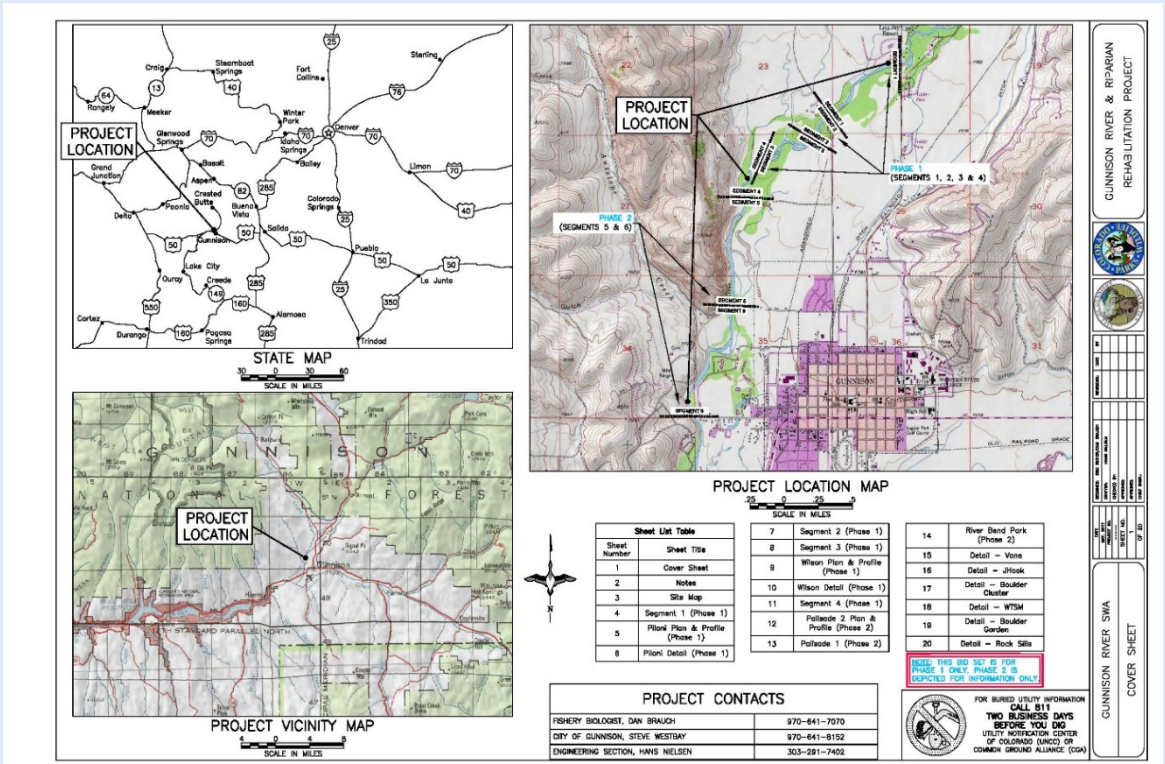
The Gunnison River and Riparian Habitat Rehabilitation Project

Local Partnerships at Work

Dan Brauch – CPW Aquatic Biologist
Steve Westbay – City of Gunnison



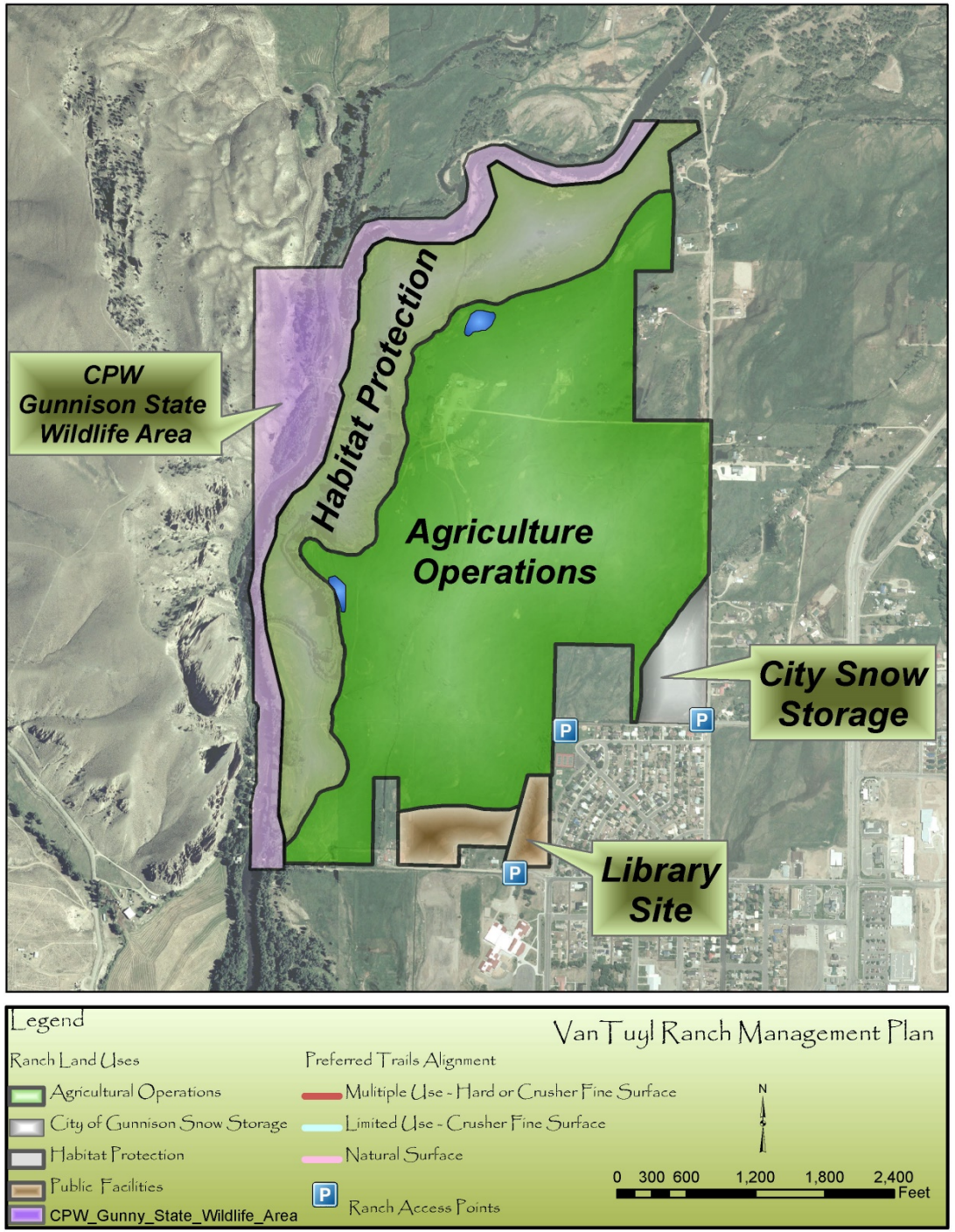
Goddard Ranch

Background
VanTuyl Ranch & Gunnison River State Wildlife Area

A Project 25 Years in the Making

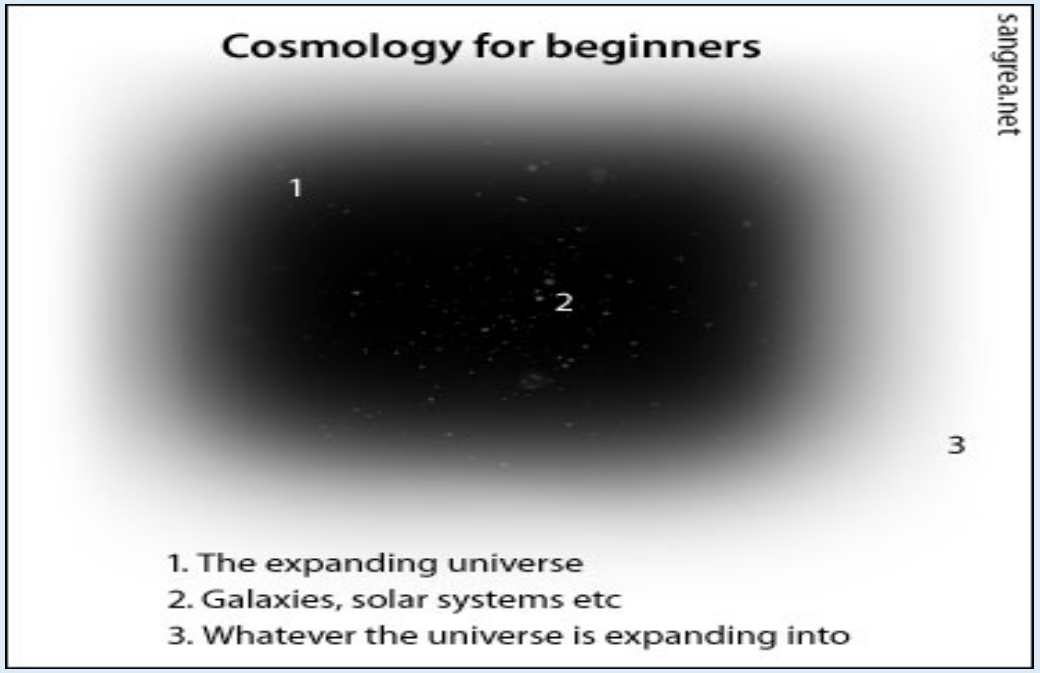
- Property purchased 1993 by the Trust for Public Lands
- Titles conveyed to Bureau of Reclamation (BOR) & the City
- State Wildlife Area deed transfer from BOR to CPW in 1994
- City took over ranch operations in 2008 after lifetime resident Ray VanTuyl passed away

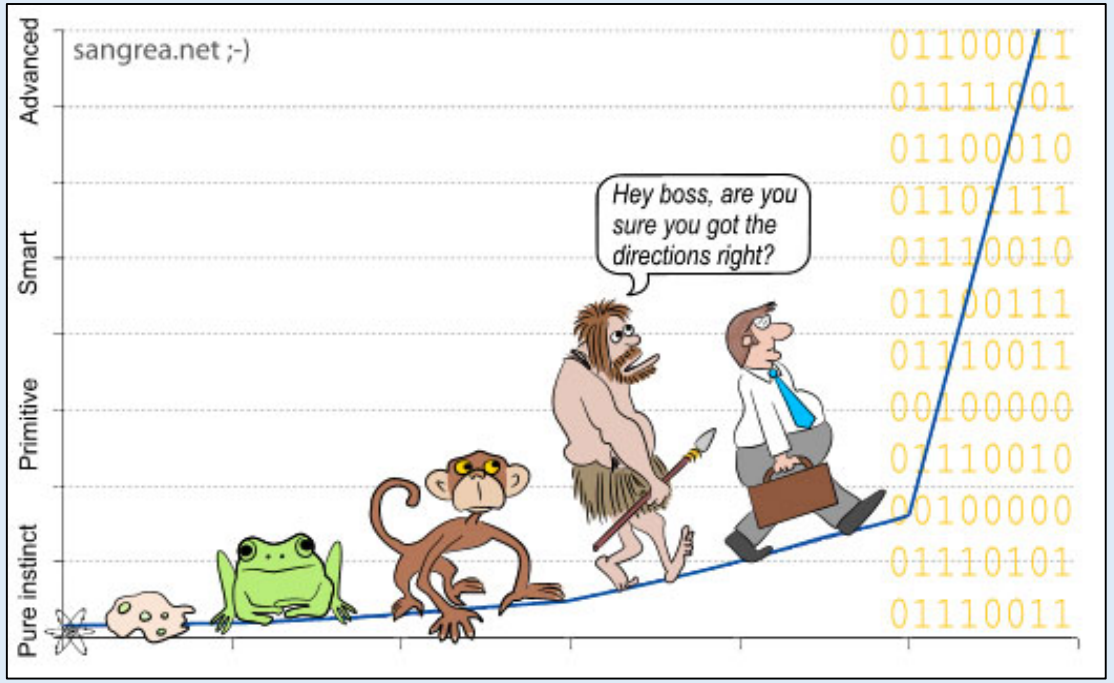
- Ranch Annexed in 2011
  - Regulated by an *Adaptive Resource Management Plan*
  - Alluvial Aquifer Recharge – City domestic water source
  - Watershed Protection – Septic system proliferation
  - Prescribed Agricultural Operations & community garden
  - Public Open Space – 5K trail system
  - Flood Control
  - Habitat Protection



Rehabilitation Project - It Starts with an IDEA in 2001

- *Fluvial Morphology & River Restoration Assessment*,2001
- Partners: CWCB, Trout Unlimited, UGRWCD, CPW, City, 2012
- Championing the Cause: CPW & City, 2012
- Funding: 2014 CWCB Grant ($440K); Private Donations ($150K)
- Design Programming 2014 through 2017
- Scope Modification 2016 – Project Cost Overruns
- Permitting: ACOE 404; Fish & Wildlife Service 2017
- Project Bid Award September 2017 & Construction through May 2018



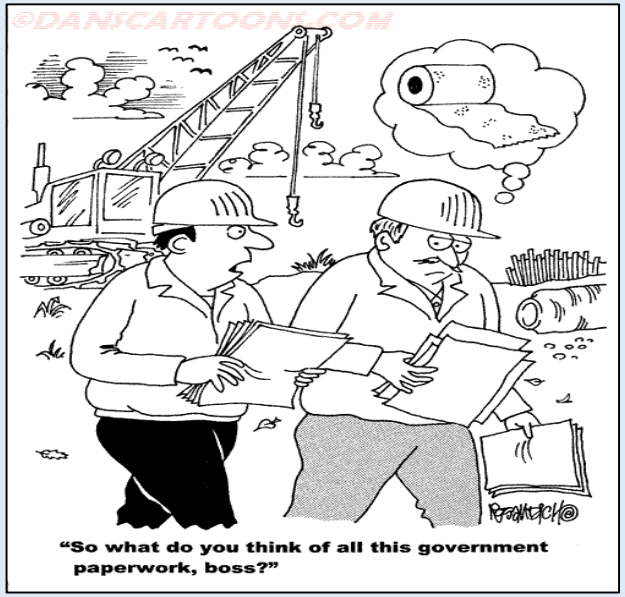


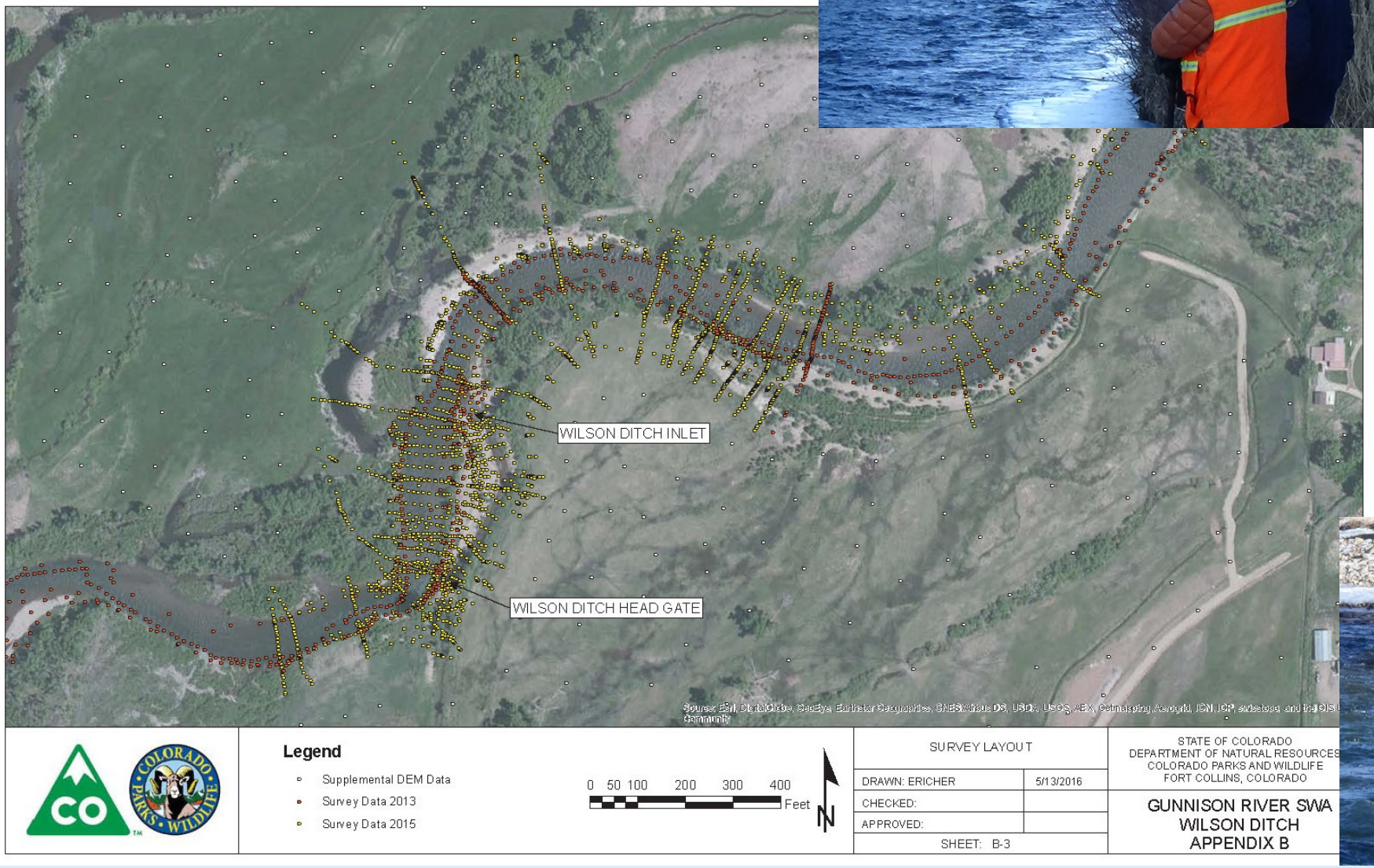
PROJECT GOALS

- Improve diversions- H2O rights due diligence
- Reconnect floodplains
- Improve channel habitat
- Increase trout biomass
- Improve trout size
- Improve riparian habitat
- Improve public river access

Permitting Overview

- Gunnison Sage-grouse Listing Decision November 12, 2014 - US Fish and Wildlife Service
- ACOE Nationwide Permit 33:*Temporary Access Construction and Dewatering – agricultural diversions*
- ACOE Regional General Permit 12: *Aquatic Habitat Improvement for Stream Channels in Colorado*
- Endangered Species Act, Section 7 Consultation, ACOE/FWS
  - *Cultural Resource Inventory*
  - *Wetland Inventory*
  - *ESA Gunnison Sage-grouse Critical Habitat Biological Assessment*
  - *Special Conditions for season of operations, equipment access, et AL*
- Coordination & Approvals from the Bureau of Reclamation
- County Flood Hazard Application



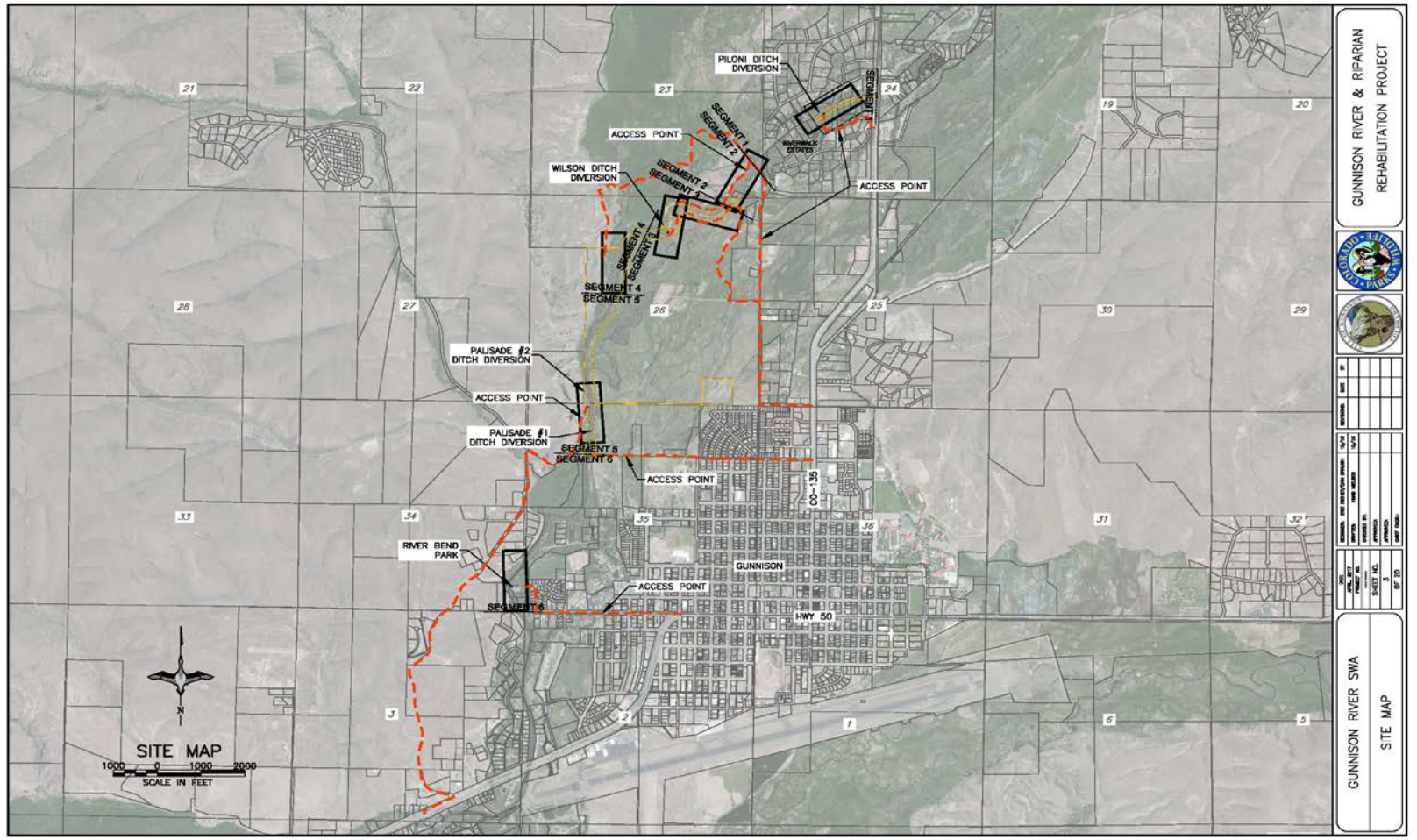


Project engineering and design was done by the CPW's engineering staff. These in kind design services, along with permit administration by local agencies added significant project value.

KEY DESIGN CONSIDERATIONS

Design Improvements on 7 Channel Segments along a 3.75 mile reach

- Abate historic channelization where practical
- Reestablish morphological function
- Improving fish habitat
- Emphasize low profile channel features
- Improve Riparian Function w/ vegetation treatment
- Reconnect floodplains where possible
- Use native vegetation: willow transplants; sod mat

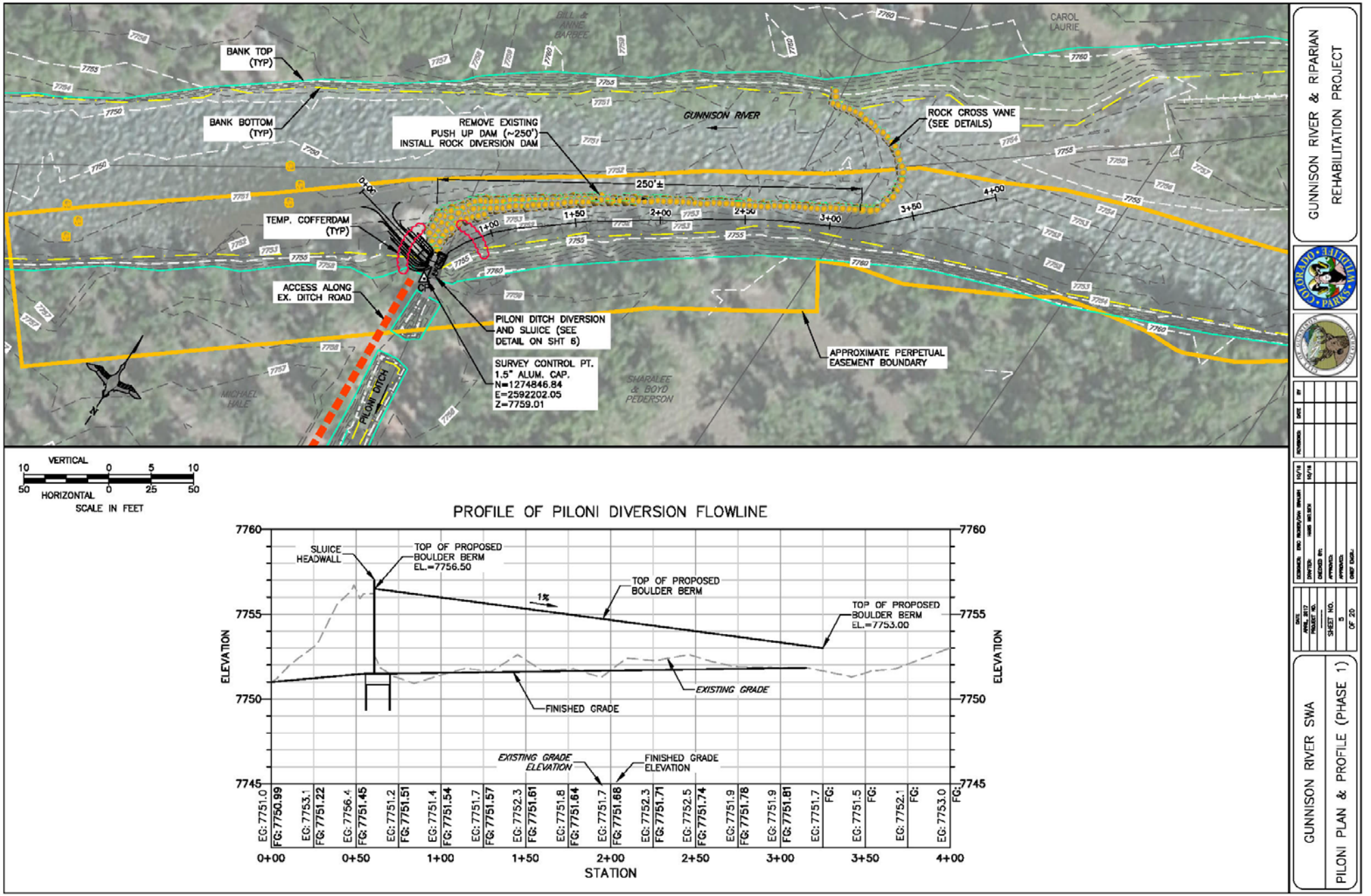


Pre-Construction Conditions – Hydraulic Modelling

Hydraulic modeling indicated that the initial designs of one channel feature would cause flood elevation rise & final design alterations were made to ensure no-rise would occur.

Elevation grade change between the head gates and diversion points were critical functions of the final design to ensure adequate water delivery and sediment control.

Piloni Ditch Diversion



Piloni Ditch – Major Diversion & Habitat Improvements

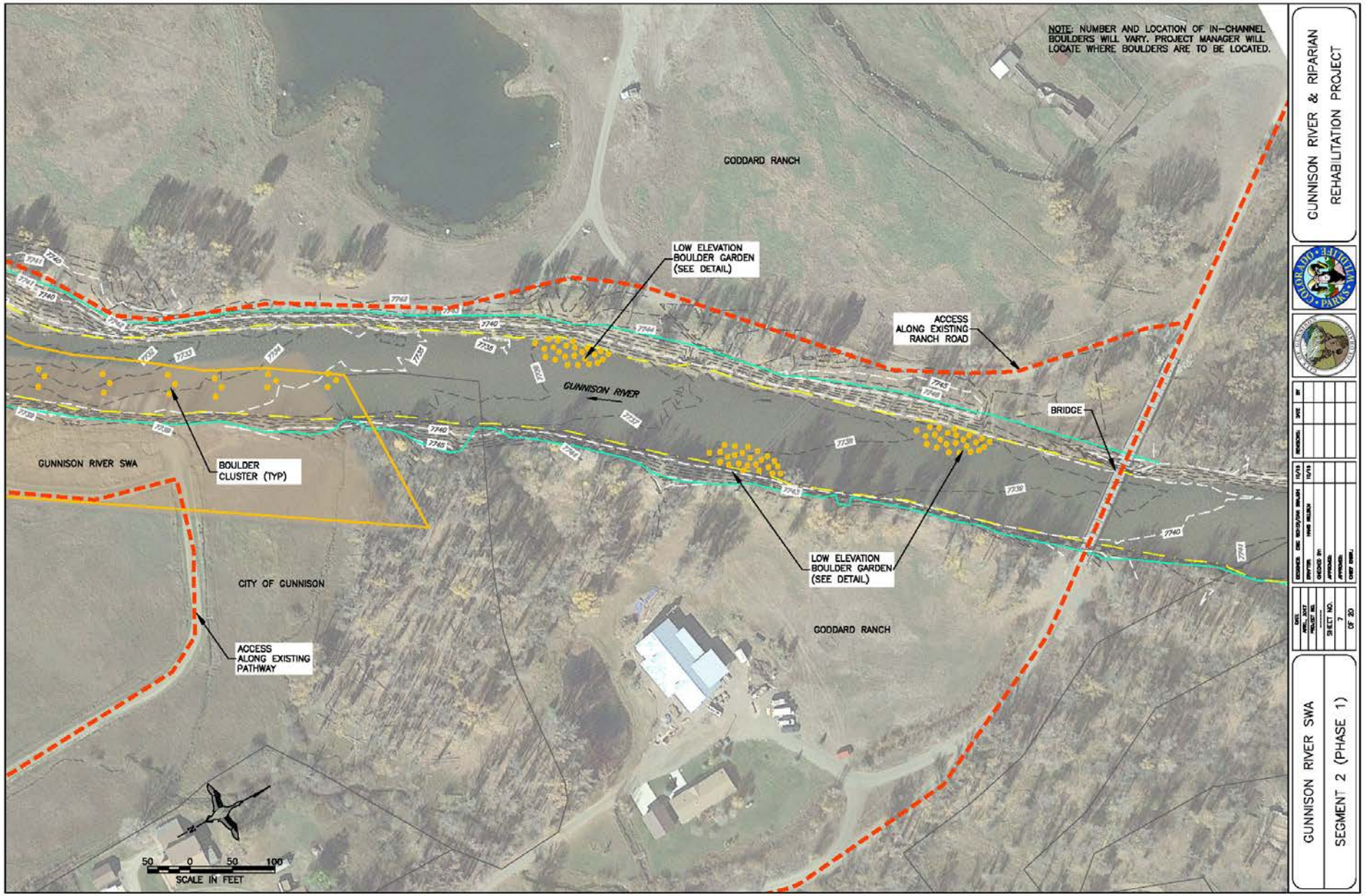
Frozen soil conditions experienced in early January 2018 finally chased the crew off for the season. Construction began again the past week – estimated completion date May 2018.

A $100,000 grant from the LOR Foundation allowed for constructing a new headworks on the Piloni Ditch & the construction of additional fish habitat structures in all reaches of the river project area.

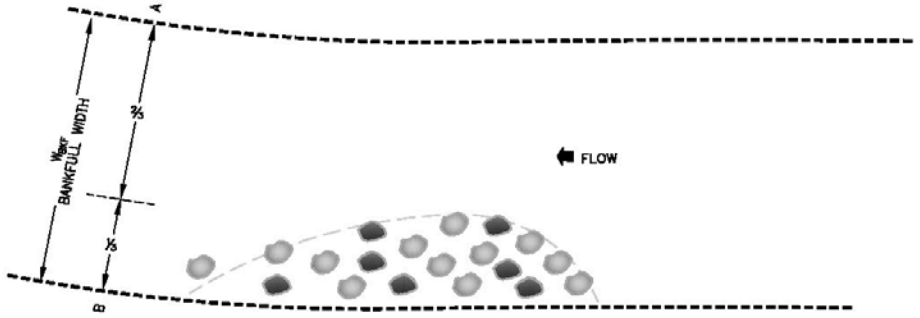
Piloni Ditch – March 27, 2018
Ongoing Construction

what's wrong
with this picture?

