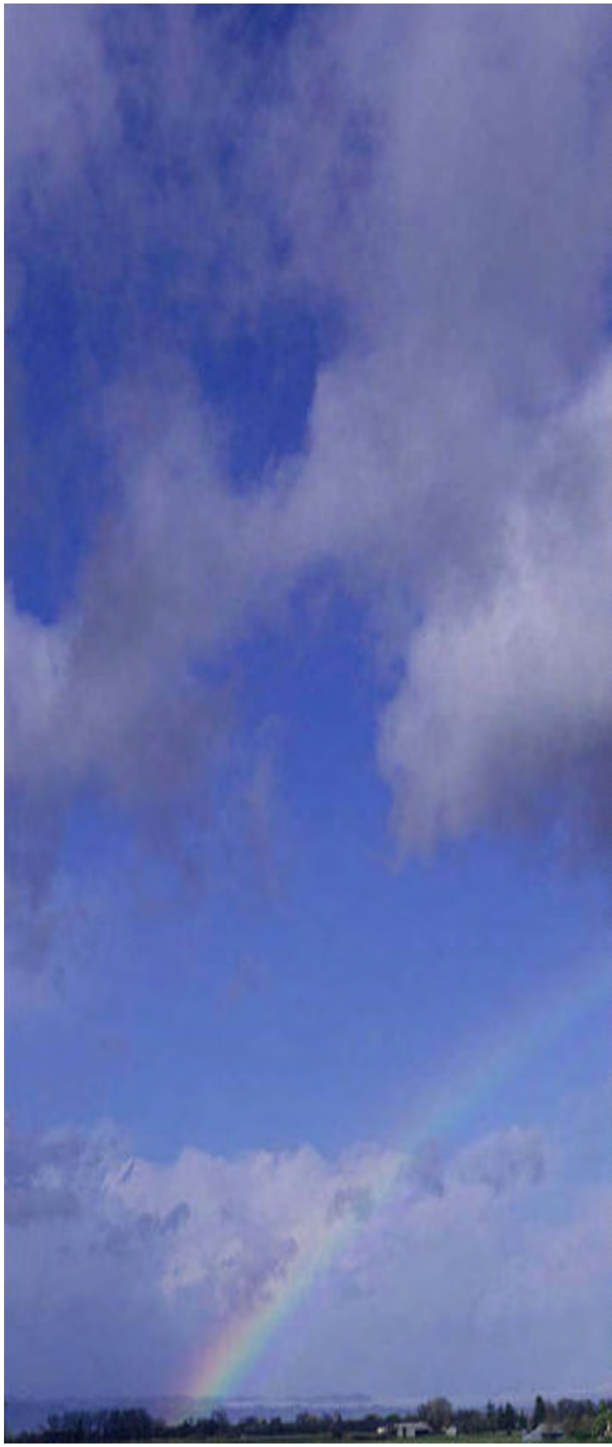
Enhances communication
- picture worth a 1000 words
- limit meetings and site visits

Improve management of Email

Death by Email

1) Let your email program manage your email as much as possible
2) Do not check your email on demand
3) Don't read and answer your email all day long
4) Don't answer your email at your most productive time of day

New York Times, Shifting Careers Column, Marci Alboher



Email Rainbow

Post Documents

agenda, meeting minutes, correspondence, decision logs, pictures, directions

Users view when needed on their schedule

Documents in their final location, not handling information more than once

Some Weather Ahead

Sophisticated cloud based systems are $

Security, Back up, Records Management

Develop a strategic document management plan, uniform filing structure

Everyone needs to use it

Weathering the Storm

Uniform Electronic Filing System

Standardized forms for field friendly entry

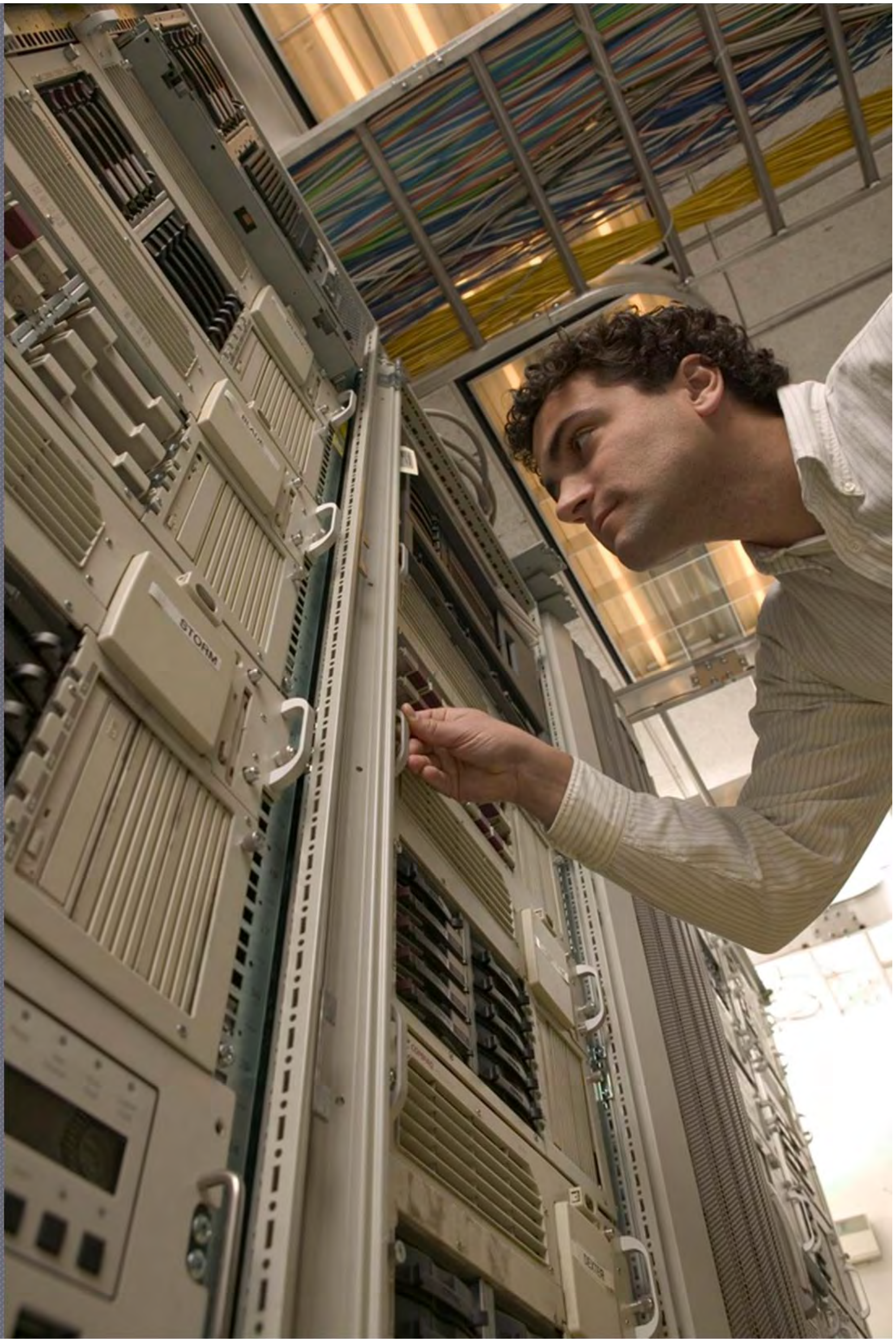
Drop Box Test Project

Dropbox

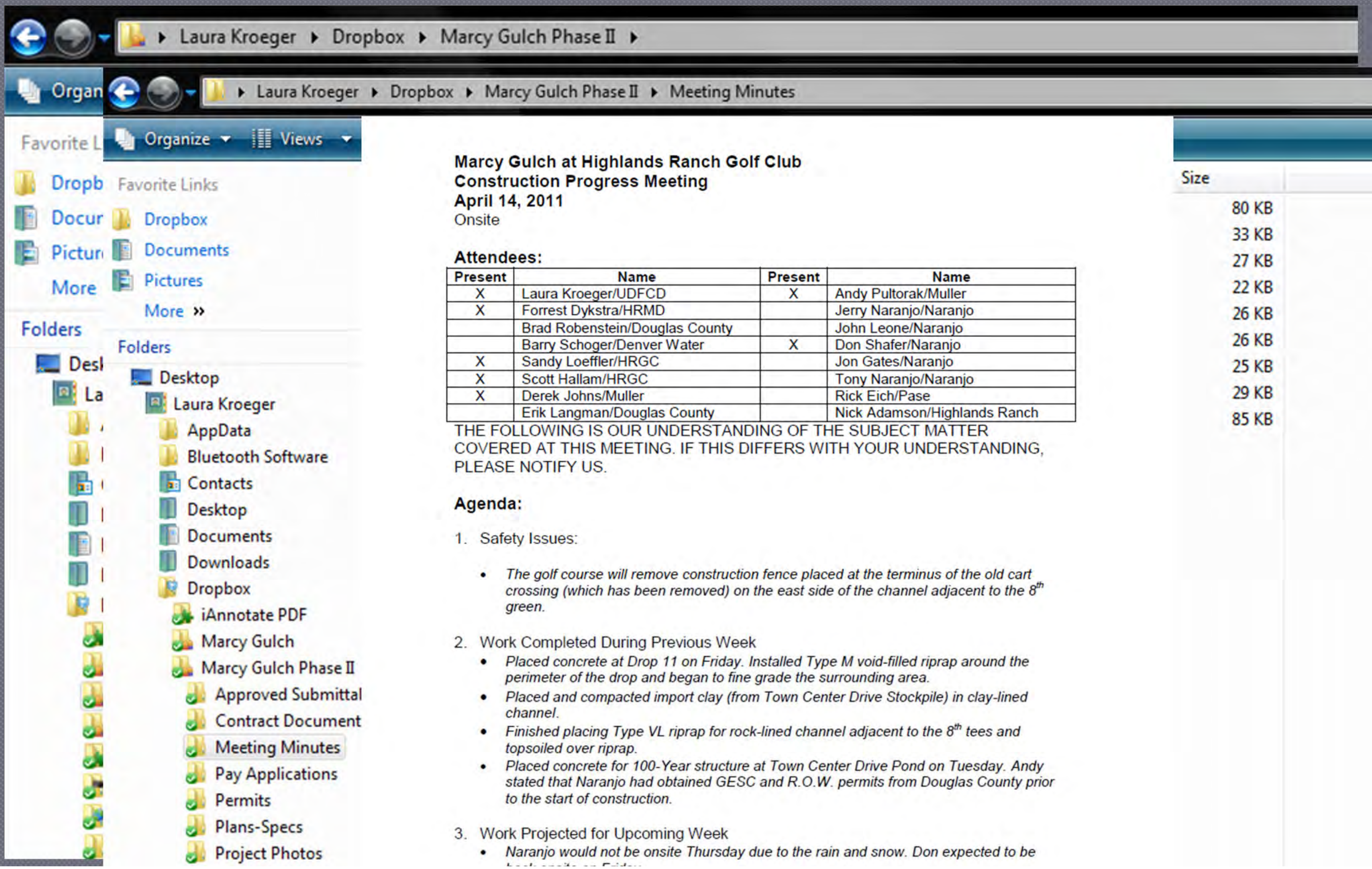
Naranjo Civil Constructors

Web-based file hosting service

Utilizes cloud computing so documents/files can be stored and shared through the internet by file synchronization



Dropbox



Marcy Gulch at Highlands Ranch Golf Club
Construction Progress Meeting
April 14, 2011
Onsite

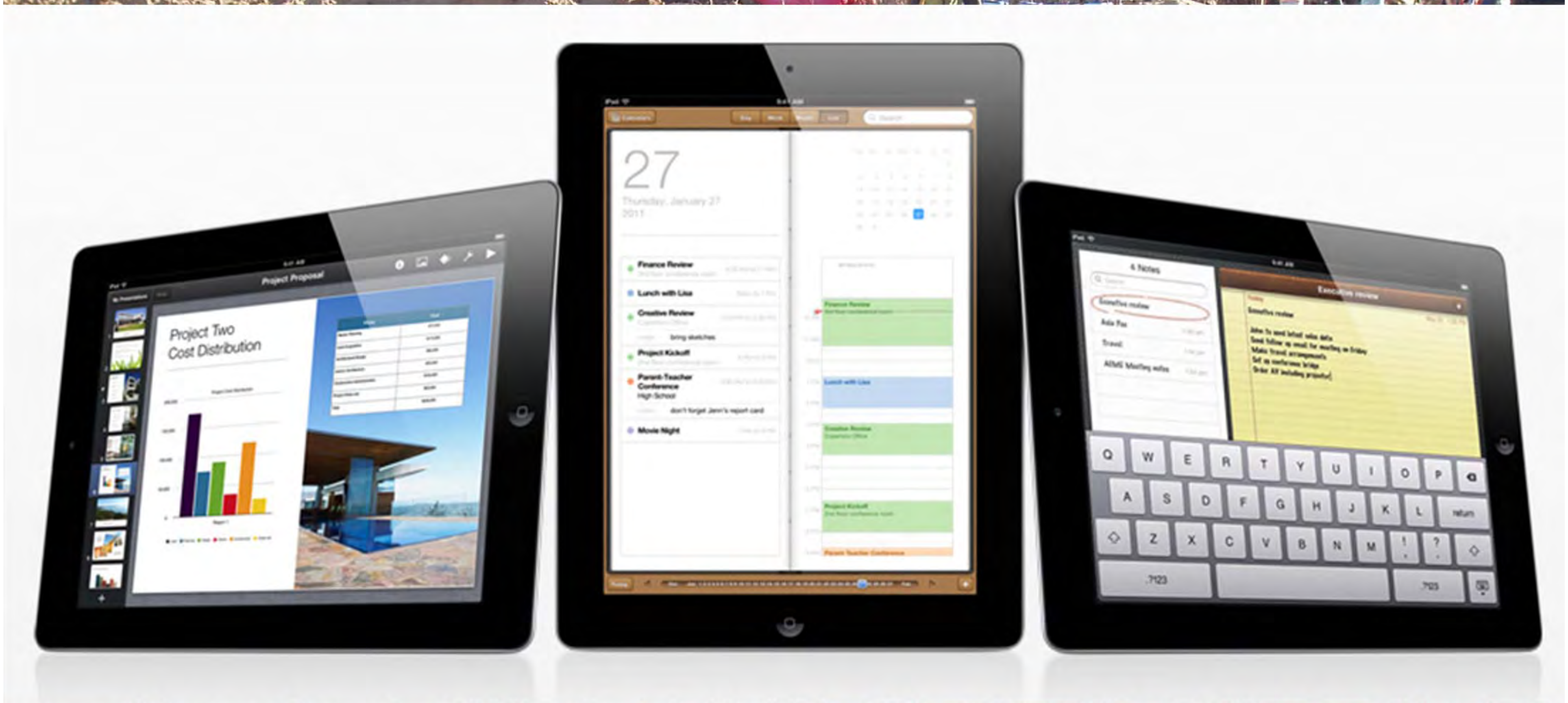
Attendees:

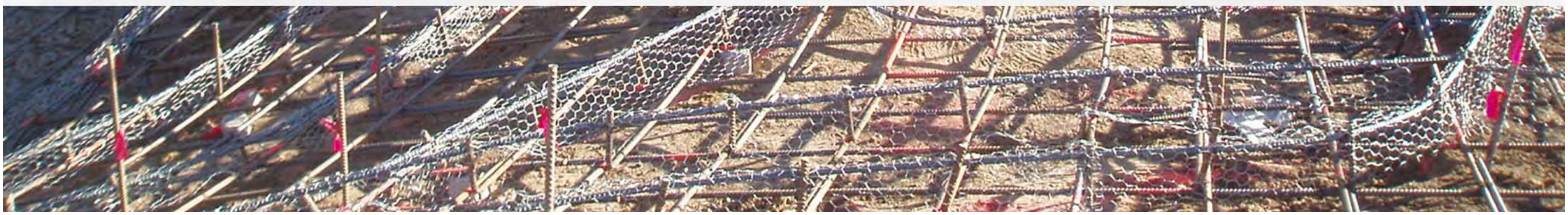
Present	Name	Present	Name
X	Laura Kroeger/UDFCD	X	Andy Pultorak/Muller
X	Forrest Dykstra/HRMD		Jerry Naranjo/Naranjo
	Brad Robenstein/Douglas County		John Leone/Naranjo
	Barry Schoger/Denver Water	X	Don Shafer/Naranjo
X	Sandy Loeffler/HRGC		Jon Gates/Naranjo
X	Scott Hallam/HRGC		Tony Naranjo/Naranjo
X	Derek Johns/Muller		Rick Eich/Pase
	Erik Langman/Douglas County		Nick Adamson/Highlands Ranch

THE FOLLOWING IS OUR UNDERSTANDING OF THE SUBJECT MATTER COVERED AT THIS MEETING. IF THIS DIFFERS WITH YOUR UNDERSTANDING, PLEASE NOTIFY US.

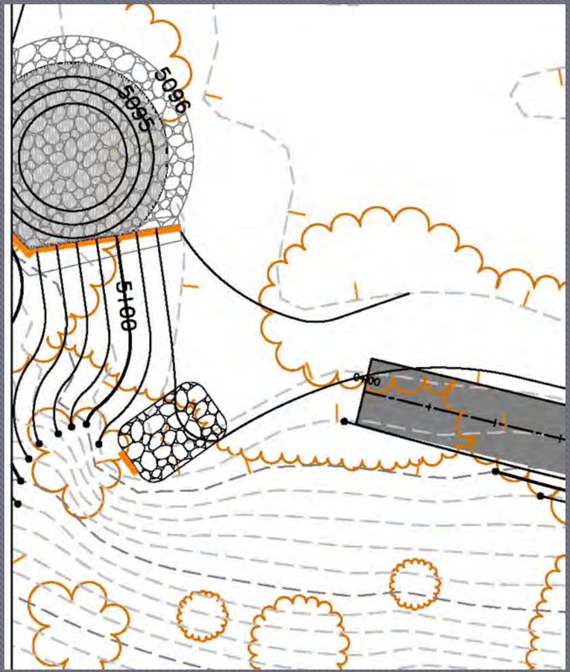
Agenda:

1. Safety Issues:
   - *The golf course will remove construction fence placed at the terminus of the old cart crossing (which has been removed) on the east side of the channel adjacent to the 8th green.*
2. Work Completed During Previous Week
   - *Placed concrete at Drop 11 on Friday. Installed Type M void-filled riprap around the perimeter of the drop and began to fine grade the surrounding area.*
   - *Placed and compacted import clay (from Town Center Drive Stockpile) in clay-lined channel.*
   - *Finished placing Type VL riprap for rock-lined channel adjacent to the 8th tees and topsoiled over riprap.*
   - *Placed concrete for 100-Year structure at Town Center Drive Pond on Tuesday. Andy stated that Naranjo had obtained GESC and R.O.W. permits from Douglas County prior to the start of construction.*
3. Work Projected for Upcoming Week
   - *Naranjo would not be onsite Thursday due to the rain and snow. Don expected to be*

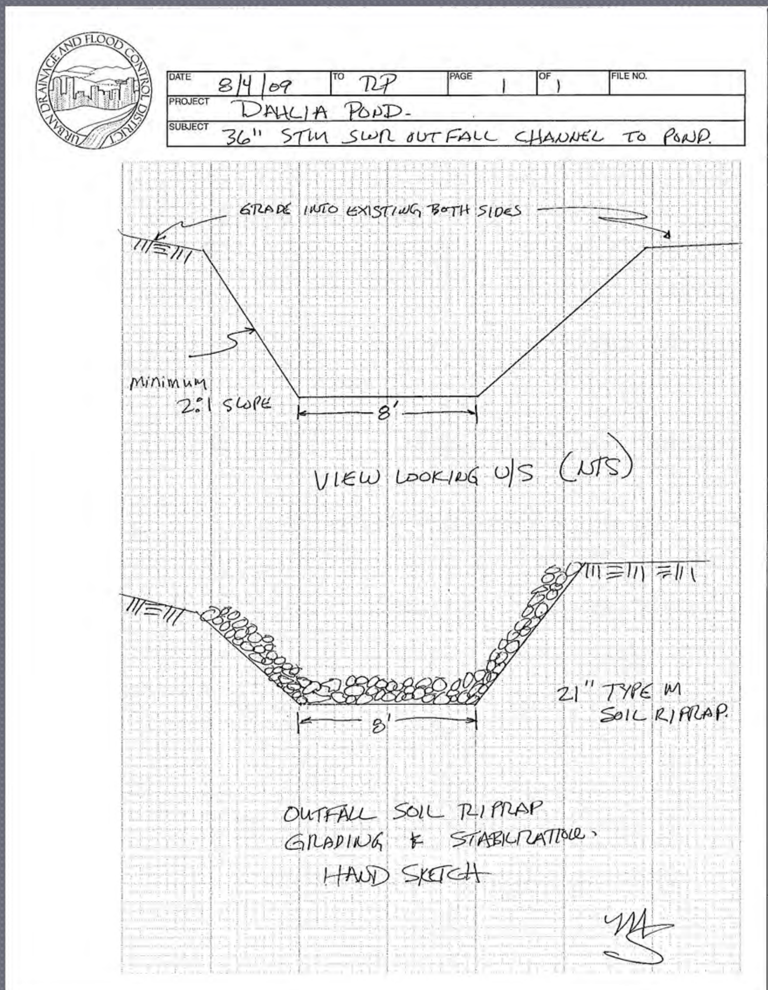

Project Proposal
Project Two
Cost Distribution
27
Finance Review
Lunch with Lisa
Creative Review
bring sketches
Project Kickoff
Parent-Teacher
Conference
High School
don't forget Jenn's report card
Movie Night
4 Notes
Executive review



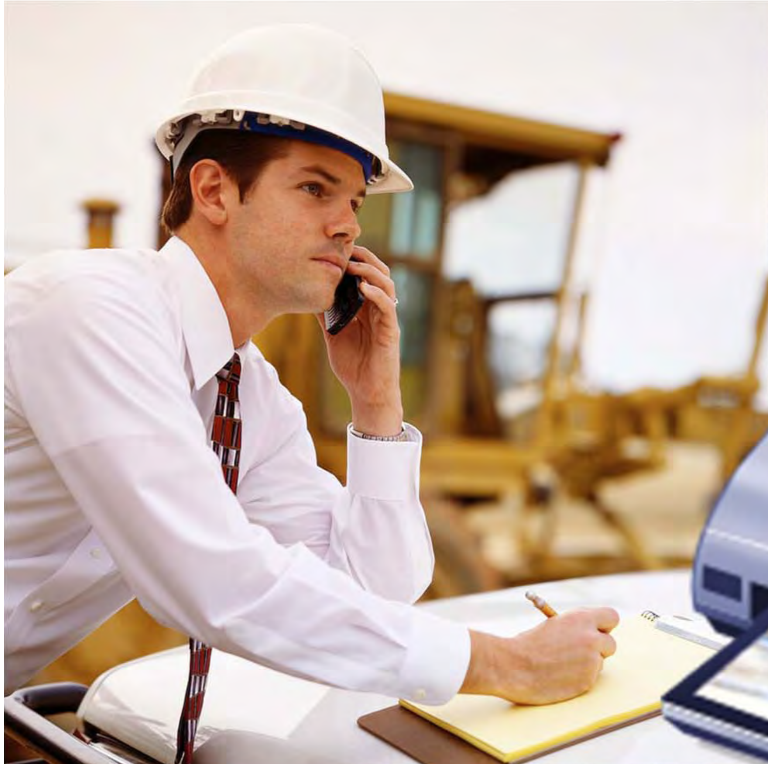
Common Field Situation



"A new way to work"



Inspection Reports



w way to work”

Urban Drainage and Flood Control District

Tel: 303-4556277 * Fax 303-455-7880 * www.udfcd.org * 2480 W. 26th AVENUE, SUITE 156 B * Denver, CO 80211

Routine Maintenance Inspection

Inspection Date: Monday, Apr 18, 2011 **Work Completion Date:** Wednesday, Apr 13, 2011

Contract: Jefferson County **Observer:** Ian Sutton

Contractor/Superintendent: L&M Enterprises Inc

Main Channel: Sanderson Gulch

Work Item Name: Maintenance **Cycle Number:** 1

Type:

○ Pre-Inspection ◉ Inspection ○ Redo Inspection ○ Extra Work Inspection

Maintenance:

☑ Debris	☐ Mowing	☐ Extra Work
○ Sch A ○ Sch B ◉ NA	○ Sch A ○ Sch B ○ NA	
◉ Approved ○ Unfinished	○ Approved ○ Unfinished	○ Approved ○ Unfinished

Significant weather event occurrence since work completed?

○ Yes ◉ No

If required, Contractor has been contacted regarding incomplete work?

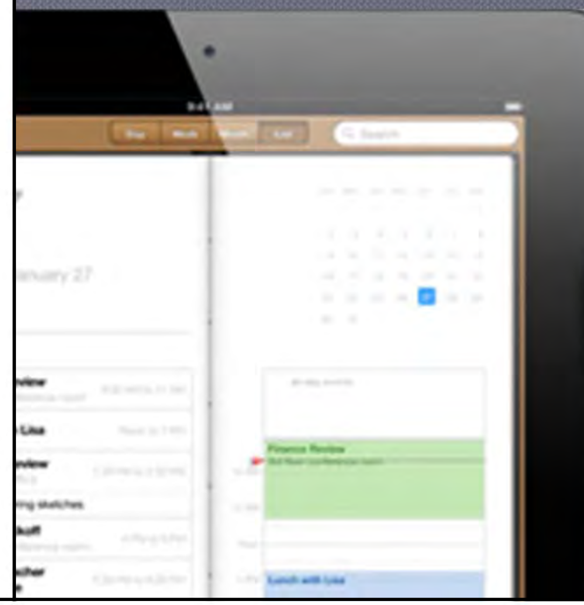
○ Yes ○ No

Were pictures taken?

◉ Yes ○ No

Details: Type inspection details below and site Figu

There are some parts of the bank that are falling into the creek at multipl
good and the rest of the major debris and trash have been removed. No r



Urban Drainage and Flood Control District

Tel: 303-4556277 * Fax 303-455-7880 * www.udfcd.org * 2480 W. 26th AVENUE, SUITE 156 B * Denver, CO 80211

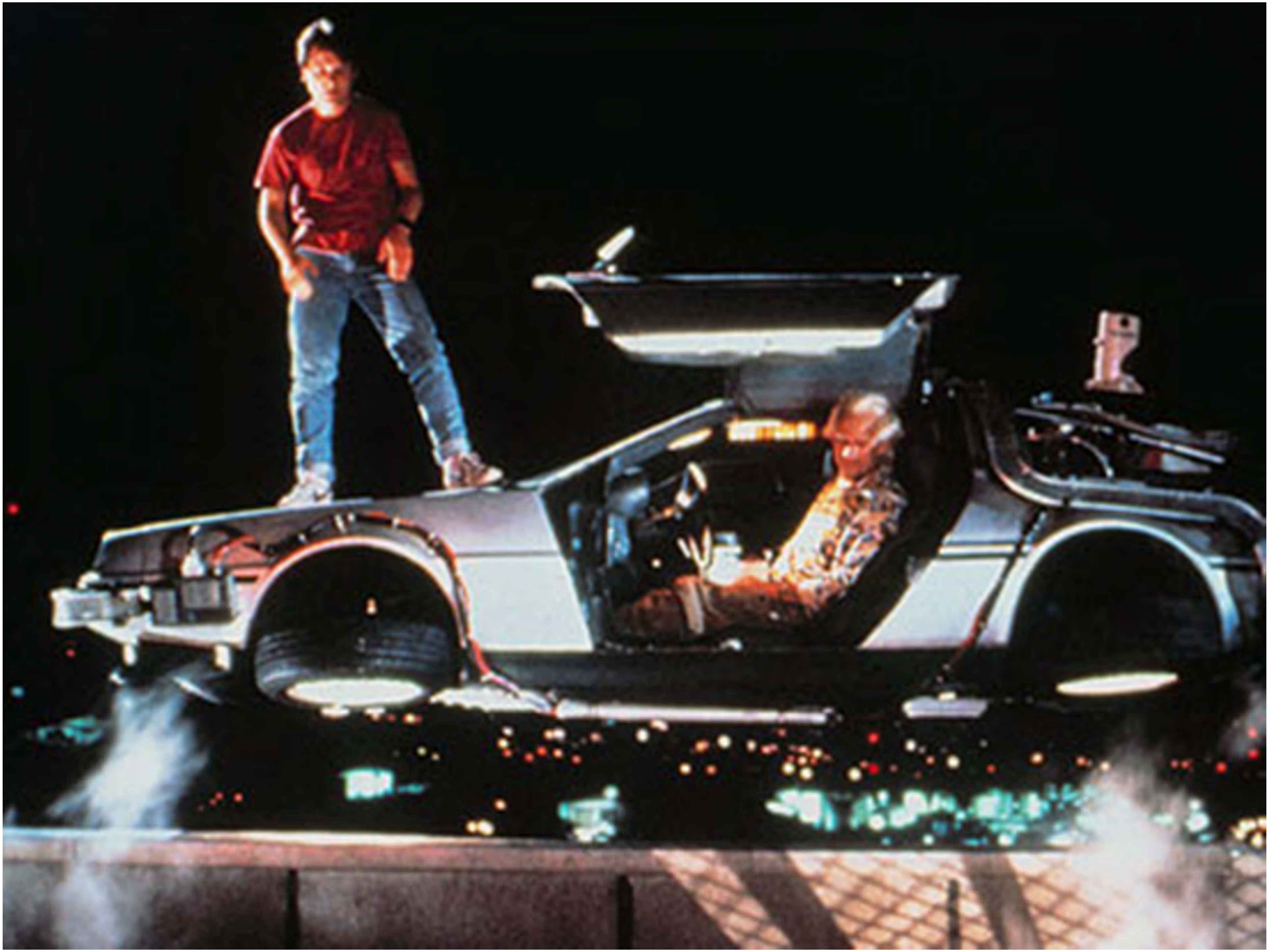
Dropbox

Have we made a difference?

Electronic file structure working well

Plan purchasing tablets for Construction Managers

Currently working with consultant on records/information management strategic plan



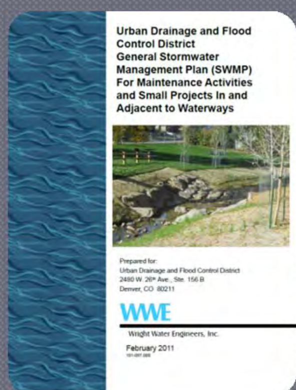
Streamlining the Stormwater Management Process in Denver and Beyond

By Barbara Chongtoua
2011 Urban Drainage Seminar

What is the Annual CASDP Process?

Streamlined process to obtain a Construction Activities Stormwater Discharge Permit (CASDP) from the City and County of Denver.

1. **UDFCD ANNUAL WORK PROGRAM**
2. **UDFCD/DENVER ANNUAL GENERAL SWMP DEVELOPMENT**
3. **CONTRACTOR ANNUAL CASDP PERMIT**
4. **PROJECT EXECUTION**
5. **CONTRACTOR ANNUAL CASDP PERMIT CLOSEOUT**



Urban Drainage and Flood Control District
General Stormwater Management Plan (SWMP)
For Maintenance Activities and Small Projects In and Adjacent to Waterways

Prepared for:
Urban Drainage and Flood Control District
2480 W. 26th Ave., Ste. 156 B
Denver, CO 80211

WWE
Wright Water Engineers, Inc.
February 2011

ENGINEER'S CERTIFICATION

I hereby certify that this *General Stormwater Management Plan (SWMP) for Maintenance Activities and Small Projects In and Adjacent to Waterways* was prepared by me (or under my direct supervision) in accordance with the provisions of the Construction Activities Stormwater Discharge Permit for the City and County of Denver. I understand that the City and County of Denver does not and will not assume liability for drainage facilities design.

T. Andrew Earles, Ph.D., P.E., CPESC — Date
Wright Water Engineers, Inc.
Colorado PE# 37237

Representing
Wright Water Engineers, Inc.

OWNER'S CERTIFICATION

This *General Stormwater Management Plan (SWMP) for Maintenance Activities and Small Projects In and Adjacent to Waterways* has been submitted to the Wastewater Management Division of the City and County of Denver to establish minimum criteria that will be followed by the Urban Drainage and Flood Control District (UDFCD) and their contractors for UDFCD maintenance activities and small projects in and adjacent to waterways. I understand that additional erosion control, sediment control, and water quality enhancing measures may be required of the owner and his or her agents due to unforeseen pollutant discharges or if site-specific conditions dictate the need for additional measures.

Owner or Authorized Agent — Date

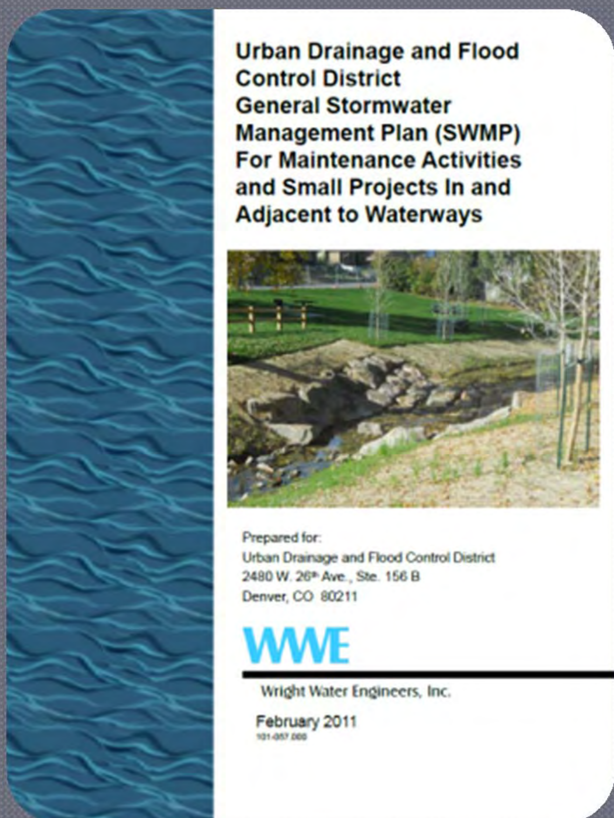
Representing
Urban Drainage and Flood Control District

UDFCD Typical Projects

- Routine Services

- Restoration Services

What is the Annual CASDP Process?



- Roles and Responsibilities
- Types of Projects Authorized
- BMP Sizing Criteria
- Typical Details and BMP Plans

Types of Project

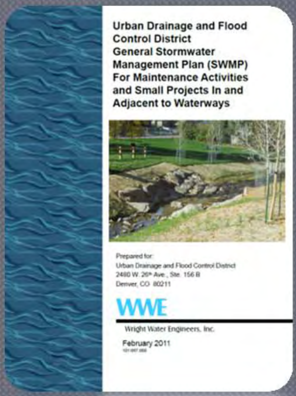
- Projects excluded from the Annual CASDP
  - CDPHE General Stormwater Permit Required
  - South Platte River projects
  - Individual 404 Permit Required
  - Capital Improvement Projects

- Other applicable permits still required.

What is the CASDP Process for projects?

- District identifies a Project

- District Project initiates the CASDP Process



Types of Projects

Field Engineered

Area< 1/4 ac

- Sediment Removal
- Pond Maintenance
- Trail Maintenance
- Tree Thinning
- Minor Bank Stabilization
- Minor Outfall Repair

All Routine and some Restoration Services.

Standard Maintenance

Area< 1ac

- Bank Stabilization
- Outfall Repair
- Minor Drop Structure

Restoration Services.

Field Engineered Projects

Secure CASDP Permit

- UDFCD Contractors obtain Annual CASDP Permits using the approved General SWMP (one CASDP per contractor).
- Once the Annual CASDP Permit has been issued, Contractor does not need to apply again.

Notify CCD of Intent

- Contractor shall prepare and submit the Field Engineered Application Form to CCD.
- CCD amends the Annual Permit to include this project.

Construction

- If, within 2 business days, CCD does not issue comments, Contractor can begin construction.
- Contractor shall implement the required BMPs as designated in the General SWMP.
- Contractor shall operate, maintain, and inspect BMPs as required by the General SWMP.

Post Construction

- Contractor shall notify CCD and UDFCD when project has been complete and accepted.
- UDFCD shall operate, maintain, and inspect projects until the individual project has been removed from the CASDP Permit.

Standard Projects

Secure CASDP Permit

- UDFCD Contractors obtain Annual CASDP Permits using the approved General SWMP.

Notify CCD of Intent

- Contractor shall prepare and submit the Standard Maintenance Application Form to CCD.
- CCD has 5 business days to review and comment on the Standard Maintenance Application Form.
- Contractor can not start construction until the CCD has approved the project.

Construction

- With approval conveyed by the CCD, Contractor can begin construction.
- Contractor shall implement the required BMPs as designated in the General SWMP.
- Contractor shall operate, maintain, and inspect BMPs as required by the General SWMP.

Post Construction

- Contractor shall notify CCD and UDFCD when project has been complete and accepted.
- UDFCD shall operate, maintain, and inspect projects until the individual project has been removed from the CASDP Permit.

Program Highlights

- Streamline Program Administration
- Streamline SWMP Preparation and Administration
- Implement projects more effectively.
- Monitor cost enhancements.

Program Improvements

- Enhance the submittal process with Denver.
- Enhance the maintenance of SWMP and preparation of inspection reports using Mobile Technology.

Stream Stabilization: the "Best(est)" Management Practice?

By Laura Kroeger
& Ken MacKenzie
2011 Urban Drainage Seminar

Water Quality is Everyone's Concern

Why this topic today?

Where does Stream Stabilization fit in?

Finding the Balance

Why this Topic Today?

Water Quality is important to all of us and is controlled in a highly regulated environment.

Currently there is frustration on all sides and at times the big picture gets lost.

As a drainage and flood control community we should be united in our approach and solutions.

Why this Topic Today?

Purpose -

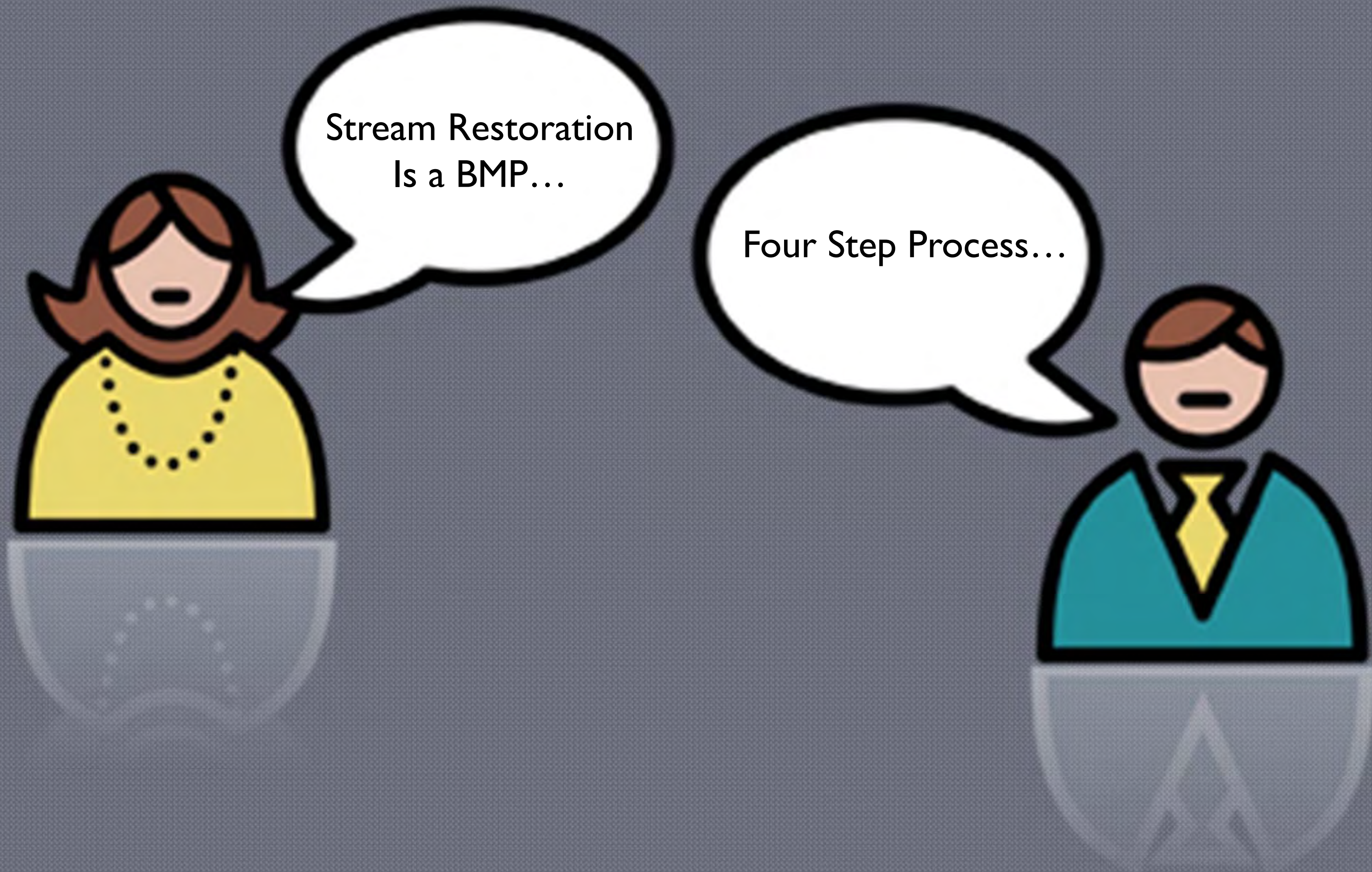
Acknowledge differences in communication

Emphasize our common concern

Recognize drainage/stream restoration as part of the solution

Offers ideas on how to address the challenges we face

Are we talking the same language?



The UDFCD "Four Step Process". We've been advocating this since 1991

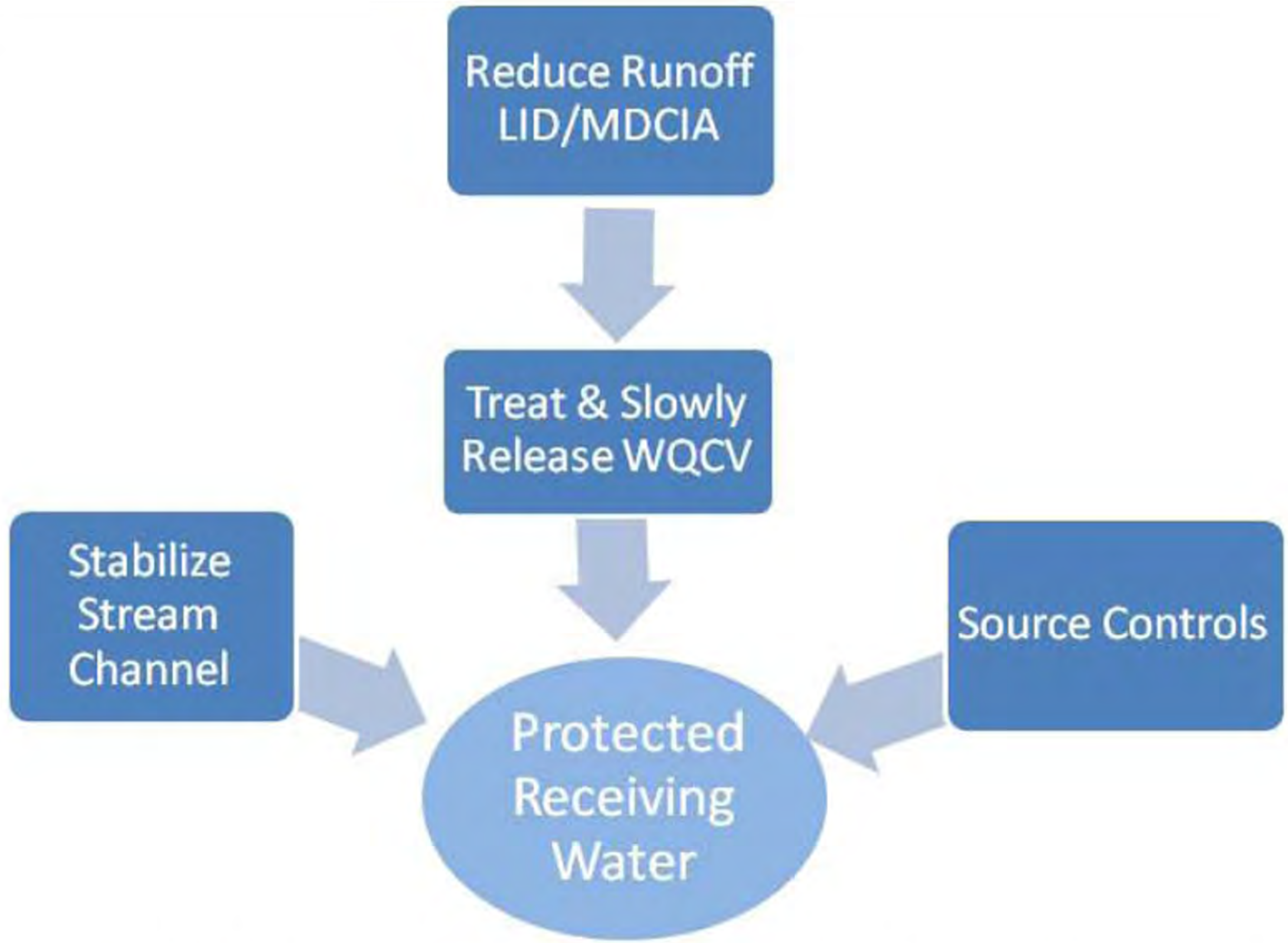
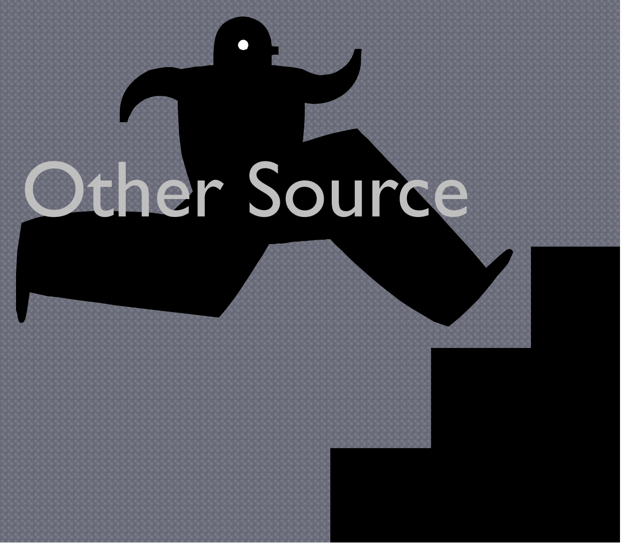


Figure 1-2. The Four Step Process for Stormwater Quality Management

What step are you on?

- Step 1: Employ Runoff Reduction Practices
- Step 2: Implement Stormwater Best Management Practices (BMPs) that Provide a Water Quality Capture Volume (WQCV) with Slow Release
- **Step 3: Stabilize Drainageways**
- Step 4: Implement Site Specific and Other Source Control BMPs



Why can't we just leave the streams alone?

During and following development, natural drainageways are subject to bed and bank erosion due to increases in:

- frequency,
- duration,
- rate, and
- volume of runoff.

Why can't we just leave the streams alone?

- Although Steps 1 and 2 help to minimize these effects, some degree of drainageway stabilization has always been required.
- This is one of the primary purposes of a drainage master plan.
- Channel erosion is a major source of sediment and associated pollutants such as phosphorus, metals and other naturally occurring constituents.

Why not wait to see if the stream stabilizes itself?

- If stream stabilization is implemented early , it is far more likely that natural drainageway characteristics can be maintained with the addition of grade control to accommodate future development.
- Targeted armoring of a relatively stable drainageway is always much less costly than repairing an unraveled channel.

What's the problem if it's just soil?

1. Fish can't breathe soil.

2. It isn't just soil. It's pollutants in the soil.

Table 1-1. Common Urban Runoff Pollutant Sources

(Adapted form: Horner, R.R., J.J. Skupien, E.H. Livingston and H.E. Shaver. 1994. *Fundamentals of Urban Runoff Management: Technical and Intuitional Issues*. Washington, DC: Terrene Institute and EPA.)

Pollutant Category Source	Solids	Nutrients	Pathogens	Dissolved Oxygen Demands	Metals	Oils	Synthetic Organics
Soil erosion	X	X		X	X		

National Guidance?

The National Pollutant Discharge Elimination System (NPDES) National Menu of Stormwater Best Management Practices:

- For Stormwater Phase II, first released in October 2000.
- The Menu of BMPs is based on the Stormwater Phase II Rule's six minimum control measures (MCMs).

Which MCM Calls for Stream Stabilization?

Six Minimum Control Measures

1. Public Education and Outreach
2. Public Involvement/Participation
3. Illicit Discharge Detection and Elimination
4. Construction Site Storm Water Runoff Control
5. Post-Construction Storm Water Management in New Development and Redevelopment
6. Pollution Prevention/Good Housekeeping for Municipal Operations

National Guidance?

Results for the National Menu of Best Management Practices

Keyword Search:

11 documents were found within your search parameters: **stream stabilization**

- Check Dams
- Compost Blankets
- Construction Entrances
- Construction Sequencing
- Geotextiles
- Permanent Slope Diversions
- Preserving Natural Vegetation
- Riprap
- Sediment Basins and Rock Dams
- Seeding
- Temporary Stream Crossings

(Every one of these documents pertains to construction activities. There is no mention of stream stabilization.)

National Guidance?

Results for the National Menu of Best Management Practices

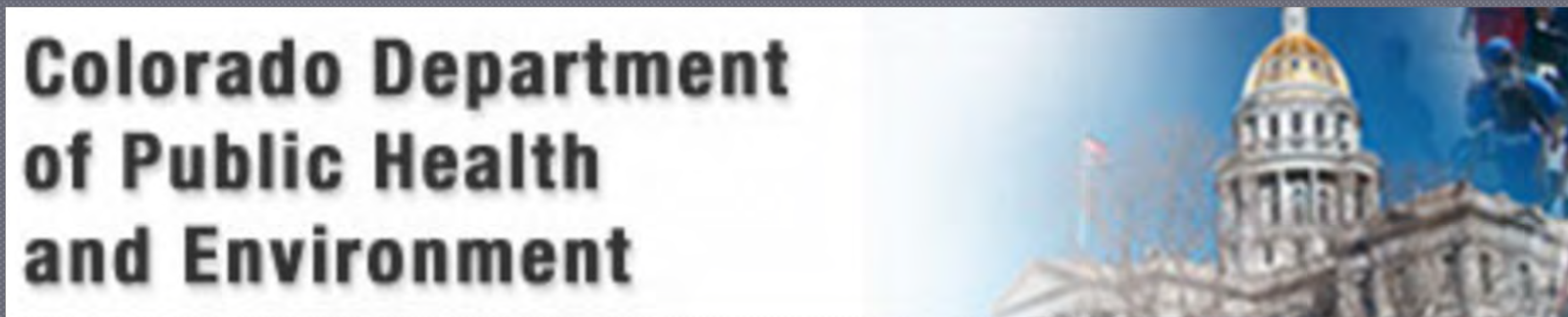
Keyword Search:

1 document was found within your search parameters: **Post-Construction Storm Water Management in New Development and Redevelopment**

Post-construction Plan Review

(There is no mention of stream stabilization in this document.)

State Guidance?



- www.cdphe.state.co.us/wq/permitsunit/GeneralPermits.htm

Municipal Separate Storm Sewer Systems (MS4s)

- **STATEWIDE MS4 General Permit COR090000**
  Effective March 10, 2008
  - Permit
  - Rationale

State Guidance?