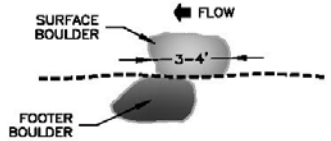
Typical Fish Habit Channel Features



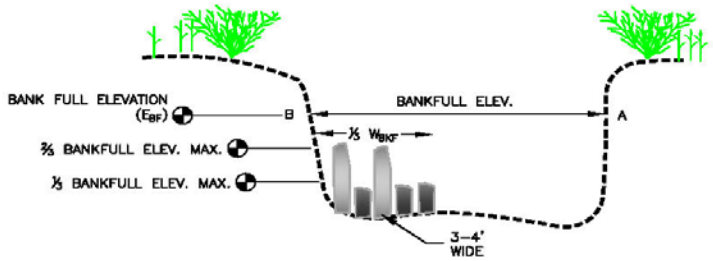
Boulder Garden Details



PLAN VIEW
NTS



BOULDER PROFILE VIEW
NTS



CROSS–SECTION VIEW
NTS

CONSTRUCTION NOTES:

1. STRUCTURE SHALL BE FIELD LOCATED BY CPW PROJECT MANAGER OR DESIGNATED REPRESENTATIVE.
2. SURFACE BOULDERS ARE THE TOP COURSE OF BOULDERS. SURFACE BOULDERS SHALL VARY IN DEPTH BETWEEN 1/3 BANK FULL DEPTH AND 2/3 BANK FULL DEPTH.
3. FOOTING BOULDERS ARE PLACED TO PROVIDE A FOUNDATION FOR THE SURFACE BOULDERS. TYPICALLY FOOTER BOULDERS SHALL BE BURIED IN THE CHANNEL BOTTOM AND NOT SEEN WHEN THE STRUCTURE IS COMPLETED. ALL SURFACE BOULDERS SHALL REQUIRED FOOTERS AND SHALL BE OMITTED ONLY AT THE DISCRETION OF CPW PROJECT MANAGER, OR DESIGNATED REPRESENTATIVE, ON A STRUCTURE BY STRUCTURE BASIS.
4. BOULDERS SHALL BE PLACED AT AN IRREGULAR SPACING.
5. BOULDERS SHALL BE PLACED APPROXIMATELY 2–4 x BOULDER DIAMETER APART.
6. CONTRACTOR SHALL USE AN EXCAVATOR OF SUITABLE CAPACITY WITH HYDRAULIC THUMB TO CONSTRUCT THE STRUCTURE.
7. CONTRACTOR SHALL ANTICIPATE THAT HANDLING OF INDIVIDUAL ROCK (ESPECIALLY BOULDERS) AFTER INITIAL PLACEMENT WILL BE REQUIRED TO achieve REQUIRED SLOPES, GRADES, ELEVATIONS, AND POSITION.
8. REFER TO PROJECT TECHNICAL SPECIFICATIONS FOR ROCK AND OTHER REQUIREMENTS FOR INSTALLING STRUCTURES

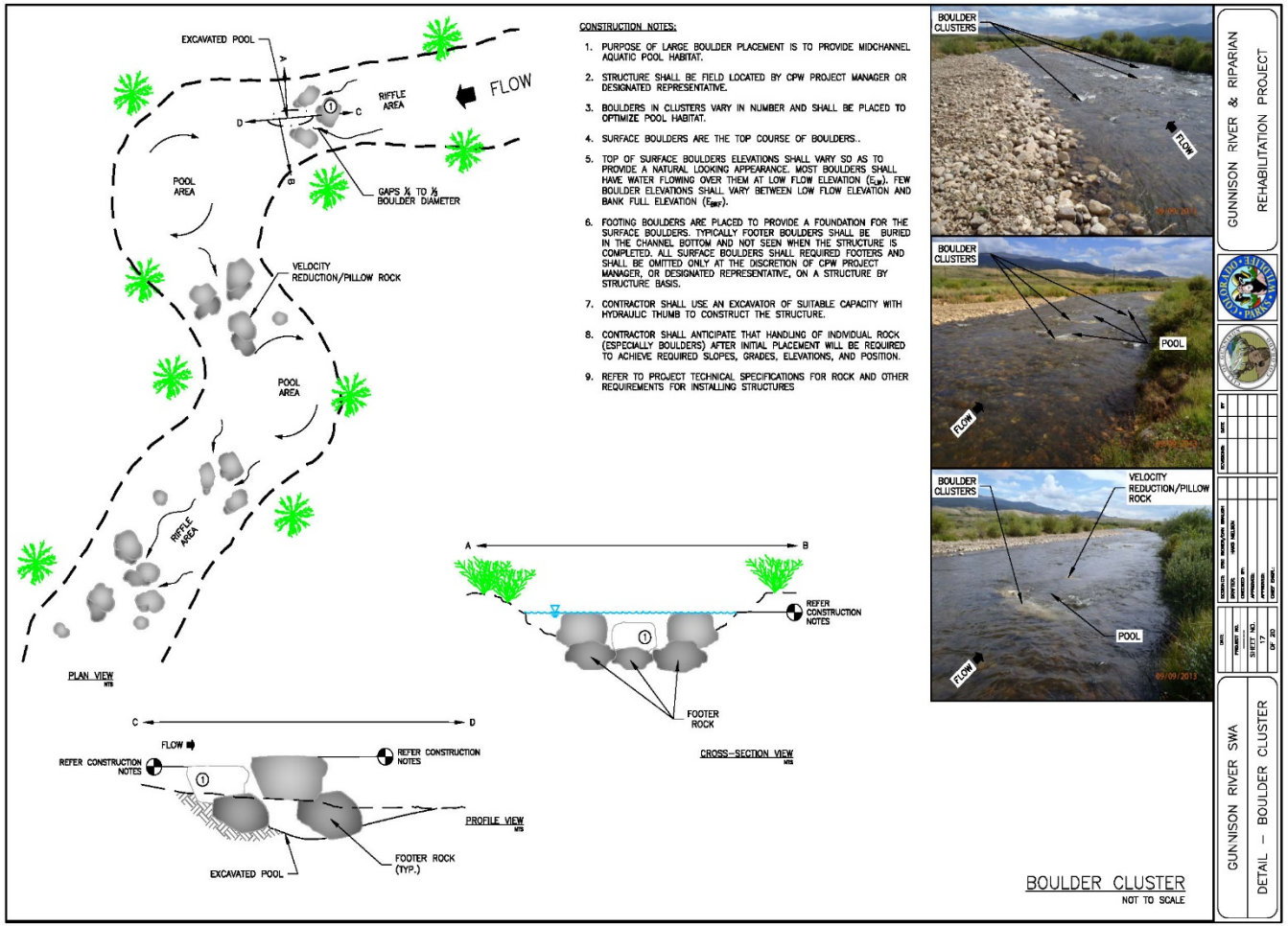
BOULDER GARDEN
NOT TO SCALE

GUNNISON RIVER & RIPARIAN REHABILITATION PROJECT

GUNNISON RIVER SWA

DETAIL – BOULDER GARDEN

Fishery habitat improvements include construction boulder gardens and boulder clusters on all project area river reaches.



Low Profile Boulders Clusters at Work

Channelization Challenges
Establishing Thalweg & Sinuosity

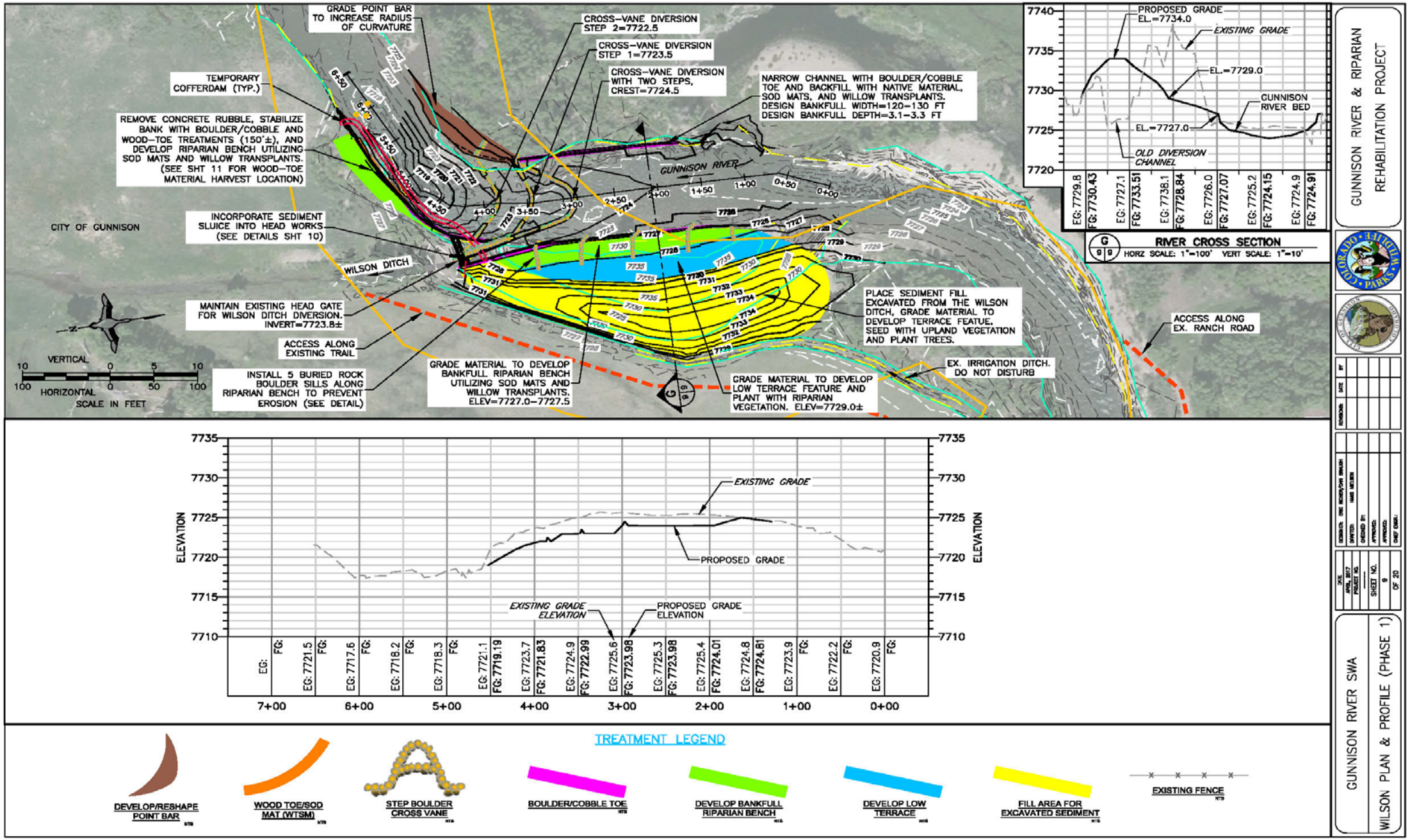
Thalweg & Sinuosity- Boulder Gardens in lieu of point bars

Wilson Diversion Pre-Construction Conditions

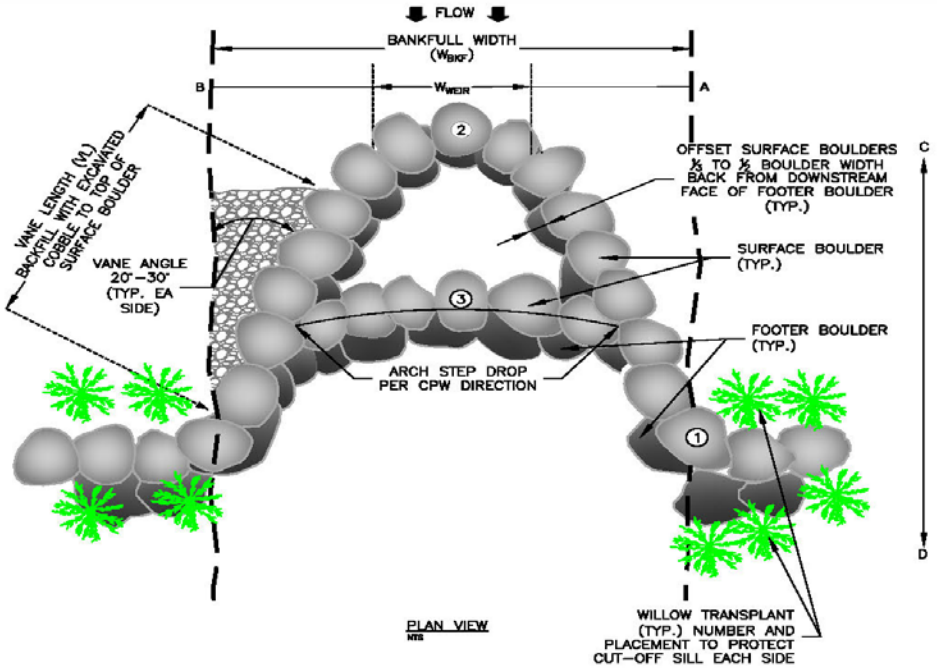
Significant design & construction challenges

Wilson Diversion Pre-Construction Conditions

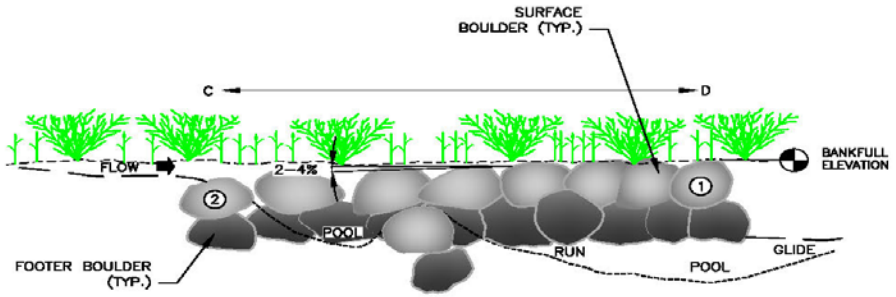
Wilson Diversion Plan and Profile



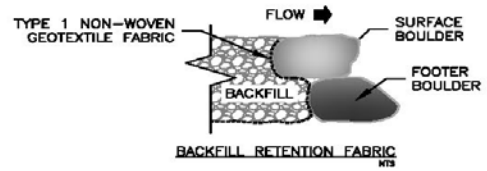
Low Profile Cross Vanes



PLAN VIEW
NTS



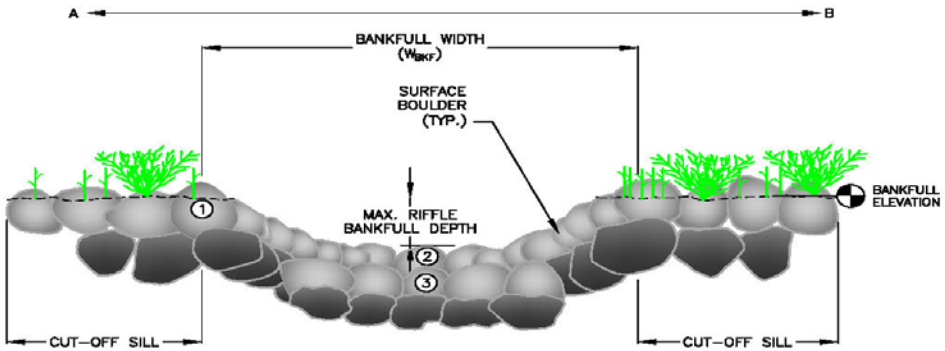
PROFILE VIEW
NTS



BACKFILL RETENTION FABRIC
NTS

BACKFILL RETENTION FABRIC NOTES:

1. THE PURPOSE OF THE BACKFILL RETENTION FABRIC IS TO INHIBIT THE PASSING OF BACKFILL MATERIAL (I.E. CHANNEL BED MATERIAL) THROUGH OR UNDER THE STRUCTURE.
2. FABRIC SHALL BE USED ON THE VANE OF ALL STRUCTURES AND SHALL BE OMITTED ONLY AT THE DISCRETION OF CPW PROJECT MANAGER, OR DESIGNATED REPRESENTATIVE, ON A STRUCTURE BY STRUCTURE BASIS.
3. FABRIC MANUFACTURER'S ROLL WIDTH SHALL GO FROM SURFACE BOULDER, ALONG FACE OF BOULDERS AND EXTEND UPSTREAM UNDERNEATH BACKFILL. ROLL WIDTH SHALL NOT BE CUT.
4. FABRIC SHALL START ½ DOWN SURFACE BOULDER FACE. FABRIC SHALL NOT BE VISIBLE AFTER BACKFILL..



CROSS–SECTION VIEW
NTS

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3. FOOTING BOULDERS ARE PLACED TO PROVIDE A FOUNDATION FOR THE SURFACE BOULDERS. TYPICALLY FOOTER BOULDERS SHALL BE BURIED IN THE CHANNEL BOTTOM AND NOT SEEN WHEN THE STRUCTURE IS COMPLETED. ALL SURFACE BOULDERS SHALL REQUIRED FOOTERS AND SHALL BE OMITTED ONLY AT THE DISCRETION OF CPW PROJECT MANAGER, OR DESIGNATED REPRESENTATIVE, ON A STRUCTURE BY STRUCTURE BASIS.
4. THE SURFACE OF THE CROSS–VANE SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES AND CROSS–SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR INVERT ELEVATIONS SHALL BE WITHIN ± ONE–INCH OF THE GRADES AND ELEVATIONS INDICATED PROVIDED ANY HEIGHT DOES NOT EXCEED 1.5 INCHES. ALL GAPS AND/OR VOIDS ALONG THE VANE SHALL BE PLUGGED WITH ROCK TO FORM A TIGHT FITTING SEAL TO 2 – 4 INCHES BELOW THE HEAD ROCK ELEVATION.
5. CONTRACTOR SHALL USE AN EXCAVATOR OF SUITABLE CAPACITY WITH HYDRAULIC THUMB TO CONSTRUCT THE STRUCTURE.
6. CONTRACTOR SHALL ANTICIPATE THAT HANDLING OF INDIVIDUAL ROCK (ESPECIALLY BOULDERS) AFTER INITIAL PLACEMENT WILL BE REQUIRED TO ACHIEVE REQUIRED SLOPES, GRADES, ELEVATIONS, AND POSITION.
7. REFER TO PROJECT TECHNICAL SPECIFICATIONS FOR ROCK AND OTHER REQUIREMENTS FOR INSTALLING STRUCTURES

GUNNISON RIVER & RIPARIAN REHABILITATION PROJECT

GUNNISON RIVER SWA

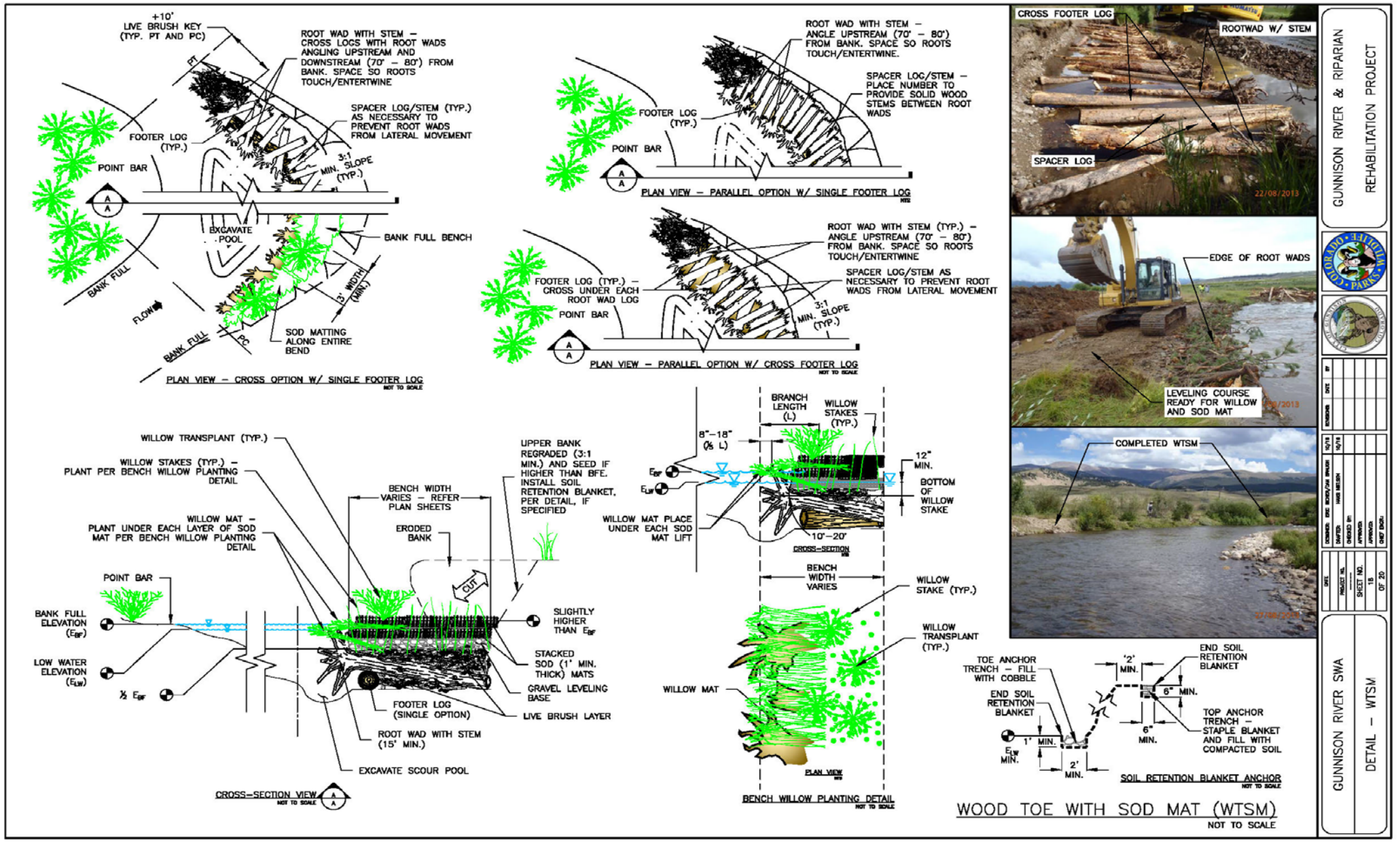
DETAIL – VANE

DATE
PROJECT NO. —
SHEET NO. 15 OF 20

STEP BOULDER CROSS–VANE

NOT TO SCALE

Wood Toe and Sod Mat Details



Local contactor Spallone Construction was awarded the Bid in August 2017. CSI Concrete was a subcontractor for the project.

Work on the Wilson diversion began in late October 2017. Favorable weather conditions allowed for completion of all rock structures & concrete work. The majority of vegetation work was also complete during the warm fall season.

Riparian Habitat Treatments

Bank stabilization, willow transplanting & other work will improve riparian habitat. Reconnection of the floodplain, where appropriate, was also a project goal


Wood Toe Construction

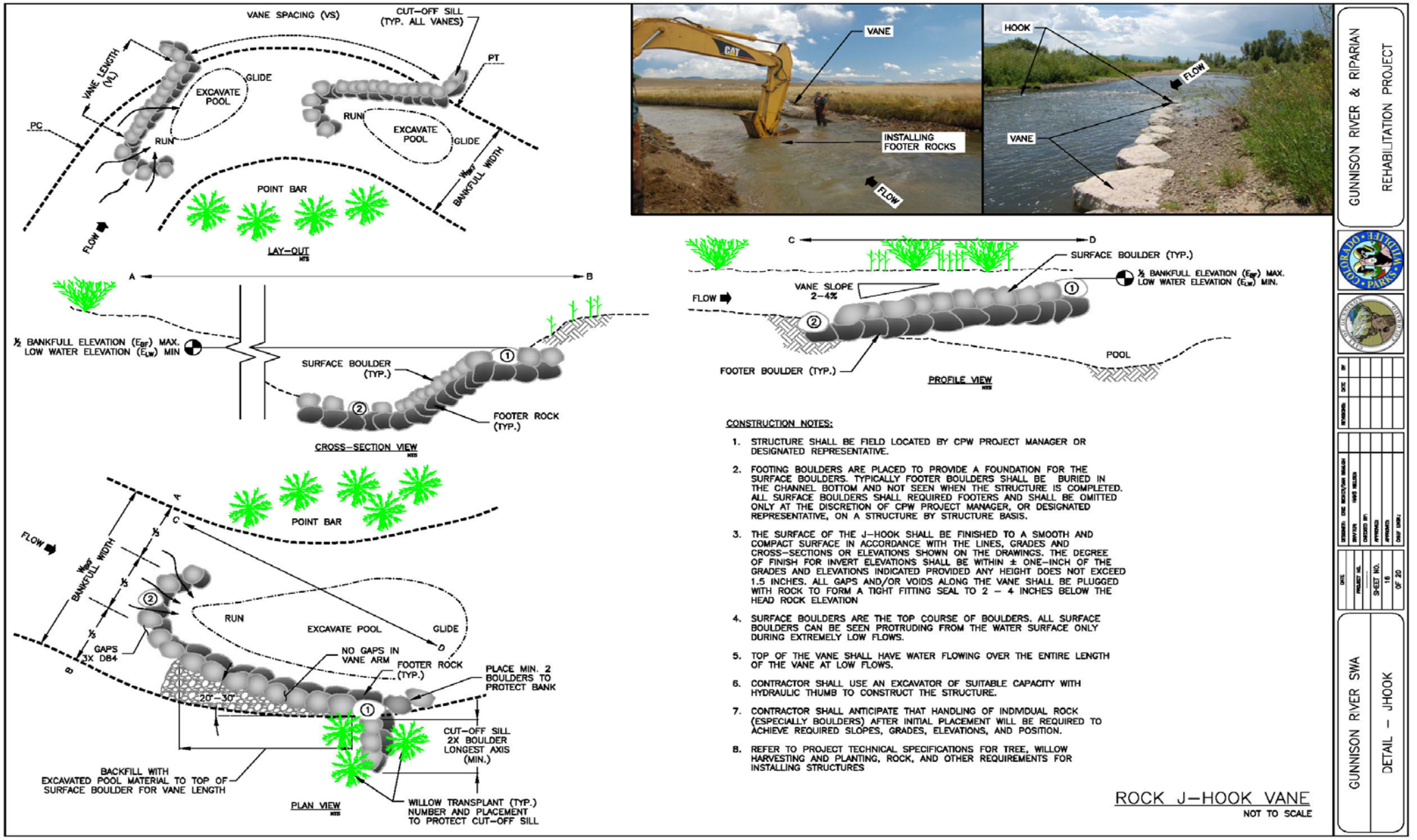

Willow Transplanting


Sod Mats

Floodplain Connection

Terrace & Floodplain Riparian Habitat Treatment

J-Hook Design Details



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3. THE SURFACE OF THE J–HOOK SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES AND CROSS–SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR INVERT ELEVATIONS SHALL BE WITHIN ± ONE–INCH OF THE GRADES AND ELEVATIONS INDICATED PROVIDED ANY HEIGHT DOES NOT EXCEED 1.5 INCHES. ALL GAPS AND/OR VOIDS ALONG THE VANE SHALL BE PLUGGED WITH ROCK TO FORM A TIGHT FITTING SEAL TO 2 – 4 INCHES BELOW THE HEAD ROCK ELEVATION
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8. REFER TO PROJECT TECHNICAL SPECIFICATIONS FOR TREE, WILLOW HARVESTING AND PLANTING, ROCK, AND OTHER REQUIREMENTS FOR INSTALLING STRUCTURES

ROCK J–HOOK VANE
NOT TO SCALE

GUNNISON RIVER & RIPARIAN REHABILITATION PROJECT

GUNNISON RIVER SWA
DETAIL – JHOOK
SHEET NO. 15 OF 20

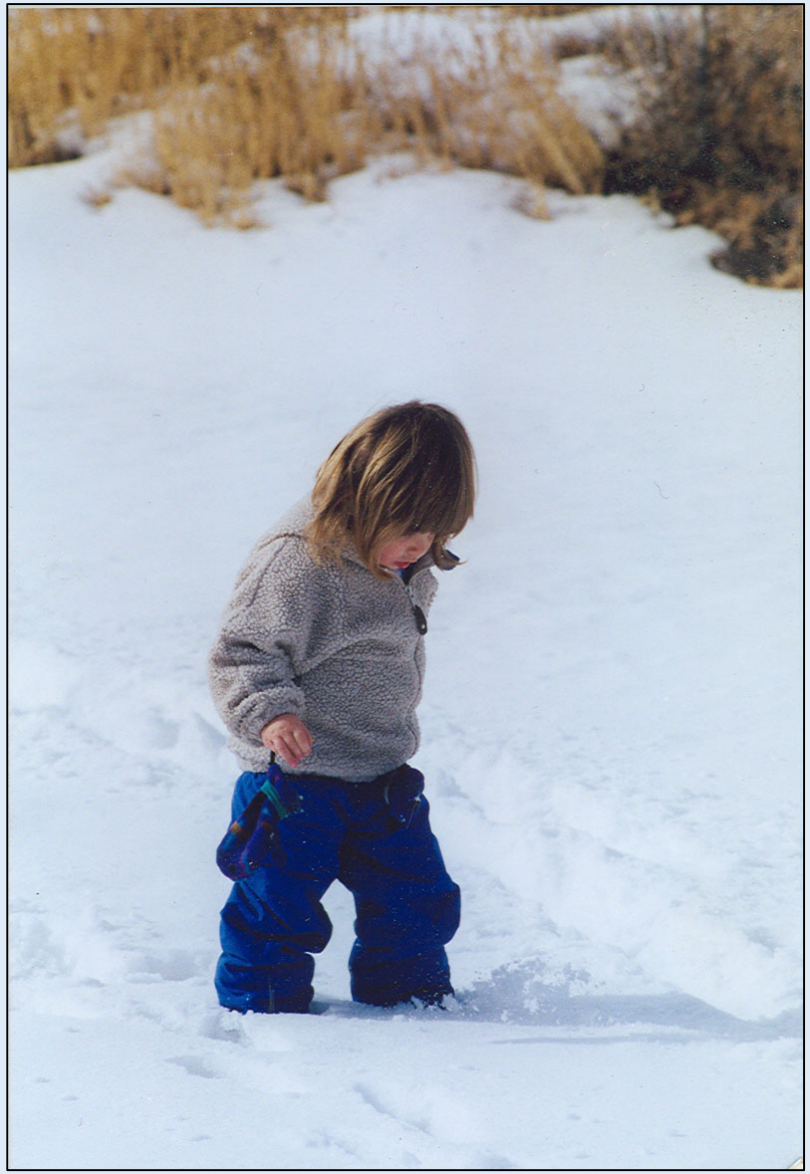
While equipment was staged at the Wilson Diversion, work to stabilize the Ohio Creek/Gunnison confluence was accomplished.

A J-Hook structure and boulder cluster habitat features were constructed at the confluence.

Observations – Lessons Learned

- Develop partnerships & allies - focus on possible stakeholders
- Be a champion of Great Projects
- Good ideas take time – do not loose focus
- Be a steward of natural resources – it is what *sustainability* requires

'A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise.'
Aldo Leopold



MESA COUNTY FEMA GRANTS

A how to, or not to, get through the HMGP Grant process

Lessons learned the hard way

TIMELINE BOSLEY WASH

August 2014- MC Applied for HMGP Grant Bosley Wash and Orchard Mesa Detention Basin (Veterans Memorial Park)

So sorry- your projects suck and your denied letter October 2015

December 2015 - Bosley Wash Just Kidding- We decided your application was accepted

Hiring consultant phase January, February, March, April…. May… Approved and have an agreement in April, 2016

Meeting with Stakeholders

Final #1 February 2017

Extension for grant applied October 2017- knowing we won't meet the March 2018 deadline….. Extended to March 2019

Division of water resources Revised, final January 2018- Denied

Just kidding- Final- FINAL, Resubmittal, Resubmittal March 5, 2018

Construction???