MCM #5: Post-Construction Stormwater Management:

- Decrease the amount of pollutants and peak quantity of stormwater leaving newly developed areas.
- Create a review process and City ordinance for regulation and enforcement.
- Require, review, inspect, and enforce proper methods for detaining/improving quality of water for sites.

(There is no mention of stream stabilization in these documents.)

What does the NRC report say?

National Research Council 2009 Report:
"*Urban Stormwater Management in the United States*"

- Committee on Reducing Stormwater Discharge Contributions to Water Pollution

- EPA's current approach to regulating stormwater is unlikely to produce an accurate or complete picture of the extent of the problem, nor is it likely to adequately control storm water's contribution to water body impairment.

What does the NRC report say?

- Recognizes that "*The sediment released by channel expansion and channel incision due to changes in flow regime and discharge can be the largest component of the overall sediment load delivered to downstream water bodies.*"

- The report makes no recommendation regarding receiving stream stabilization.

- Recommends rather that nonstructural stormwater control measures be considered first before structural practices, because their use reduces the reliance on and need for structural measures.

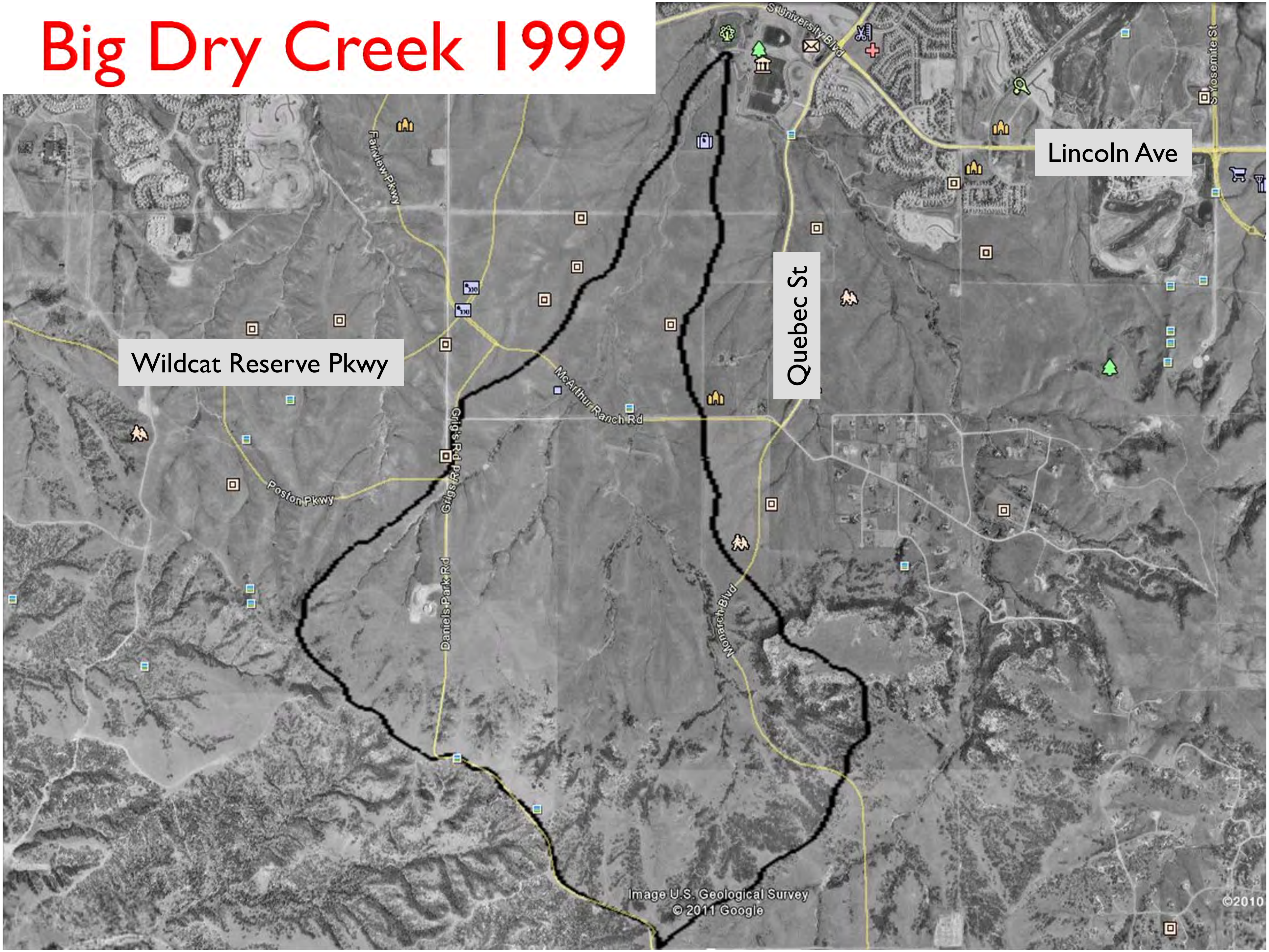
An Opinion and a Question…

- ✓ MCM #5: Post-Construction Stormwater Management is important but without a requirement for stream stabilization, will not get us where we need to be.
- ✓ The recommendations in the NRC report are fine, but are not likely to be fully implemented, meaning receiving streams will continue to erode.
- ✓ Can we, by applying LID and green infrastructure techniques, " return, maintain, or restore natural hydrologies" to the point where receiving streams will not degrade and erode?

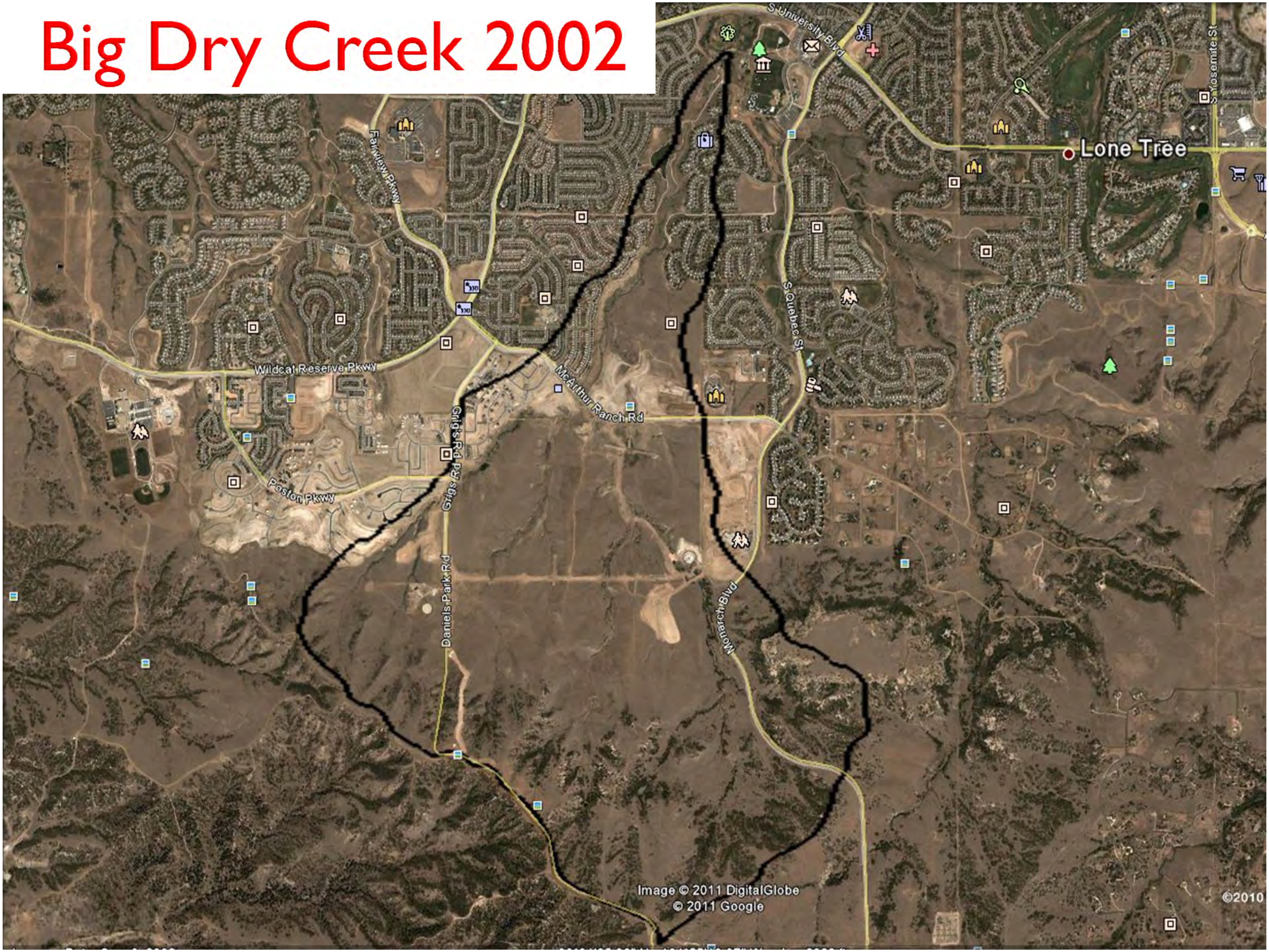
Too bad we didn't fix this one earlier…

- ≈240 tons of sediment washed into the lake before action was taken.
- Required giant boulder drop structures to stabilize longitudinal slope.
- Giant boulder drop structures = Giant $$$ to construct.

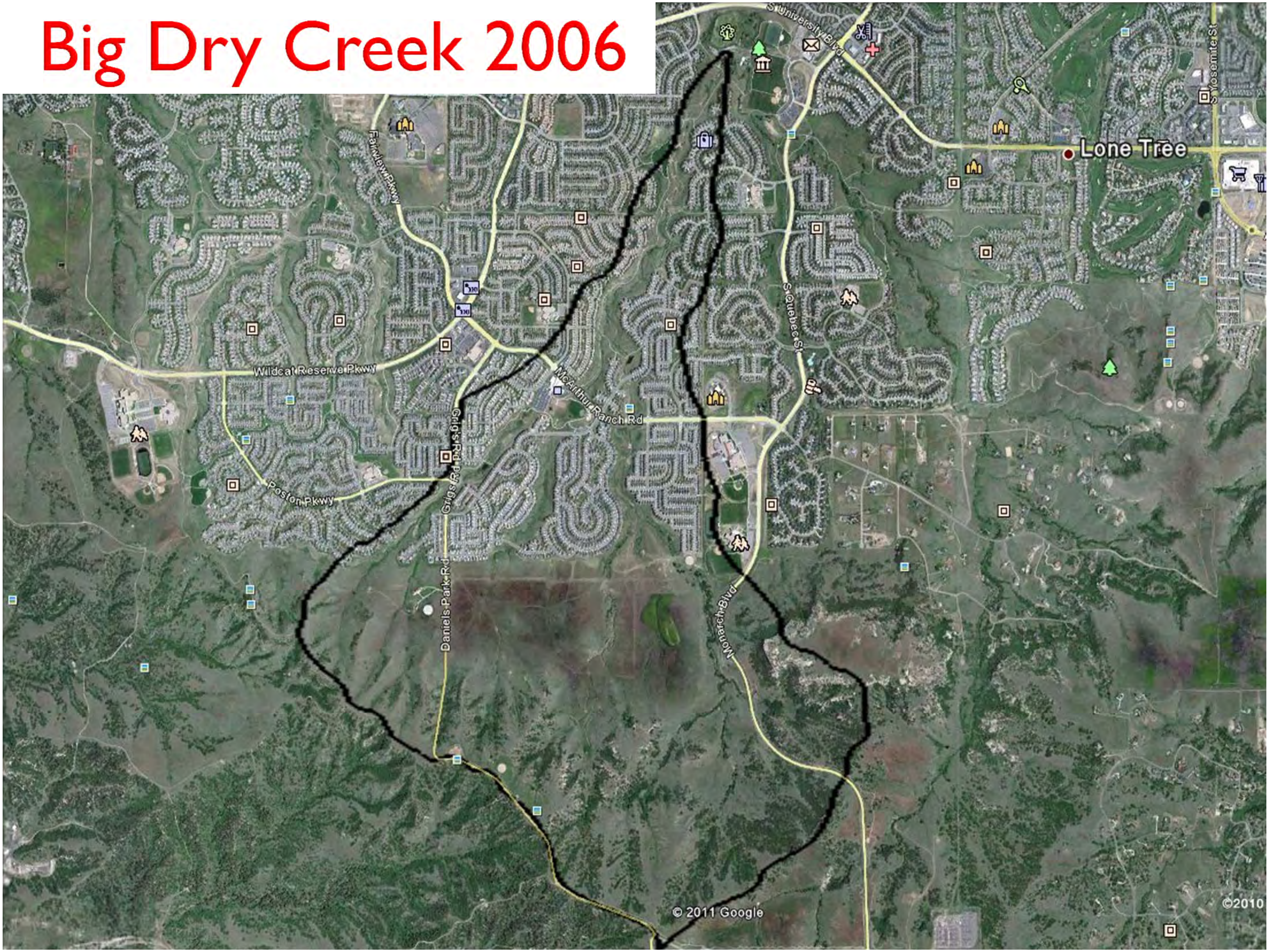
Big Dry Creek 1999



Big Dry Creek 2002



Big Dry Creek 2006



Big Dry Creek 2004

Big Dry Creek 2006

Big Dry Creek 2007


Big Dry Creek 2004

Big Dry Creek 2007

Big Dry Creek 2007

Big Dry Creek 2009

Big Dry Creek Summary:

Project Length = 2,400 LF

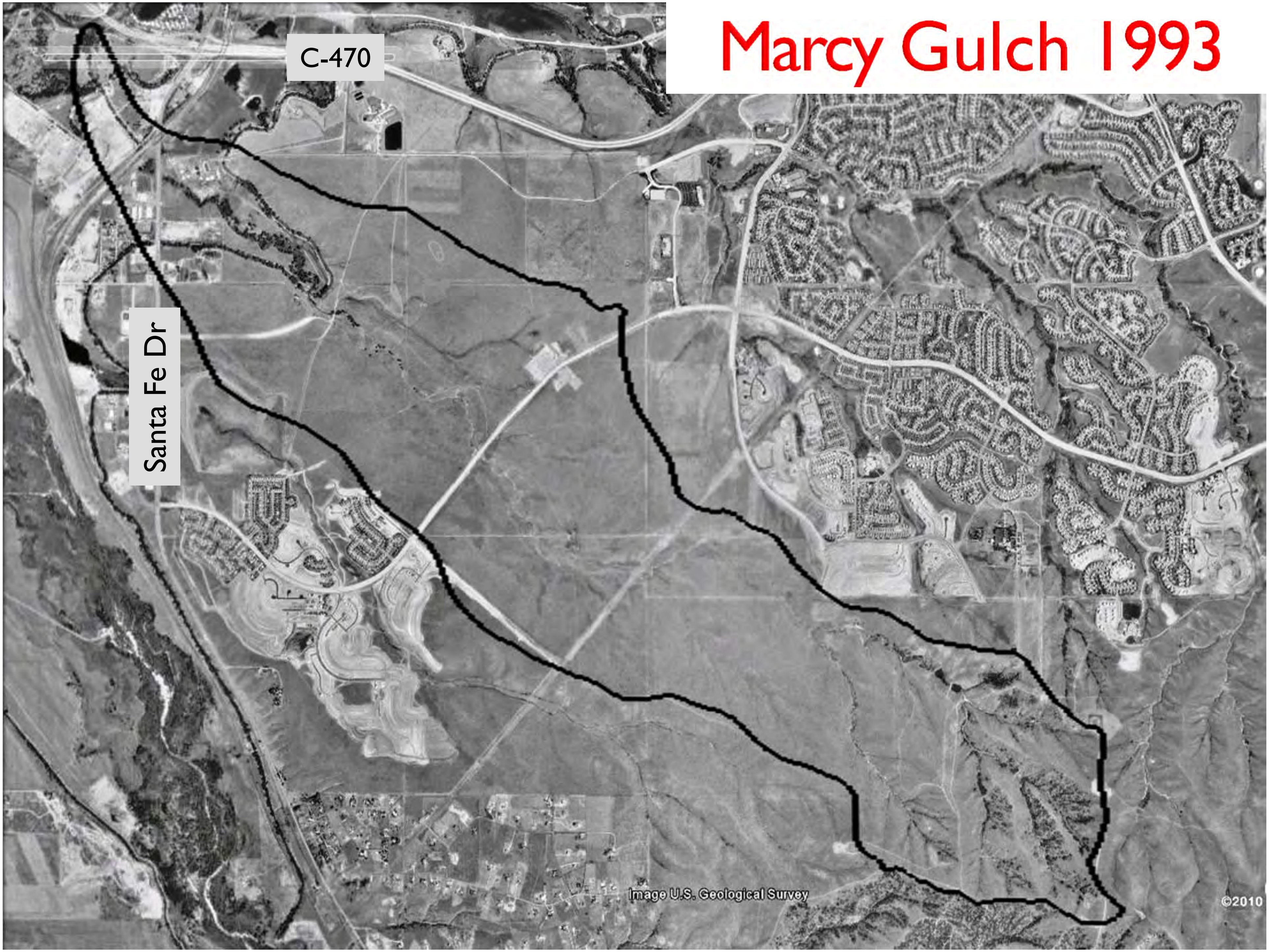
Brought invert of channel up on average 5 feet

Dirt placed to bring channel back to grade before erosion = 8,500 CY

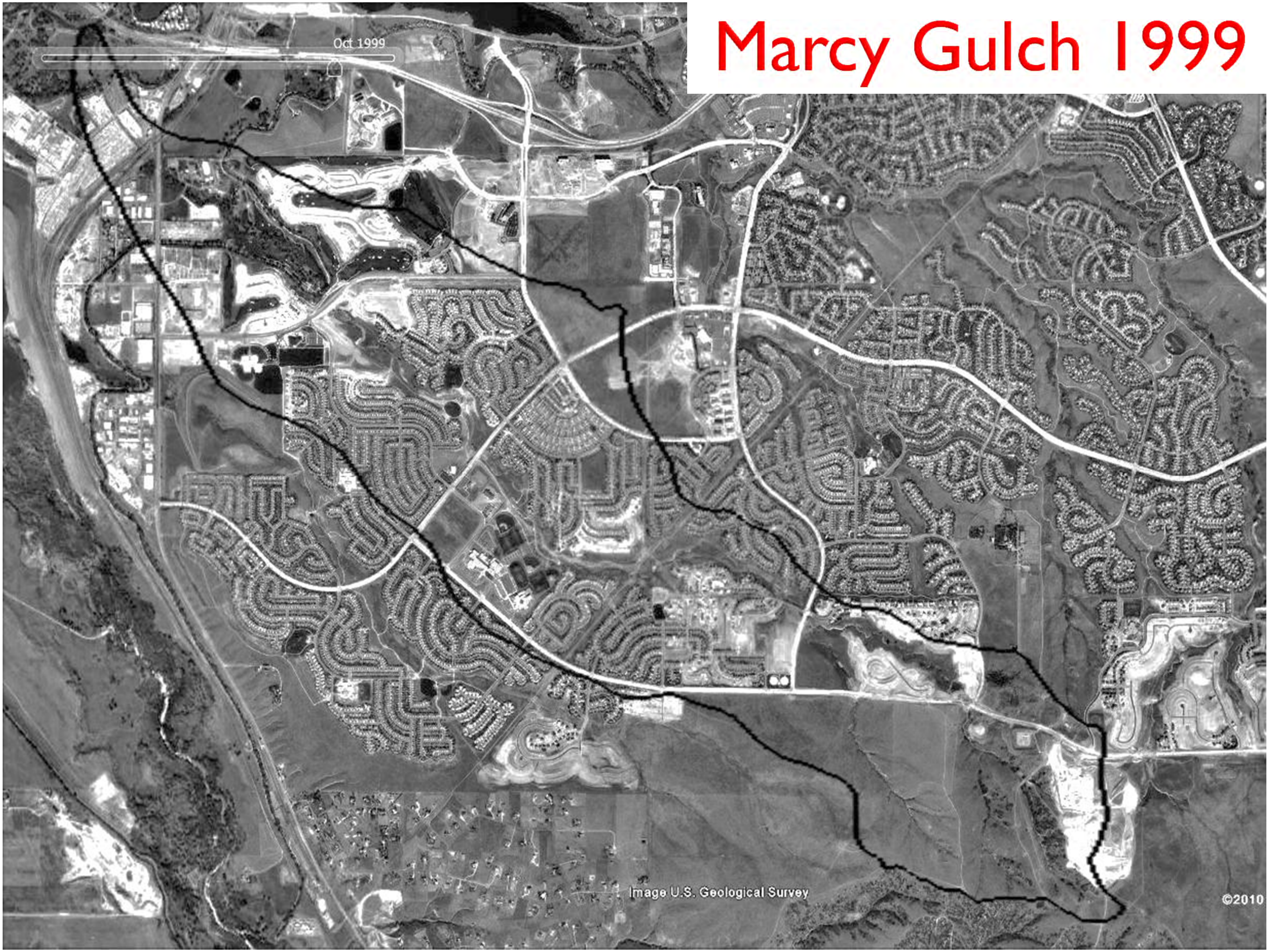
Construction Cost = $438,000

Approximately 500 CY

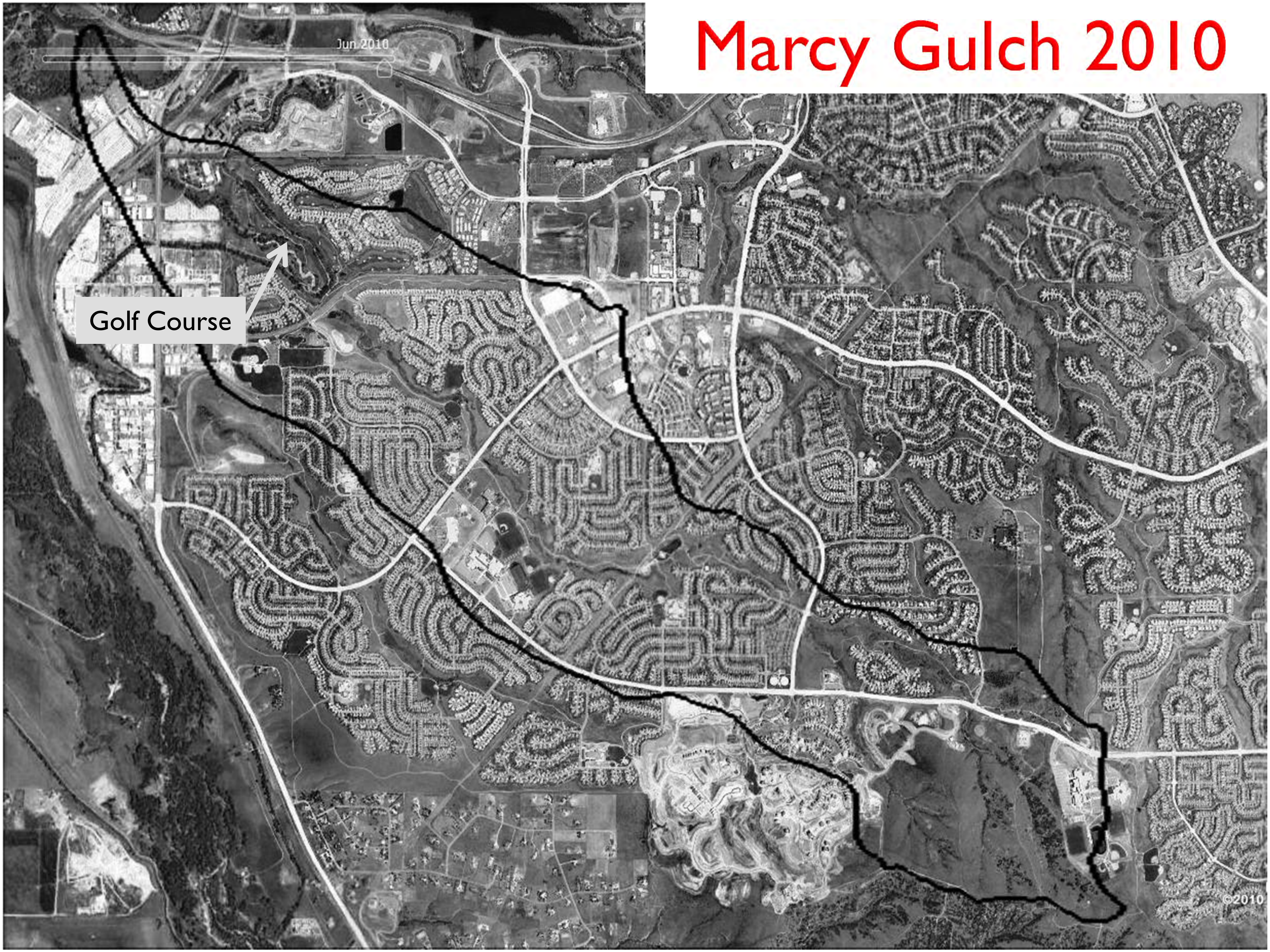
Marcy Gulch 1993



Marcy Gulch 1999

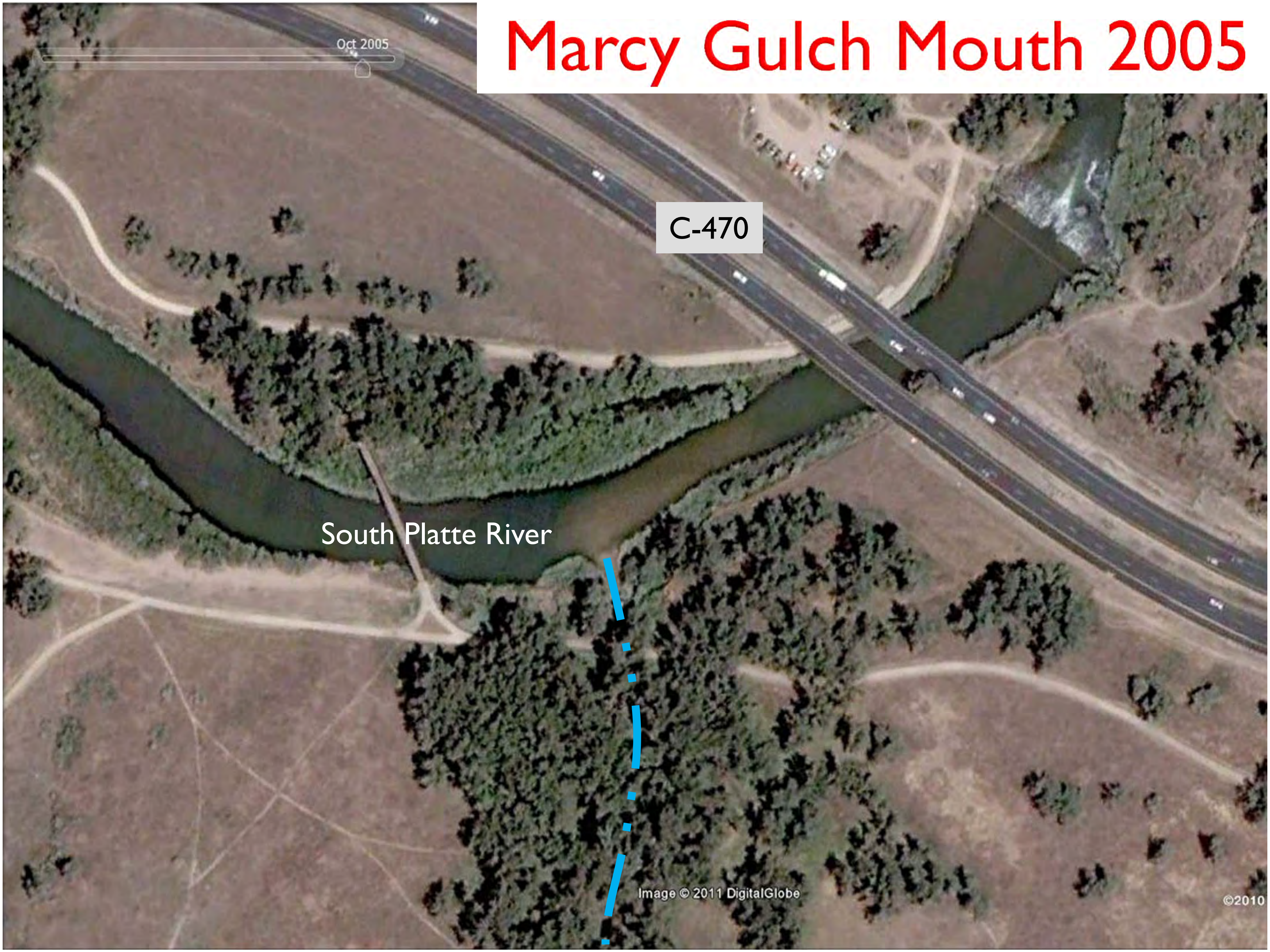


Marcy Gulch 2010



Highlands Ranch Golf Club 2005

Marcy Gulch Mouth 2005



Highlands Ranch Golf Club 2006

Marcy Gulch Mouth 2006

Highlands Ranch Golf Club 2007

Marcy Gulch Mouth 2008

Highlands Ranch Golf Club 2010

Highlands Ranch Golf Club 2010

Highlands Ranch Golf Club 2010

Highlands Ranch Golf Club 2011

Marcy Gulch Summary:

Project Length = 3,000 LF

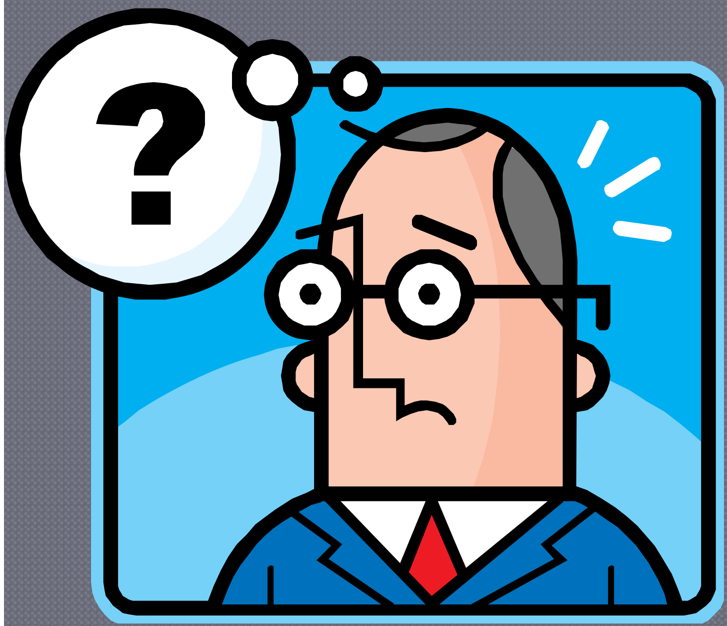
Brought invert of channel up 7-8 feet u/s reach
4-5 feet d/s reach

Dirt placed to bring channel back to grade before erosion = 35,600 CY

Construction Cost = $1,680,000

What is the Bestest BMP?

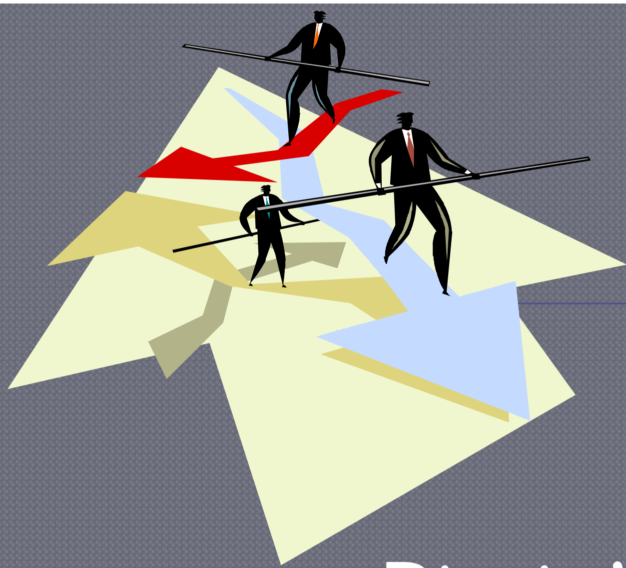
Stream Stabilization



Construction BMPs

Extended Detention

Is one better than another?

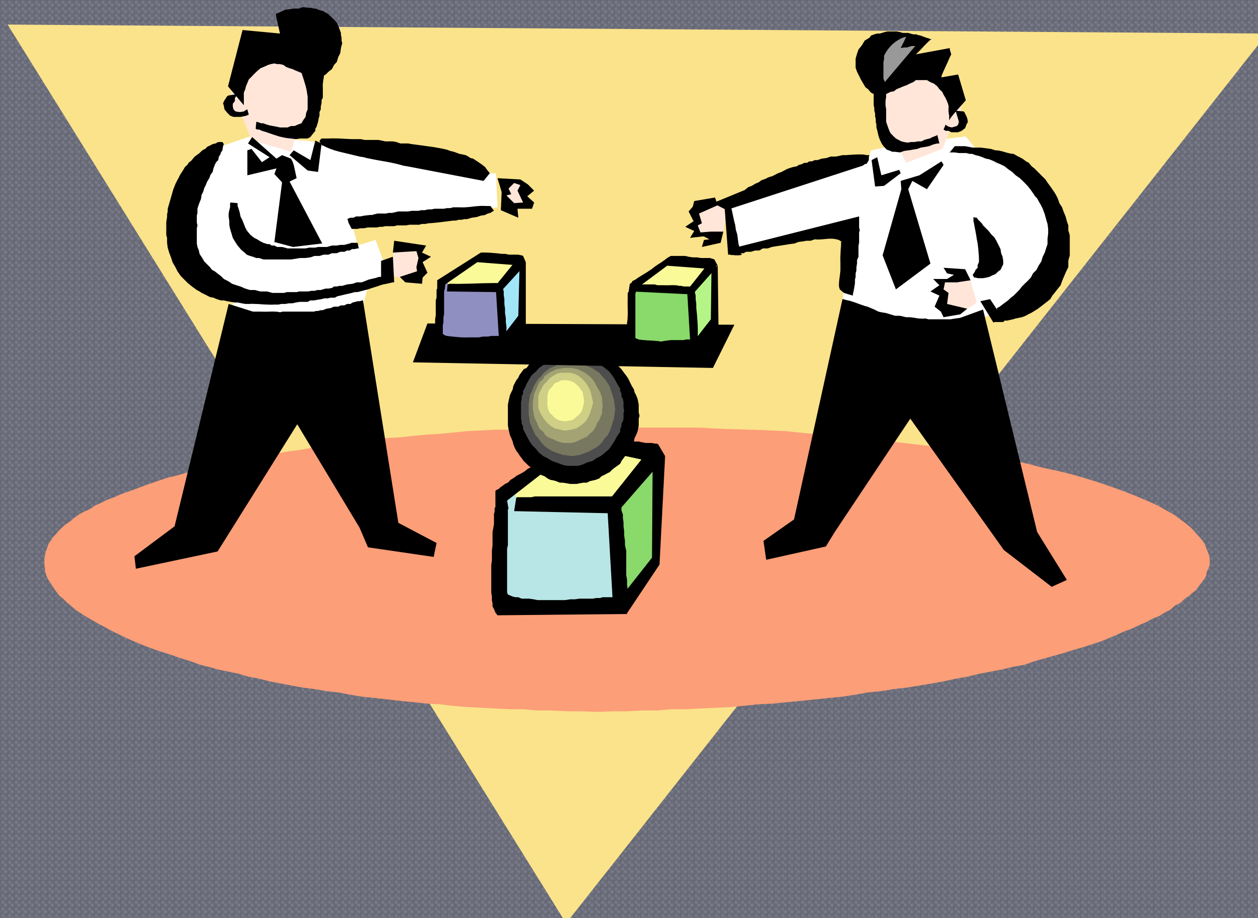


Finding the Balance:

District's Definition of BMP, Volume 3

"A technique, process, activity, or structure used to reduce pollutant discharges in stormwater. BMPs include source control practices (non-structural BMPs) and engineered structures designed to treat runoff. BMPs are most effective when used in combination and selected and designed based on site-specific characteristics."

The Four Step Process:



Challenge with NPDES Process:

Focus on pollutant prevention through source control and treatment control BMPs

Neglects stream restoration and may even create barriers to it

Long term water quality benefits do not outweigh good construction practices

But we can't afford to miss the full benefits of permanent stream restoration because of not being recognized in the NPDES process

How to Implement the Balance?

Develop an alternative BMP guidance and review process for stream restoration projects

- Consider partnership with pre-qualified drainageway specialty contractors
- Flexible BMP selection and implementation
- Take better advantage of the pre-construction process with the contractor
- Standardized reports and forms that can be applied to multiple stream restoration projects

Water Quality

Before stream restoration

After stream restoration

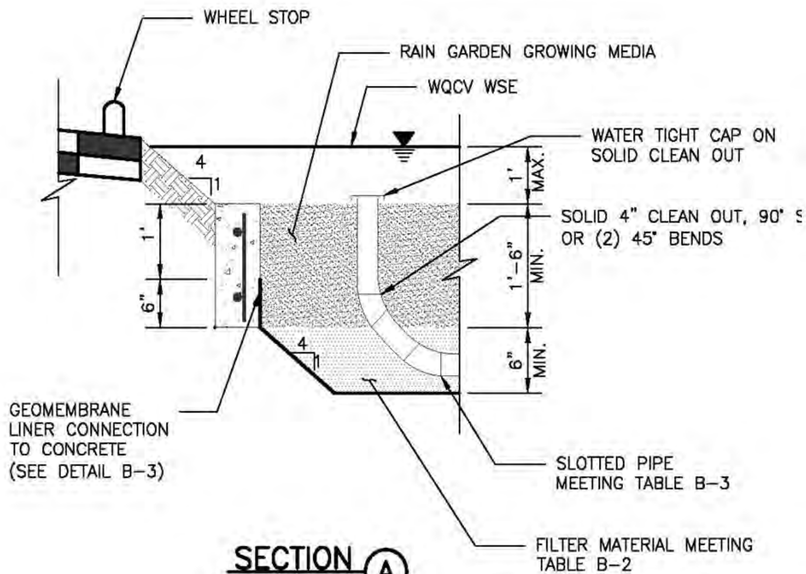
Questions?

Rain Garden Design and Construction Considerations

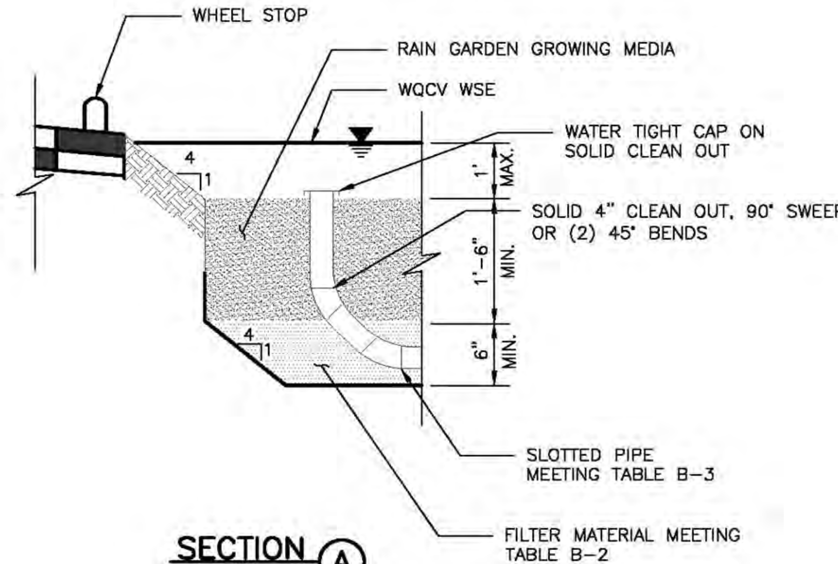
Holly Piza, PE, UDFCD
and
Erik Nelson, Douglas County

2011 Urban Drainage Seminar

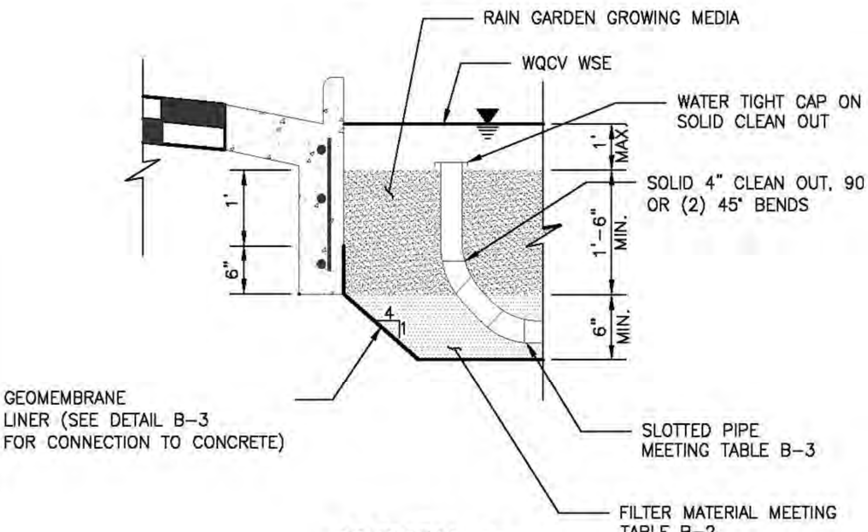
Rain Gardens



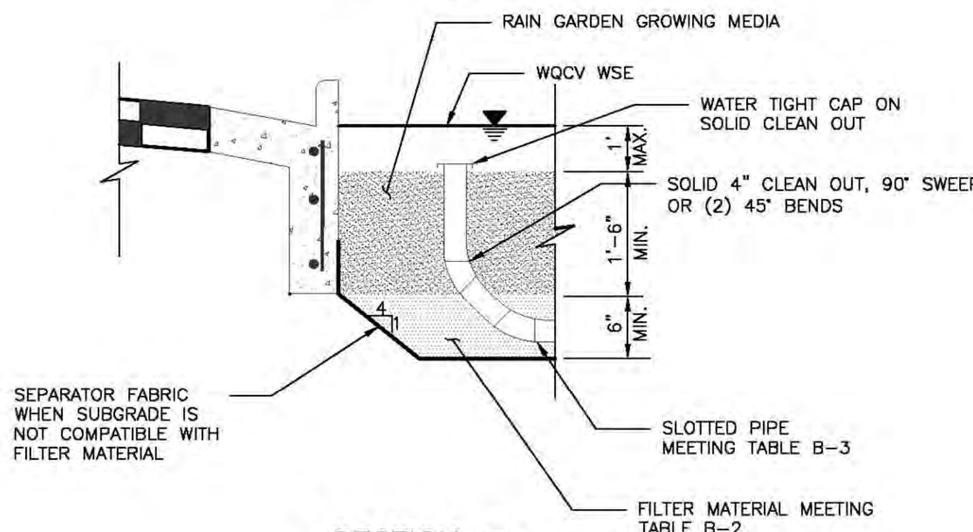
SECTION A
NTS



SECTION A
NTS



SECTION B
NTS



SECTION B
NTS

NO-INFILTRATION SECTIONS

PARTIAL INFILTRATION SECTIONS

21st and Iris

21st and Iris

Project Sponsors

- UDFCD
- Lakewood
- UWRI
- CSC
- Contech

Design
Muller Engineering

Construction
Edge Contracting

Watershed

1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a (100% if all paved and roofed areas upstream of rain garden)	I_a =	47.0	%
B) Tributary Area's Imperviousness Ratio ($i = I_a/100$)	i =	0.470	
C) Water Quality Capture Volume (WQCV) for a 12-hour Drain Time ($WQCV = 0.8 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i)$)	WQCV =	0.16	watershed inches
D) Contributing Watershed Area (including rain garden area)	Area =	83,300	sq ft
E) Water Quality Capture Volume (WQCV) Design Volume Vol = (WQCV / 12) * Area	V_{WQCV} =	1,101	cu ft

Depth, Surface Area and Volume

2. Basin Geometry

A) WQCV Depth (12-inch maximum)	D_{WQCV} =	6	in	
B) Rain Garden Side Slopes (Z = 4 min., horiz. dist per unit vertical) (Use "0" if rain garden has vertical walls)	Z =	0.00	ft / ft	
C) Mimimum Flat Surface Area	A_{Min} =	734	sq ft	
D) Actual Flat Surface Area	A_{Actual} =	1385	sq ft	
E) Area at Design Depth (Top Surface Area)	A_{Top} =	1385	sq ft	
F) Rain Garden Total Volume (V_T= ((A_{Top} + A_{Actual}) / 2) * Depth)	V_T=	693	cu ft	TOTAL VOLUME < DESIGN VOLUME

$$A \geq (2/3)\frac{V}{1\text{ foot}}$$

Where:

V= design volume (ft^3)

A = minimum filter area (flat surface area) (ft^2)

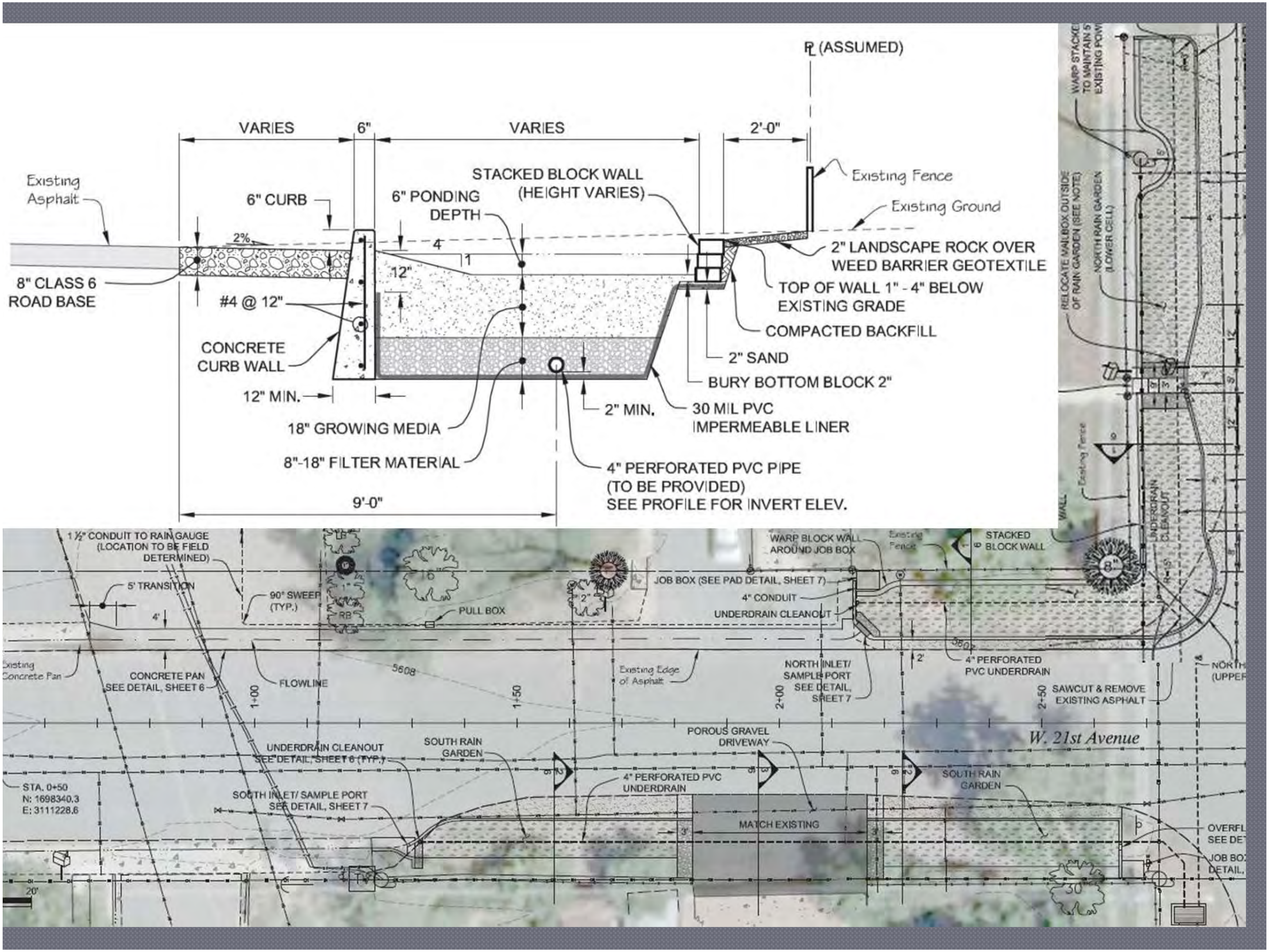
12-Hour Drain Time for Infiltrating BMPs

$$D_{12\ \text{hour drain time}} = \sqrt{\frac{V}{1414\, y^{0.41}}} \qquad \text{Equation B-3}$$

Where:

D	= orifice diameter (in)
y	= distance from the lowest elevation of the storage volume (i.e., surface of the filter) to the center of the orifice (ft)
V	= volume (WQCV or the portion of the WQCV in the rain garden) to drain in 12 hours (ft^3)

- Attenuation
- Increased volume reduction (evapotranspiration and infiltration)


PL (ASSUMED)
VARIES
6"
VARIES
2'-0"
Existing Fence
Existing Ground
Existing Asphalt
6" CURB
6" PONDING DEPTH
STACKED BLOCK WALL (HEIGHT VARIES)
2%
4
1
12"
8" CLASS 6 ROAD BASE
#4 @ 12"
CONCRETE CURB WALL
2" LANDSCAPE ROCK OVER WEED BARRIER GEOTEXTILE
TOP OF WALL 1" - 4" BELOW EXISTING GRADE
COMPACTED BACKFILL
2" SAND
BURY BOTTOM BLOCK 2"
12" MIN.
2" MIN.
30 MIL PVC IMPERMEABLE LINER
18" GROWING MEDIA
8"-18" FILTER MATERIAL
4" PERFORATED PVC PIPE (TO BE PROVIDED) SEE PROFILE FOR INVERT ELEV.
9'-0"
1 ½" CONDUIT TO RAIN GAUGE (LOCATION TO BE FIELD DETERMINED)
5' TRANSITION
90° SWEEP (TYP.)
PULL BOX
JOB BOX (SEE PAD DETAIL, SHEET 7)
4" CONDUIT
UNDERDRAIN CLEANOUT
WARP BLOCK WALL AROUND JOB BOX
STACKED BLOCK WALL
Existing Fence
Existing Concrete Pan
CONCRETE PAN SEE DETAIL, SHEET 6
FLOWLINE
Existing Edge of Asphalt
NORTH INLET/ SAMPLE PORT SEE DETAIL, SHEET 7
4" PERFORATED PVC UNDERDRAIN
SAWCUT & REMOVE EXISTING ASPHALT
1+00
1+50
2+00
2+50
W. 21st Avenue
UNDERDRAIN CLEANOUT SEE DETAIL, SHEET 6 (TYP.)
SOUTH RAIN GARDEN
POROUS GRAVEL DRIVEWAY
4" PERFORATED PVC UNDERDRAIN
SOUTH INLET/ SAMPLE PORT SEE DETAIL, SHEET 7
STA. 0+50
N: 1698340.3
E: 3111228.6
MATCH EXISTING
RELOCATE MAILBOX OUTSIDE OF RAIN GARDEN (SEE NOTE)
NORTH RAIN GARDEN (LOWER CELL)
UNDERDRAIN CLEANOUT

Description

A BMP that utilizes bioretention is an engineered, depressed landscape area designed to capture and filter or infiltrate the water quality capture volume (WQCV). BMPs that utilize bioretention are frequently referred to as rain gardens or porous landscape detention areas (PLDs). The term PLD is common in the Denver metropolitan area as this manual first published the BMP by this name in 1999. In an effort to be consistent with terms most prevalent in the stormwater industry, this document generally refers to the treatment process as *bioretention* and to the BMP as a *rain garden*.

Photograph B-1. This recently constructed rain garden provides bioretention of pollutants, as well as an attractive amenity for a residential building. Treatment should improve as vegetation matures.