September 2013 Catastrophic flooding in Colorado State of Emergency Federal Assistance

Summer 2015 - Bosley Wash RFI- questions and answers

September 2015 **Review historical and environmental – RFI before grant would be approved.

Executed Grant January 2016

2016-2017 BLM- ACEC- Visual Resource Right-of way exclusion area.

Thought we had Shovel ready 90% plans…. June 2016

Nope, don't have 90% plans, have to pretty much start from scratch.

Approved FHWA permit through CDOT, told they don't issue many of these - February 2018

FINAL #2 Division of Water resources review Submittal September 2017 – Back to the drawing board

Preliminary Approval From Dam Safety March 20, 2018

Close out paperwork- needs to be completed before March 2019


DILBERT
BY SCOTT ADAMS
WHEN DO YOU EXPECT TO FINISH YOUR PROJECT?
NEVER.
THAT'S YOUR PLAN?
NO. MY PLAN IS TO BE DONE IN A WEEK.
YOU ASKED ME WHAT I EXPECT.
I BASE MY EXPECTATIONS ON THE QUALITY OF PEOPLE YOU ASSIGNED TO MY PROJECT WITHOUT ASKING MY OPINION.
THE TIME-WASTERS OUTNUMBER THE PRODUCTIVE PEOPLE ON THE TEAM BY THREE TO ONE.
UNDER THAT SCENARIO, PLUS YOUR TOTAL LACK OF LEADERSHIP, THE WORLD WILL END BEFORE THIS PROJECT DOES.
THEN WHY IS YOUR PLAN TO BE DONE IN ONE WEEK?
BECAUSE YOU DON'T LIKE IT WHEN I TELL THE TRUTH.
LET'S COMPROMISE ON TWO WEEKS.
CAN WE SET THOSE TWO WEEKS ON AUTO-RENEW?
DilbertCartoonist@gmail.com
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www.dilbert.com
5-15-16

TIMES UP

BOSLEY WASH

- Budget:

Project Category	Federal (75%)	State (12.5%)	Local (12.5%)	Total Budget (100%)
Engineering	$175,954.00	$29,326.00	$29,326.00	$234,606.00
Permitting	$70,380.00	$11,730.00	$11,730.00	$93,840.00
Construction	$1,759,523	$293,235.00	$293,235.00	$2,346,030.00
Construction management and inspection	$87,976.00	$14,663.00	$14,663.00	$117,302.00
Total Project Budget	$2,093,833.00	$348,972.00	$348,972.00	$2,791,778.00

BOSLEY WASH

- Stats:
  - High hazard Dam 10.5 feet
  - Embankment Height 17.5 feet
  - Maximum capacity is 190.14 acre-feet
  - Normal reservoir capacity 62.80 Acre-feet
  - Surface area is 15.75 Acres
  - Maximum discharge capacity is 2,839 cfs
  - Land Swap completed – Mesa County owned property

WOES OF BOSLEY

- Clearance for Historical and environmental before project would be granted
- USACE Permit
- Utilities- High pressure water line
- Agreement with CDOT - FHWA
- Construction cost estimate: $2,870,000 after multiple revisions
  - Original engineers estimate: total project: $2,791,778.00
  - Original engineers estimate for construction: $2,346,030.00
- BLM-
  - Area of Critical environmental Concern ACEC
  - Viewing area from Mt. Garfield

BLM- AREA OF CRITICAL ENVIRONMENTAL CONCERN -ACEC

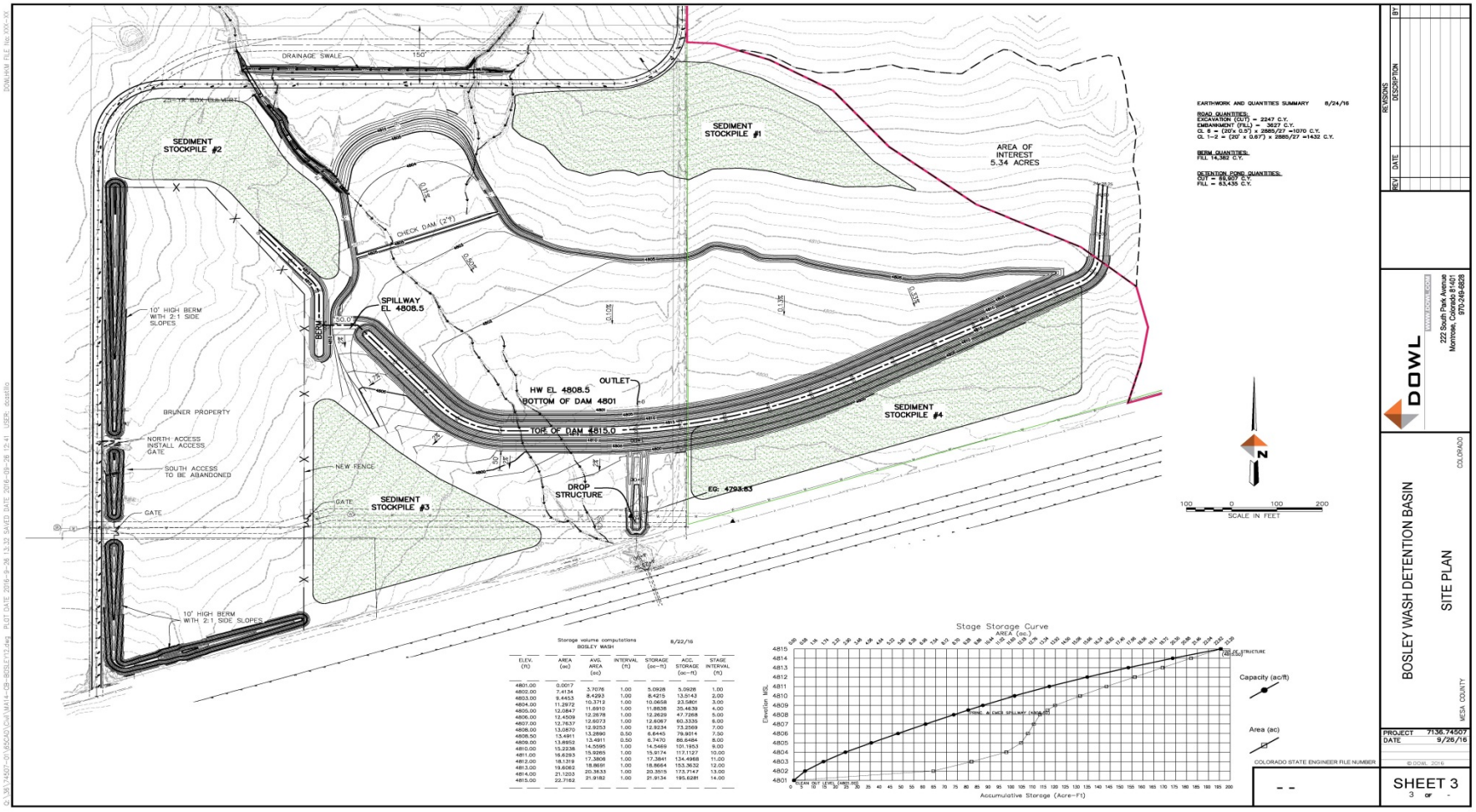
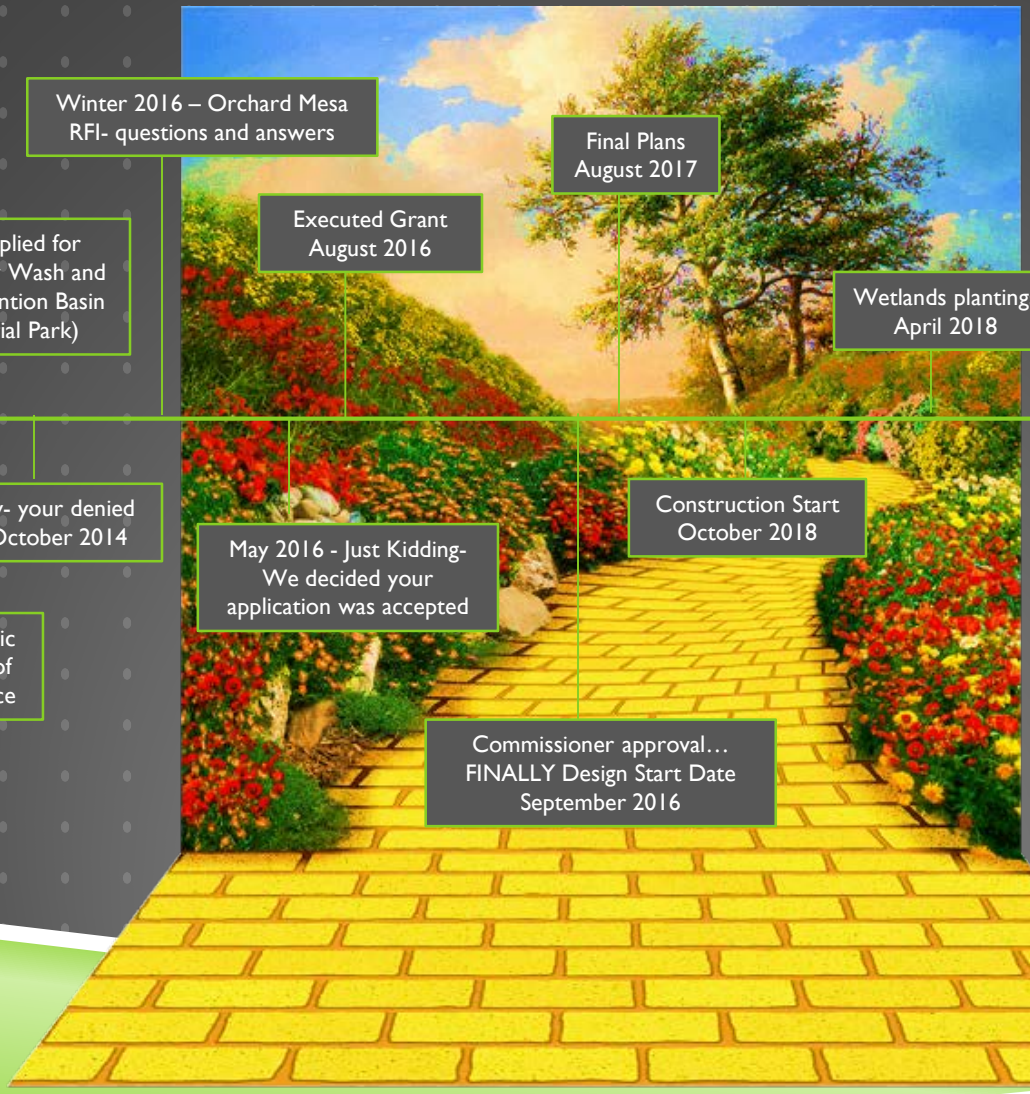



Image Landsat

TIMELINE ORCHARD MESA DETENTION FACILITY – VETERANS MEMORIAL PARK



September 2013 Catastrophic flooding in Colorado State of Emergency Federal Assistance

July 2014- MC Applied for HMGP Grant Bosley Wash and Orchard Mesa Detention Basin (Veterans Memorial Park)

So sorry- your denied letter October 2014

Winter 2016 – Orchard Mesa RFI- questions and answers

May 2016 - Just Kidding- We decided your application was accepted

Executed Grant August 2016

Commissioner approval… FINALLY Design Start Date September 2016

Final Plans August 2017

Construction Start October 2018

Wetlands plantings April 2018

Targeted Completed Construction June 2018

Close out paperwork and waiting for reimbursements Summer 2018

ORCHARD MESA

- Budget:

Project Category	Federal (75%)	State (12.5%)	Local (12.5%)	Total Budget (100%)
Engineering	$62,577.00	$10,430.00	$10,429.00	$83,436.00
Permitting	$15,644.00	$2,607.00	$2,608.00	$20,859.00
Construction	$782,217	$130,369.00	$130,370.00	$1,042,956.00
Construction management and inspection	$39,111.00	$6,519.00	$6,6518.00	$52,148.00
Total Project Budget	$899,549.00	$149,925.00	$149,92500	$1,199,399.00

ORCHARD MESA

- Stats:
  - Not a high hazard dam
  - Reconstruction of wetlands
  - Moving a irrigation pond used at the fairground to a different location
  - Worked with the BOR and irrigation company
  - Construction estimate at time of grant v.s. actual engineers estimates
  - Change order
  - Future construction and long term use of the facility. Pre-planning
  - USACE Permit
  - Multi use facility

TIME-LAPSE PHOTOS

TIME-LAPSE PHOTOS

TIME-LAPSE PHOTOS

TIME-LAPSE PHOTOS

TIME-LAPSE PHOTOS

THE WOES

- Top 10 list
  - I wish I would have known then what I know now
  - Checklist for expenses and submittals for reimbursements
  - DHSEM Site visits
  - Grant Monitoring
  - Design changes and budget for the project. Significant changes. CHANGE ORDERS
  - Stakeholders… BLM, Ute Water, BOR, CDOT, Federal Highways….
  - No Force Account for Construction but a contingency account
  - Affirmative action steps
  - Cost reasonableness for contractors
  - Paperwork, paperwork and paperwork
    - Schedule of fees
    - Procurement policies
    - Mileage reimbursement
    - Cost reasonableness
    - Historical contract reasonableness

CURRENT REIMBURSEMENTS

Project Title	Total Amount	Total Eligible	Work flow step	Days since step change
Flood Control Orchard Mesa Pond	$10,688.00	$10,688.00	2) Programmatic Review	77
Flood Control Orchard Mesa Pond	$280,488.24	$280,488.24	2) Programmatic Review	72
Flood Control Orchard Mesa Pond	$6,751.50	$6,751.50	2) Programmatic Review	51
Flood Control Orchard Mesa Pond	$79,606.20	$79,606.20	2) Programmatic Review	26
Flood Control Orchard Mesa Pond	$863.50	$863.50	2) Programmatic Review	20
Bosley Wash Reservoir A	$115,273.55	$103,218.45	3) Procurement Review	90
Bosley Wash Reservoir A	$25,457.00	$0.00	3) Procurement Review	135
Flood Control Orchard Mesa Pond	$34,052.48	$0.00	4) State Supervisor	1
Bosley Wash Reservoir A	$180,765.00	$162,408.60	5) Complete	288
Flood Control Orchard Mesa Pond	$37,020.00	$32,779.53	5) Complete	126
Flood Control Orchard Mesa Pond	$32,287.50	$29,058.75	5) Complete	126

NOW WHAT

- Continue to wait for the Dam safety to approve Bosley Wash
- Just approved April 2, 2018
- Finish up the Fairgrounds Detention Basin construction

- Apply for anther Grant……

WAIT- WHAT???


CARTOONSTOCK
.com
Search ID: aton4564
"Well, now we know what not to do."

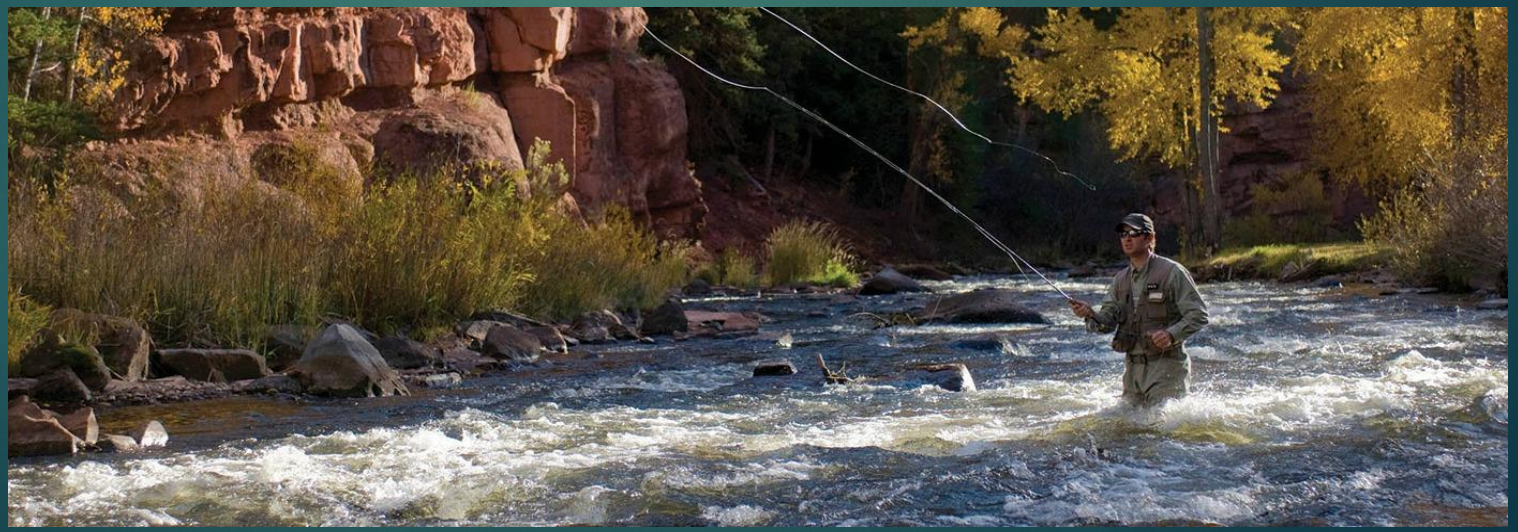
Questions?

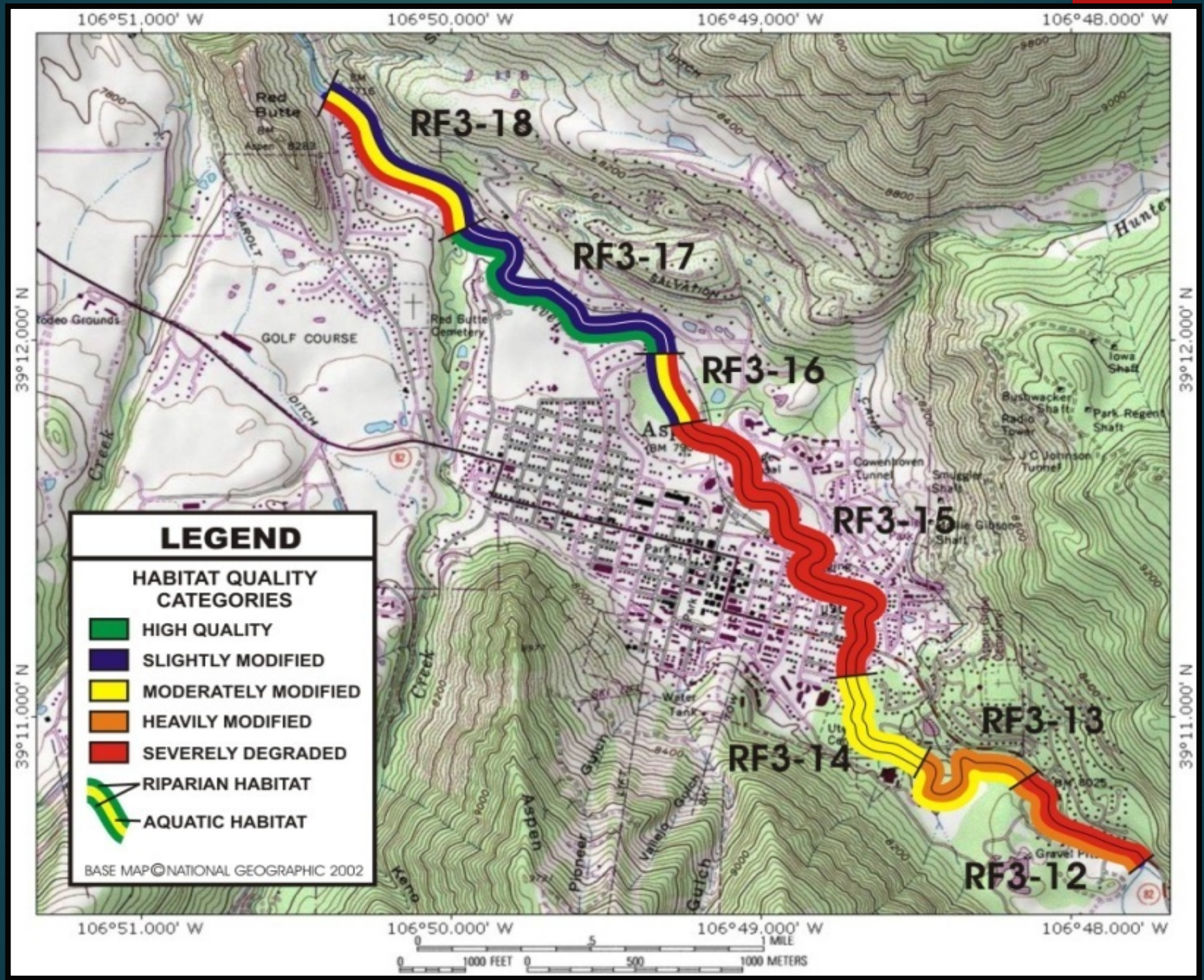
The Aspen Water Equation:

Balancing Environmental Health and Community Water Needs

Margaret Medellin, PE – Utilities Portfolio Manager, City of Aspen

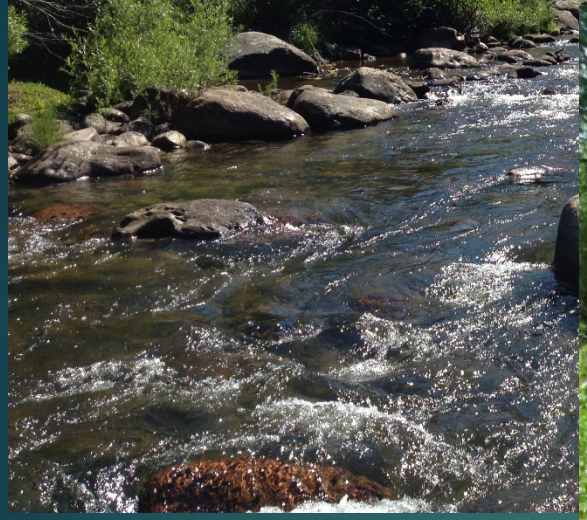
April Long, PE – Clean River Program Manager, City of Aspen




106°51.000' W
106°50.000' W
106°49.000' W
106°48.000' W
39°12.000' N
39°11.000' N
RF3-18
RF3-17
RF3-16
RF3-15
RF3-14
RF3-13
RF3-12
Red Butte
Aspen 8283
GOLF COURSE
Rodeo Grounds
Red Butte Cemetery
MAROLT
SALVATION
DITCH
Creek
Hunter
Iowa Shaft
Bushwacker Shaft
Radio Tower
Park Regent Shaft
J C Johnson Tunnel
Cowenhoven Tunnel
Smuggler Shaft
Water Tank
Pioneer Gulch
Aspen
Keno
Gulch
Gravel Pit
LEGEND
HABITAT QUALITY CATEGORIES
HIGH QUALITY
SLIGHTLY MODIFIED
MODERATELY MODIFIED
HEAVILY MODIFIED
SEVERELY DEGRADED
RIPARIAN HABITAT
AQUATIC HABITAT
BASE MAP©NATIONAL GEOGRAPHIC 2002
0 .5 1 MILE
0 1000 FEET 0 500 1000 METERS


PIKES PEAK
THE BROADMOOR
DOWNTOWN COLORADO SPRINGS
25
COLORADO COLLEGE
GARDEN OF THE GODS
PENROSE HEALTH CENTER
25
N. Cascade Ave.
COSTCO
PATTY JEWETT MUNICIPAL GOLF COURSE
TO HEALTHSOUTH & MEMORIAL HOSPITALS
NANCY LEWIS PARK
MacKenzie Place
E. Fillmore St.
E. Van Buren St.
CSHP
AUDUBON
N. Union Blvd.
ROCKY MOUNTAIN
N. Circle Dr.
COLORADO SPRINGS COUNTRY CLUB
N

Photographs by:
Brent Gardner Smith



Photographs by:
Brent Gardner Smith

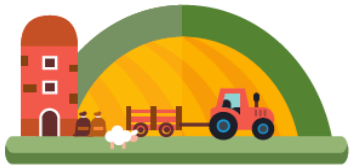
RECOGNIZING TRADE OFFS

Allocation of water to one use often comes at a cost to another use

Snowmelt and rainfall in the mountains above Aspen provide water for human uses and in support of river health.

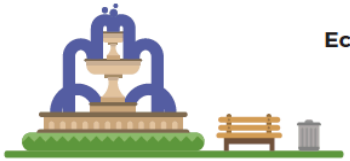
Patterns of water use are dictated by water rights administration, local policy, and community values and preferences.

Water flowing through many local streams and rivers is allocated in such a way that makes it difficult to provide the entire supply needed to meet all uses, particularly during times of drought. Use of water to meet one need, often results in less water available to meet some other need.



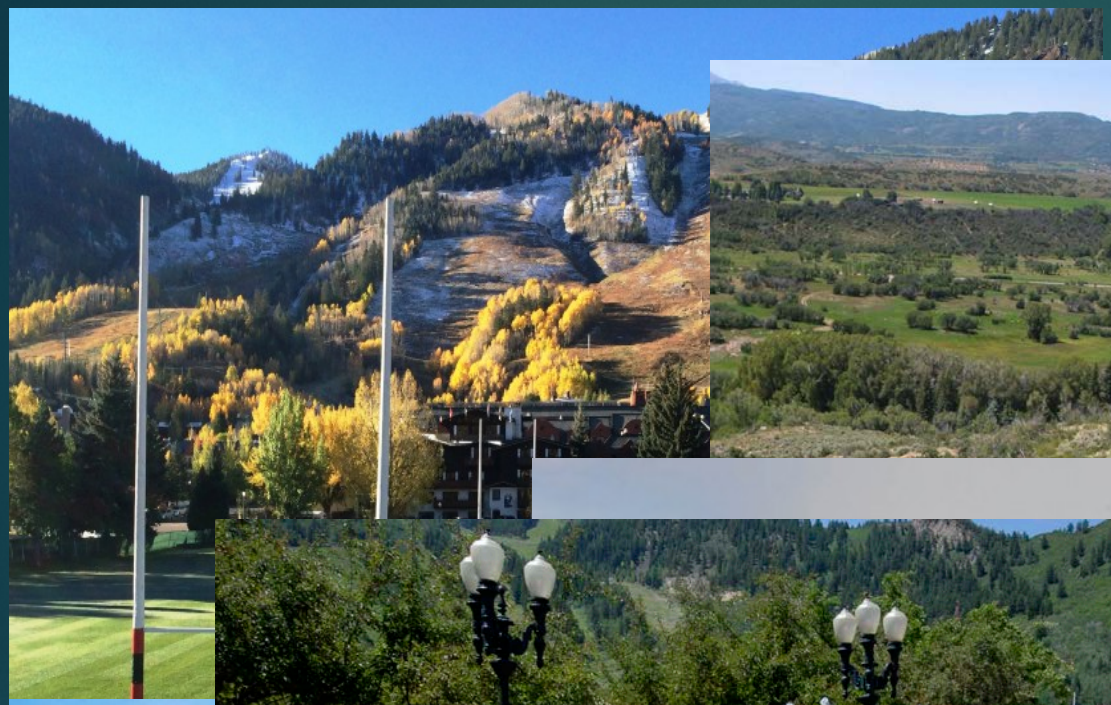
Local Food Production

Ecological Integrity



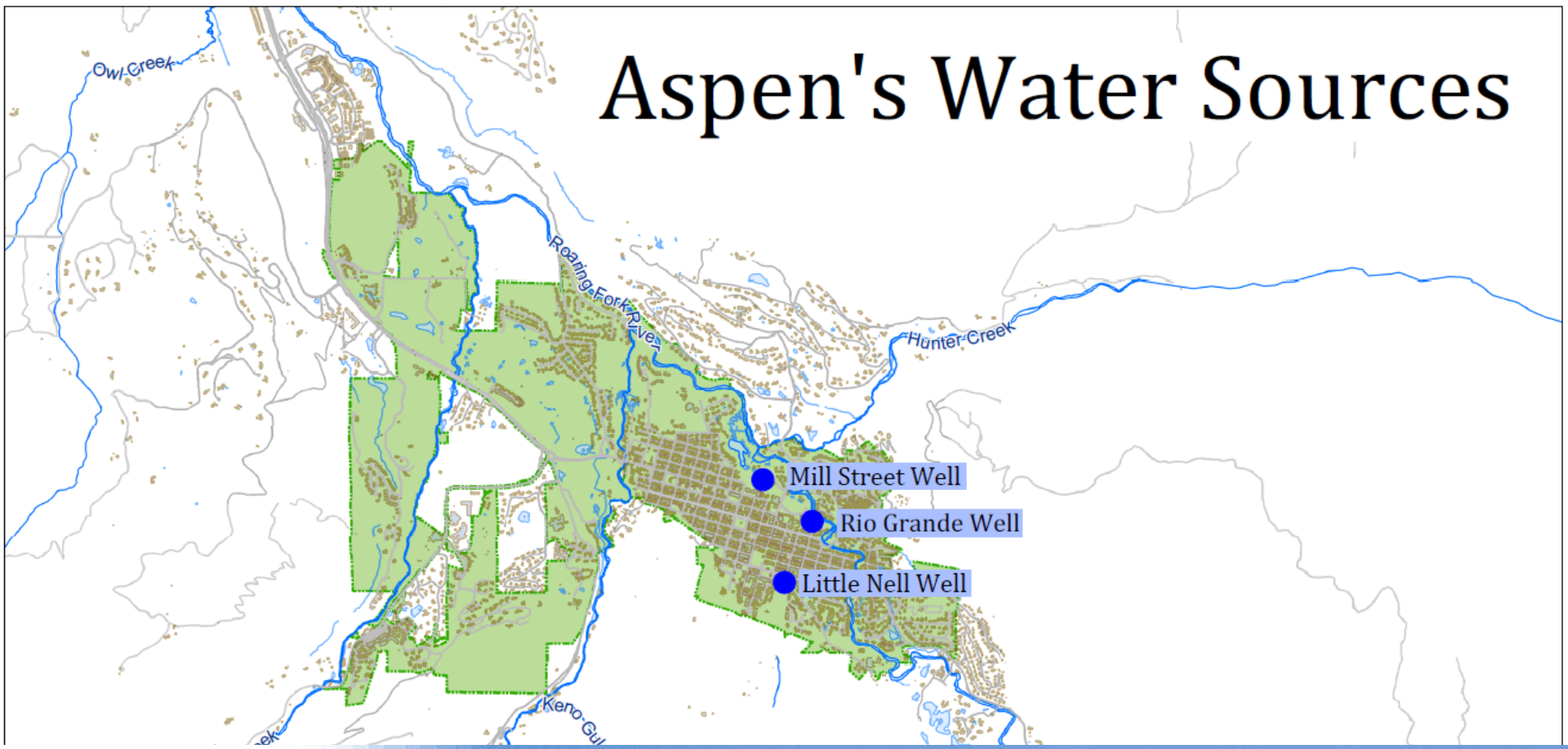
Parks and Amenities

Drinking Water




ASPEN BREWING COMPANY

Aspen's Water Sources



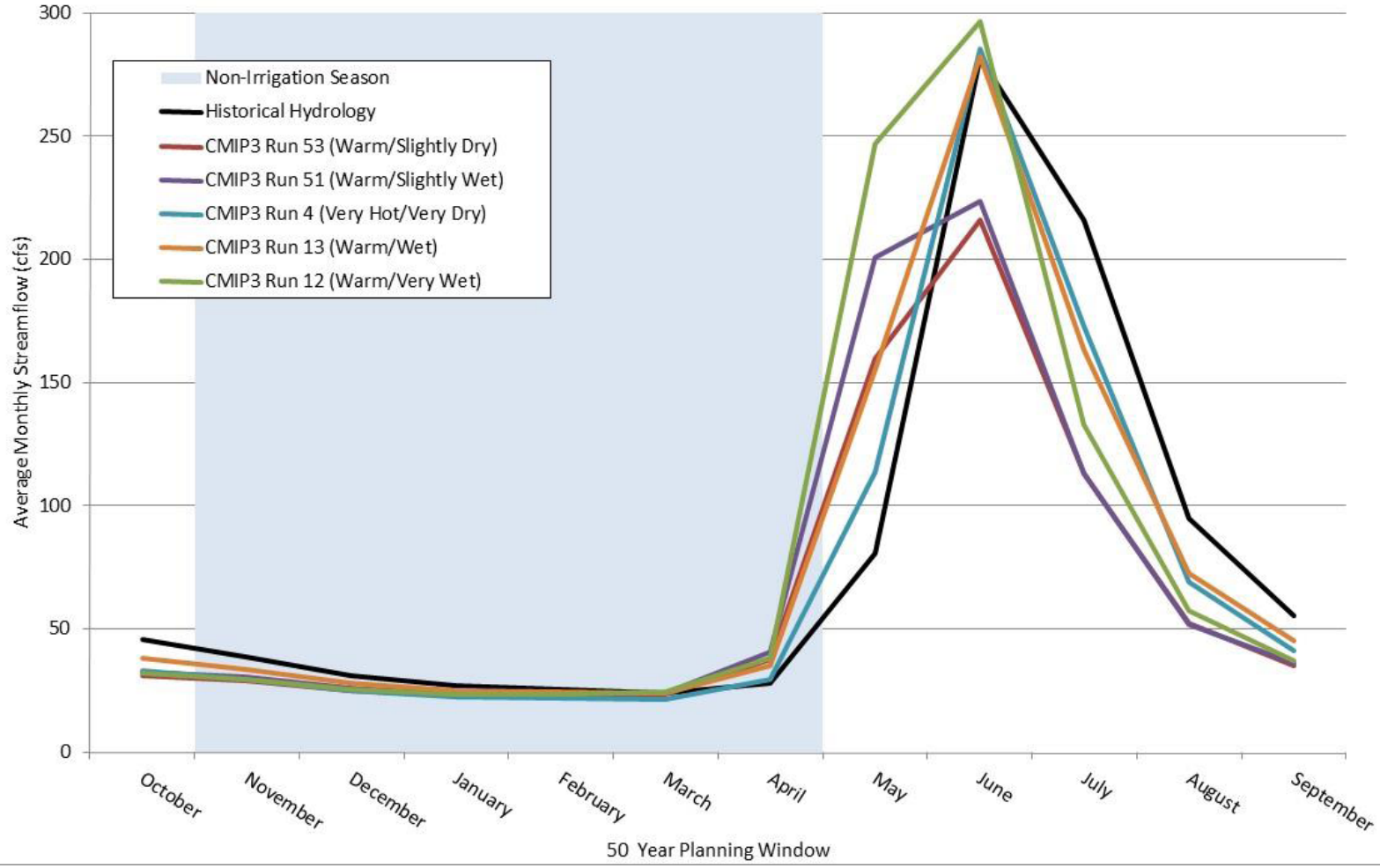
Aspen Tap

better than bottled!