The design of a rain garden may provide detention for events exceeding that of the WQCV. There are generally two ways to achieve this. The design can provide the flood control volume above the WQCV water surface elevation, with flows bypassing the filter usually by overtopping into an inlet designed to restrict the peak flow for a larger event (or events). Alternatively, the design can provide and slowly release the flood control volume in an area downstream of one or more rain gardens.

This infiltrating BMP requires consultation with a geotechnical engineer when proposed near a structure. A geotechnical engineer can assist with evaluating the suitability of soils, identifying potential impacts, and establishing minimum distances between the BMP and structures.

Bioretention (Rain Garden)	
Functions	
LID/Volume Red.	Yes
WQCV Capture	Yes
WQCV+Flood Control	Yes
Fact Sheet Includes EURV Guidance	No
Typical Effectiveness for Targeted Pollutants[3]	
Sediment/Solids	Very Good[1]
Nutrients	Moderate
Total Metals	Good
Bacteria	Moderate
Other Considerations	
Life-cycle Costs[4]	Moderate

[1] Not recommended for watersheds with high sediment yields (unless pretreatment is provided).

[3] Based primarily on data from the International Stormwater BMP Database (www.bmpdatabase.org).

[4] Based primarily on BMP-REALCOST available at www.udfcd.org. Analysis based on a single installation (not based on the maximum recommended watershed tributary to each BMP).

Terminology

The term *bioretention* refers to the treatment process although it is also frequently used to describe a BMP that provides biological uptake and retention of the pollutants found in stormwater runoff. This BMP is frequently referred to as a *porous landscape detention (PLD) area* or *rain garden*.

Bioretention

Why not Peat?

- Environmental Impacts
- Peat is not produced in Colorado

Why Paper?

- Compost alone leaches more nutrients than desired
- Paper captures nutrients from the compost for slow release to roots
- Paper temporarily slows the infiltration rate of the media and retains moisture

UDFCD Rain Garden Media

- Rain Garden Compost Mixture (by volume)
  - 50% Class 1 STA registered compost (approximate bulk density 1000 lbs/CY)
  - 50% loosely packed shredded paper (approximate bulk density 50 to 100 lbs/CY)
- Rain Garden Growing Medium
  - 15% rain garden compost mixture described above (by volume)
  - 85% coarse sand (either Class C Filter Material or sand meeting ASTM C-33) (by volume)

Material Costs at 21st and Iris

Contractor	Class C Filter Material	Rain Garden Growing Media
A	$ 35.00	$ 121.00
B*	$ 67.00	$ 94.00
C	$ 49.00	$ 86.00
Average	$ 50.33	$ 100.33
final price	$ 65.00	$ 72.00

* low bid

Cost from supplier delivered to the site $32.99/CY or $25.38/ton (1.3 tons /CY)

21st and Iris Suppliers

Golf and Sport Solutions
Eric Pollock
Ft. Lupton, CO
970-284-6030

Resourceful Paper
Greeley, CO
970-353-1710

A1 Organics
Greeley, CO
970-590-9955







VOLVO


Feedback from the 2010 seminar

"I would like to see more videos included in the presentations. That captures your attention much more than just slides. Kudos to the girl who tested the porous pavement. Excellent job!"

Media Recommendations

- Ask who the suppliers are and how the materials will be mixed.
- Ask for certification of STA Class 1 compost.
- Observe it on site.







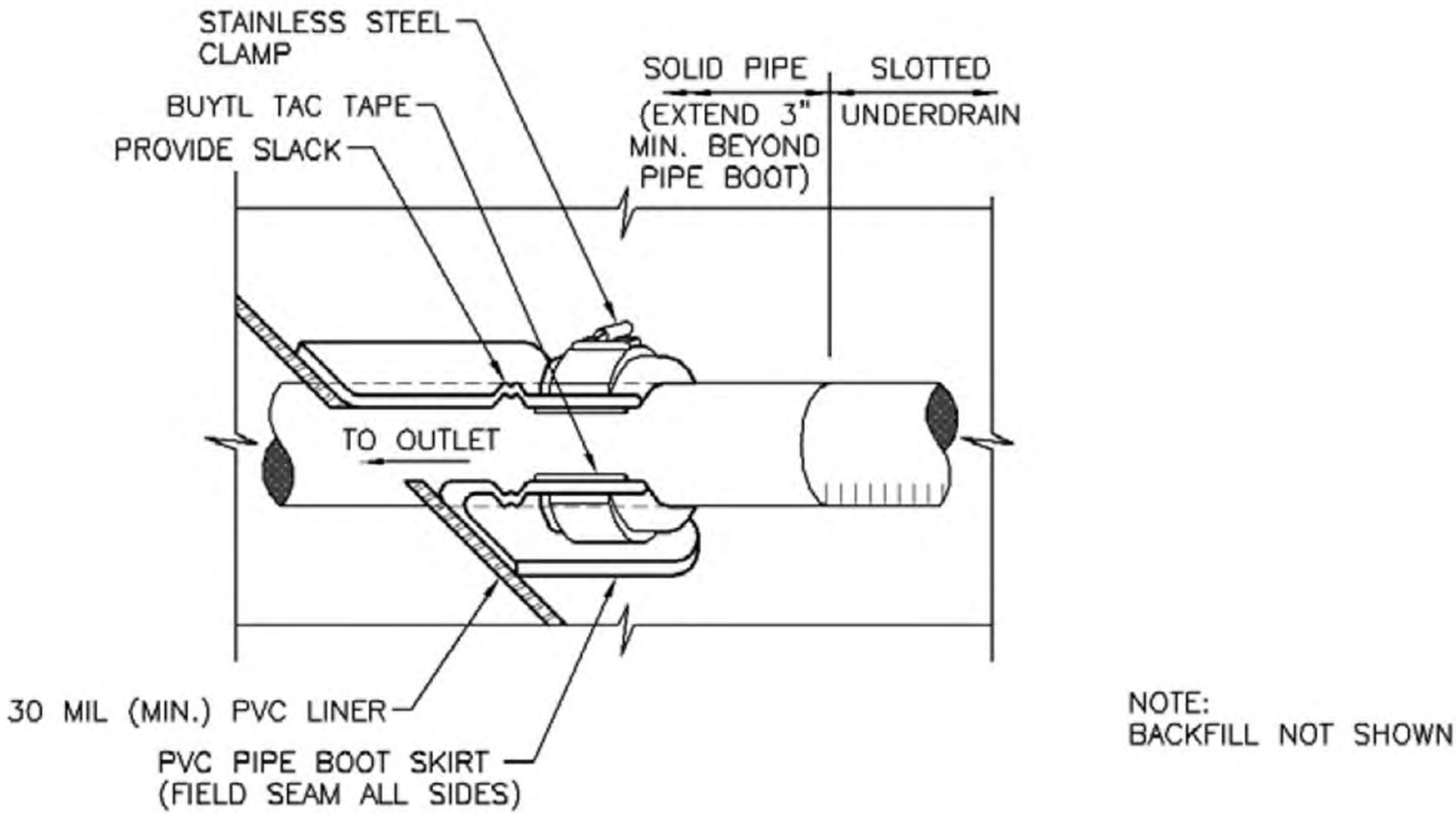
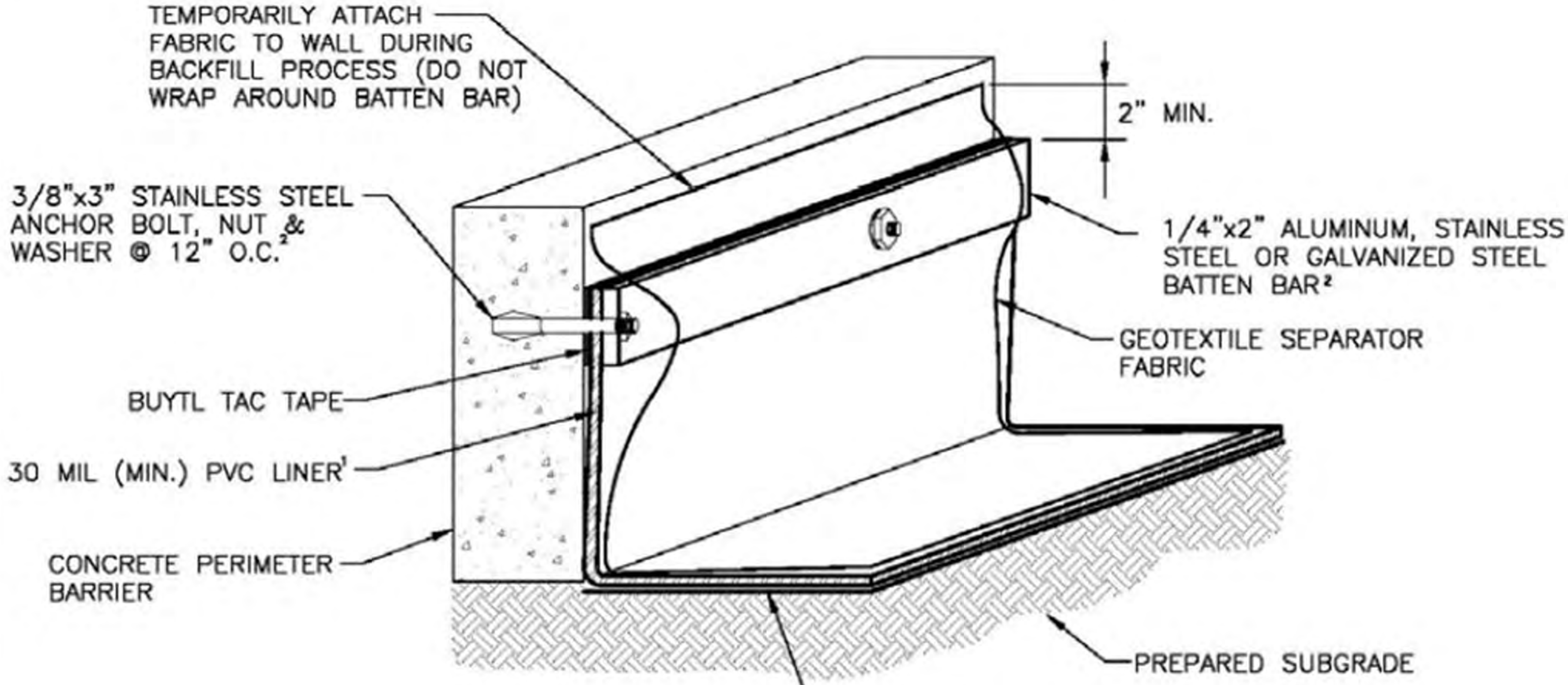


Figure PPS-4. Geomembrane Liner/Underdrain Penetration Detail



[1] PROVIDE SLACK IN LINER PLACEMENT TO ENSURE PROPER INSTALLATION AND BACKFILL WITHOUT DAMAGE

[2] NITRILE POLYMER BASED VINYL MEMBRANE SEAMING ADHESIVE MAY BE USED AS AN ALTERNATIVE TO THE BOLTED BATTEN BAR IN AREAS WHERE THE NEED FOR AN IMPERMEABLE LINER IS LESS CRITICAL.

NOTE:
BACKFILL AND UNDERDRAIN SYSTEM NOT SHOWN

Figure PPS-5. Geomembrane Liner/Concrete Connection Detail

Liner Recommendations

- Specify thermal welds at all seams
- Consider specifying "shop fabricated"
- Test seams after installation
- Be on site!

South Rain Garden at 21st and Iris

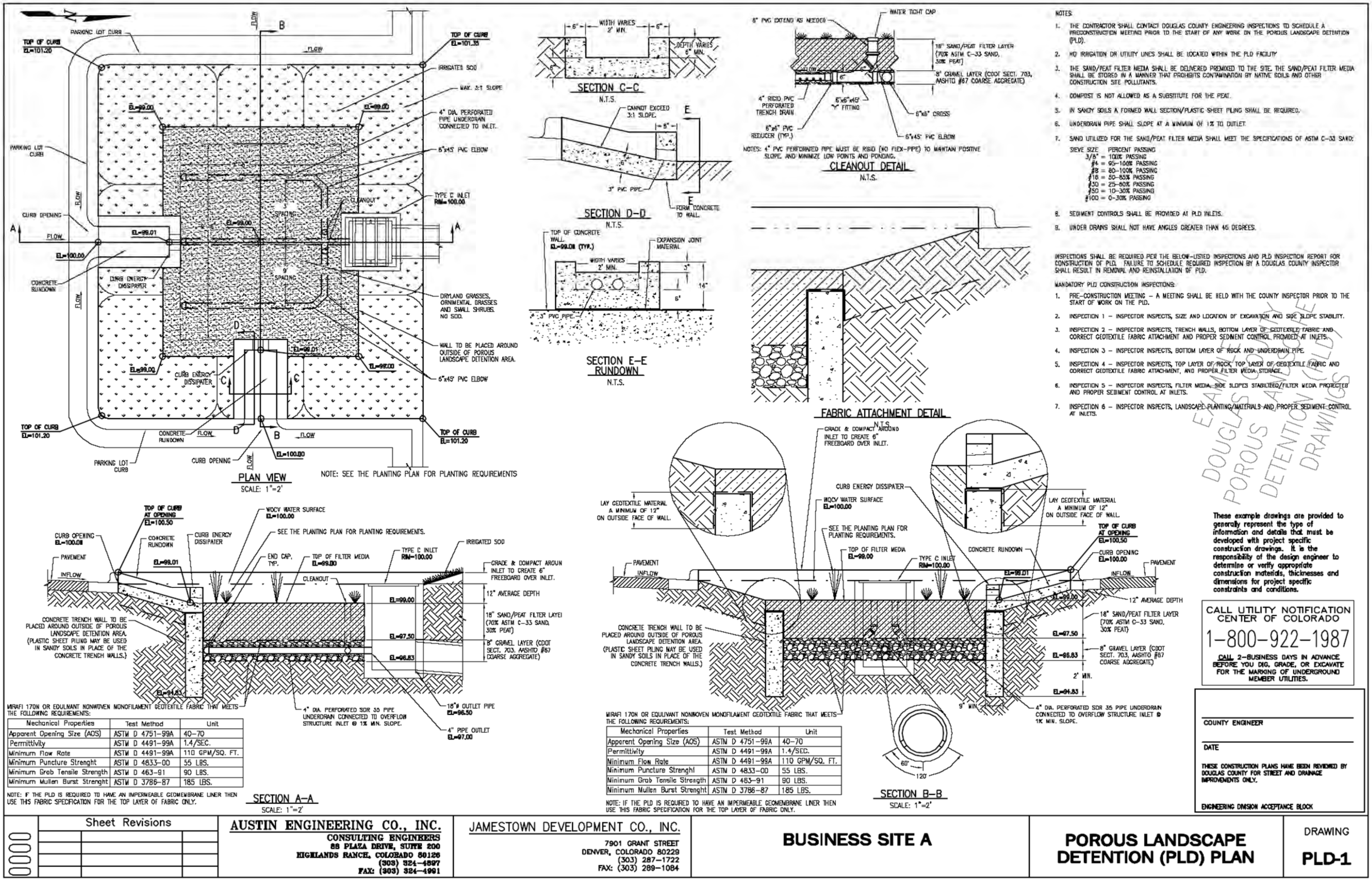
Rain Garden Issues

- Design and/or Review Issues
- Construction and/or Inspection Issues

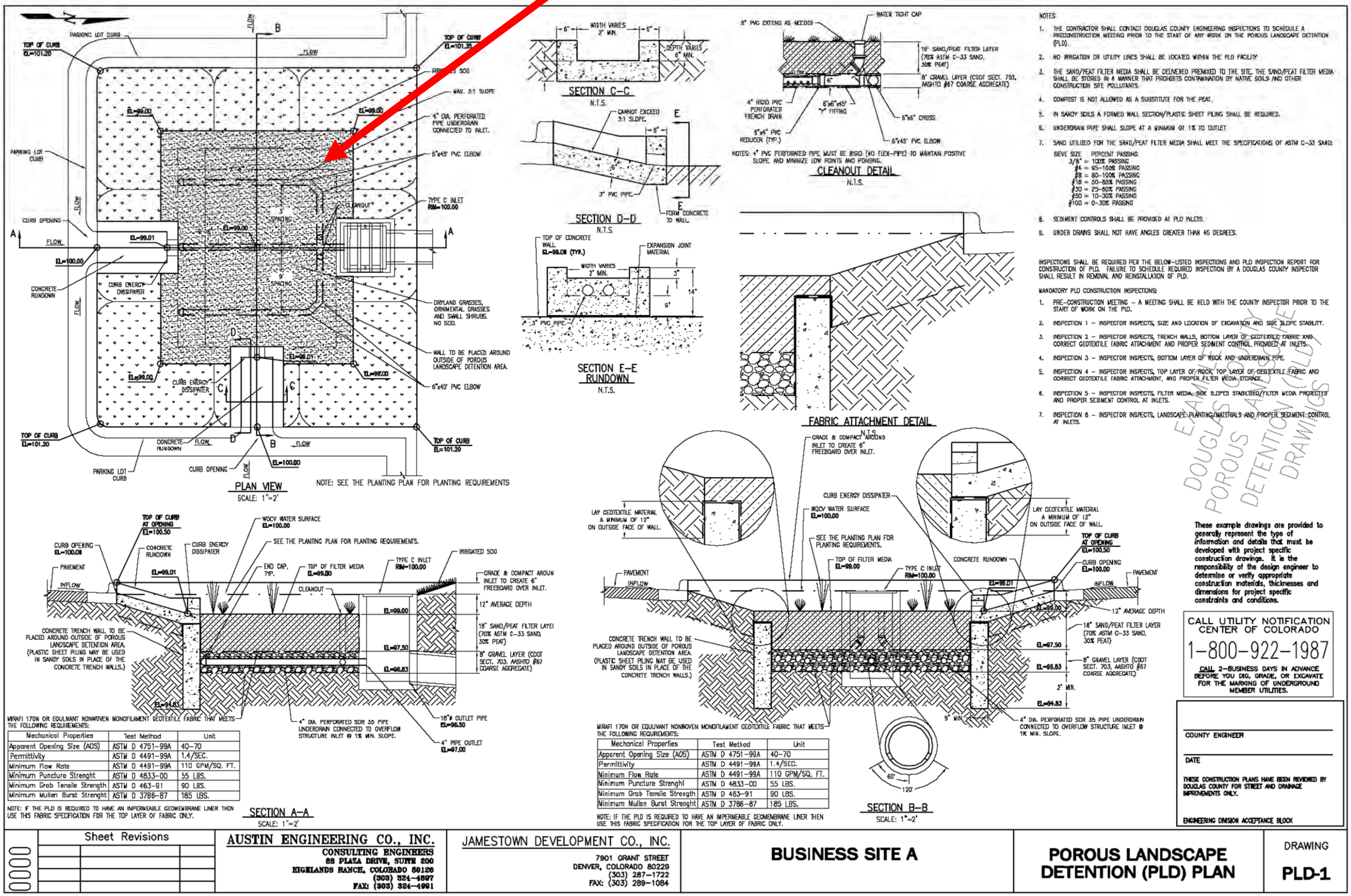
Overview of Design/Review Issues

- **Lack of complete details/plans**

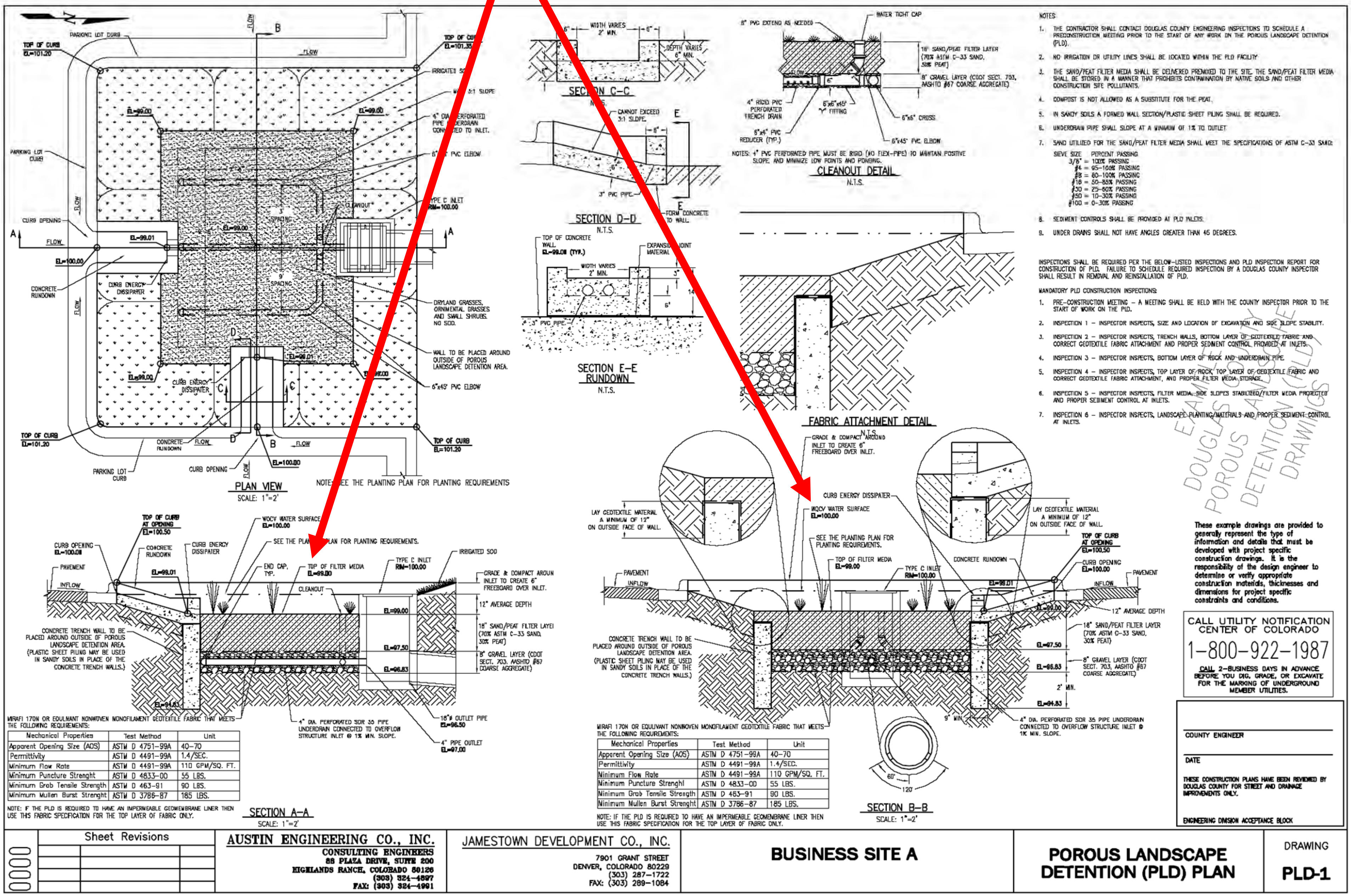
Construction drawings need to be comprehensive and have sufficient detail so that non-engineers, contractors, subcontractors and even laborers can successfully build off the plans.