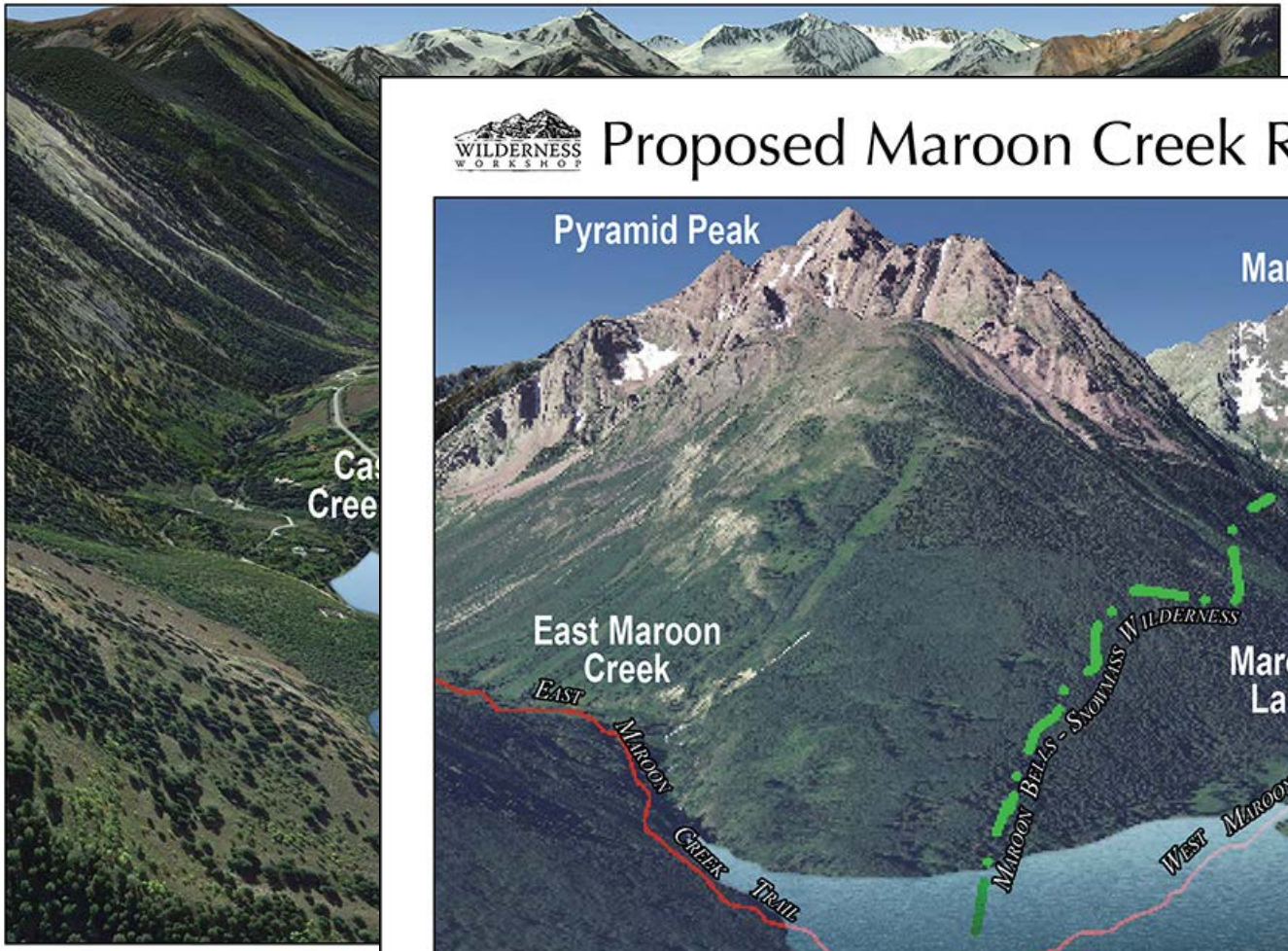
FIGURE 2 - *DRAFT*

CLIMATE SCENARIOS

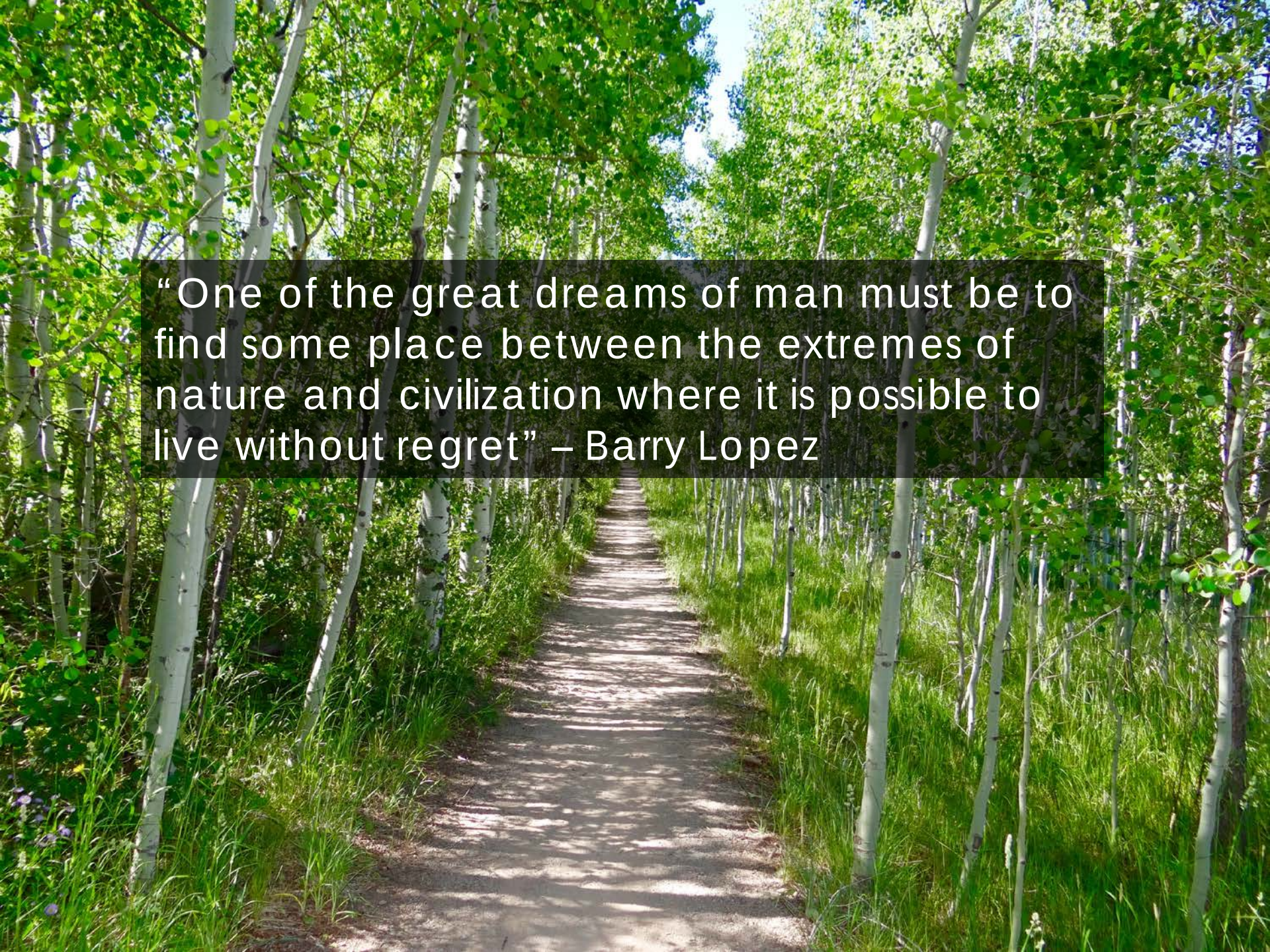
Maroon Creek Streamflow (USGS Gage 09075700)



Proposed Castle Creek Reservoir



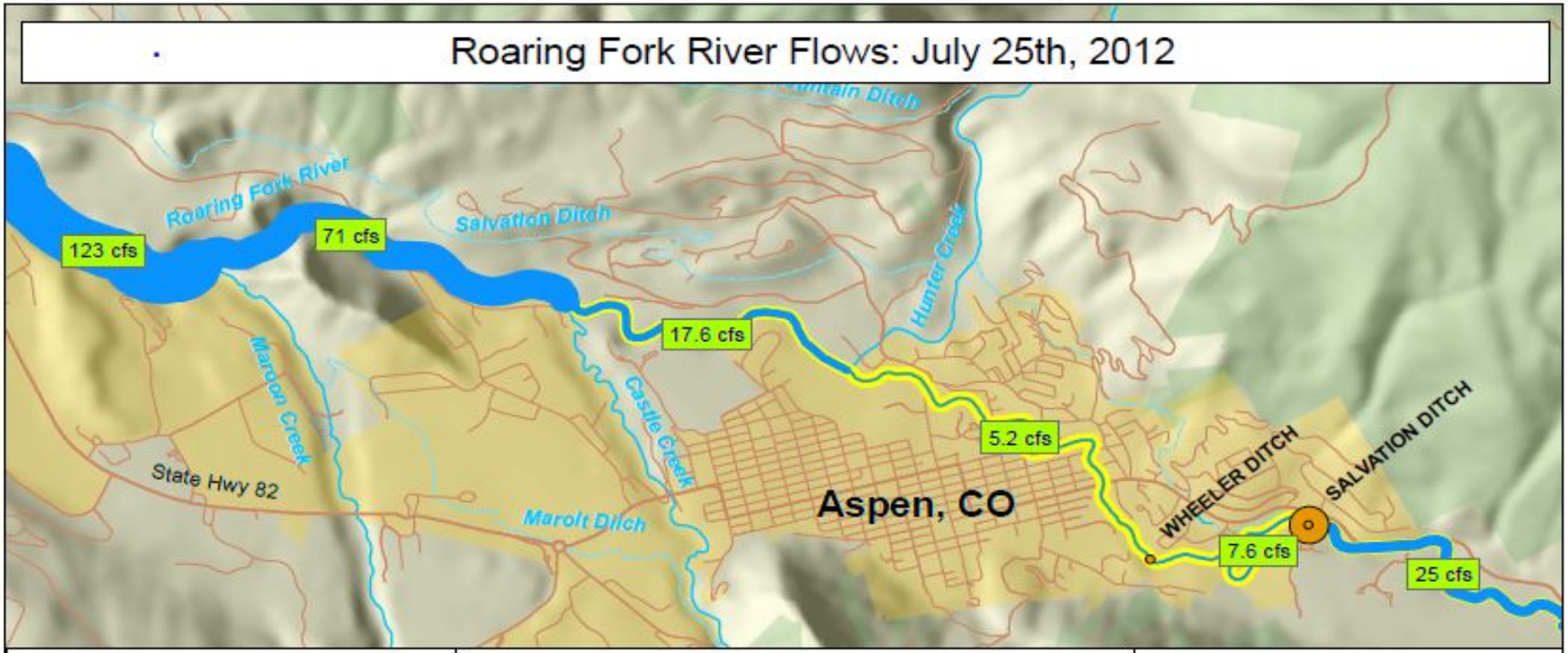
Proposed Maroon Creek Reservoir


“One of the great dreams of man must be to find some place between the extremes of nature and civilization where it is possible to live without regret” – Barry Lopez

Potential Solutions:

- Off-line storage
- In-situ reservoirs
- Conservation
- Reuse
- River Management Plan
- Alternative Transfer Mechanisms
- Cloud Seeding


Vagneur Gravel Pit



S.K.Mason Environmental, LLC

Created By: Bill Hoblitzell

Created On: 8/1/2012

Data Sources: S.K.Mason Environmental, LLC; CDWR; USDA; NRCS; and Pitkin County.

Description

This map depicts flows in different segments of the Roaring Fork River near Aspen, Colorado. The thickness of the blue line is proportional to the amount of water flowing in that segment of river. Observed stream flows are also indicated in the green callout boxes. Orange circles indicate diversion points on this section of river. Their size is proportional to the decreed diversion rate at these points. Several of the ditch names are indicated for reference.

Flows in the river increase below confluences with tributaries such, as Castle Creek. Flows generally decrease at major diversion points. The yellow band proportionally represents the 32-cfs Instream Flow (ISF) right held by the Colorado Water Conservation Board.

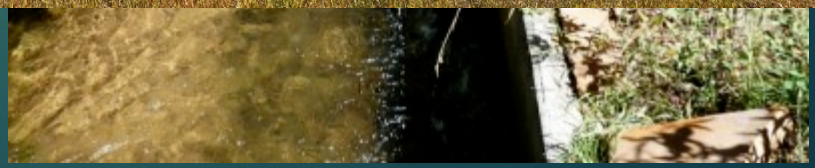
Legend

Decreed Diversion Rate (cfs)
- 0 - 10
- 10 - 18
- 18 - 27
- 27 - 42
- 42 - 75

- Streamflow
- ISF Right
- Streams
- Ditches
- City Limits
- Federal Land
- Streets

0 0.25 0.5 1 Miles

Figure 5. Roaring Fork River Pilot Study, July 25



The Equation:

Supply –

Diversions –

(weighted community value +

weighted community value + ... **) =**

Remaining flow

(environmental and recreational needs)


The health of our waters is the principle measure of how we live on the land.
- Luna Leopold
margaret.medellin@cityofaspen.com
april.long@cityofaspen.com

Revised Colorado Hydrology and Potential Floodplain Implications

March 6th, 2018

Agenda

- Project Summary and Approach
- Flood Frequency Analysis Approach
- Paleoflood Data Incorporation
- Results Discussion

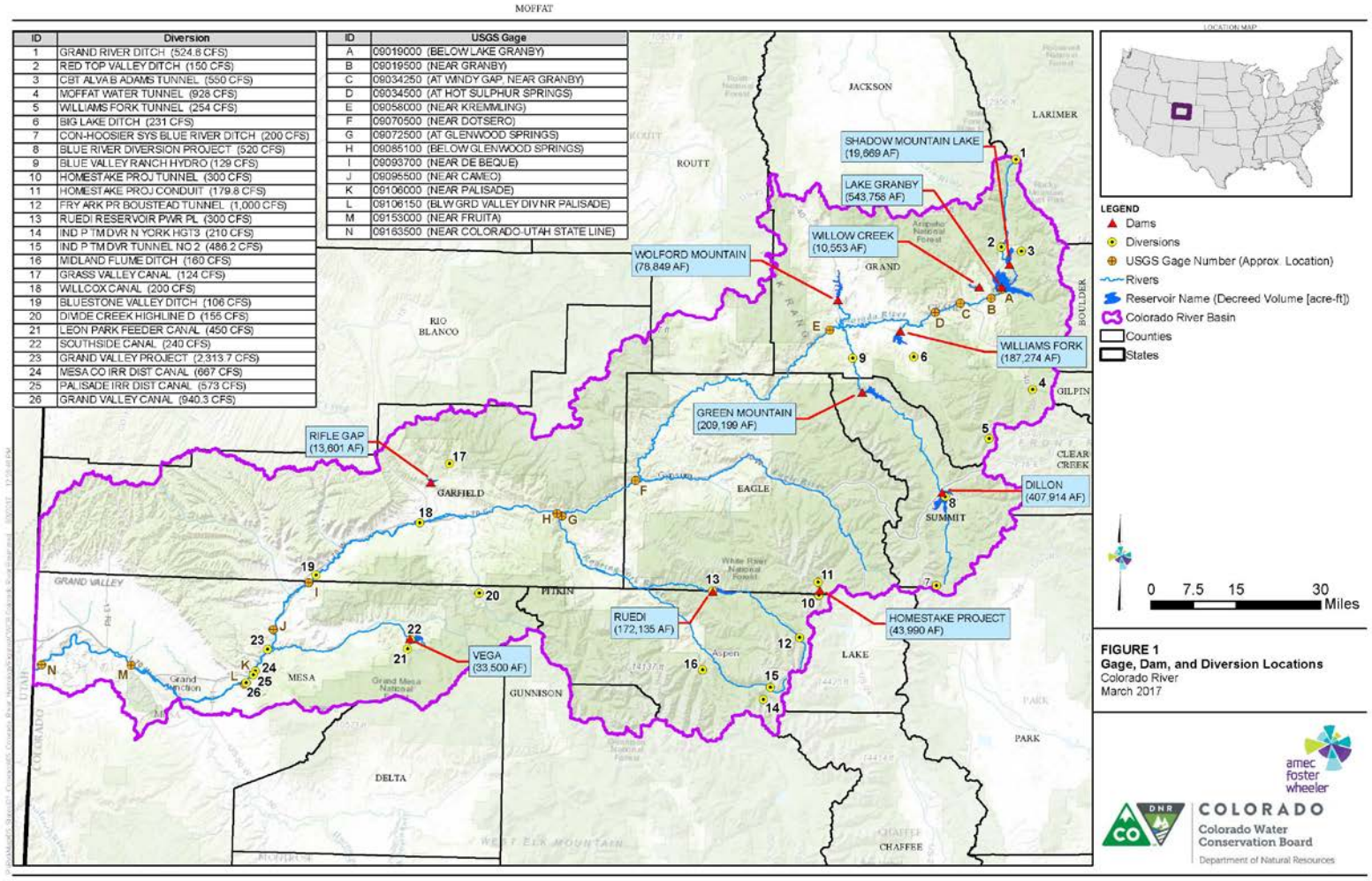
Project Summary and Approach

Overall Project Goals

- Investigate Colorado River Watershed Hydrology
  - Compile existing documentation
  - Assess impacts of diversions and reservoirs
  - Compare results to effective hydrology
  - Provide report and data for use in subsequent studies

First Steps

Overall Project Goals



Flood Frequency Analysis Approach

Overall Analysis Objectives

Three objectives of this analysis:

1. Simplify analysis by assuming observed records are independent and are one possible scenario in one given year.

2. Evaluate whether all or parts of the basin are inherently different pre-reservoir vs. post-reservoir to a point where the influence is lost due to increasing flows.

3. Develop new flows at current and potential future FIS flow change locations.

Flood Frequency Analysis Approach

Impact of Reservoirs

- Determined Gage Length of Record vs. Reservoir Completion Date

Colorado River - Granby to State Line				Gage Record (Years)
START DATE	END DATE	GAGE #	STREAM GAGE NAME	
	1945		SHADOW MOUNTAIN LAKE	
	1950		LAKE GRANBY	
6/13/51	6/1/82	09019000	COLORADO RIVER BELOW LAKE GRANBY, CO	32
6/17/08	6/22/16	09019500	COLORADO RIVER NEAR GRANBY, CO	79
	1952		WILLOW CREEK	
7/3/82	6/23/16	09034250	COLORADO RIVER AT WINDY GAP, NEAR GRANBY, CO	35
6/8/05	6/1/94	09034500	COLORADO RIVER AT HOT SULPHUR SPRINGS, CO	86
	1959		WILLIAMS FORK	
	1995		WOLFORD MOUNTAIN	
	1942		GREEN MOUNTAIN	
	1963		DILLON	
6/4/05	6/9/16	09058000	COLORADO RIVER NEAR KREMMLING, CO	68
	1967		HOMESTAKE	
5/15/41	6/10/16	09070500	COLORADO RIVER NEAR DOTSERO, CO	76
5/30/00	5/8/66	09072500	COLORADO RIVER AT GLENWOOD SPRINGS, CO	67
	1968		RUEDI	
6/5/67	6/8/16	09085100	COLORADO RIVER BELOW GLENWOOD SPRINGS, CO	50
	1967		RIFLE GAP	
5/26/67	6/5/97	09093700	COLORADO RIVER NEAR DE BEQUE, CO	31
5/11/34	6/11/16	09095500	COLORADO RIVER NEAR CAMEO, CO	83
	1960		VEGA	
5/17/02	6/2/33	09106000	COLORADO RIVER NEAR PALISADE, CO	32
6/15/91	6/8/16	09106150	COLO RIVER BELOW GRAND VALLEY DIV NR PALISADE, CO	26
6/13/08	5/29/23	09153000	COLORADO RIVER NEAR FRUITA, CO *	17
6/23/51	6/9/16	09163500	COLORADO RIVER NEAR COLORADO-UTAH STATE LINE	66
			*Additional Data point exists for 7/4/1884	

- Gage data available
- Construction completed

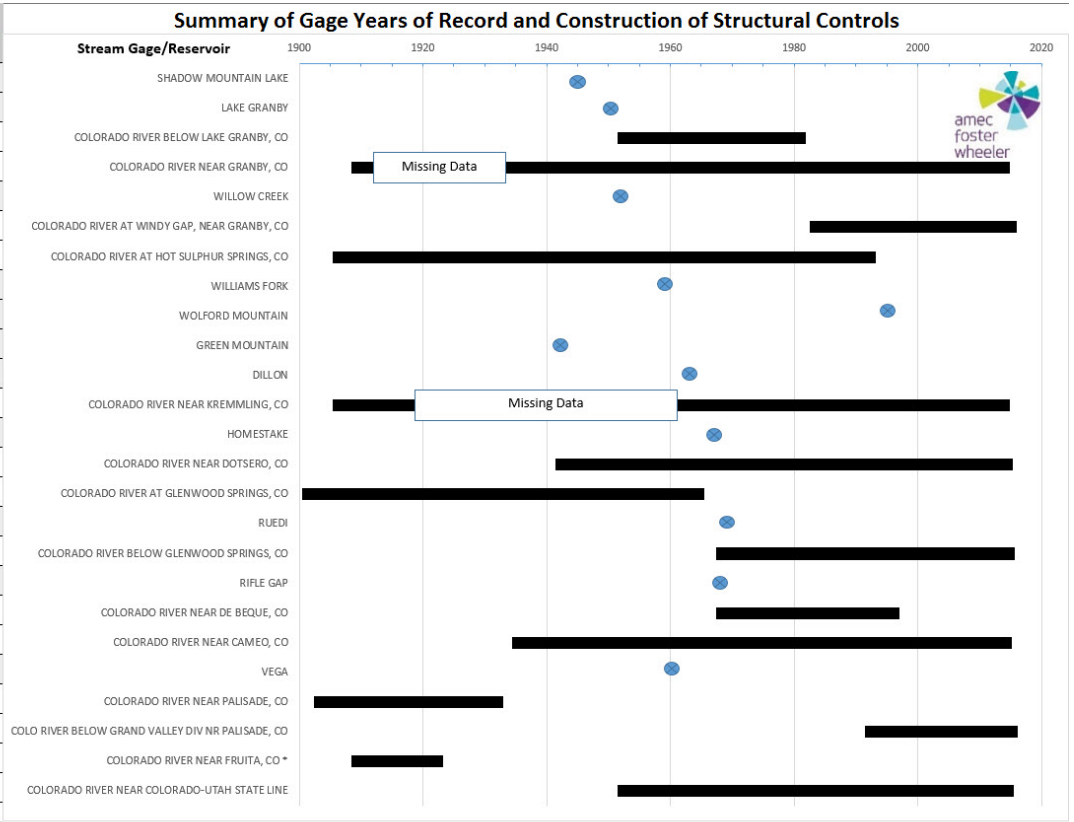


Figure 2-2 – Summary of Gage Years of Record and Construction of Structural Controls

Flood Frequency Analysis Approach

Impact of Reservoirs

- Meeting with Alan Martellaro, Division Engineer
  - Colorado Division of Water Resources District 5
    - Discussed reservoir impacts on large events
    - Non-independent annual flows (e.g. 2016 can depend on 2015)
    - Non-independent diversions (e.g. diversions depend on eastern slope levels)
    - No reservoirs dedicated to flood control within basin
    - Lake Granby outlet capped at 75 cfs unless spillway active

Flood Frequency Analysis Approach

Impact of Reservoirs

- Reservoir Impacts on FFA
  - Many low outliers due to regulation of medium and low flows
    - Same problem as PILFs

Flood Frequency Analysis Approach

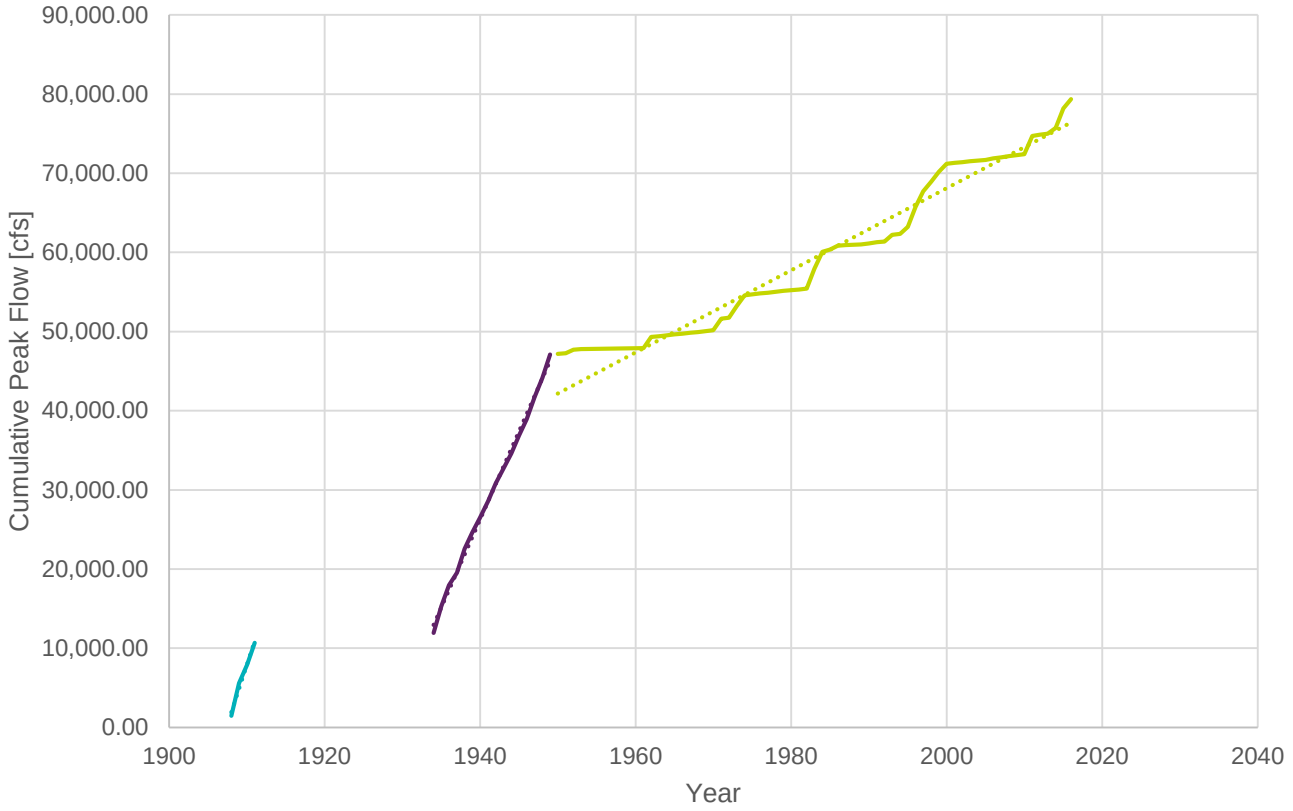
FFA Methodology

- Basin is inherently different pre-reservoir vs post-reservoir
  - Focus on post-reservoir conditions at gages within reservoir influence
    - Have the data (+/- 50 years)
    - Matches future conditions
  - Use a statistical approach to simplify a stochastic problem
    - Any condition which has occurred could happen again
  - Rely on 17C MGB test to filter outliers
    - Adjust if needed to ensure expected curve matches data
  - Use gages with most reliable/defensible data
  - Simplify as much as possible

Flood Frequency Analysis Approach

Reservoir Influence

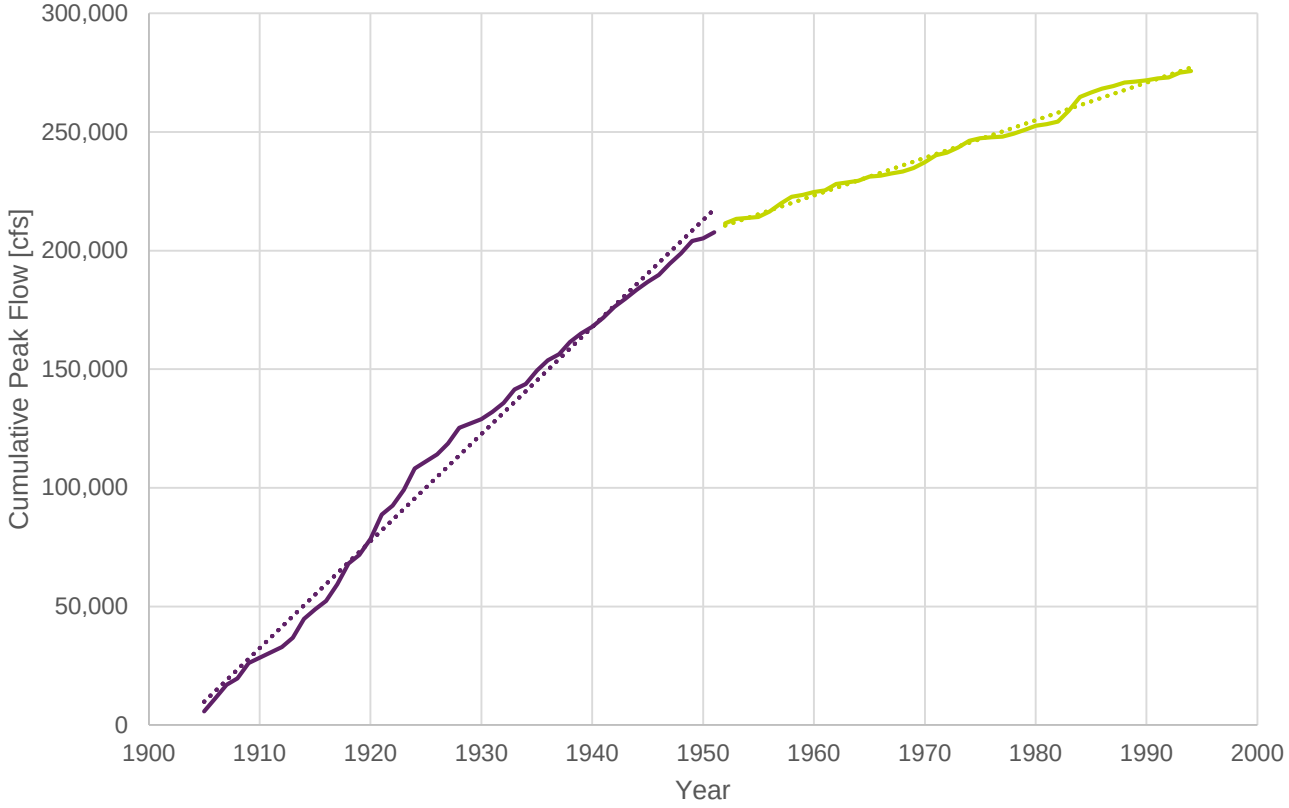
- Cumulative flow plots to track changes post-reservoir
- Granby:



Flood Frequency Analysis Approach

Reservoir Influence

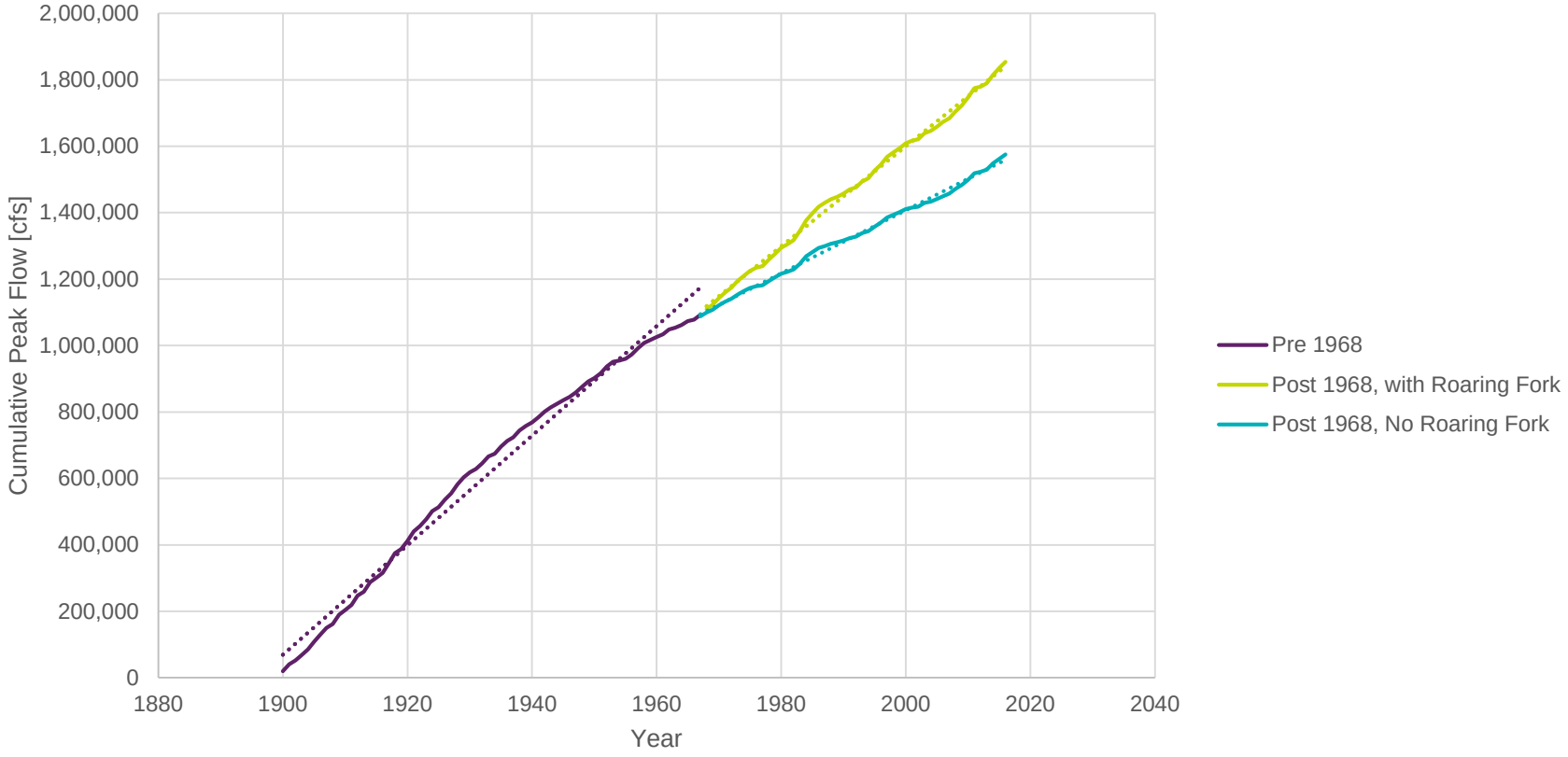
- Cumulative flow plots to track changes post-reservoir
- Hot Sulphur Springs:



Flood Frequency Analysis Approach

Reservoir Influence

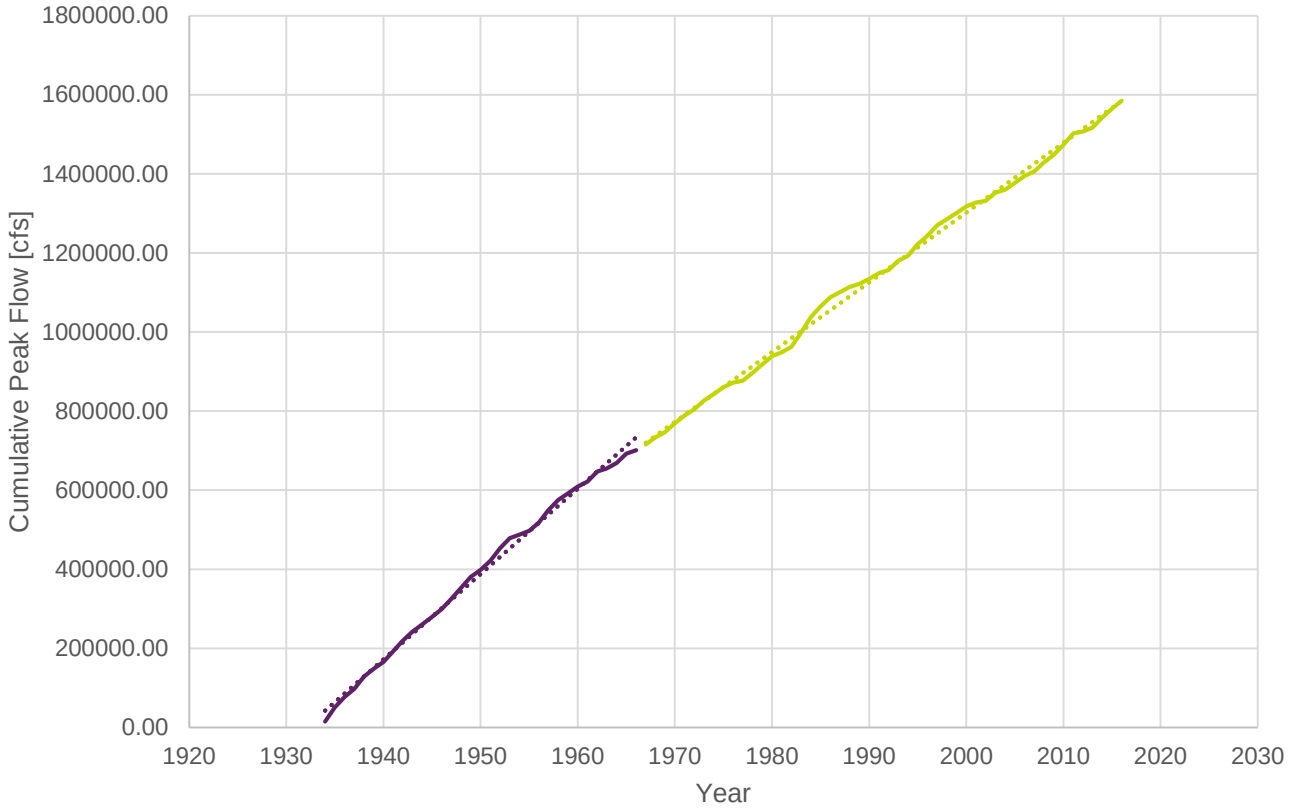
- Cumulative flow plots to track changes post-reservoir
- Glenwood:



Flood Frequency Analysis Approach

Reservoir Influence

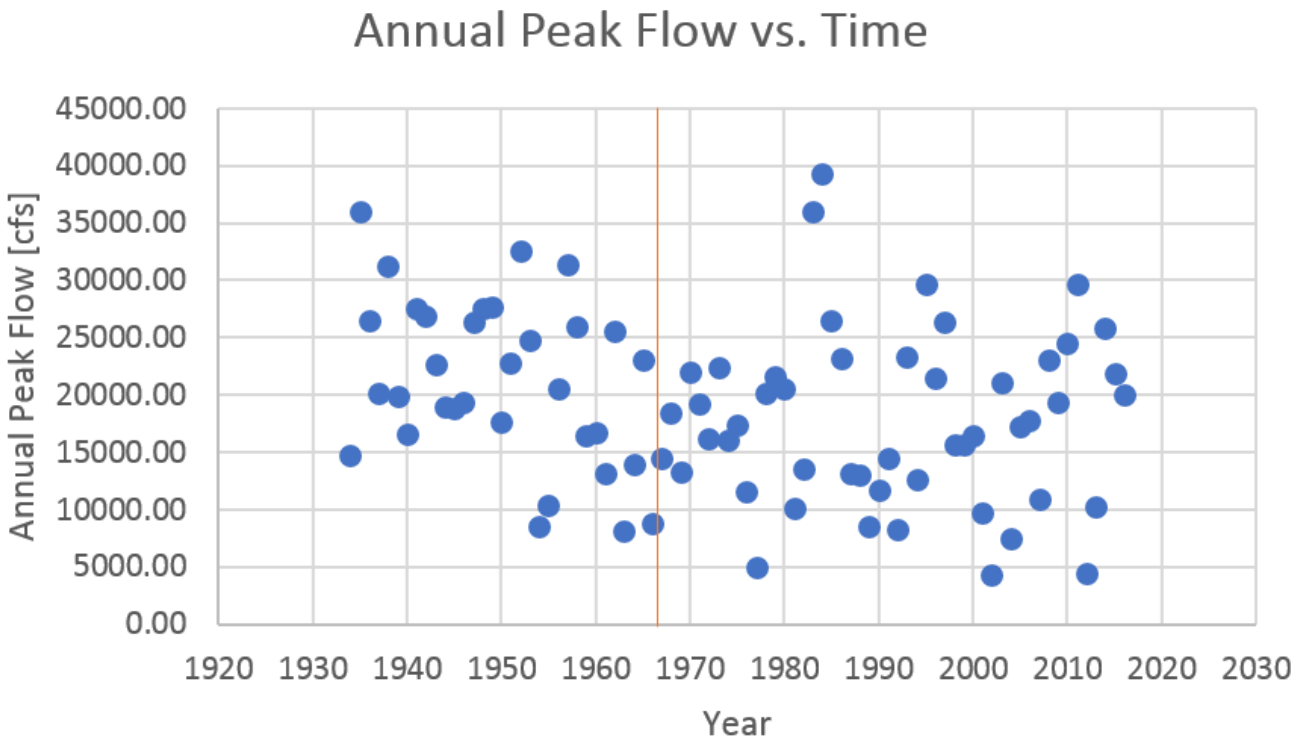
- Cumulative flow plots to track changes post-reservoir
- Cameo:



Flood Frequency Analysis Approach

Reservoir Influence

- Cumulative flow plots to track changes post-reservoir
- Cameo:



Flood Frequency Analysis Approach

Case Study

- Glenwood US vs DS of Roaring Fork

Upstream

Percent Chance Exceedance	Computed Curve Flow in cfs
0.2	39358.6
0.5	36487.7
1.0	34148.3
2.0	31636.8
5.0	27985.4
10.0	24887.8
20.0	21358.8
50.0	15401.0
80.0	10590.5
90.0	8538.2
95.0	7072.5
99.0	4839.4

500-year predicted peak: 39,359 cfs
100-year predicted peak: 34,148 cfs

Downstream

Percent Chance Exceedance	Computed Curve Flow in cfs
0.2	35226.6
0.5	33405.2
1.0	31797.6
2.0	29947.2
5.0	27027.3
10.0	24339.7
20.0	21051.8
50.0	15015.8
80.0	9829.6
90.0	7594.7
95.0	6018.0
99.0	3701.2

500-year predicted peak: 35,227 cfs
100-year predicted peak: 31,798 cfs

Downstream includes substantial tributary area from the Roaring Fork…

Task 2 - Flood Frequency Analysis Progress Report

Case Study

- Glenwood US vs DS of Roaring Fork

Upstream

Percent Chance Exceedance	Computed Curve Flow in cfs
0.2	39358.6
[illegible]	36487.7
[illegible]	34148.3
2.0	31636.8
5.0	27985.4
10.0	24887.8
20.0	21358.8
50.0	15401.0
80.0	10590.5
90.0	8538.2
95.0	7072.5
99.0	4839.4

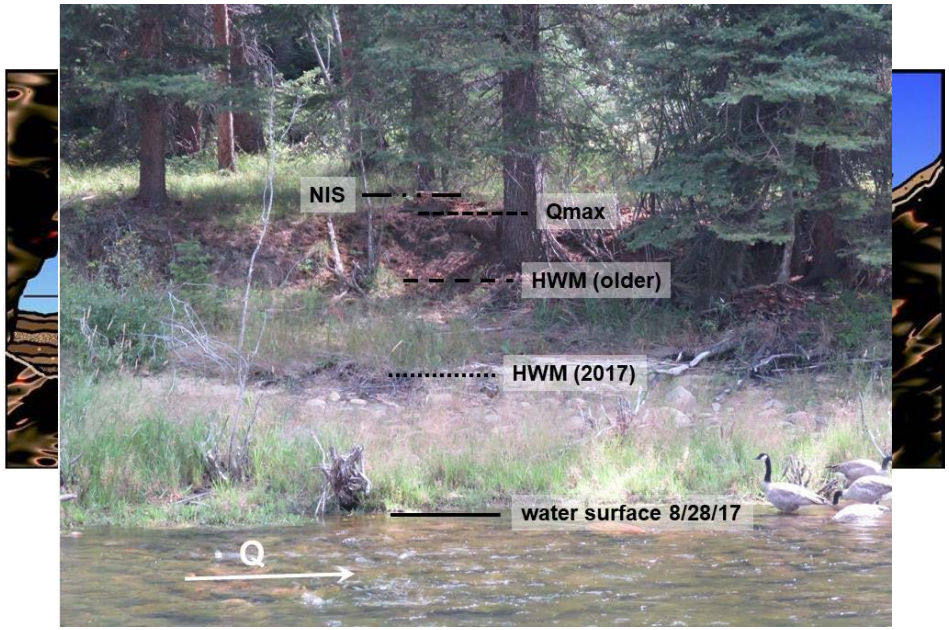
Pre-Reservoir
Gage stopped
recording in 1966

Downstream

Percent Chance Exceedance	Computed Curve Flow in cfs
0.2	35226.6
0.5	33405.2
1.0	31797.6
2.0	29947.2
5.0	27027.3
10.0	24339.7
20.0	21051.8
50.0	15015.8
80.0	9829.6
90.0	7594.7
95.0	6018.0
99.0	3701.2

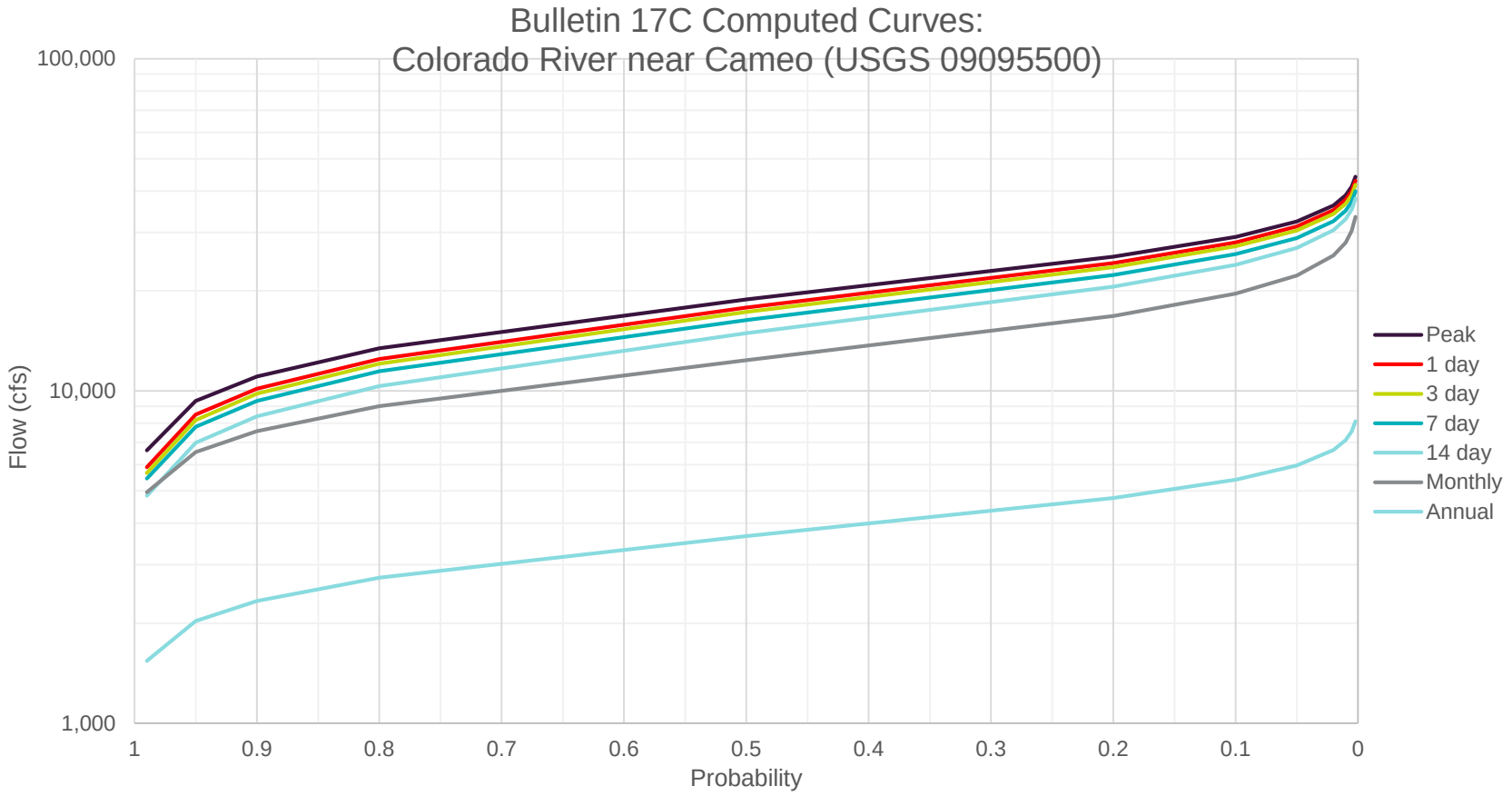
Paleoflood Data

- Dr. Bob Jarrett performed paleoflood study in the upper part of the Colorado Basin
  - Non-Inundation Surface (NIS) and Maximum Paleoflood (Qmax) determined by paleoflood study confirmed gage results
  - Unable to perform detailed analysis in middle part of basin due to safety concerns and human development destroying paleoflood evidence



Results

- Focusing on good quality gages like Cameo helps produce quality results.



Results

Gage	Gage Number	Data Set (# of Records)	Drainage Area (mi^2)	FIS Analysis				Bulletin 17B Analysis				Bulletin 17C Analysis				Percent Difference				Sta. Skew	MSE
				10%	2%	1%	0.20%	10%	2%	1%	0.20%	10%	2%	1%	0.20%	10%	2%	1%	0.20%		
Colorado River Below Lake Granby	9019000	Entire Record (32)	312	-	-	-	-	532	1,363	1,949	4,196	532	1,363	1,949	4,196	0%	0%	0%	0%	-	-
Colorado River Near Granby	9019500	LOT ** 1100 cfs (33)	323	-	-	-	-	2,770	9,146	14,070	34,147	2,709	3,876	4,208	4,712	-2%	-58%	-70%	-86%	-1.27	0.213
Windy Gap/Hot Sulphur Springs Combined	Combo	Combination (65)	825	-	-	-	-	3,660	6,524	7,967	11,860	3,756	5,330	5,830	6,687	3%	-18%	-27%	-44%	-1.07	0.183
Colorado River Near Kremmling	9058000	Recent Flows (54)	2,379	-	-	-	-	7,431	12,988	15,912	24,234	7,410	12,926	15,823	24,053	0%	0%	-1%	-1%	0.18	0.110
Colorado River Near Kremmling	9058000	Recent Flows (54)	3,400	-	-	-	-	9,508	16,617	20,358	31,005	9,480	16,537	20,244	30,774	-	-	-	-		
FIS - Upstream of Eagle River	-	FIS Flows	3,400	14,649	19,685	21,650	25,933	-	-	-	-	-	-	-	-	-35%	-16%	-6%	19%		
FIS - Downstream of Eagle River	-	FIS Flows	4,344	18,950	24,900	27,140	31,830	-	-	-	-	-	-	-	-	-17%	-16%	-16%	-15%		
Colorado River Near Dotsero	9070500	Recent Flows (49)	4,344	-	-	-	-	15,690	21,054	23,174	27,804	15,778	20,915	22,868	26,980	-	-	-	-		
Colorado River Near Dotsero	9070500	Recent Flows (49)	4,390	-	-	-	-	15,796	21,196	23,331	27,992	15,885	21,056	23,023	27,162	1%	-1%	-1%	-3%	-0.50	0.141
Colorado River at Glenwood Springs	9072500	Entire Record (67)	4,558	-	-	-	-	24,821	31,322	33,705	38,579	24,888	31,637	34,148	39,359	0%	1%	1%	2%	-0.48	0.108
Colorado River Near Dotsero	9070500	Recent Flows (49)	4,560	-	-	-	-	16,185	21,718	23,905	28,681	16,276	21,574	23,590	27,831	-	-	-	-		
FIS - Upstream of Roaring Fork River	-	FIS Flows	4,560	21,500	29,000	32,500	41,000	-	-	-	-	-	-	-	-	-5%	-13%	-18%	-28%		
Colorado River Below Glenwood Springs	9085100	Entire Record (50)	4,560	-	-	-	-	18,938	27,028	29,131	32,063	20,389	25,086	26,636	29,509	-	-	-	-		
Colorado River Below Glenwood Springs	9085100	Entire Record (50)	6,014	-	-	-	-	22,608	32,266	34,776	38,276	24,340	29,947	31,798	35,227	8%	-7%	-9%	-8%	-0.79	0.165
Colorado River Below Glenwood Springs	9085100	Entire Record (50)	6,020	-	-	-	-	22,622	32,287	34,798	38,300	24,355	29,966	31,818	35,249	-	-	-	-		
FIS - Just Downstream of Roaring Fork River *	-	FIS Flows	6,020	22,000	33,000	40,000	57,000	-	-	-	-	-	-	-	-	11%	-9%	-20%	-38%		
Colorado River Below Glenwood Springs	9085100	Entire Record (50)	6,300	-	-	-	-	23,290	33,240	35,826	39,431	25,074	30,851	32,757	36,290	-	-	-	-		
FIS - At New Castle *		FIS Flows	6,300	22,900	34,800	41,000	56,800	-	-	-	-	-	-	-	-	9%	-11%	-20%	-36%		
Colorado River Below Glenwood Springs	9085100	Entire Record (50)	6,590	-	-	-	-	23,971	34,211	36,872	40,583	25,807	31,753	33,714	37,351	-	-	-	-		
FIS - Downstream of Divide Creek	-	FIS Flows	6,590	28,300	37,700	41,800	51,300	-	-	-	-	-	-	-	-	-9%	-16%	-19%	-27%		
FIS - At Rifle	-	FIS Flows	6,930	23,900	37,900	45,000	65,000	-	-	-	-	-	-	-	-	11%	-13%	-21%	-38%		
Colorado River Near Cameo	9095500	Entire Record (83)	6,930	-	-	-	-	26,896	32,641	34,503	37,903	26,585	33,057	35,435	40,326	-	-	-	-		
Colorado River Near De Beque	9093700	Entire Record (31)	7,370	-	-	-	-	27,887	37,803	42,050	52,087	28,185	37,621	41,455	50,072	1%	0%	-1%	-4%	-0.25	0.182
FIS - At Confluence with Parachute Creek	-	FIS Flows	7,370	30,200	40,000	44,200	54,100	-	-	-	-	-	-	-	-	-8%	-14%	-17%	-22%		
Colorado River Near Cameo	9095500	Entire Record (83)	7,370	-	-	-	-	27,977	33,953	35,889	39,426	27,653	34,385	36,859	41,947	-	-	-	-		
Colorado River Near Cameo	9095500	Entire Record (83)	7,986	-	-	-	-	29,452	35,743	37,781	41,504	29,111	36,198	38,802	44,158	-1%	1%	3%	6%	-0.47	0.090
Colorado River Near Palisade	9106000	Entire Record (32)	8,738	-	-	-	-	46,670	57,648	61,869	70,950	46,672	57,649	61,870	70,947	0%	0%	0%	0%	-0.28	0.179
Colorado River Near Cameo	9095500	Entire Record (83)	8,800	-	-	-	-	31,340	38,033	40,203	44,164	30,977	38,517	41,288	46,988	-	-	-	-		
Upstream of Confluence with Gunnison River	-	FIS Flows	8,800	32,900	44,400	49,300	61,000	-	-	-	-	-	-	-	-	-7%	4%	8%	16%		
Colorado River Below Grand Valley Div	9106150	Entire Record (27)	8,800	-	-	-	-	38,136	65,197	78,249	112,003	30,732	46,395	53,463	70,834	-	-	-	-		
Colorado River Below Grand Valley Div	9106150	Entire Record (27)	8,813	-	-	-	-	38,172	65,259	78,323	112,109	30,761	46,439	53,514	70,901	-19%	-29%	-32%	-37%	-0.14	0.183
Downstream of Confluence with Gunnison Rvr	-	FIS Flows	17,000	50,600	73,100	83,700	111,400	-	-	-	-	-	-	-	-	-7%	-3%	-1%	0%		
Colorado River Near CO-UT State Line	9163500	Entire Record (66)	17,000	-	-	-	-	40,537	69,409	78,108	91,395	46,823	71,257	82,590	111,232	-	-	-	-		
Colorado River Near Fruita	9153000	Entire Record (17)	17,100	-	-	-	-	87,324	128,220	147,676	198,378	75,025	105,978	120,464	157,705	-14%	-17%	-18%	-21%	0.32	0.332
Colorado River Near CO-UT State Line	9163500	Entire Record (66)	17,849	-	-	-	-	41,821	71,608	80,583	94,291	48,306	73,515	85,207	114,756	16%	3%	6%	22%	-0.37	0.102
Colorado River Near CO-UT State Line	9163500	Entire Record (66)	24,100	-	-	-	-	50,682	86,780	97,657	114,269	58,541	89,091	103,260	139,070	-	-	-	-		
FIS - Near Cisco, Utah	-	FIS Flows	24,100	59,000	78,500	86,000	100,000	-	-	-	-	-	-	-	-	-1%	13%	20%	39%		-
Colorado River Near Cisco, UT	9180500	Entire Record (99)	24,100	-	-	-	-	60,399	82,600	91,168	109,359	58,664	79,122	86,858	102,985	-3%	-4%	-5%	-6%	-0.55	0.083

Gage FFA Calculation

WIR-99 Gage FFA Projection

Existing FIS Effective Flows

Gage Recommended for Omission

* Data from preliminary Garfield County FIS and may have changed after creation of this table.