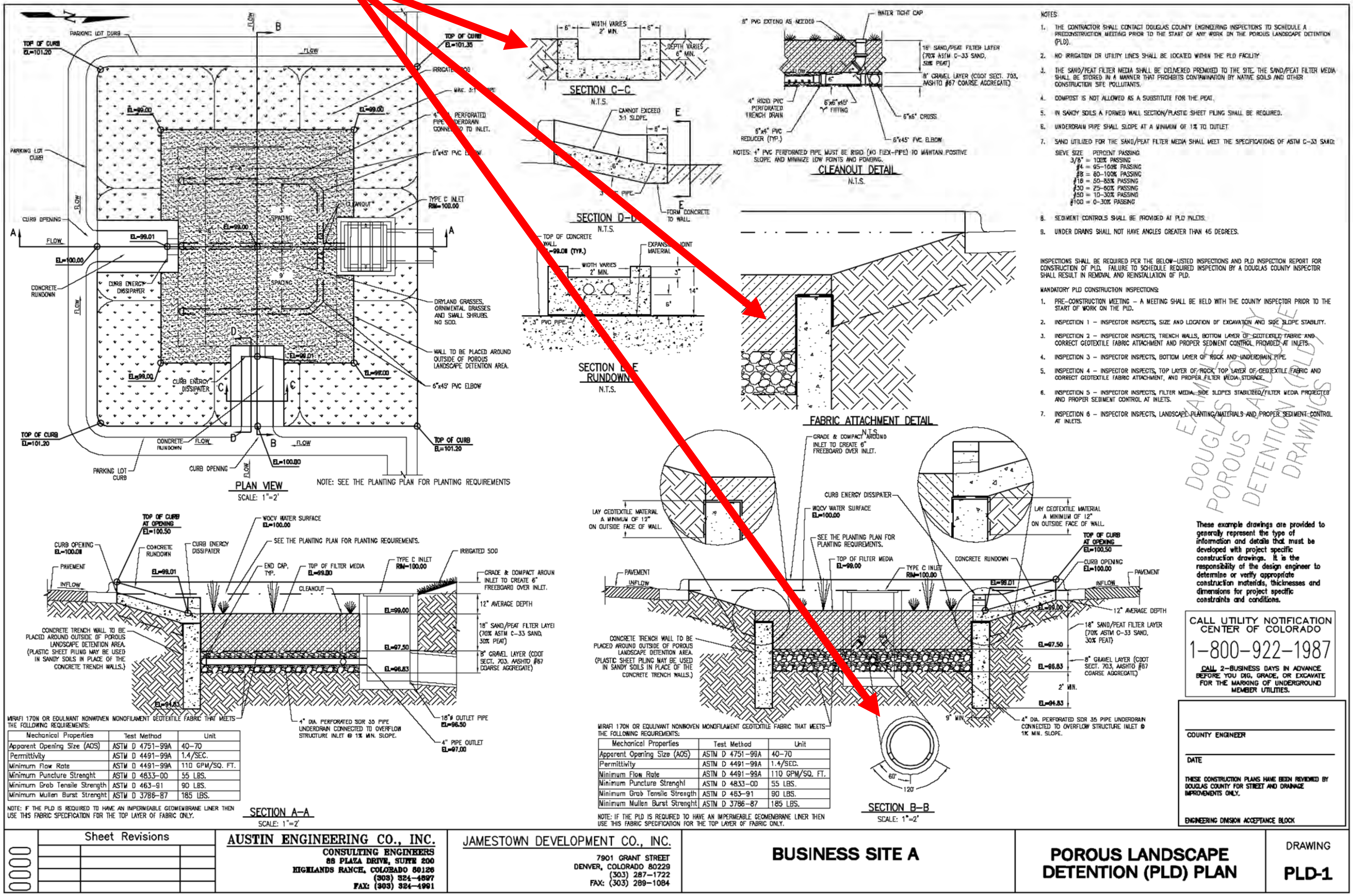
Construction drawings need detailed plan views that include dimensions, spot elevations, locations of components of the BMP



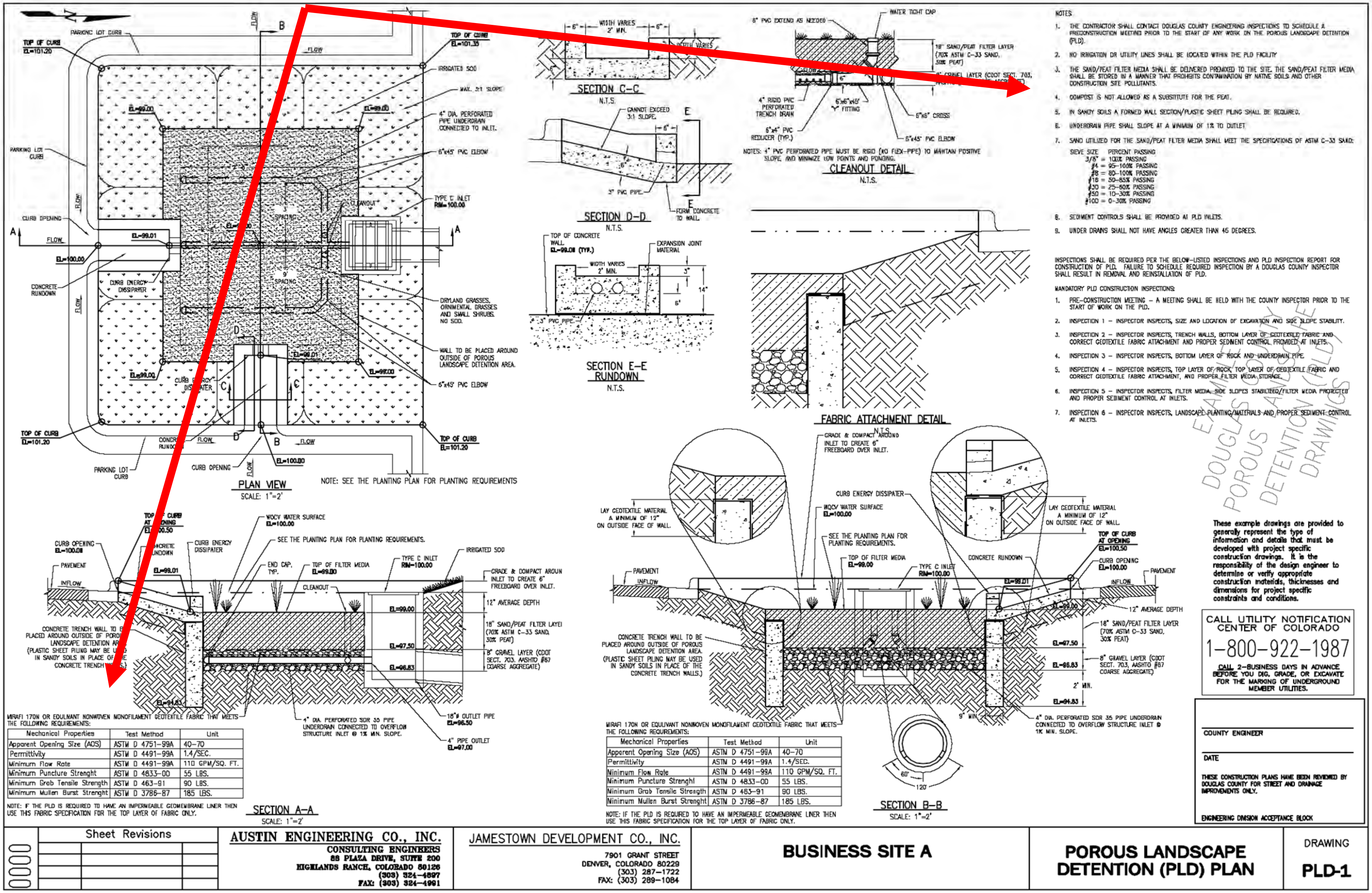
Construction drawings need detailed cross sections that include dimensions, spot elevations, depths, locations of components of the BMP



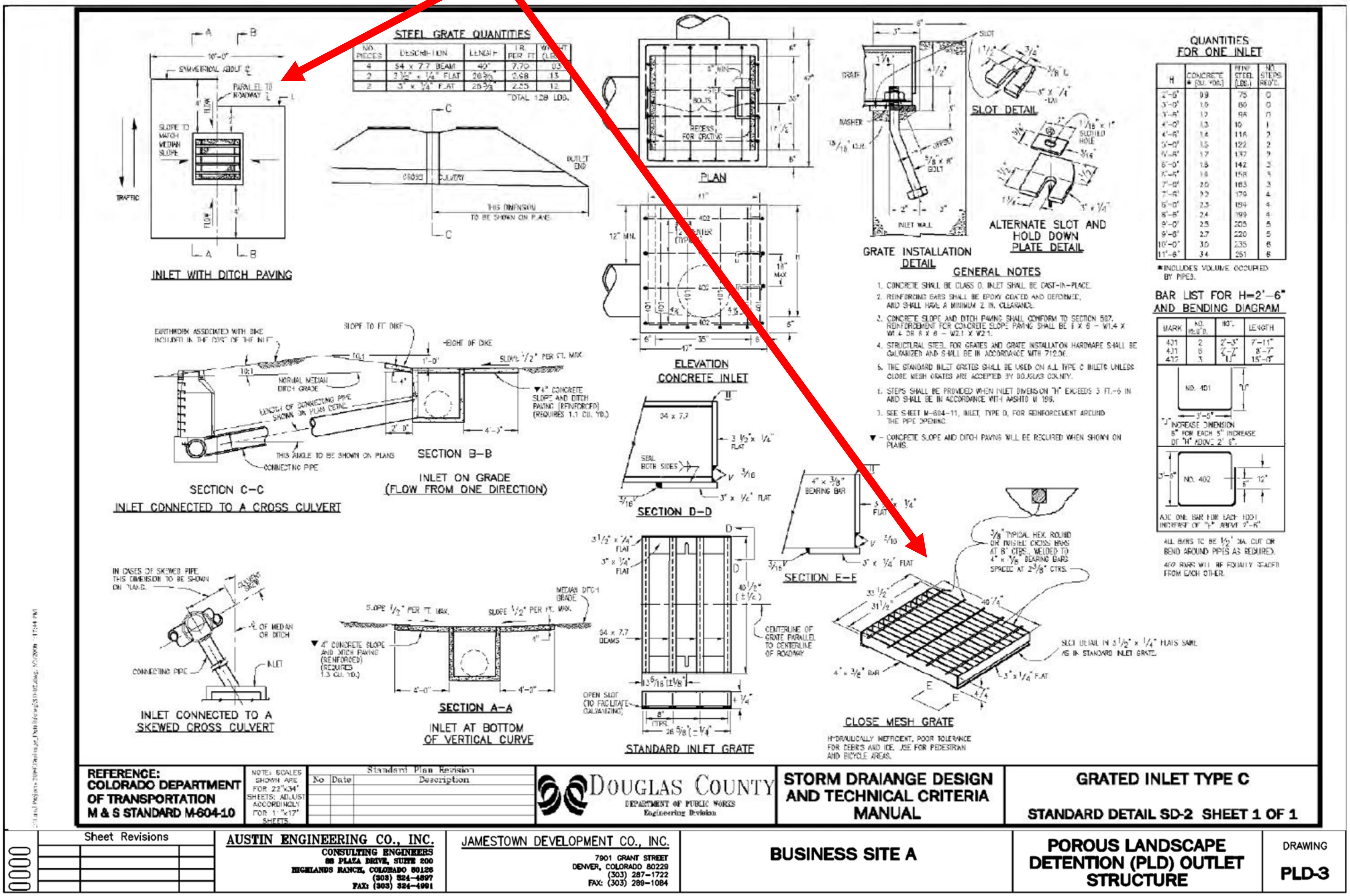
Construction drawings need "blown-up" details of different components of the BMP such as rundowns, under drains, liner/geotextile attachment, clean-outs, etc.



Construction drawings need notes that list specific information necessary to properly construct the BMP such as filter media mix, pipe specifications, geotextile/geomembrane specifications for mandatory inspection, etc



Construction drawings need details for all structures that are constructed as part of the BMP such as inlets, rundowns, grates, etc.



Overview of Design/Review Issues

- Lack of complete details/plans
- **Lack of field time/experience**

Overview of Design/Review Issues

Overview of Design/Review Issues

- Lack of complete details/plans
- **Failure to consult with experts in the field for specific design issues**

Overview of Design/Review Issues

Overview of Design/Review Issues

Overview of Design/Review Issues

- Lack of complete details/plans
- Failure to consult with experts in the field for specific design issues
- **Failure to consider maintenance during the design**

Overview of Design/Review Issues

Overview of Design/Review Issues

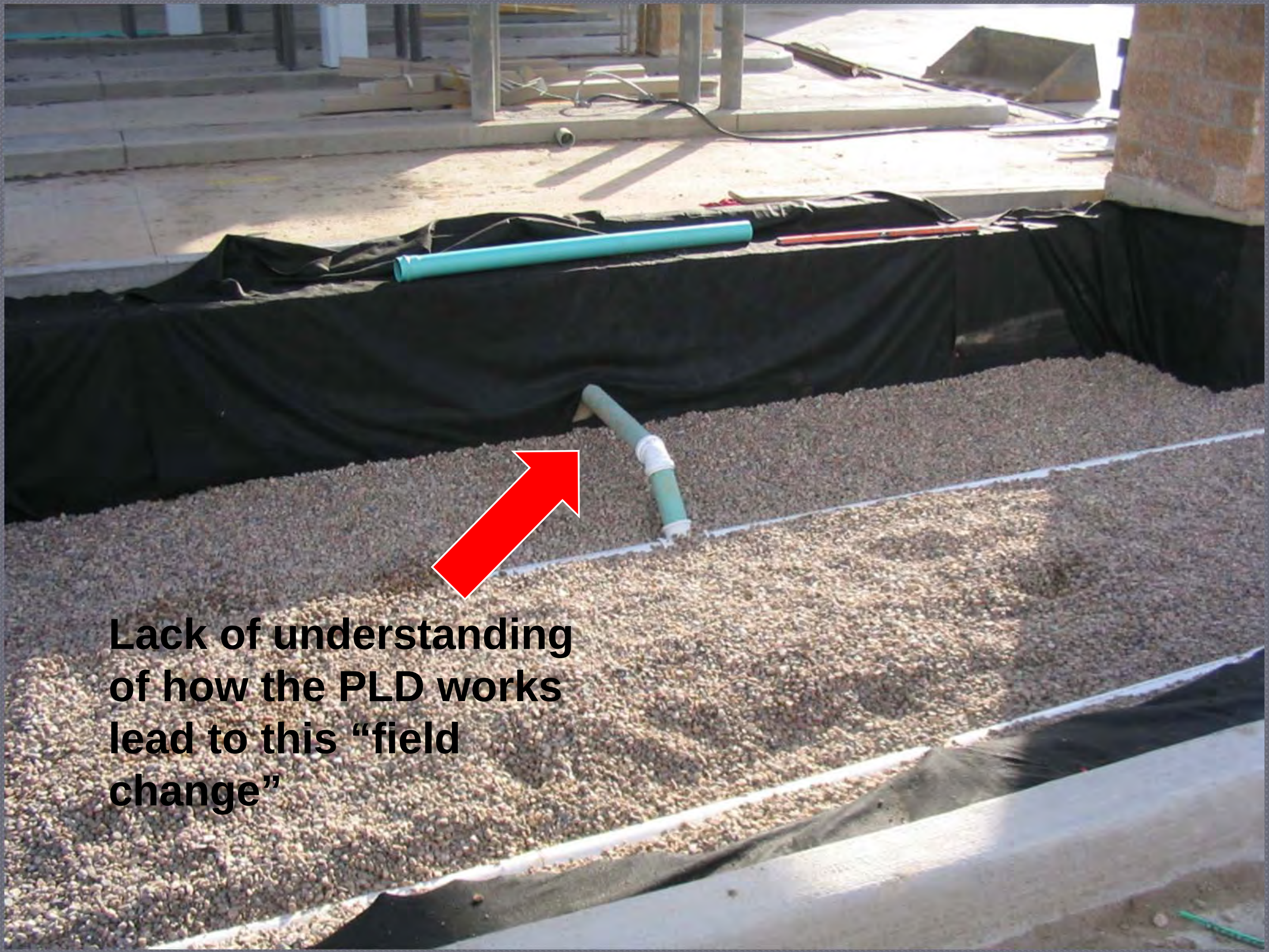
Overview of Design/Review Issues

Overview of Design/Review Issues

Overview of Construction/Inspection Issues

- **Lack of understanding by contractors/Inspectors on how different stormwater BMPs function**

Overview of Construction/Inspection Issues



Overview of Construction/Inspection Issues

Overview of Construction/Inspection Issues

- Lack of understanding by contractors/inspectors on how different stormwater BMPs function
- **Pressures to complete project on time and on budget results in "cost cutting measures"**

Overview of Construction/Inspection Issues


6 02 '98

Real World "Issues"

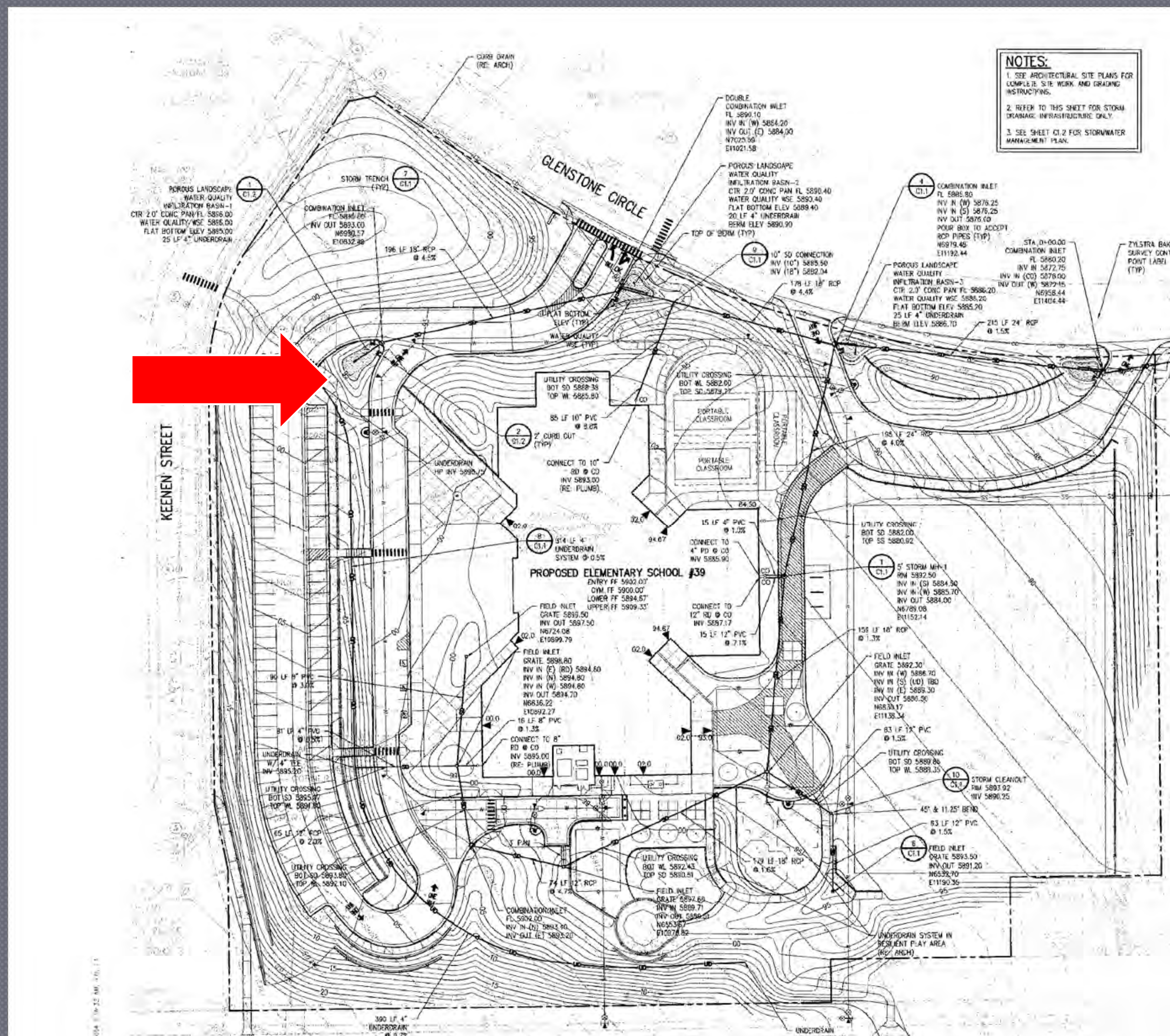
Several Rain Garden Projects

Each Project Had Several Problems.
They Were Caused By-

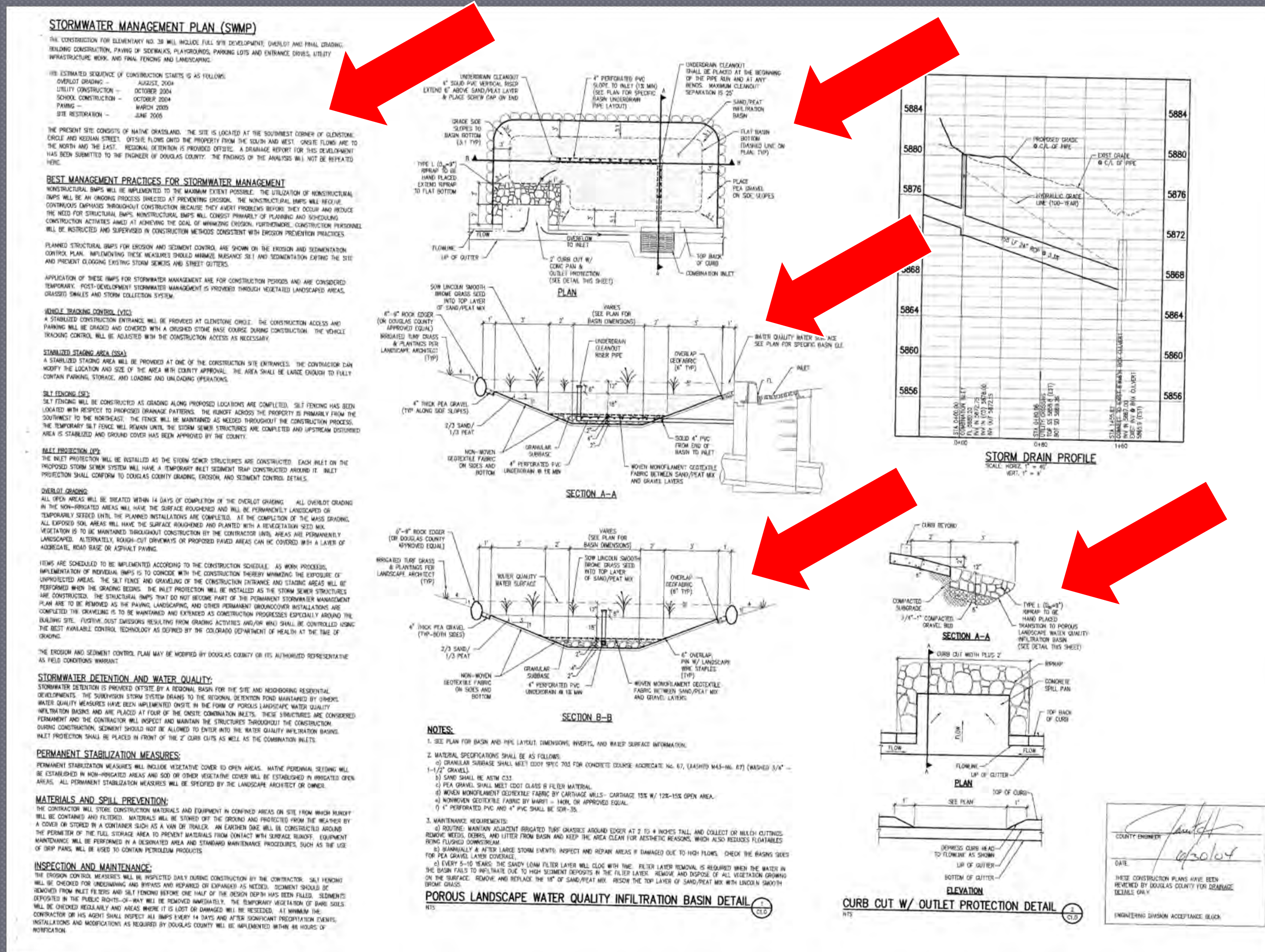
- Design Issues
- Review Issues
- Construction Issues
- Inspection Issues
- Any or All of the Above

Real World "Issues"

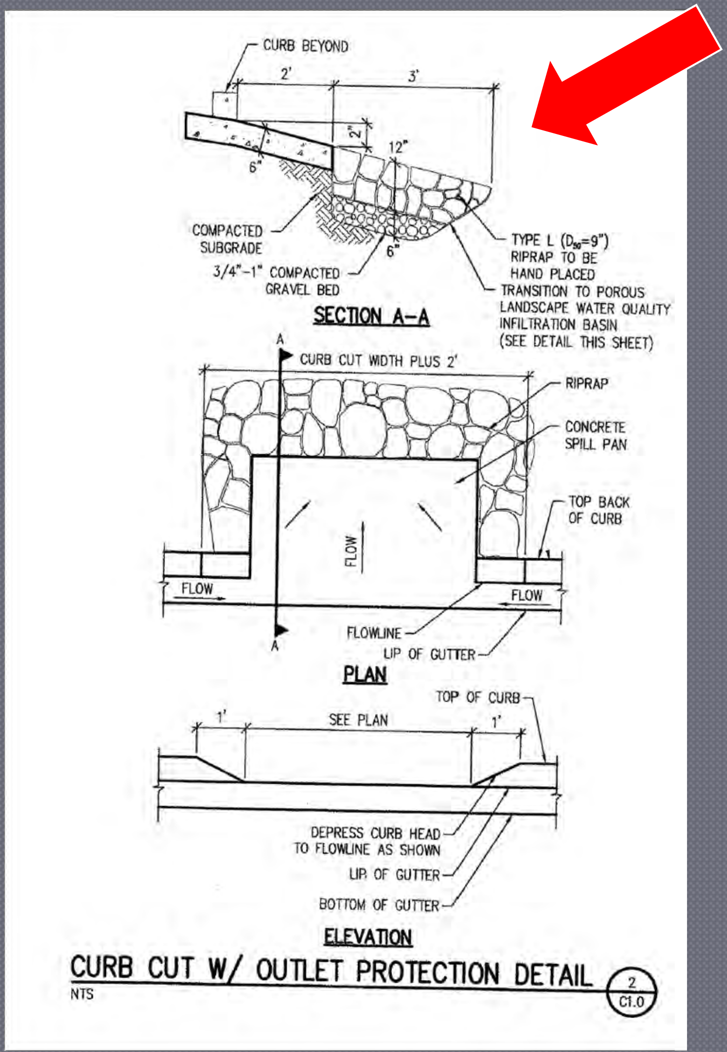
Real World "Issues"



Real World "Issues"



Real World "Issues"



Real World “Issues”

Real World "Issues"