** LOT - Low Outlier Threshold set to

Results

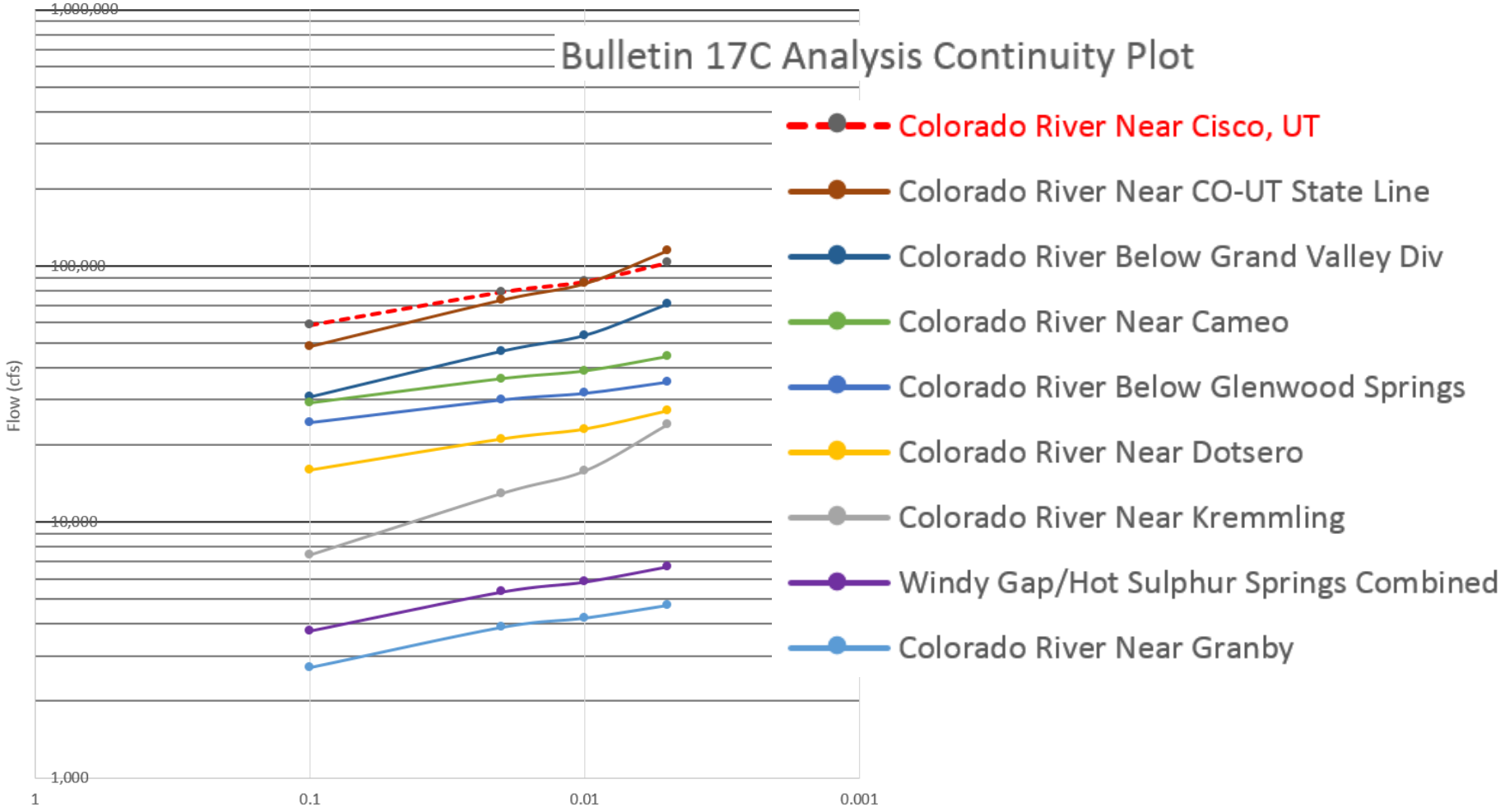
Gage	Gage Number	Data Set (# of Records)	Source	Drainage Area (mi^2)	Bulletin 17C Analysis				Effective FIS		1% % Change	0.2% % Change
					10%	*2%*	*1%*	*0.20%*	*1%*	*0.20%*		
Colorado River Near Granby	9E+06	LOT * 1100 cfs (33)	FFA Analysis	323	2,710	3,880	4,210	4,710	-	-	-	-
Windy Gap/Hot Sulphur Springs Combined	Combo	Combination (65)	FFA Analysis	825	3,760	5,330	5,830	6,690	-	-	-	-
Colorado River Near Kremmling	9E+06	Recent Flows (54)	FFA Analysis	2,379	7,740	12,100	13,800	17,800	-	-	-	-
Upstream of Eagle River	-	-	WIR-99 (Kremmling)	3,400	9,900	15,500	17,700	22,800	21,650	25,933	-18%	-12%
Downstream of Eagle River	-	-	WIR-99 (Dotsero)	4,344	15,800	21,000	22,800	27,000	27,140	31,830	-16%	-15%
Colorado River Near Dotsero	9E+06	Recent Flows (49)	FFA Analysis	4,390	15,900	21,100	23,000	27,200	-	-	-	-
Upstream of Roaring Fork River	-	-	Below Glenwood - Roaring Fork FFA	4,560	16,400	21,600	23,400	27,300	32,500	41,000	-28%	-33%
Colorado River Below Glenwood Springs	9E+06	Entire Record (50)	FFA Analysis	6,014	24,300	29,900	31,800	35,200	-	-	-	-
Just Downstream of Roaring Fork River	-	-	WIR-99 (Below Glenwood)	6,020	24,300	29,900	31,800	35,200	40,000	57,000	-21%	-38%
At New Castle	-	-	WIR-99 (Below Glenwood)	6,300	25,000	30,800	32,800	36,300	41,000	56,800	-20%	-36%
Downstream of Divide Creek	-	-	WIR-99 (Below Glenwood)	6,590	25,800	31,700	33,700	37,300	41,800	51,300	-19%	-27%
At Rifle	-	-	WIR-99 (Cameo)	6,930	26,600	33,100	35,400	40,400	45,000	65,000	-21%	-38%
At Confluence with Parachute Creek	-	-	WIR-99 (Cameo)	7,370	27,600	34,400	36,900	42,000	44,200	54,100	-17%	-22%
Colorado River Near Cameo	9E+06	Entire Record (83)	FFA Analysis	7,986	29,100	36,200	38,800	44,200	-	-	-	-
Upstream of Confluence with Gunnison River	-	-	WIR-99 (Grand Valley)	8,800	30,800	46,400	53,400	70,800	49,300	61,000	8%	16%
Colorado River Below Grand Valley Div	9E+06	Entire Record (27)	FFA Analysis	8,813	30,800	46,400	53,500	70,900	-	-	-	-
Downstream of Confluence with Gunnison Rvr	-	-	WIR-99 (State Line)	17,000	46,800	71,200	82,600	111,000	83,700	111,400	-1%	0%
Colorado River Near CO-UT State Line	9E+06	Entire Record (66)	FFA Analysis	17,849	48,300	73,500	85,200	115,000	-	-	-	-
Colorado River Near Cisco, UT	9E+06	Entire Record (99)	FFA Analysis	24,100	58,700	79,100	86,900	103,000	86,000	100,000	1%	3%

** LOT - Low Outlier Threshold set to*

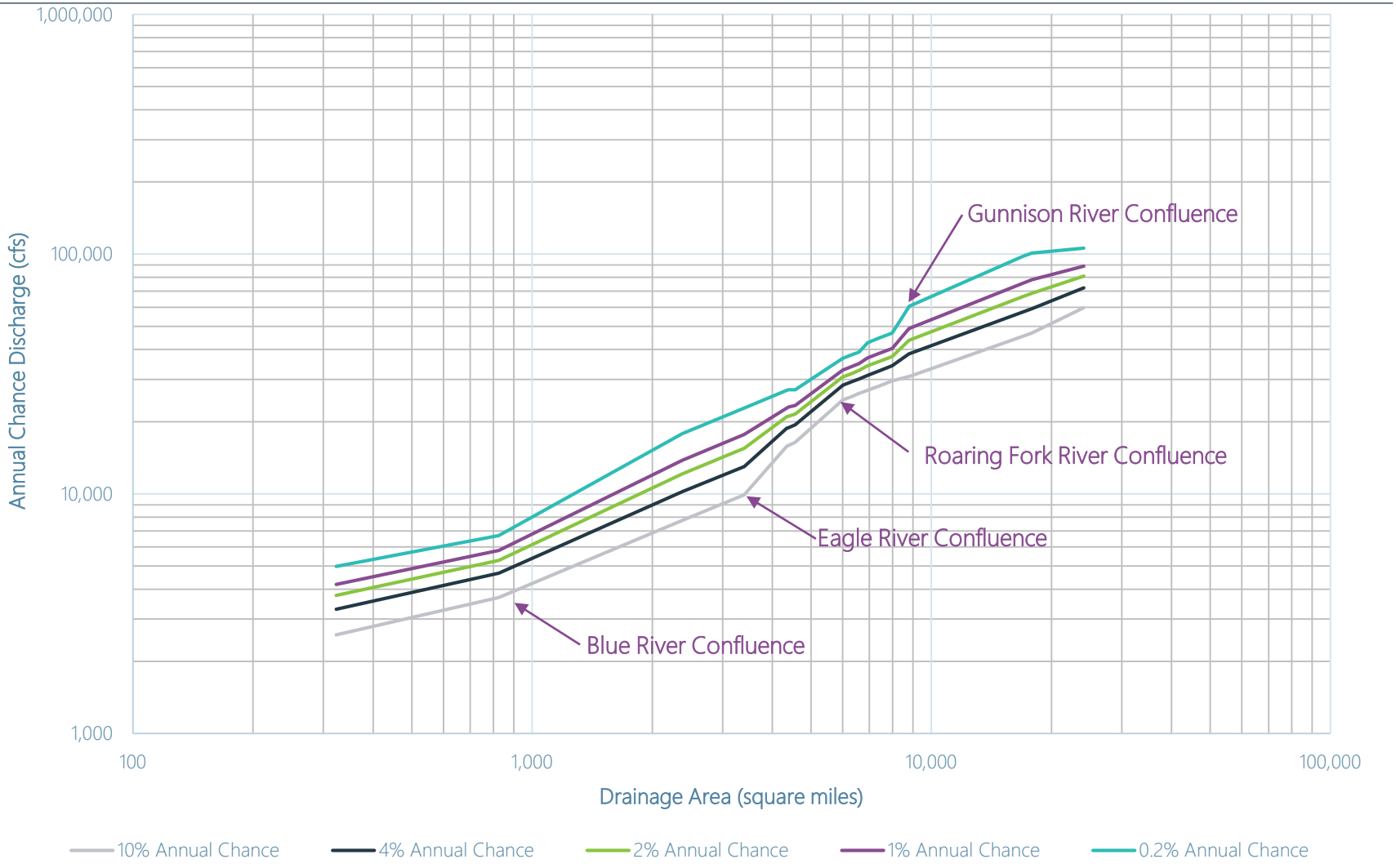
† WIR-99 – Analysis of the Magnitude and Frequency of Floods in Colorado Water Resources Investigations Report 99-4190 (2000) – Equation 3

Results

- Results are continuous, consistent and reasonable.

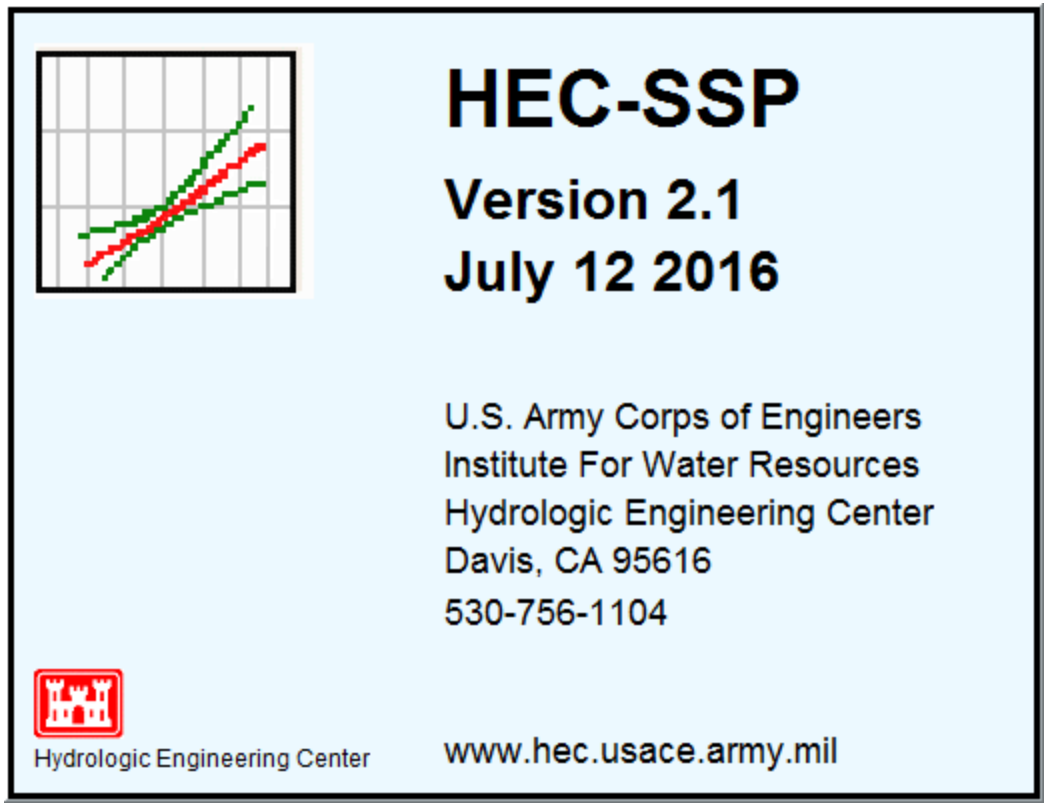


Results



Discharge Versus Drainage Area

Specific Questions?



Q&A

woodplc.com

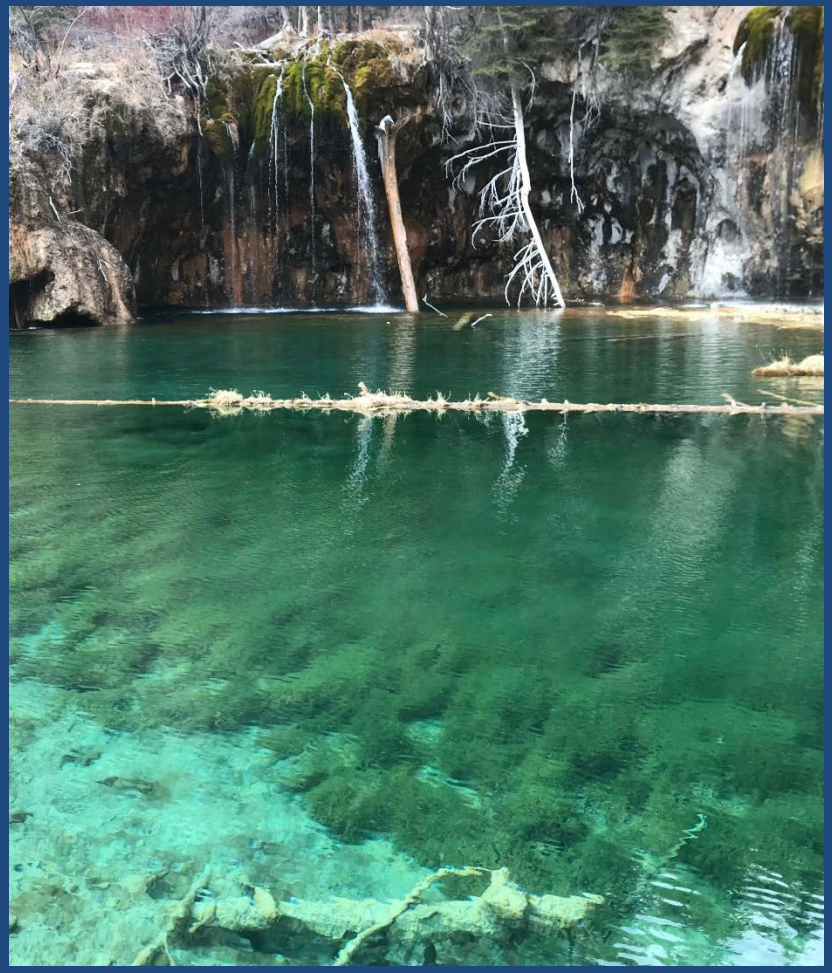
Navigating Water Quality Regulations in Colorado

Jane Clary, CPESC, LEED AP
Wright Water Engineers

CASFM Seminar
Glenwood Springs, Colorado
April 2018

Overview

- Clean Water Regulatory Process in Colorado
  - Roles
  - Process
- Relationships among water quality policies, regulations, programs
- 10-year Water Quality Road Map
- Permit-related flexibilities
- Case study



Colorado Water Quality Control

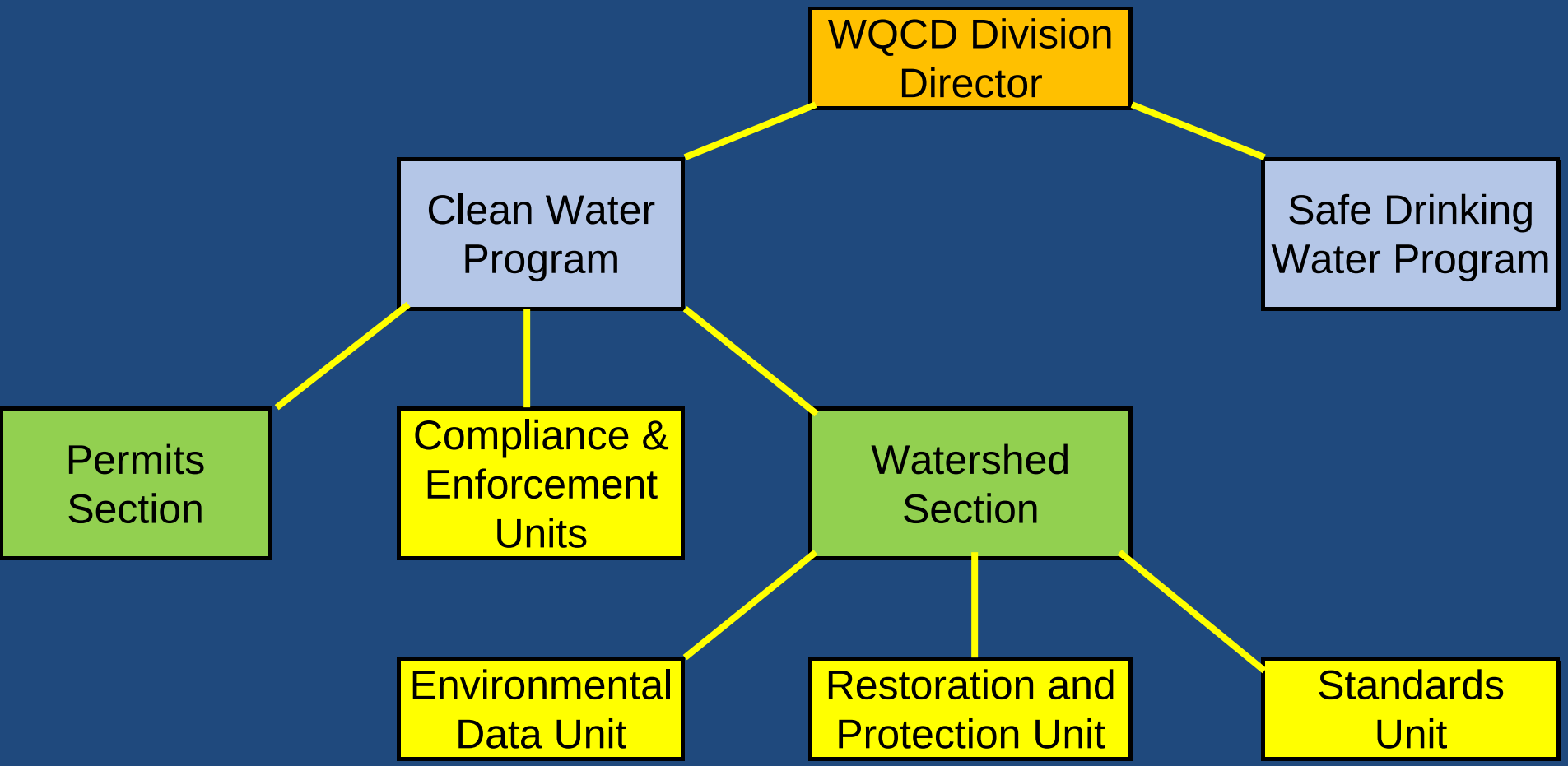
Commission

- 9-member citizen commission, appointed by Governor and confirmed by Senate
- Must have at least 2 members from west slope; otherwise must represent various interests in water quality
- 3-year terms; current administration added 2-term limit

Division

- ~190 staff across 2 programs – clean water and drinking water
- Commission establishes water quality requirements, and the division implements and enforces them
- Division staff are technical staff to the commission for rulemaking hearings

CDPHE Water Quality Control Division



Colorado Water Quality Forum

Colorado Water Quality Forum Work Groups

Permit Issues

303(d) Listing Methodology Policy 10-1

MS4 - Stormwater

Nutrients

Reclaimed Water

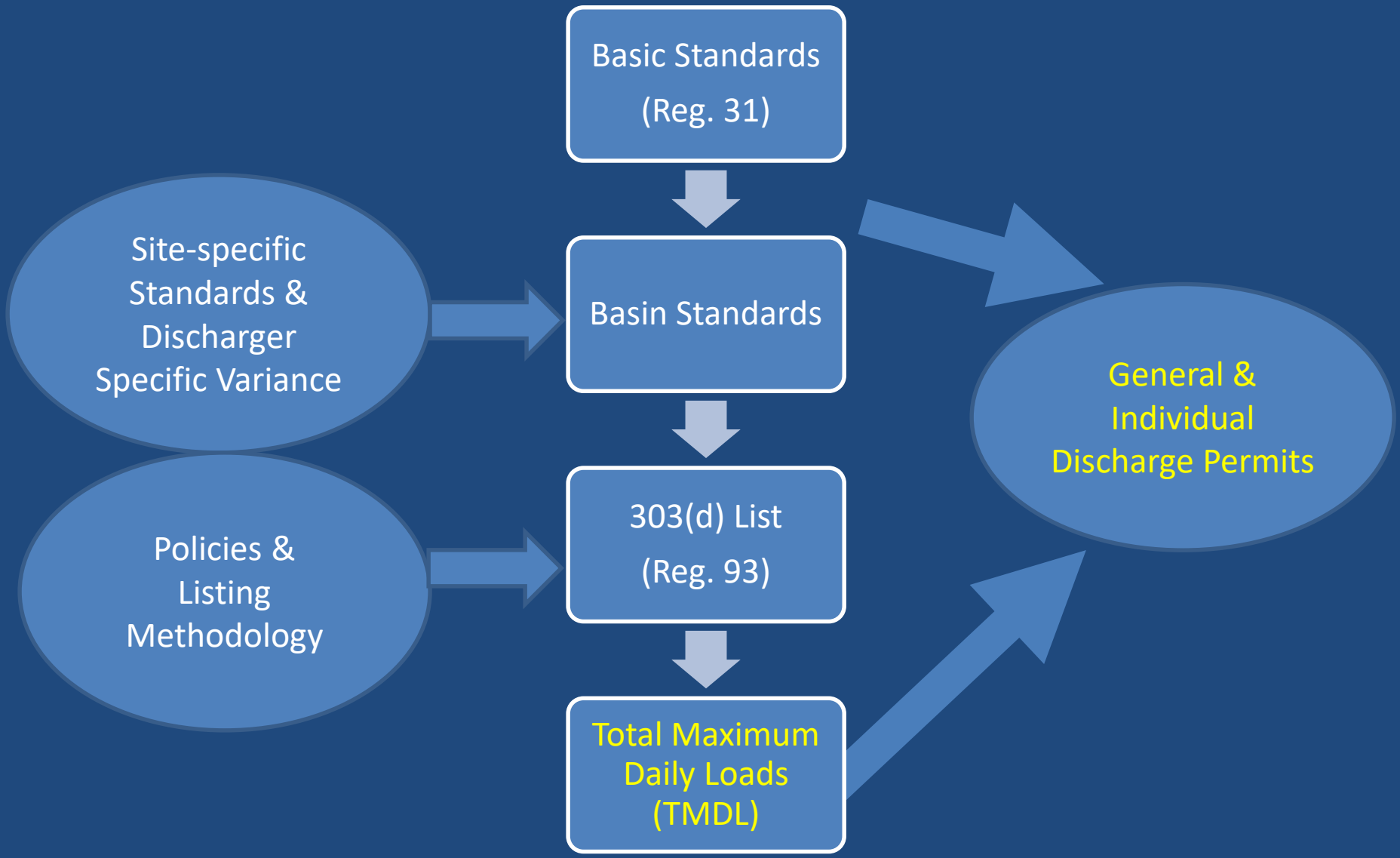
Temperature

Regulation 82 Workgroup

Division-Led Workgroups

Work Groups	Master Calendar	Workgroup Signup Form	Workgroup Rationale Form
Membership Meetings	Annual Retreat	Archives	Links

Regulatory Relationships



Rulemaking Process

- Notice approved and published
- Party Status Requests
- Proponent Prehearing Statement
- Responsive Prehearing Statement
- Rebuttals
- Prehearing Conference
- Rulemaking Hearing

Suggestions for Effective Rulemaking Hearing Participation

- Provide an executive summary of the issue(s).
- Maps, photos, tables and graphs are helpful.
- Be concise and organized in writing—Commissioners are processing large volume of information from many parties.
- Take the time to increase the font on graphs and figures used in Powerpoints.
- Work with Division in advance to reach consensus and narrow the issues.
- Stay within the scope of the hearing.
- Include “actionable items”--not just complaints.
- Don’t be deceptive with data and statistics.
- Don’t be a no-show.

Where to Find Commission Regulations and Policies

Commission Policies

COLORADO
Department of Public Health & Environment

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WQCC policies

Back to WQCC regulations, policies and water quality statutes

- Policy 17-1: Voluntary Incentive Program for Early Nutrient Reductions (expires Dec. 31, 2020).
- Policy 13-1: Interim Guidance for Implementation of Discharger Specific Variances Provisions (expires Mar. 31, 2019).
- Policy 10-1: Aquatic Life Use Attainment (expires Dec. 31, 2020).
- Policy 06-1: Temperature Criteria Methodology (expires Jan. 31, 2023).
- Policy 98-1: Guidance for Implementation of Colorado's Narrative Sediment Standard, Regulation #31, Section 31.11(1)(a)(i) (expires Jan. 31, 2022).
- Policy 98-2: A Guide to Colorado Programs for Water Quality Management and Safe Drinking Water (expires Dec. 31, 2018).
- Policy 96-2: Human Health-Based Water Quality Criteria and Standards (expires Dec. 31, 2021).

Division—Implementation of Regulations through Permits

COLORADO
Department of Public Health & Environment

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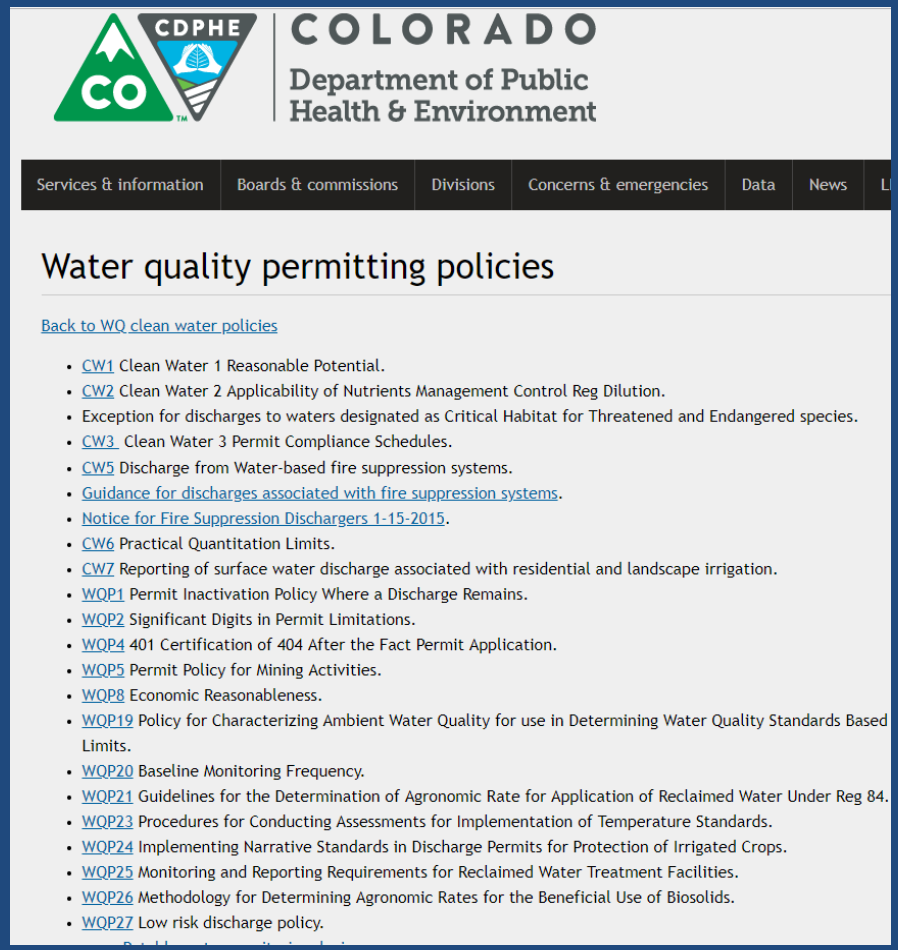
Clean water permitting sectors

Back to water quality permits

Planning — preliminary effluent limits; permits — including applications and forms; compliance assistance and guidance; enforcement; contact information for each sector

- Commerce and industry.
  - For discharges from commercial and industrial activities - aquatic animal production, commercial washing outdoor structures, coal mining, metal mining, sand and gravel mining, non-extractive industrial, produced water, non-contact cooling water, subterranean dewatering or well development, and water treatment plant wastewater discharges.
- Construction.
  - For discharges from construction activities - construction dewatering, ground water remediation, hydrostatic testing, and construction stormwater (erosion control).
- Municipal separate storm sewer systems (MS4).
  - For discharges from municipalities' storm sewer systems.
- Sewage systems.
  - For discharges from wastewater treatment plants/facilities - to surface water and to groundwater
- Biosolids.
  - For use and application of biosolids.
- Pesticides.
  - For discharges from application of pesticides.
- Reclaimed water.
  - For reuse of treated domestic wastewater.
- Pretreatment.
  - For nondomestic wastewater to be discharged to a wastewater system.



COLORADO
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Water quality permitting policies

Back to WQ clean water policies

- CW1 Clean Water 1 Reasonable Potential.
- CW2 Clean Water 2 Applicability of Nutrients Management Control Reg Dilution.
- Exception for discharges to waters designated as Critical Habitat for Threatened and Endangered species.
- CW3 Clean Water 3 Permit Compliance Schedules.
- CW5 Discharge from Water-based fire suppression systems.
- Guidance for discharges associated with fire suppression systems.
- Notice for Fire Suppression Dischargers 1-15-2015.
- CW6 Practical Quantitation Limits.
- CW7 Reporting of surface water discharge associated with residential and landscape irrigation.
- WQP1 Permit Inactivation Policy Where a Discharge Remains.
- WQP2 Significant Digits in Permit Limitations.
- WQP4 401 Certification of 404 After the Fact Permit Application.
- WQP5 Permit Policy for Mining Activities.
- WQP8 Economic Reasonableness.
- WQP19 Policy for Characterizing Ambient Water Quality for use in Determining Water Quality Standards Based Limits.
- WQP20 Baseline Monitoring Frequency.
- WQP21 Guidelines for the Determination of Agronomic Rate for Application of Reclaimed Water Under Reg 84.
- WQP23 Procedures for Conducting Assessments for Implementation of Temperature Standards.
- WQP24 Implementing Narrative Standards in Discharge Permits for Protection of Irrigated Crops.
- WQP25 Monitoring and Reporting Requirements for Reclaimed Water Treatment Facilities.
- WQP26 Methodology for Determining Agronomic Rates for the Beneficial Use of Biosolids.
- WQP27 Low risk discharge policy.

TMDL Process

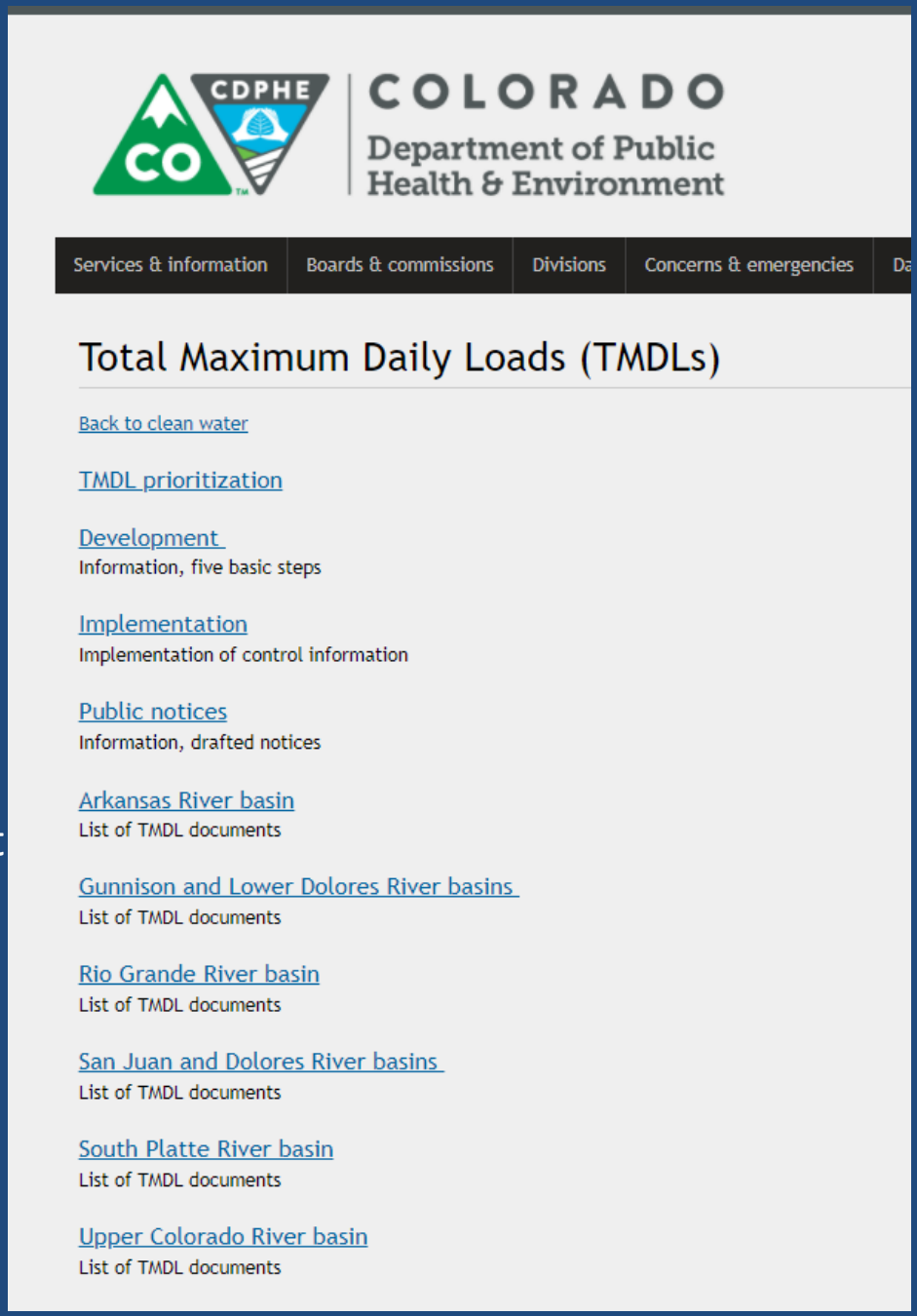
TMDL = ΣWLA + ΣLA + MOS

Where:

WLA =the sum of wasteload allocations (point sources such as permitted wastewater and stormwater discharges)

LA= the sum of load allocations (nonpoint sources and background)

MOS=the margin of safety



Impairment Decisions

Category 1

- Attaining water quality standards for all classified uses.

Category 2

- Attaining water quality standards for some classified uses.

Category 3

- 3a - Lacking data to determine whether or not classified uses are being attained.
- 3b - Segment placed on the Monitoring and Evaluation List.

Category 4

- 4 - Not supporting a standard for one or more classified uses, but a TMDL is not needed.
- 4a - TMDL has been completed.
- 4b - Plan for attainment of water quality standards.
- 4c - Impairment not caused by a pollutant.

Category 5

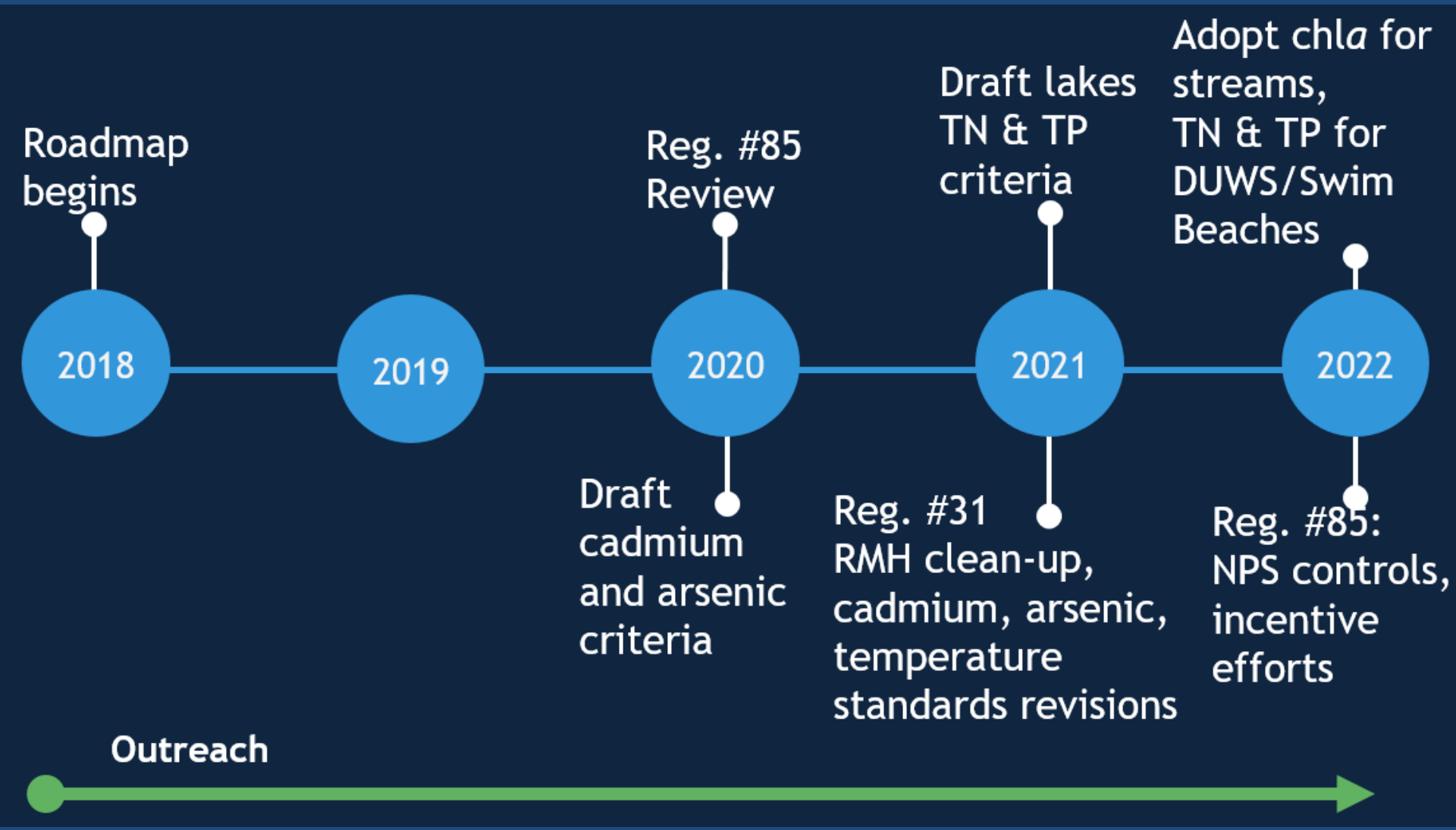
- Not meeting applicable water quality standards for one or more classified uses by one or more pollutants (303(d) waterbodies). Includes -
- Category 5-alt. - Alternative restoration approaches.

Nutrients

- Adopted by the WQCC in 2012
  - Includes nitrogen, phosphorus, and chlorophyll *a* criteria for rivers/ streams and lakes/reservoirs
  - Direct use water supply (DUWS) and swim beaches
- EPA's 2016 action letter
- Phased implementation
  - Protect headwaters
  - Allow time for dischargers to optimize treatment/implement enhanced treatment technologies
  - Regulation #85, monitoring

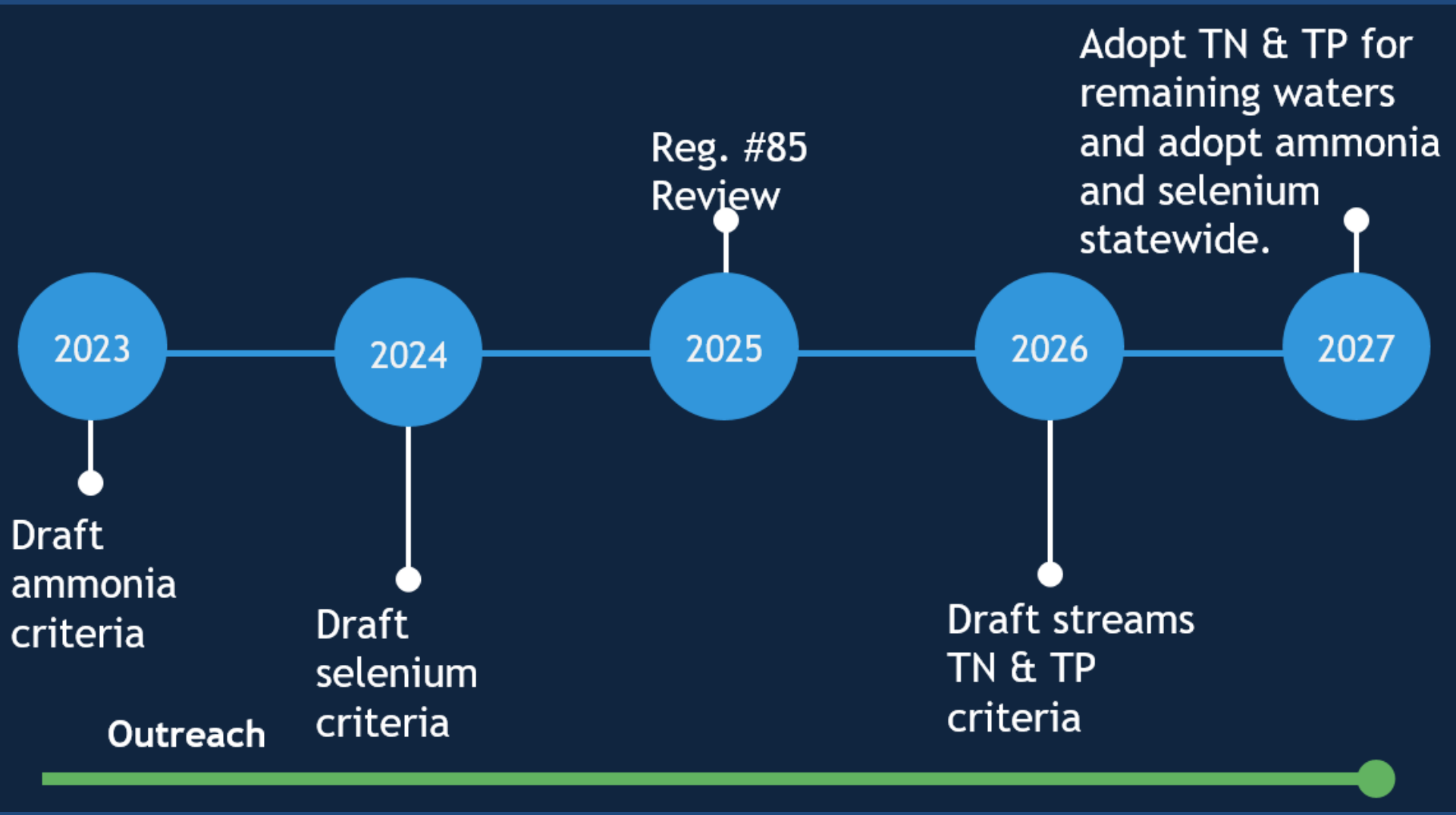
Slide Source: Blake Beyea and Stephanie Baker, WQCD

10-Year Water Quality Roadmap



Slide Source: Blake Beyea and Stephanie Baker, WQCD

10-Year Water Quality Roadmap



Slide Source: Blake Beyea and Stephanie Baker, WQCD

Nutrients Voluntary Incentive Program

- WQCC Policy 17-1 continues tech-based approach to initial nutrient reductions
- Allows facilities to make nutrient reductions in exchange for an extended compliance schedule (up to 10 years) for criteria adopted in 2027
- Creates certainty regarding the year the facility will need to meet water quality based effluent limits

Accumulation of incentive months		
Total phosphorus annual median (mg/L)	≥1	≤0.7
Months earned	0	12
Total inorganic nitrogen annual median (mg/L)	≥15	≤7
Months earned	0	12

Slide Source: Blake Beyea and Stephanie Baker, WQCD

Regulatory Tools for Addressing Difficulty in meeting the WQBEL

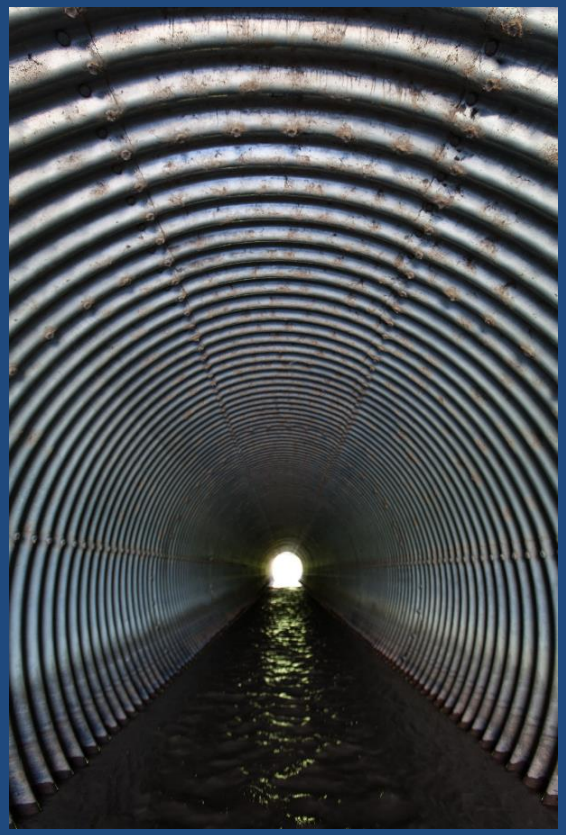
Regulatory Tool	Situation
Compliance Schedule	More time is required to achieve the effluent limit
Grants and Loans	Provide grants and low interest financing to help public entities pay for improvements
Use Attainability Analyses/Resegmentation	Classified use may not be an actual use (e.g., water supply) or may only be in a portion of a segment.
Ambient Standards	Water body cannot attain standard due to conditions that are natural/infeasible to correct
Site-Specific Criteria-Based Standards	An alternative value is protective of the particular uses in the water body.
Temporary Modifications	Time is needed to evaluate whether the standards are appropriate to protect the uses or source of pollution
Discharger Specific Variances	Meeting the WQBEL is infeasible

Slide Source: Blake Beyea and Stephanie Baker, WQCD

Discharger Specific Variances

A discharger specific variance (DSV) is a temporary water quality standard that represents the greatest protection of a classified use that is feasible.

- Regulation 31.7(4) and Policy 13-1
  - DSVs are last resort after other regulatory options
  - DSVs are Temporary
  - Best Feasible Water Quality
  - Require an Alternatives Analysis
- Feasibility Tests
  - Limits of Technology Test
  - Economics Test
  - Other Consequences Test



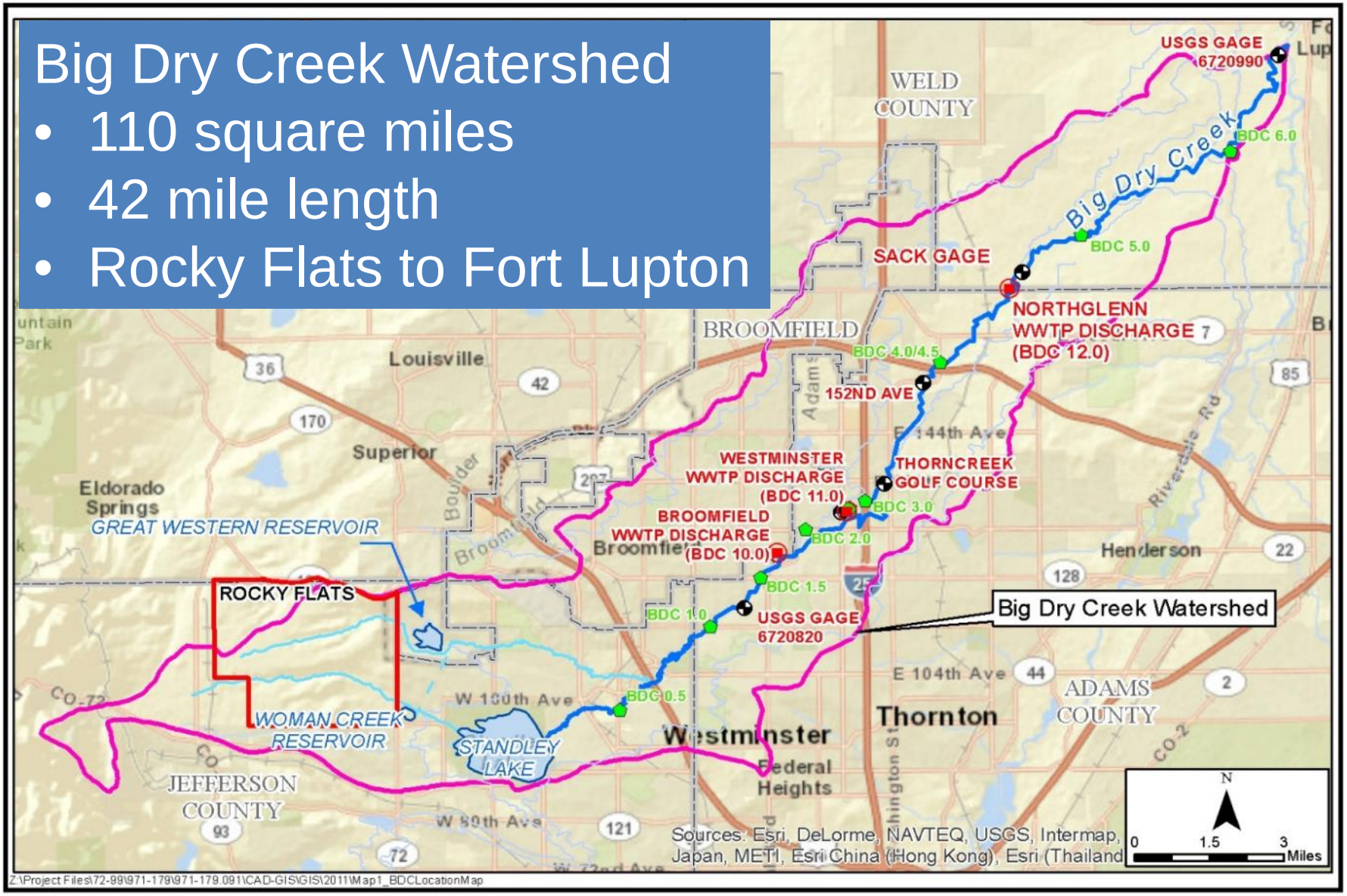
Slide Source: Blake Beyea and Stephanie Baker, WQCD

Case Study: Big Dry Creek Watershed Association

- Formed 501(c)(3) in 2004; active since 1997
- Board of Directors
  - City and County of Broomfield
  - City of Westminster
  - City of Northglenn
  - Adams County (no WWTP)
  - Weld County (no WWTP)

Big Dry Creek Watershed

- 110 square miles
- 42 mile length
- Rocky Flats to Fort Lupton



Highlights of Annual Water Quality Analysis (for 2016 data)

- Data summary and comparison to stream standards
- Key constituents of interest
  - a. *E. coli*
  - b. Iron
  - c. Nutrients
- Biological Overview (MMI)
- Flow conditions
- Quality assurance/quality control

Regulation 38 Standards

REGULATION #38 STREAM CLASSIFICATIONS and WATER QUALITY STANDARDS
Big Dry Creek Basin

1. Mainstem of Big Dry Creek, including all tributaries and wetlands, from the source to the confluence with the South Platte River, except for specific listing in Segments 4a, 4b, 5 and 6.

COSPBD01	Classifications
Designation	Agriculture
UP	Aq Life Warm 2
	Recreation P

Qualifiers:

Other:

*chlorophyll a (mg/m^2)(chronic) = applies only above the facilities listed at 38.5(4).
*Phosphorus(chronic) = applies only above the facilities listed at 38.5(4).
*Selenium(acute) = 19.1 ug/L from 11/1 - 3/31
TVS from 4/1 - 10/31.
Refer to Section 38.6(4)(d).
*Selenium(chronic) = 15 ug/L from 11/1 - 3/31
7.4 ug/L from 4/1 - 10/31.
Refer to Section 38.6(4)(d).

Physical and Biological	DM	MWAT
Temperature °C	WS-I	WS-I
	acute	**chronic**
D.O. (mg/L)	---	5.0
pH	6.5 - 9.0	---
chlorophyll a (mg/m^2)	---	150*
E. Coli (per 100 mL)	---	205

Inorganic (mg/L)	acute	chronic
Ammonia	TVS	TVS
Boron	---	0.75
Chloride	---	---
Chlorine	0.019	0.011
Cyanide	0.005	---
Nitrate	100	---
Nitrite	---	4.5
Phosphorus	---	0.17*
Sulfate	---	---
Sulfide	---	0.002

Metals (ug/L)	acute	chronic
Aluminum	---	---
Arsenic	340	---
Arsenic(T)	---	100
Beryllium	---	---
Beryllium(T)	---	100
Cadmium	TVS	TVS
Chromium III	TVS	TVS
Chromium III(T)	---	100
Chromium VI	TVS	TVS
Copper	TVS	TVS
Iron(T)	---	1000
Lead	TVS	TVS
Manganese	TVS	TVS
Mercury	---	0.01(t)
Molybdenum(T)	---	150
Nickel	TVS	TVS
Selenium	---	varies*
Selenium	varies*	---
Silver	TVS	TVS
Uranium	---	---
Zinc	TVS	TVS

Overall Comparison to Designated Uses and Standards (same as 2015)

Designated Uses	Use Attained?
Aquatic Life Life Warm 2	Partial*
Recreation P (Potential Primary Contact)	no
Agriculture	yes
Parameter Groups	**Standards Attained?**
Physical (e.g., DO, pH)	yes
Biological (E. coli)	no
Inorganics (e.g., CN, NH3)	yes
Metals (e.g., Cu, Cd, Zn, Se)	Partial (*Fe below WCR 8)
Other	**Comments**
Interim Nutrient Values (e.g., TP, TN)	Future Issue
Aquatic Life Policy 10-1 (e.g., MMI)	Attains

Example 303(d) List Excerpt

Listed portion: [1]	**COSJSJ10_A**	Mainstem of the Rito Blanco River from Echo Ditch to the confluence with the Rio Blanco River.		
	Affected Use	Analyte	Category / List [2]	Priority
	Aquatic Life Use	Temperature	3b. - M&E list	NA
	Recreational Use	E. coli	3b. - M&E list	NA
COSPBD01	1. Mainstem of Big Dry Creek, including all tributaries and wetlands, from the source to the confluence with the South Platte River, except for specific listing in Segments 4a, 4b, 5 and 6.			
Listed portion: [1]	**COSPBD01_B**	Mainstem of Big Dry Creek From Weld County road 8 to the confluence with the South Platte River		
	Affected Use	Analyte	Category / List [2]	Priority
	Aquatic Life Use	Iron (Total)	5. - 303(d)	M
COSPBE01a	1a. Mainstem of Bear Creek from the boundary of the Mt. Evans Wilderness area to the inlet of Evergreen Lake.			
Listed portion: [1]	**COSPBE01a_B**	Bear Creek below Yankee Creek to the inlet of Evergreen Lake		
	Affected Use	Analyte	Category / List [2]	Priority
	Aquatic Life Use	Temperature	5. - 303(d)	H
COSPBE01b	1b. Mainstem of Bear Creek from Harriman Ditch to the inlet of Bear Creek Reservoir.			
Listed portion: [1]	**COSPBE01b_A**	Mainstem of Bear Creek from Harriman Ditch to the inlet of Bear Creek Reservoir.		
	Affected Use	Analyte	Category / List [2]	Priority
	Aquatic Life Use	Temperature	5. - 303(d)	M

Recent Changes to 2018 303(d) Listing Methodology for E. coli

- Rolling 61-day geometric mean
  - No more fixed bi-monthly evaluations
  - No more combining multiple years of data for bimonthly period
- Sample size requirements for listing
  - 5 or more for normal 303(d) listing
  - 4 or more for "overwhelming evidence"
  - 2&3 M&E List
- Delisting
  - Attain standard (based on geometric mean of 5 samples/61 days) for same time period during which impairment was identified for most recent 2 years.

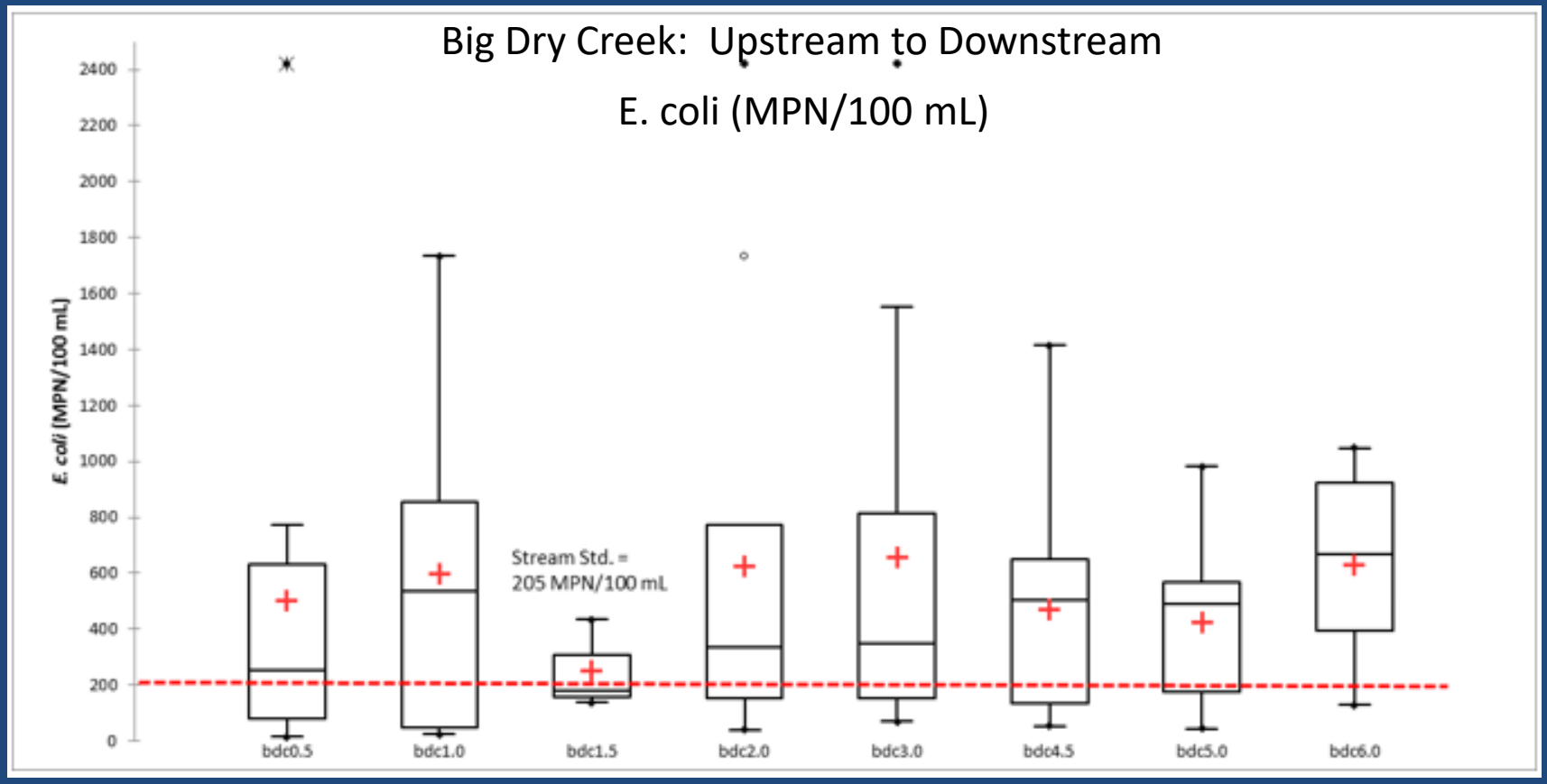
Standard Components

- Magnitude: 126 cfu/100 mL
- Duration: 61-day rolling average
- Frequency: Geometric mean cannot exceed standard

Historical Annual E. coli Summary (2000-2016)

Geometric Mean *E. coli* (#/100 mL)[1]										
Year	bdc0.5	bdc1.0	bdc1.5	bdc10.0 (Broom. WWTP)[2]	bdc2.0	bdc11.0 (West. WWTP)[2]	bdc3.0 (I-25)	bdc4.5	bdc5.0	bdc6.0
2000	212	151	389	--	**574**	--	294	500	212	323
2001	477	118	332	215	**649**	68	387	634	442	510
2002	858	230	363	364	**934**	16	536	441	451	572
2003[3]	191	210	293	27	**615**	24	382	225	249	339
2004	279	181	217	18	346	28	205	187	156	**377**
2005	152	122	281	26	**328**	35	204	113	182	301
2006	76	241	316	20	309	48	214	163	179	**333**
2007	196	177	257	14	324	66	230	231	198	**364**
2008	266	197	267	10	**461**	6	439	376	290	380
2009[4]	61	78	147	5	207	14	**251**	137	149	197
2010	111	191	193	12	**483**	16	376	280	235	368
2011	64	228	323	6	622	8	518	537	380	**730**
2012	267	397	260	7	**555**	8	544	497	390	545
2013	239	214	292	3	398	10	424	342	272	**505**
2014	119	269	254	5	323	9	371	410	287	**1085**
2015	257	251	230	4	311	9	**528**	415	266	490
2016	207	254	221	5	312	18	358	315	300	536

5-year E. coli—Boxplots



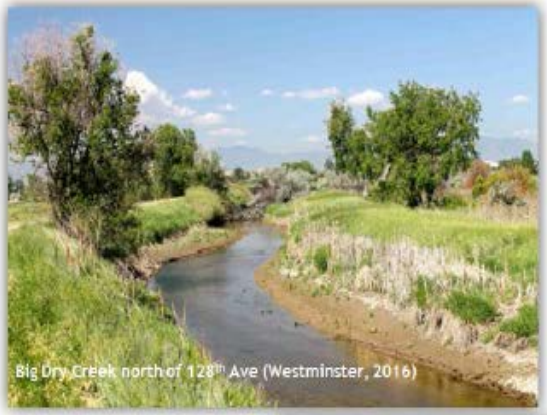
E. coli TMDL

- Load duration curve approach
- 10% MOS + Reserve Capacity
- Reductions not targeted to WWTPs
- Public notice and final notice completed summer 2016
- Prepared by Division with input from BDCWA
- Hydrology was a major complicating factor

COLORADO
Department of Public Health & Environment

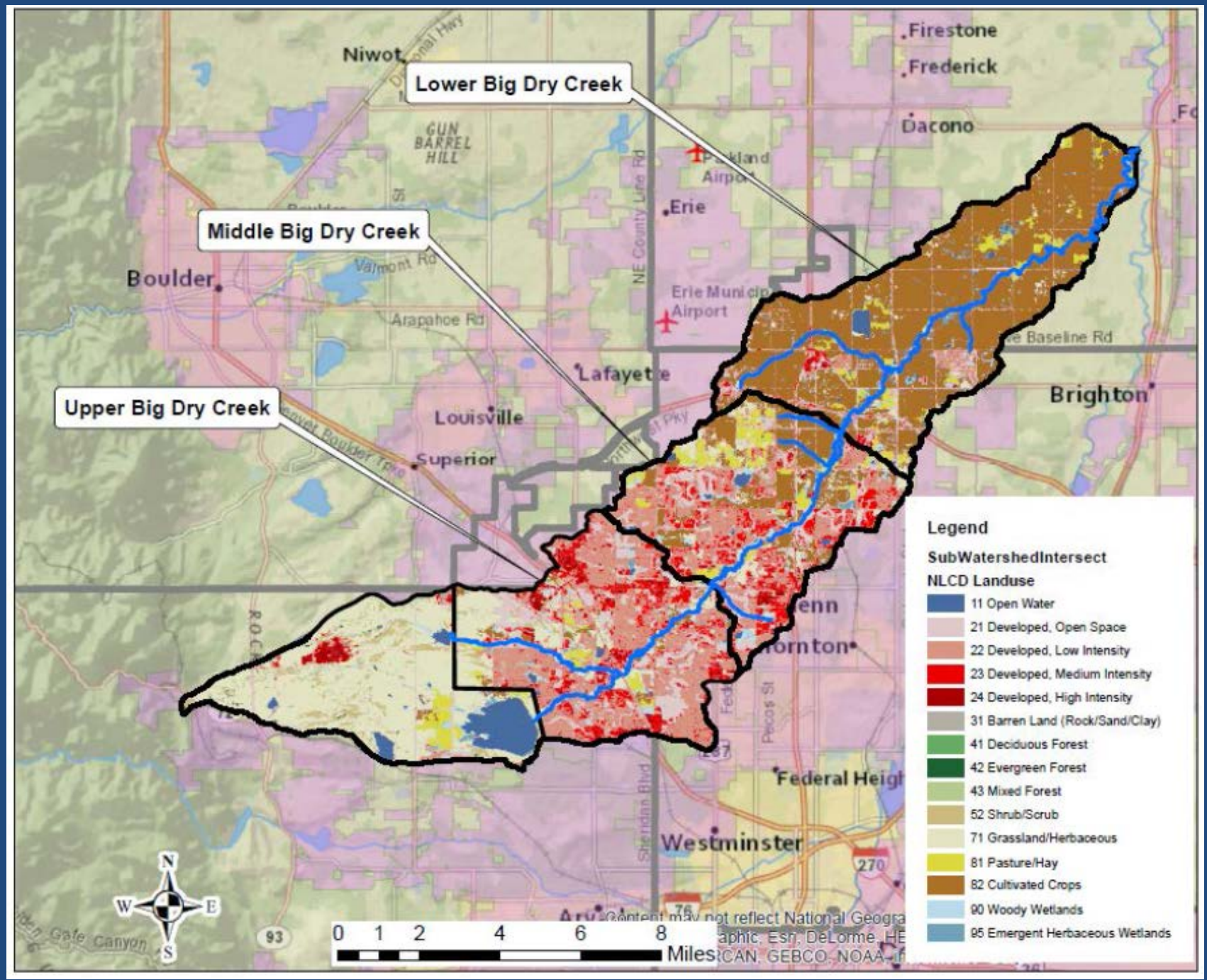
Total Maximum Daily Load Assessment

Big Dry Creek – COSPBD01, Broomfield, Jefferson, Adams, and Weld Counties, Colorado