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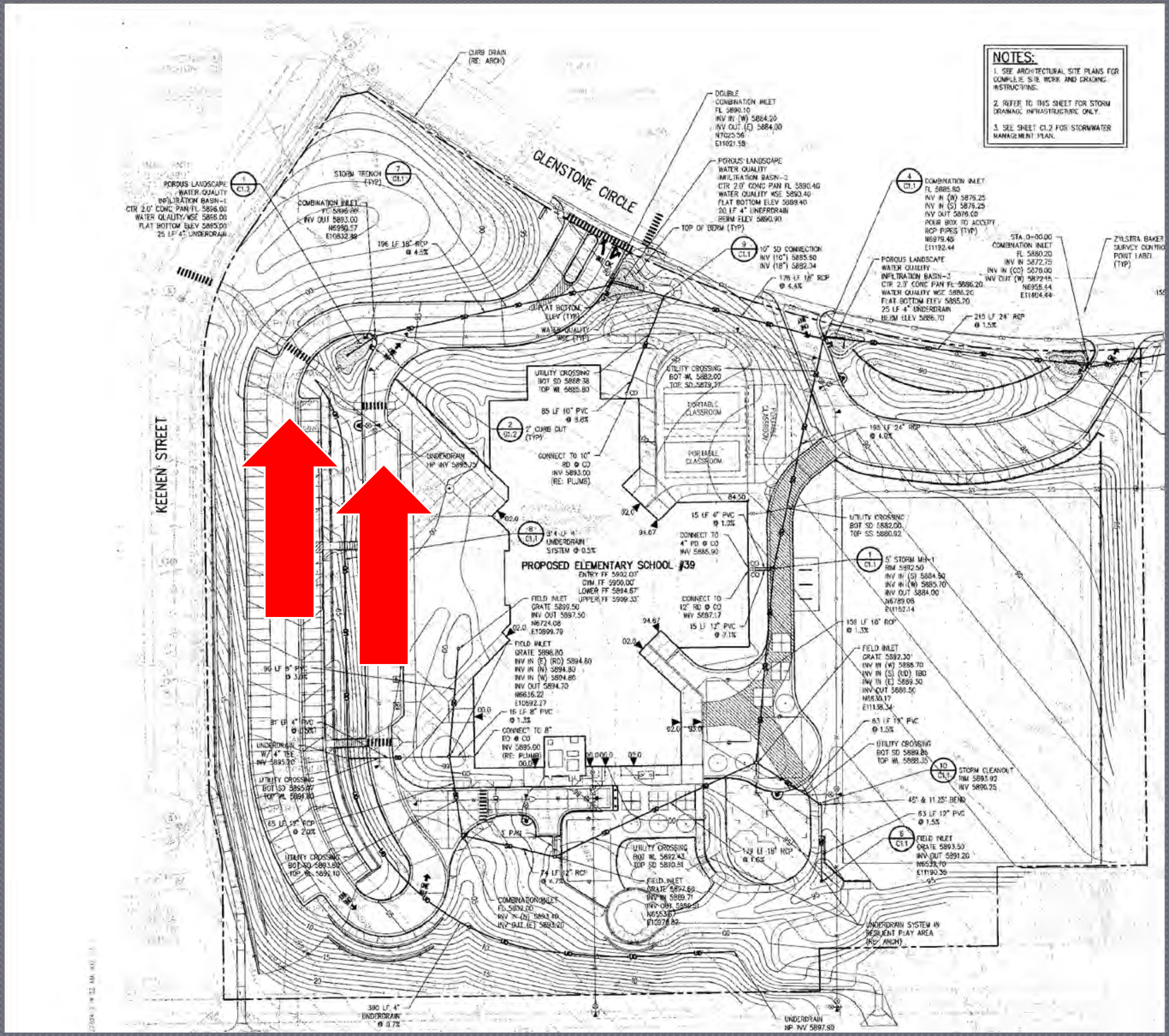
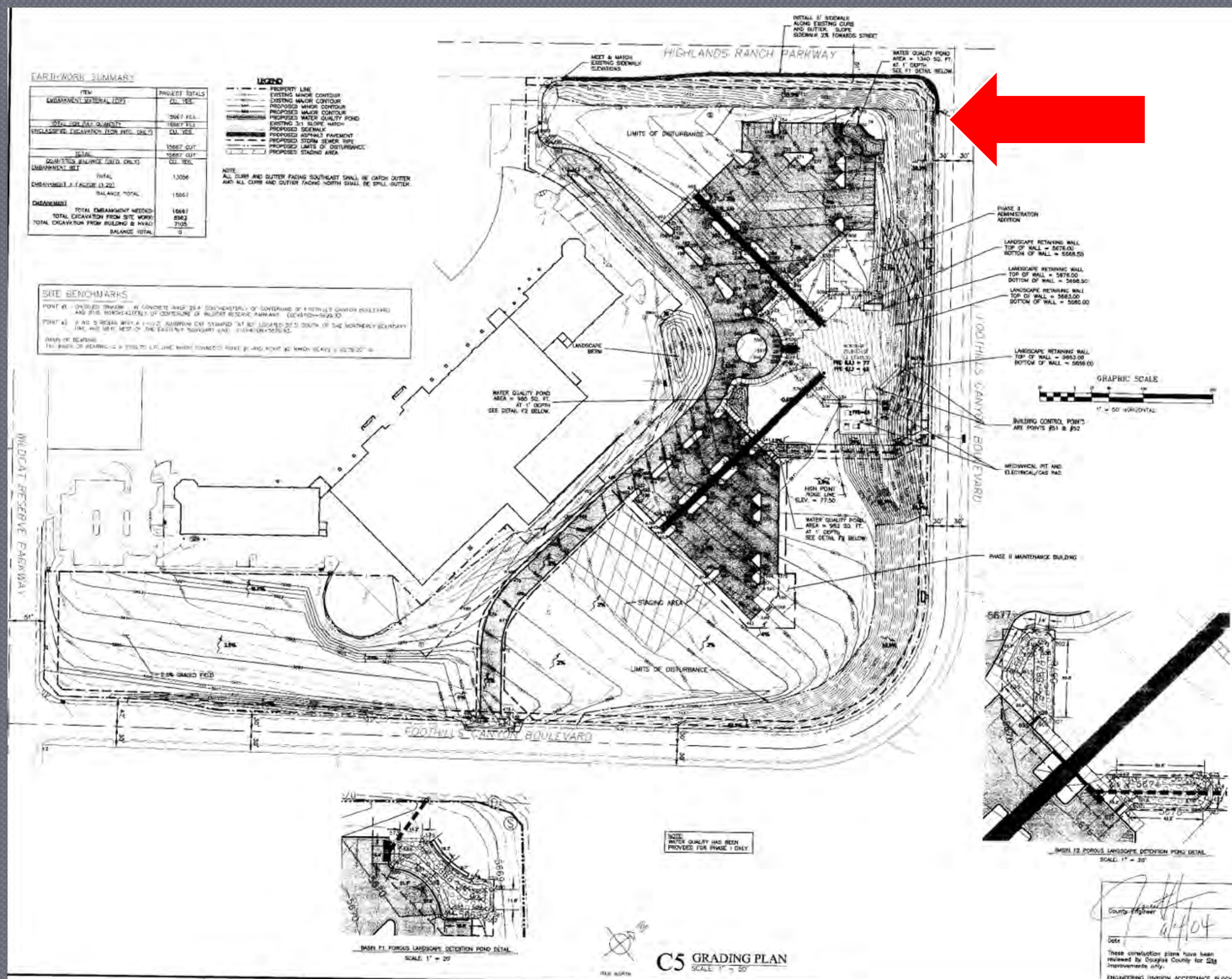


Real World "Issues"

Real World “Issues”

Real World "Issues"



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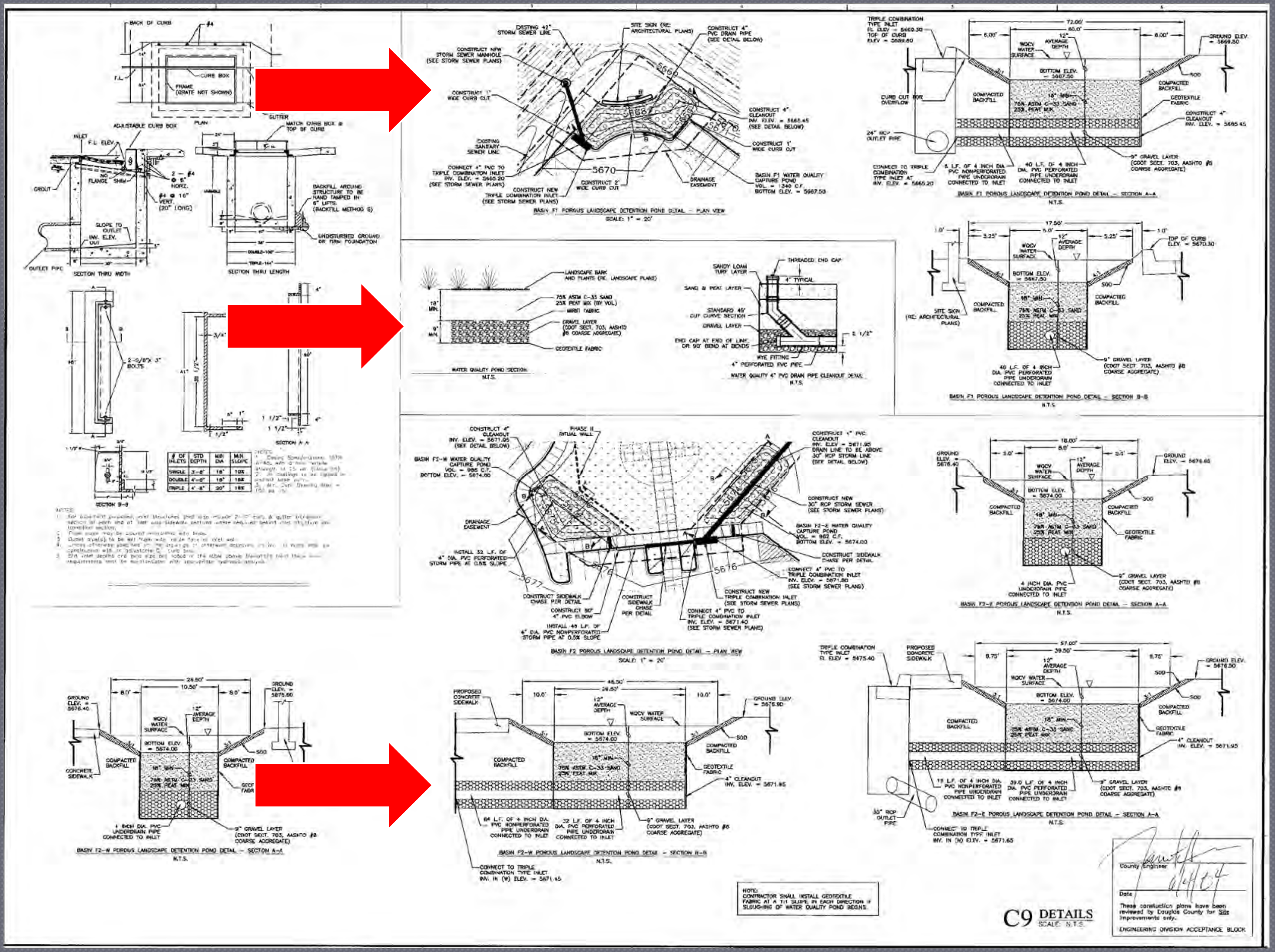

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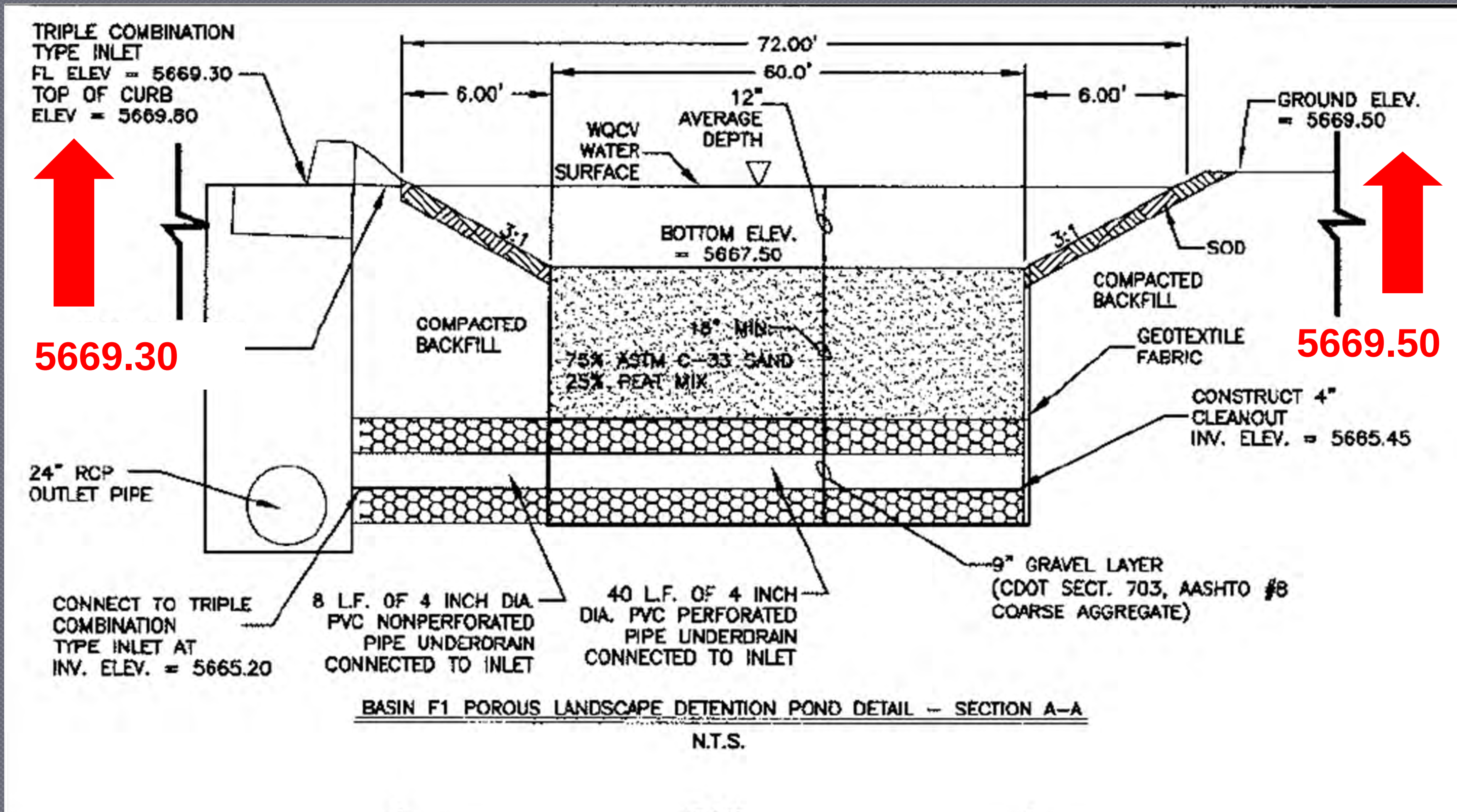

Real World "Issues"

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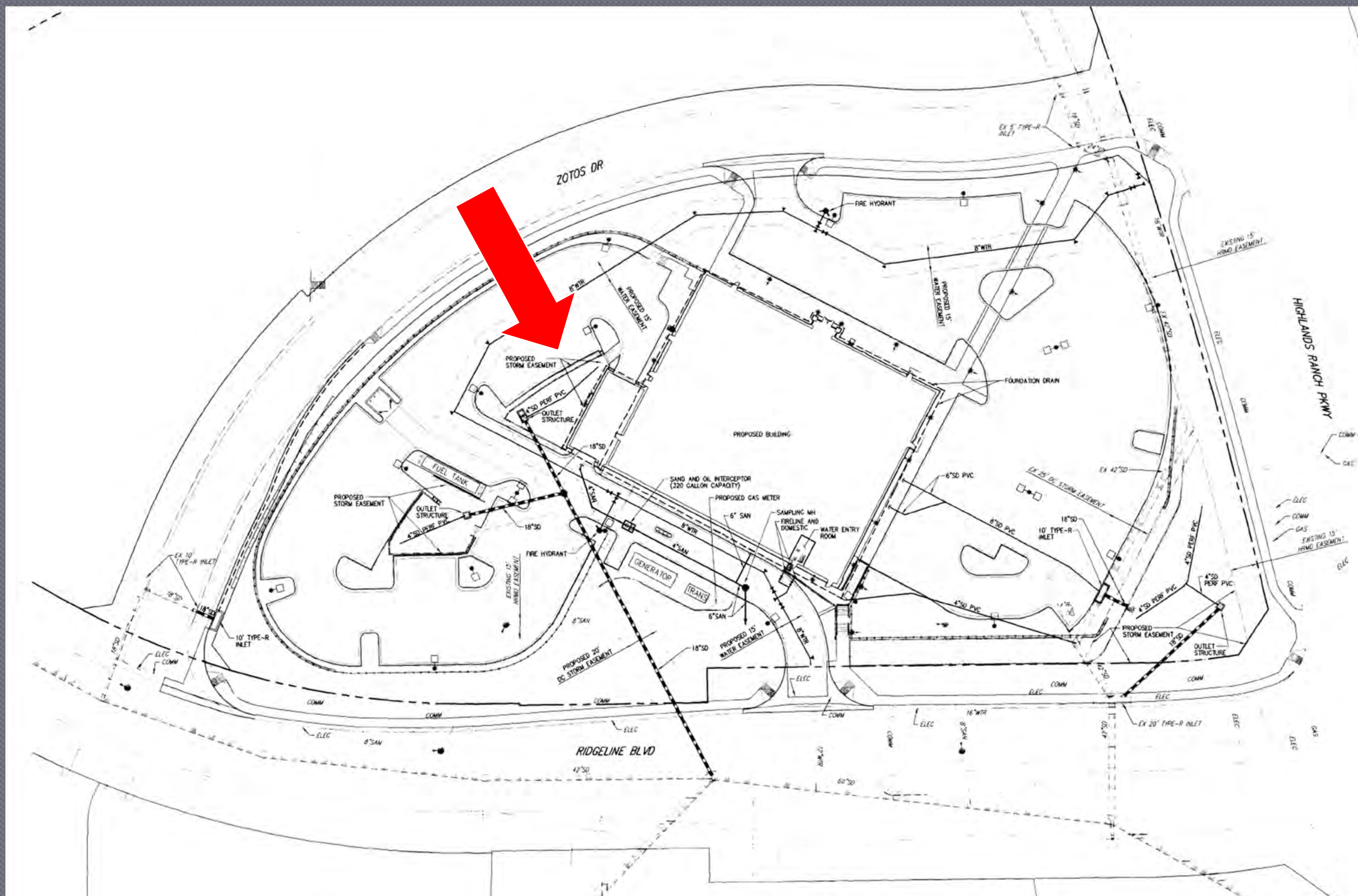

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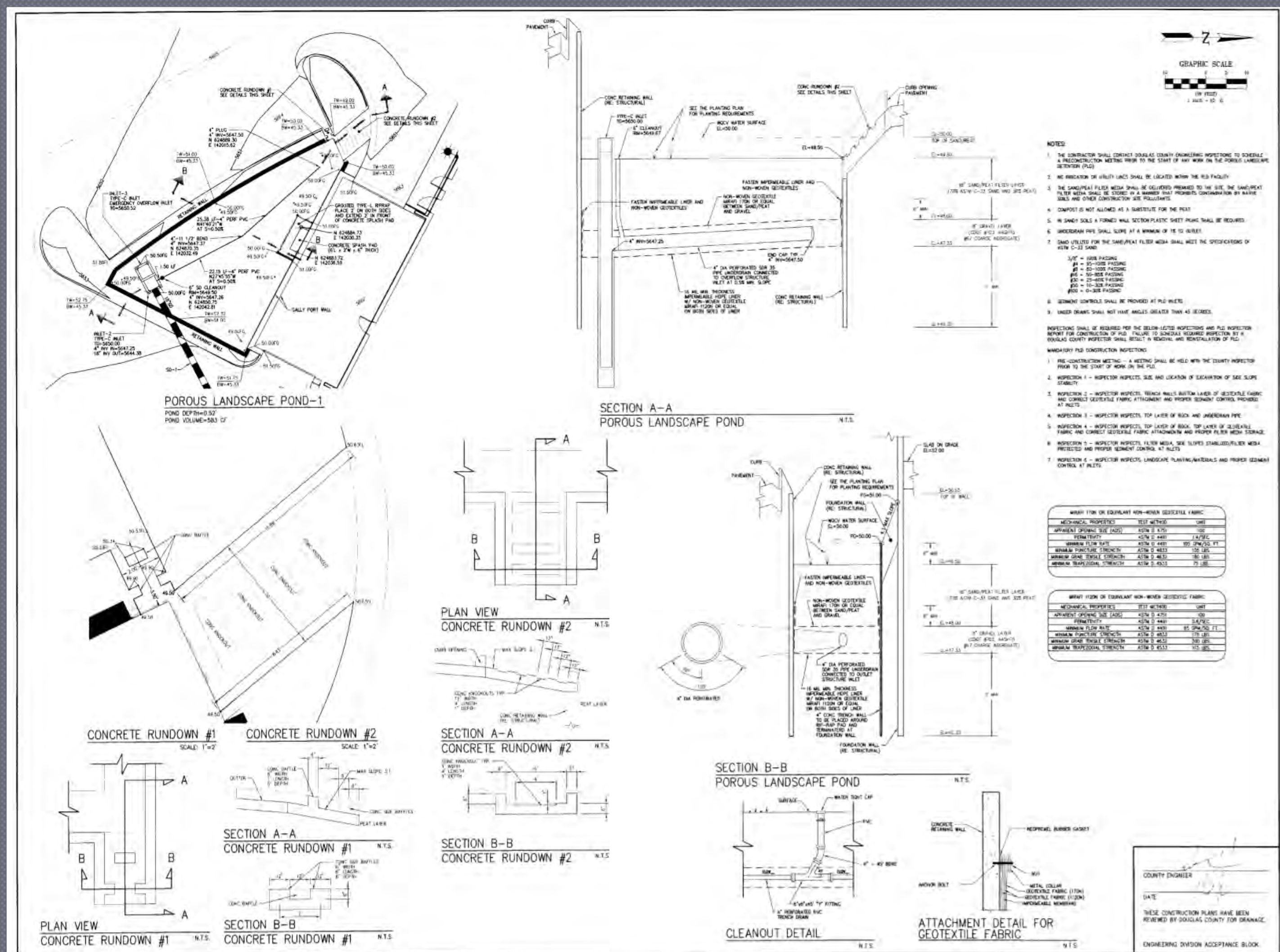


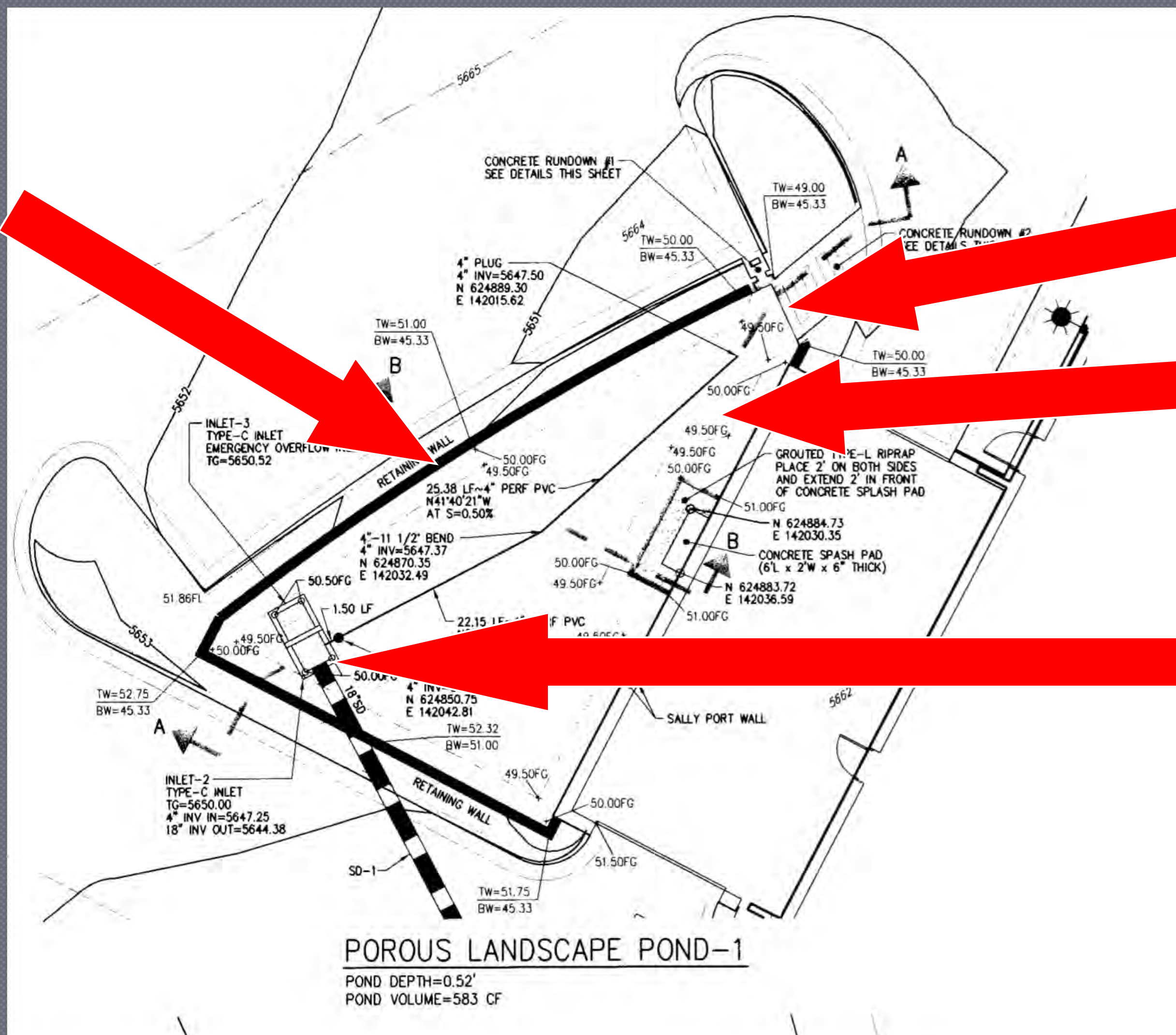
Real World "Issues"

50.00 F.G.

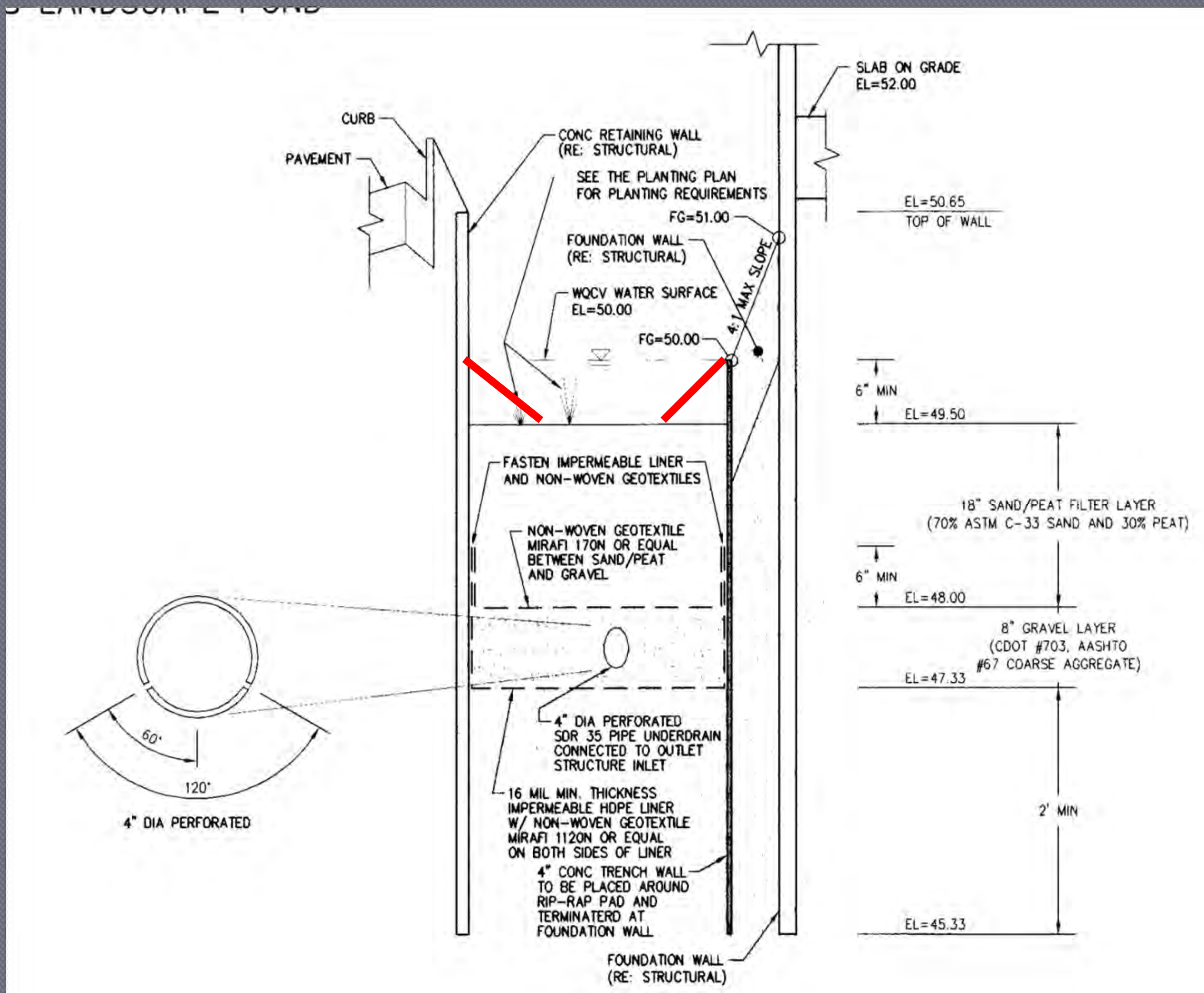
T.W. 50.00

49.50 F.G.

50.00 F.G.



Real World "Issues"



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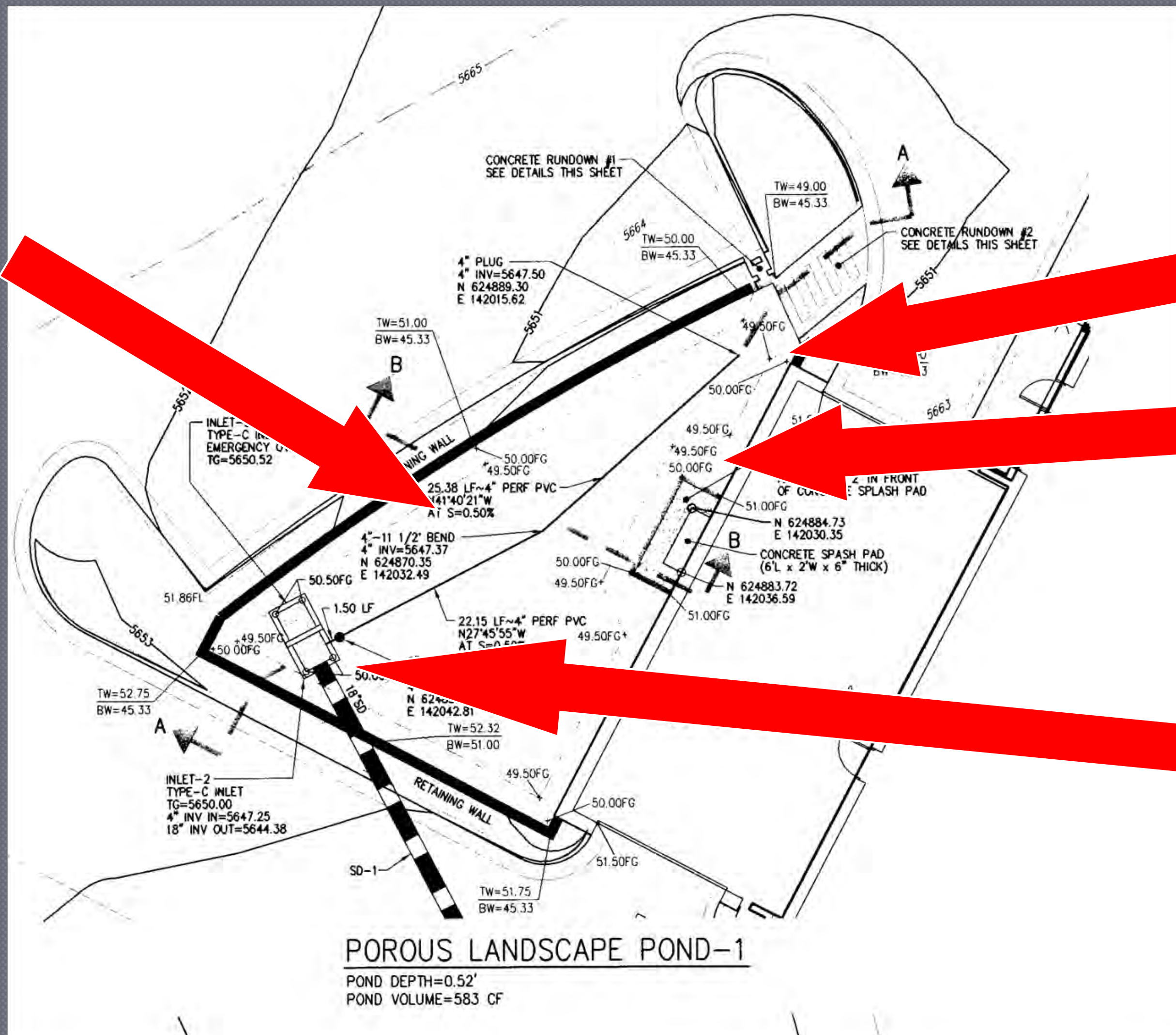


Real World "Issues"

Real World "Issues"

Real World "Issues"

“Lessons Learned”

- Complete Plans – Can a “rookie” build off them
- Ask for help
- Get training/field time

UDFCD Annual Seminar

Colorado Floodplain Rules and Regulations

Denver, Colorado

April 25, 2011

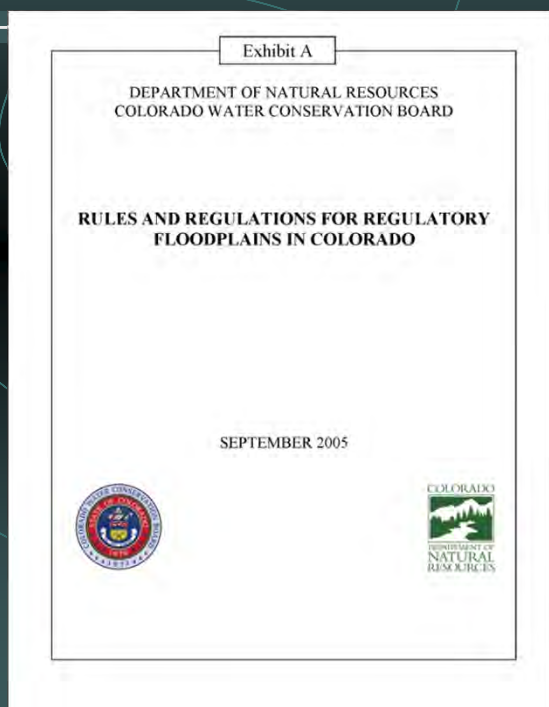
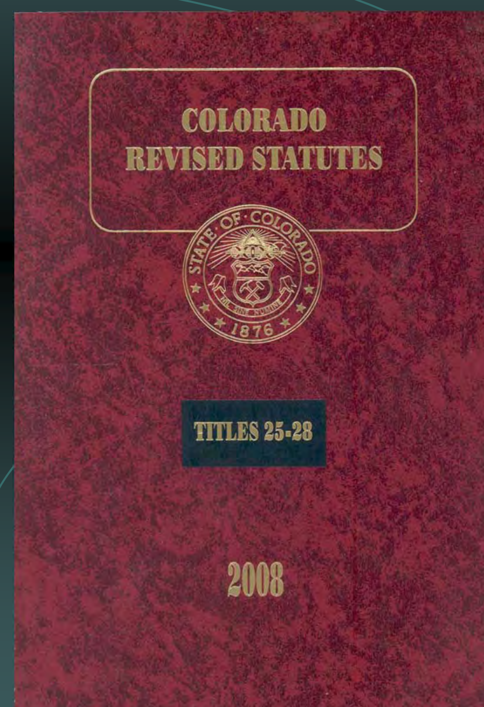


Exhibit A

DEPARTMENT OF NATURAL RESOURCES
COLORADO WATER CONSERVATION BOARD

RULES AND REGULATIONS FOR REGULATORY FLOODPLAINS IN COLORADO

SEPTEMBER 2005



Examples of Colorado Flood Events

- 10’s – Cherry Creek in Denver ($161 million, 2 deaths)
- 20’s – Arkansas River at Pueblo ($1.02 billion, 78 deaths)
- 30’s – Monument Creek ($69 million, 18 deaths)
- 50’s – Purgatoire River at Trinidad ($48 million, 2 deaths)
- 60’s – South Platte River in Denver ($2.95 billion, 8 deaths)
- 70’s – Big Thompson Canyon ($114 million, 144 deaths)
- 80’s – Heavy Snowmelt Runoff 1984 ($63 million, 2 deaths)
- 90’s – Fort Collins, Sterling, Lower Arkansas River ($518 million, 6 deaths)
- 00’s – No major disasters, but damages occurred

All values are in 2010 dollars

Since 1900, the AVERAGE annual flood losses in Colorado is over $50 million. 300 lives have been lost.

Statutory Floodplain Citations

- 24-65.1-101
  - It is the intent of the general assembly that land use, land use planning, and quality of development are matters in which the state has responsibility for the health, welfare, and safety of the people of the state and for the protection of the environment of the state.
  - Flooding as it relates to land use has been declared as a matter of statewide interest.
  - State agencies (e.g. CWCB) shall assist local governments to identify, designate, and adopt guidelines for administration of matters of state interest.

Statutory Floodplain Citations

- 24-65.1-202(2)(a)(I)
  - Floodplains shall be administered so as to minimize significant hazards to public health and safety or to property.
  - The CWCB shall promulgate model floodplain regulations.
  - Building of structures in the floodplain shall be designed in terms of the availability of flood protection devices, etc.
  - Need to reduce hazards to public health and safety or to property.
  - Activities shall be discouraged that, in time of flooding, would create significant hazards to public health and safety or to property.

Statutory Floodplain Citations

- 30-28-111(1)–(2)
  - For adequate safety, county planning commissions may regulate uses on or along any storm or floodwater runoff channel or basin only after designation and approval by the CWCB.
  - CWCB designation is required in order to reduce or avoid hazards to persons and damage to property resulting from floods.
  - The county planning commission or the board of adjustment of any county may condition any portion of a zoning resolution… upon the preservation, improvement, or construction of any storm or floodwater runoff channel designated and approved by the CWCB.
- Municipalities have a similar citation at 31-23-301(1)–(3)

Statutory Floodplain Citations

- 37-60-106(1)
- It is the duty of the board to promote the conservation of the waters of the state of Colorado in order to secure the greatest utilization of such waters and the utmost prevention of floods;

History of Rules and Regulations

- Rules initially promulgated 1987
- Rules revised in 2005
  - Revisions focused on updating mapping activities
- Revision in 2010
  - New Rules Became effective on January 14, 2011

Background for Rules and Regs

- Colorado statutes require state designation and approval of floodplain information prior to local regulation
- Flooding is considered an issue of statewide concern
- Rules were initially developed to provide mapping standards and outline processes for designation

FEMA Support for Higher Standards

- FEMA will support State-initiated enforcement actions by providing technical assistance and FEMA enforcement actions, even in instances where State regulations are more restrictive than the NFIP minimum criteria (FEMA CAP guidance document)

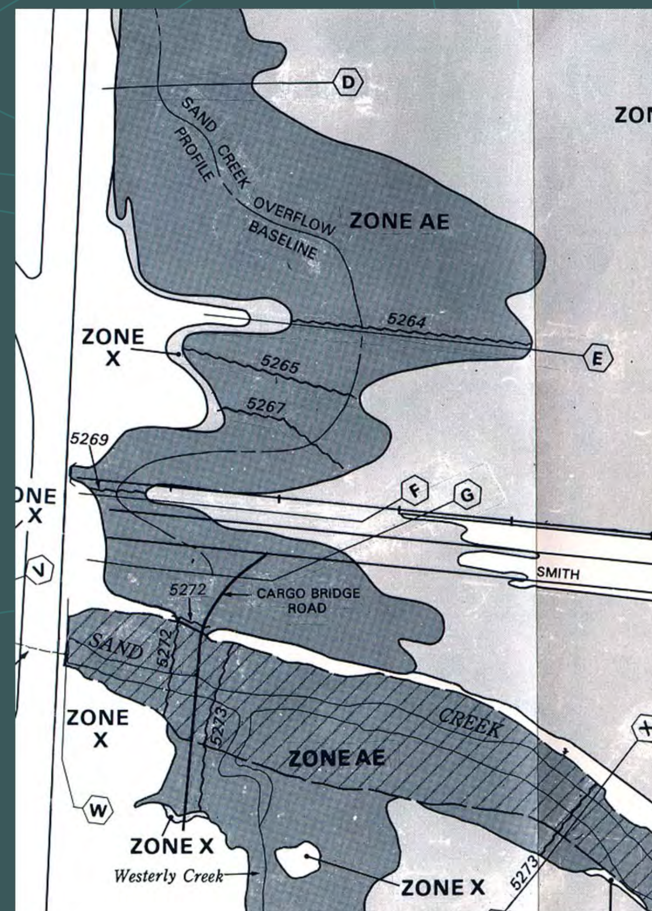
- 44 CFR 60.1(d) states that “any floodplain management regulations adopted by a State or a community which are more restrictive than the criteria set forth in this Part are encouraged and shall take precedence.”

Summary Statement Rule #3

- RULE 3 PURPOSE AND SCOPE
- Intent: Statement of purpose and scope
- Modifications: Clarification of which entities must follow Rules. In particular, explicit statement regarding the following:
  - All local communities, regardless of NFIP participation
  - All state agencies (clarification, not new)

Summary Statement Rule #5

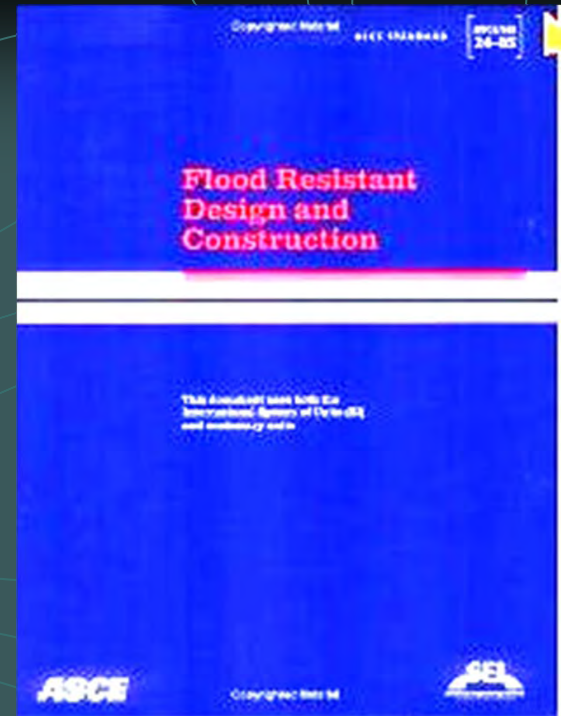
- <u>RULE 5</u>   STATE REGULATORY FLOODPLAIN
- **Intent:** Clarify definition of
- Regulatory floodplain
- **Modifications:** Lands removed by
- LOMR-F remain in regulatory
- floodplain for certain purposes. Added ability for CWCB to designate 500-year floodplains, but ONLY by community request



Summary Statement Rule #6

- RULE 6 CRITICAL FACILITIES
- Intent: Defines critical facilities and provides regulatory requirements for their development and use. Regulatory floodplain is the basis for these structures.
- Modifications: New Rule

Protection of Critical Facilities



- For critical facilities within the 100-year floodplain, structure shall be floodproofed or elevated to 100-year level plus two feet of freeboard
  - Consistent with International Building Code and Flood Resistant Design and Construction (ASCE 24-05), currently adopted by the State

Which Critical Facilities Do These Rules Apply To?

- New Critical Facilities
- Existing Critical Facilities that are Substantially Damaged or Substantially Improved
- Additions to Existing Facilities
- Critical Facilities are NOT prohibited in the floodplain!

Notes:

1. This is a similar requirement to all existing regulations, just to a higher standard.
2. Existing critical facilities are not affected by this rule.
3. A variance procedure exists when necessary

Critical Facilities

- Critical Facilities Include the Following:
  - Essential Service Facilities
  - Hazardous Materials Facilities
  - At-Risk Population Facilities
  - Facilities Vital to Restoring Normal Services

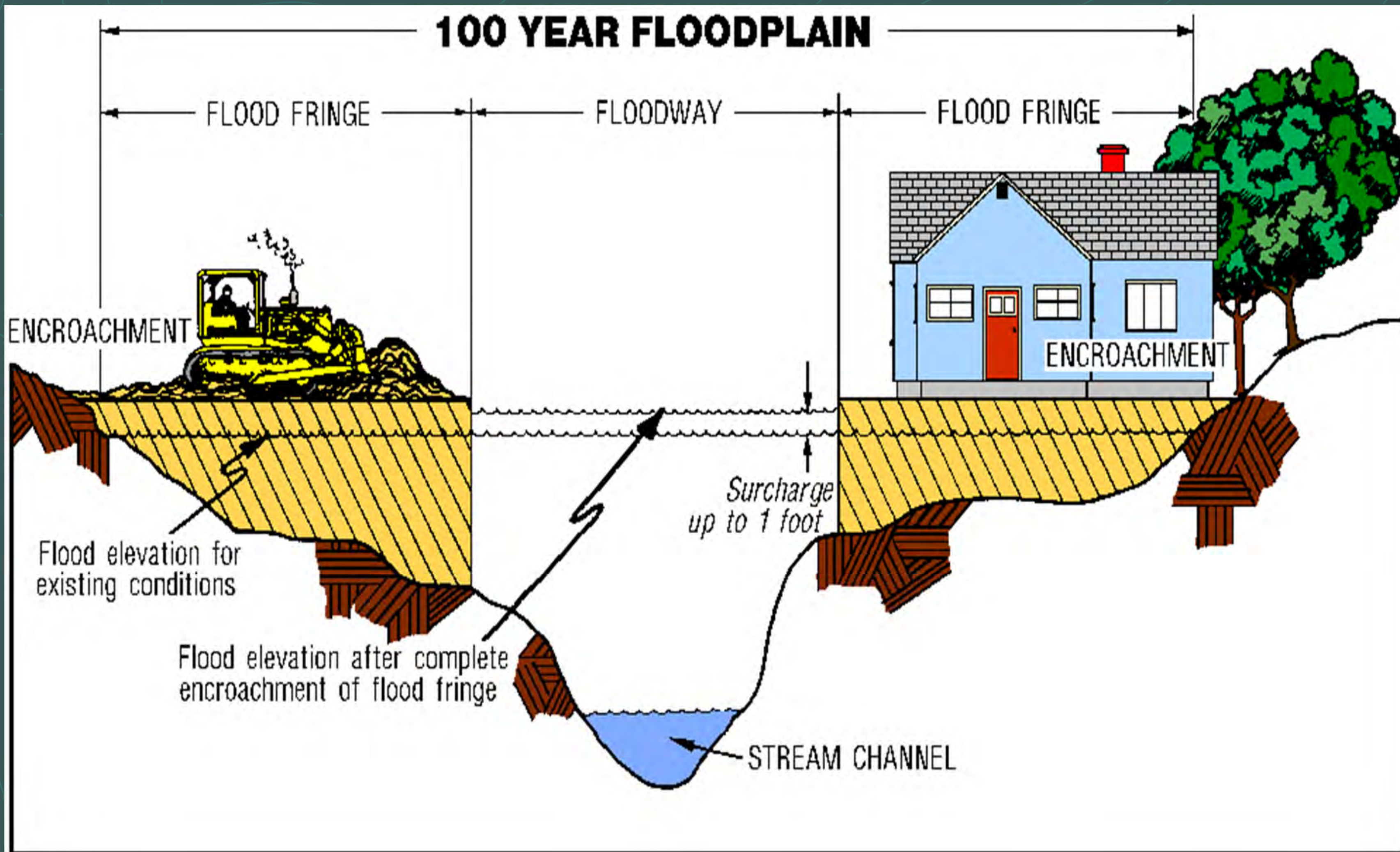
Identification of Critical Facilities

- The local government is ultimately responsible for identification of critical facilities
- All structures that <u>clearly</u> meet the CWCB criteria for critical facilities must be classified as such
- For ambiguous or “gray area” structures, the local government is given the discretion as to the classification of the structure

Summary Statement Rule #8

- RULE 8   STANDARDS FOR REGULATORY FLOODWAYS
- Intent: Discuss the use of floodways as regulatory tools
- Modifications:
  - Application of a ½ foot floodway
  - Does not require automatic mapping of ½ floodway by community
  - Only when new mapping (PMR) is generated in future
  - Does not apply to communities where flood elevations (BFE's) have not been established
  - LOMRs should be based on current (e.g. one foot) floodway to avoid "patchwork" floodways on community maps

Floodway Schematic



Summary Statement Rule #11

- RULE 11 FLOODPLAIN MANAGEMENT REGULATIONS
- Intent: Sets forth minimum floodplain management standards statewide.
- Modifications:
  - Requires compliance with NFIP minimum standards regardless of community participation in NFIP (clarification, not new requirement)
  - Requires one foot minimum freeboard for new and substantially changed structures
  - Establishes more restrictive requirements on issuance of permits on properties removed from FEMA's floodplain due to Letters of Map Revision Based on Fill (LOMR-F).

Summary Statement Rule #12

- RULE 12   EFFECTS OF FLOOD MITIGATION MEASURES AND STREAM ALTERATION ACTIVITIES ON REGULATORY FLOODPLAINS
- Intent: Provide floodplain regulation requirements for stream alteration activities.
- Modifications:
  - Clarification of when a Letter of Map Revision (LOMR) is required (0.3 feet)

How does this affect communities and developers?

Ordinance Updates

- Communities will have up to three years to update ordinances based on the new standards. CWCB will provide free technical assistance.
- For some communities, ordinance updates can happen simultaneously with new DFIRM mapping, depending on timing.
- CWCB will develop and provide a model ordinance for guidance and assistance to communities
- Communities at their discretion may allow without violation development based on designs permitted prior to local ordinance update or with valid CLOMR

Moving Forward - Floodways

- This rule does not affect LOMRs. Applicants are highly encouraged to check with FEMA/Baker prior to work to determine if a study will result in a LOMR or PMR.
- All mapping work started prior to January 14, 2011 is not required to use the 6” surcharge. It is recommended where feasible.
- The State will develop a database of stream reaches with 6” surcharge data to assist with future mapping changes

Moving Forward - Floodways

- When floodways are to be delineated, FEMA and State mapping begun after January 14, 2011 will use a 6-inch floodway surcharge criteria for new and revised stream reaches
- FEMA and State mapping not yet complete but begun before January 14, 2011 may use either surcharge criteria at local's request – 6" is encouraged where feasible (not mandatory)
- Existing reaches that are not revised may continue to use the 1-foot surcharge

Moving Forward - Floodways

- When current FEMA maps show 1-foot surcharge, but 6-inch data is currently available, community will not be forced to use the 6-inch data
- Finally, a reminder that this rule deals with maximum allowable surcharges. This may not impact stream reaches as much as believed – many mapped cross-sections already show surcharges less than 0.5 feet.
- 6-inch floodway also applies to anticipatory floodplains in detailed stream reaches. Community may wait to regulate until after ordinance update.

Moving Forward - Freeboard

- Communities are urged to begin regulating freeboard as soon as feasibly possible – this is an easy ordinance update
- Not mandatory until ordinance is updated, but this must be done by January 14, 2014

Moving Forward – Critical Facilities

- Not mandatory until ordinance is updated, but this must be done by January 14, 2014
- Communities do not need to make a list of critical facilities beforehand as they do with emergency management planning
- Suggested approach is to simply add a checklist item to floodplain development permit
- If a structure is labeled a critical facility, then one extra foot of freeboard is required

Moving Forward – Critical Facilities

- For all gray areas, community is given the discretion as to whether something is a critical facility
- Please contact the CWCB for further clarifications – additional guidance may be issued as needed

Moving Forward – LOMR-F

- Community is responsible for keeping track of LOMR-F properties
- On these properties, lowest floor must remain at or above BFE (even if FEMA has removed the property from the regulatory floodplain); no other mandatory floodplain restrictions apply

Next Steps

- Initial guidance document being prepared to address initial clarifications
  - Anticipated release May or June 2011
  - Further guidance documents may be released as needed in future
- State and FEMA will develop Colorado-specific model ordinance
  - Anticipated release summer-fall 2011
- Communities must adopt new state-mandated regulations by January 14, 2011

THANK YOU!

For questions, contact:

Kevin Houck, PE, CFM

303-866-3441, x3219

Kevin.houck@state.co.us

Cwcb.state.co.us

For a copy of the Rules and related documents,

http://cwcb.state.co.us/Pages/CWCBProposedFloodplainRulesandRegulations.aspx

(link from the front page)