Big Dry Creek north of 128th Ave (Westminster, 2016)

USGS Westminster gage on Big Dry Creek (USGS 2015)


Lower Big Dry Creek
Middle Big Dry Creek
Upper Big Dry Creek
Niwot
Boulder
Lafayette
Louisville
Superior
Erie
Firestone
Frederick
Dacono
Brighton
Westminster
Federal Heigh
Arapahoe Rd
Valmont Rd
GUN BARREL HILL
Erie Municip Airport
Legend
SubWatershedIntersect
NLCD Landuse
11 Open Water
21 Developed, Open Space
22 Developed, Low Intensity
23 Developed, Medium Intensity
24 Developed, High Intensity
31 Barren Land (Rock/Sand/Clay)
41 Deciduous Forest
42 Evergreen Forest
43 Mixed Forest
52 Shrub/Scrub
71 Grassland/Herbaceous
81 Pasture/Hay
82 Cultivated Crops
90 Woody Wetlands
95 Emergent Herbaceous Wetlands
0 1 2 4 6 8
Miles
N
S
E
W

Load Duration Curve: Middle Portion

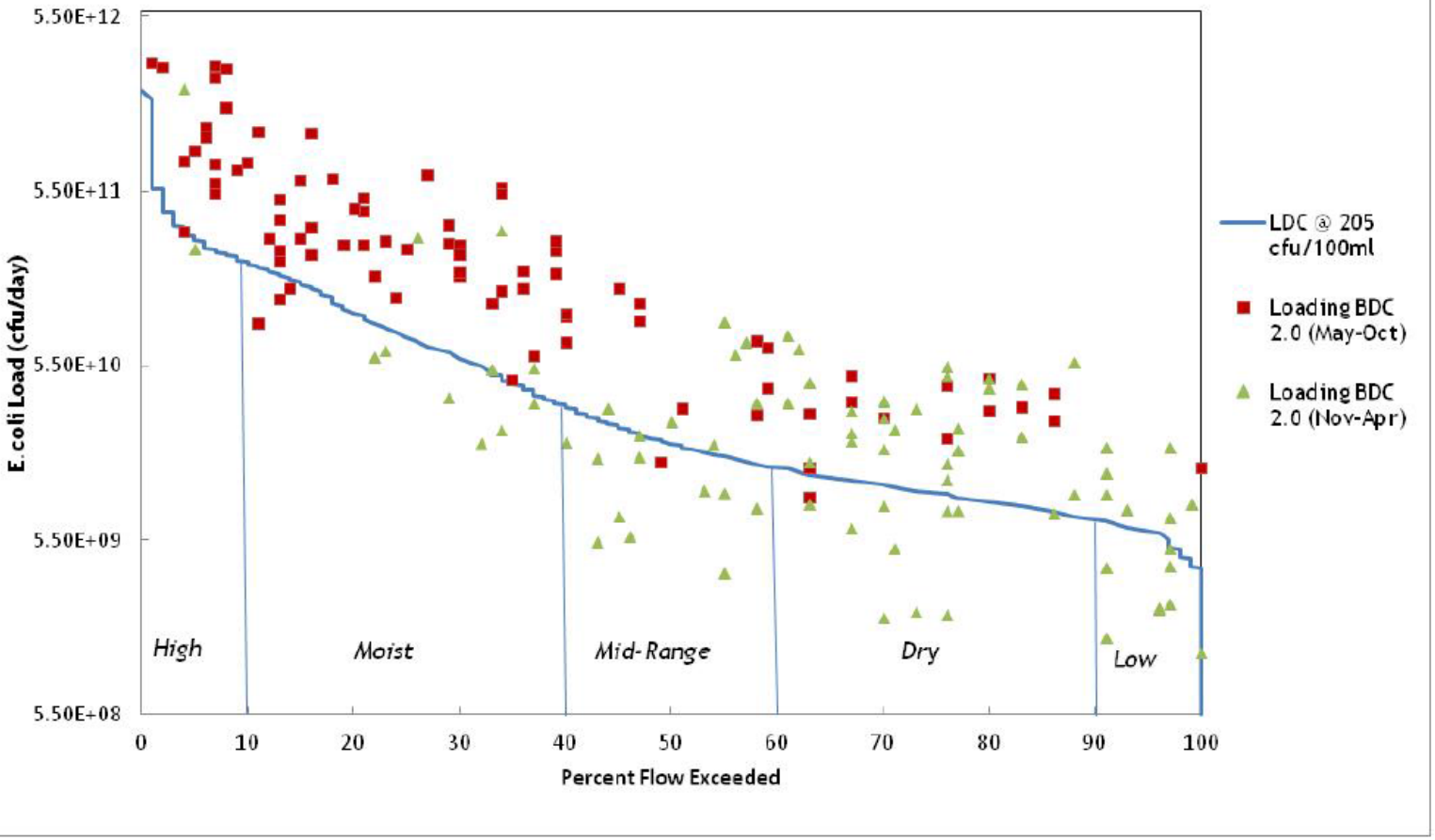


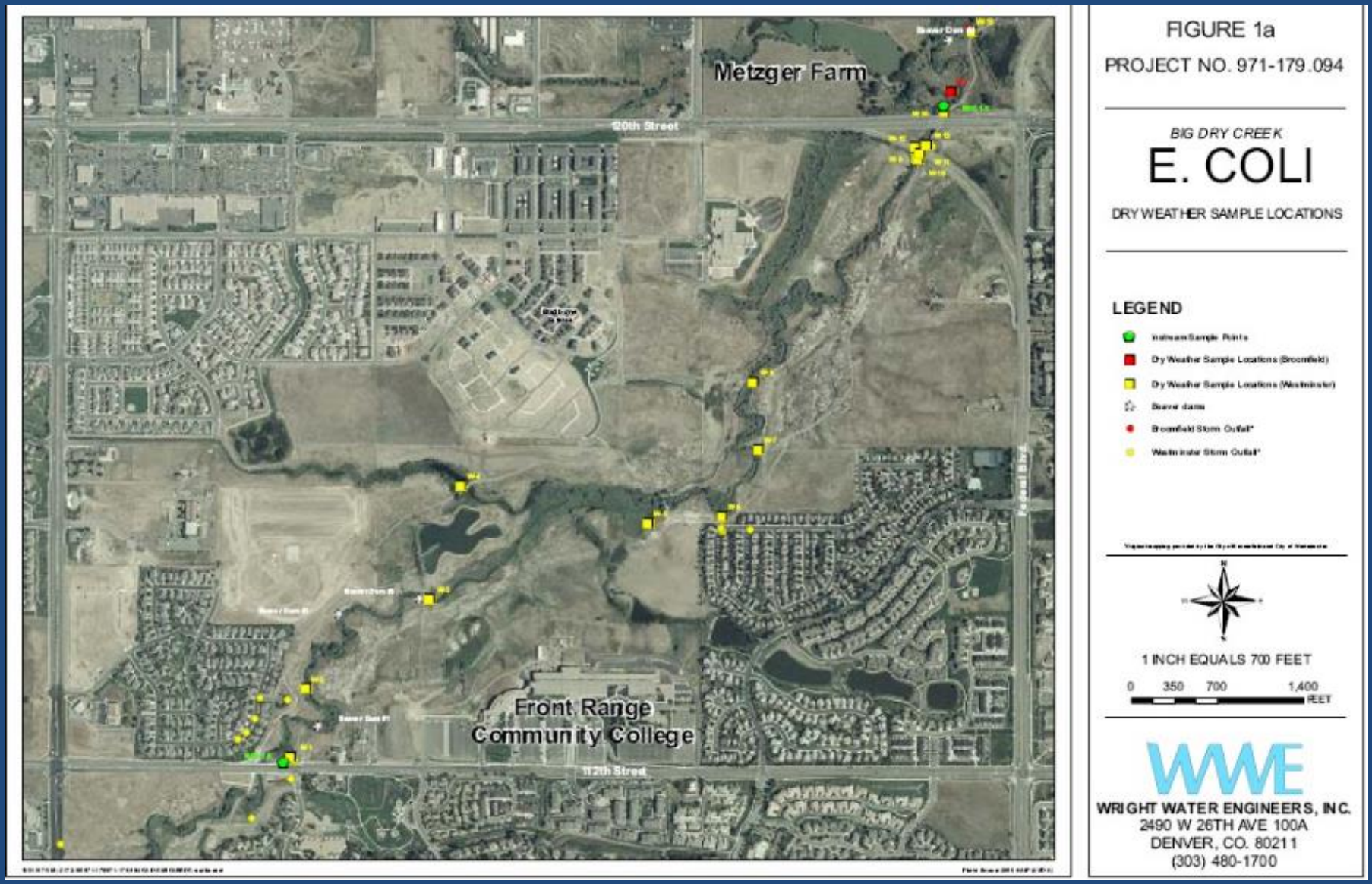
Figure 6.2-1 E. coli data (2003-2014) for bdc2.0 plotted on load duration curve based on Westminster flow gage.

Middle Reach Allocations

Table 3. Middle Reach *E. coli* TMDL: allowable loading and pollutant reductions necessary to meet the recreation based *E. coli* standard in Big Dry Creek.

Loading Calculations (Giga-cfu/day)	High Flow	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flow
TMDL	423.34	198.56	129.18	73.58	27.94
MOS (10%)	42.33	19.86	12.92	7.36	2.79
Allowable Load	381.01	178.71	116.26	66.22	25.14
Exisiting Load	1119.13	425.48	244.05	114.49	94.98
Required Recuctions	66%	58%	52%	42%	74%
WLA					
Westminster WWTF	58.24	54.32	51.49	31.97	16.99
Broomfield WWTF	74.20	64.00	57.63	31.58	4.92
MS4s	149.14	36.23	4.29	1.60	1.94
Reserve Capacity	7.46	1.81	0.21	0.08	0.10
LA					
Non-point Source	91.97	22.34	2.64	0.99	1.19

Dry Weather Outfall Sampling



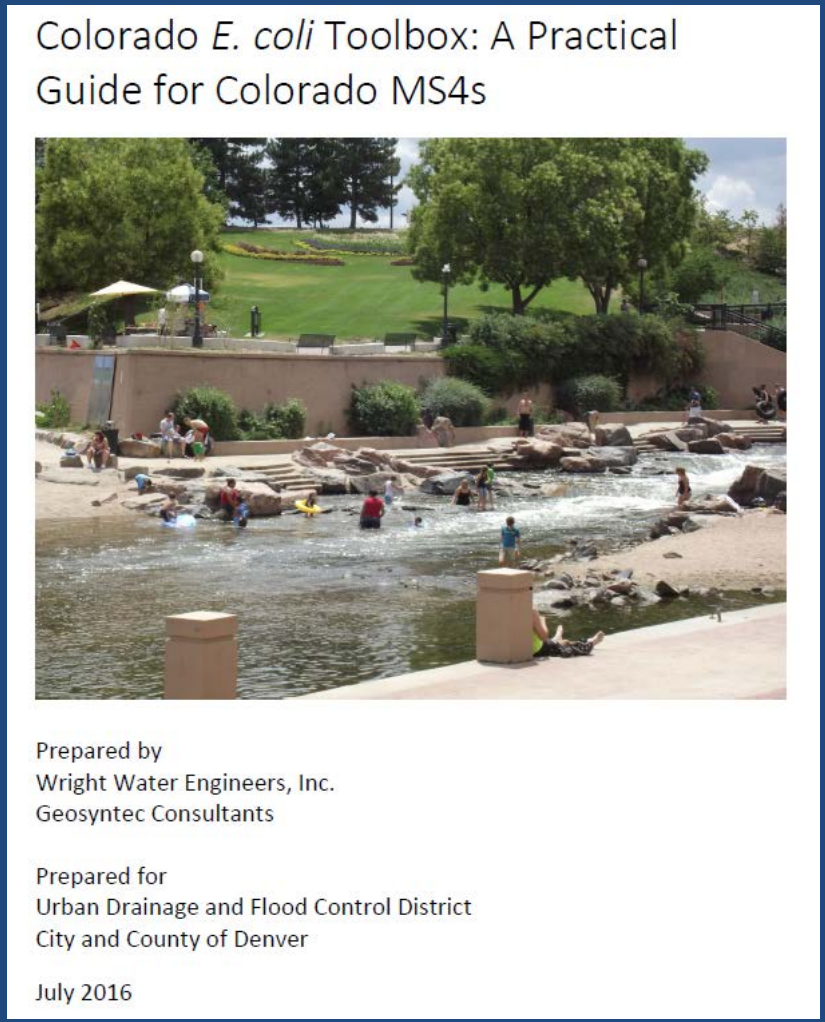
One Illicit Discharge Identified and Corrected

Four years later—E. coli still well above standards downstream…


Controllable E. coli Source?

Colorado E. coli Toolbox: A Practical Guide for Colorado MS4s

- Introduction
  - Colorado regulations
  - Extent of problem
  - TMDLs
- Finding the sources
- Developing a control strategy
  - Progression of controls
  - Modeling
- Source controls
- Structural BMPs
- Regulatory considerations/site-specific standards

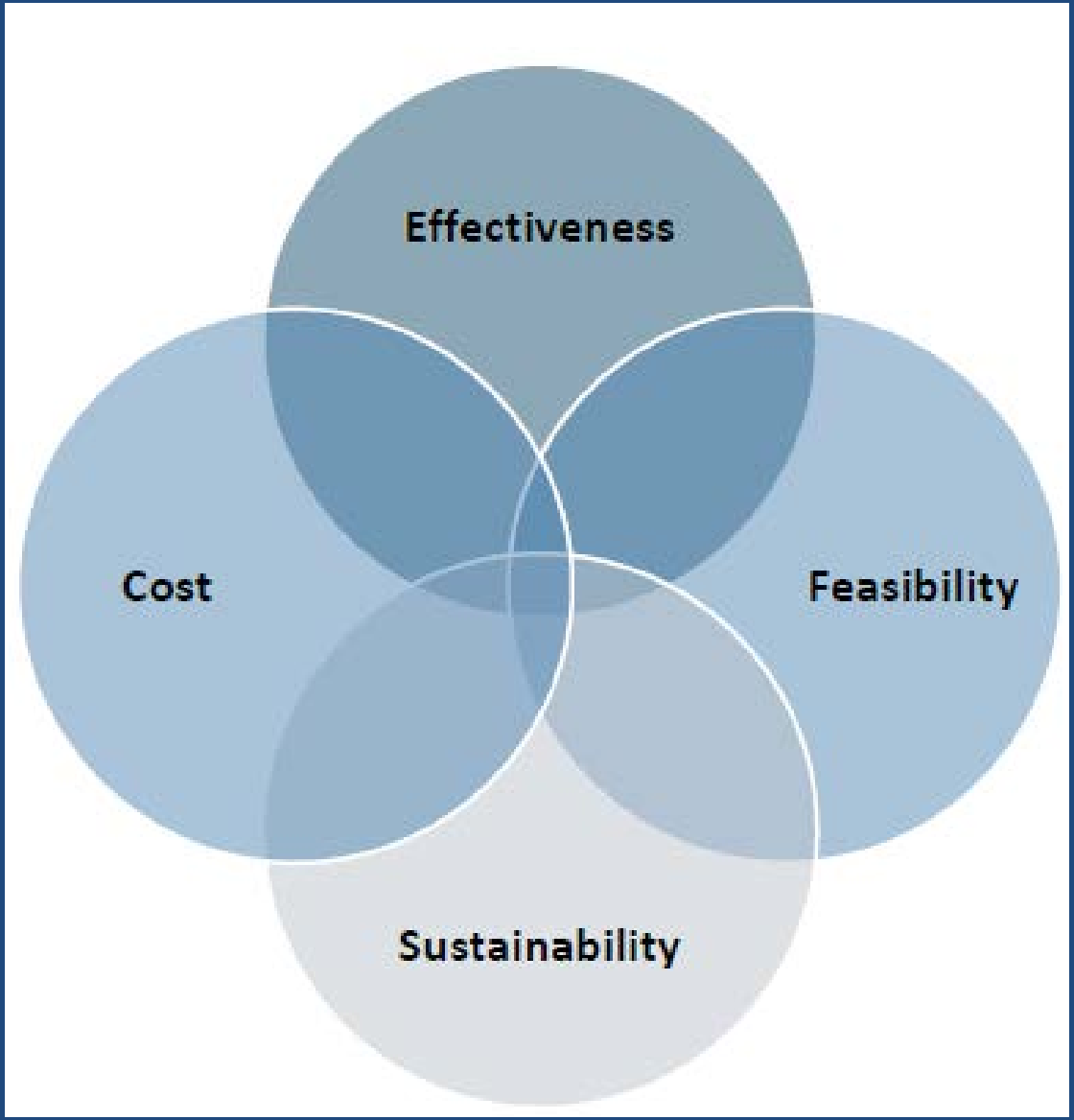


Accessible at www.udfcd.org

Developing an E. coli Control Strategy

General Themes:

- Address human source first, then other sources
- Address dry weather first, then wet weather
- Implement nonstructural/ source controls, then structural

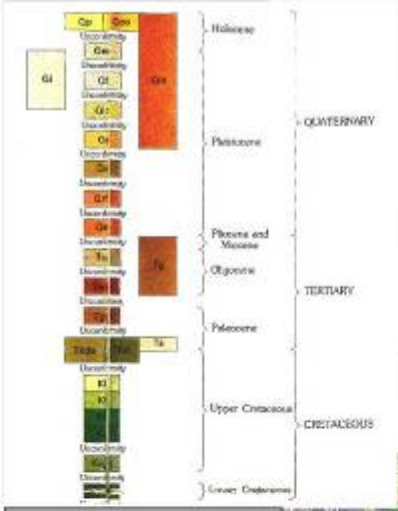


Site Specific Standard: Selenium

Selenium (µg/L)				
	Irrigation Season		Non-irrigation Season	
	2012-2016 (Apr-Oct)	Reg. 38 Standard	2012-2016 (Nov-Mar)	Reg. 38 Standard
All Sites (85th %)	5.0	N/A	7.9	N/A
bdc1.5, 2.0, 4.5 (85th %)	5.1	7.4 (ch)	9.6	15.0 (ch)
bdc1.5, 2.0, 4.5 (Max)	11.0	18.4 (ac)	13.0	19.1 (ac)

- 5-year analysis meets stream standards.
- Sampling frequency switched to quarterly in 2013, consistent with other metals.
- Removed from 303(d) List in 2016.
- Also new statistical methodology for site-specific standards for 2016 303(d) Listing Methodology

CORRELATION OF MAP UNITS



DESCRIPTION OF SELECTED FORMATIONS EXPECTED TO BE SOURCES OF SELENIUM

(SEE ORIGINAL MAPPING FOR A COMPLETE KEY)

TKda DAWSON AND ARAPAHOE FORMATIONS (PALEOCENE TO UPPER CRETACEOUS)—Arkosic sandstone, siltstone, claystone, and/or minor amounts of conglomerate. Where unit underlies the Denver Formation, it is called the Arapahoe Formation. Where Denver Formation intertongues and pinches out to the south and east, the unit is called the Dawson Formation. Forms most of bedrock between Denver and Colorado Springs. As much as 610 m thick (Scott and Wobus, 1973). A conglomerate at the base of the Arapahoe Formation is an important aquifer in the Denver area

TKd DENVER FORMATION (PALEOCENE AND UPPER CRETACEOUS)—Claystone, siltstone, sandstone, and conglomerate composed primarily of altered andesitic (volcanic) debris. Claystone and siltstone partly altered to montmorillonitic clay. Underlies most of Denver metropolitan area. Montmorillonitic clay swells when wet, and causes damage to buildings, roads, and other structures. Thickness 280 m

Kl LARAMIE FORMATION (UPPER CRETACEOUS)—Shale, claystone, siltstone, and sandstone containing coal beds, mainly in the lower part. Thickness variable but as much as 230 m. Source of coal, brick clay, and refractory clay

MAP KEY

BIG DRY CREEK WATERSHED

SELENIUM SAMPLING SITES

- 0.95 - 4.99 ug/L
- 5.00 - 9.99 ug/L
- 10.00 - 20.00 ug/L
- 20.01 - 96.20 ug/L

WELL COMPLETED IN SELENIUM BEARING FORMATION

NOTE: SEE TABLE FOR DETAILED SAMPLE LOCATION VIA IDENTIFIER ○

N W E S

0 0.75 1.5 Miles

1" = 1.5 Miles

MAP SOURCES:

U.S. Geological Survey Miscellaneous Investigations Series Map I-855-G
Geology in the Boulder-Fort Collins-Greeley Area, Front Range Urban Corridor Colorado
By Roger Colten 1978

U.S. Geological Survey Miscellaneous Investigations Series Map I-856-H
Geology Map of the Greater Denver Area, Front Range Urban Corridor Colorado
By Donald Trimble and Michael Machette 1979

NOTES:

Watershed Boundary and Monitoring Locations are Approximate

New Colorado Nutrient Interim "Values" (Regulation 31)

(b) Interim Phosphorus Values

Table 1 Interim Total Phosphorus Values	
Lakes and Reservoirs, cold, >25 acres	25 ug/L [1]
Lakes and Reservoirs, warm > 25 acres	83 ug/L [1]
Lakes and Reservoirs, <=25 acres	RESERVED
Rivers and Streams – cold	110 ug/L [2]
Rivers and Streams - warm	170 ug/L [2]

[1] summer (July 1-September 30) average Total Phosphorus (ug/L) in the mixed layer of lakes (median of multiple depths), allowable exceedance frequency 1-in-5 years.
[2] annual median Total Phosphorus (ug/L), allowable exceedance frequency 1-in-5 years.

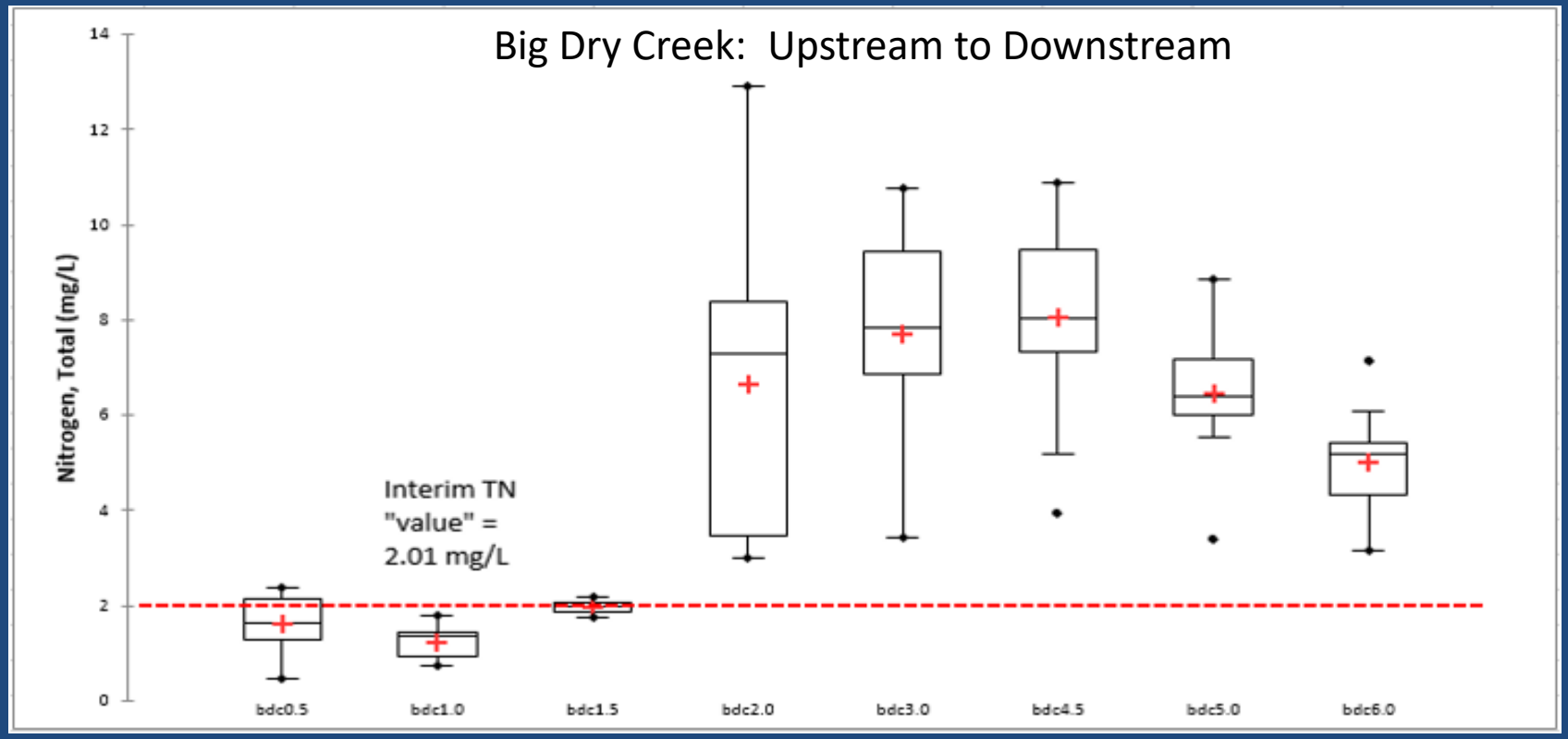
(c) Interim Nitrogen Values (Effective May 31, 2017)

Table 2 Interim Total Nitrogen Values	
Lakes and Reservoirs, cold, >25 acres	426 ug/L [1]
Lakes and Reservoirs, warm, > 25 acres	910 ug/L [1]
Lakes and Reservoirs, <=25 acres	RESERVED
Rivers and Streams – cold	1,250 ug/L [2]
Rivers and Streams - warm	2,010 ug/L [2]

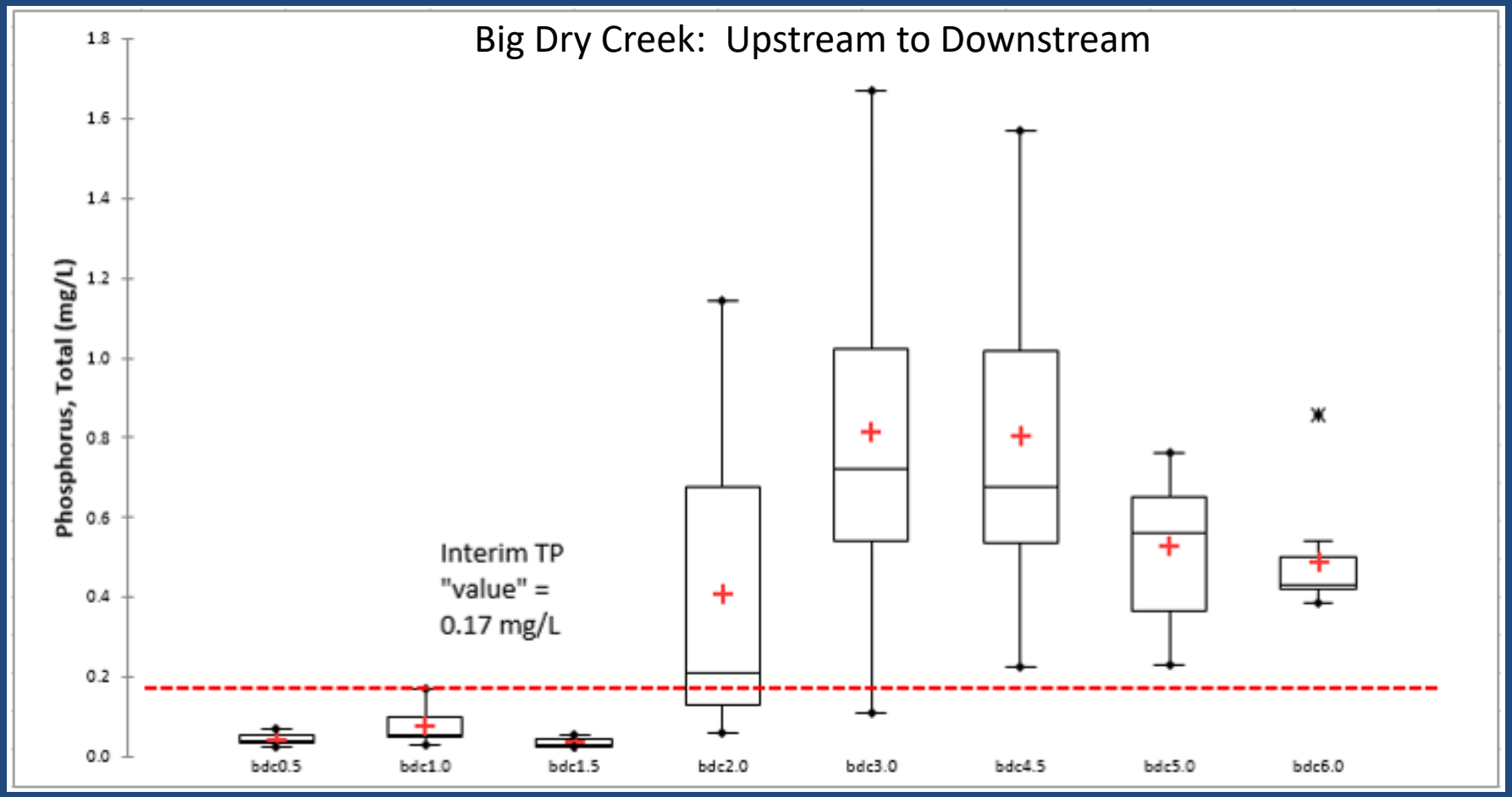
[1] summer (July 1–September 30) average Total Nitrogen (ug/L) in the mixed layer of lakes (median of multiple depths), allowable exceedance frequency 1-in-5 years.
[2] annual median Total Nitrogen (ug/L), allowable exceedance frequency 1-in-5 years.

Big Dry Creek Total Nitrogen (2016)

- Third year of TN data (due to adding TKN to monitoring program)
- Does not meet interim values below WWTPs to South Platte.



2016 Total Phosphorus



Regulation 85 Effluent Limits for Existing and New Facilities

(not yet in BDC permits)

PARAMETER	PARAMETER LIMITATIONS	
Existing Facility	Annual Median[1]	95th Percentile[2]
(a) Total Phosphorus	1.0 mg/L	2.5 mg/L
(b) Total Inorganic Nitrogen as N[3]	15 mg/L	20 mg/L
New Facility	Annual Median[1]	95th Percentile[2]
(a) Total Phosphorus	0.7 mg/L	1.75 mg/L
(b) Total Inorganic Nitrogen as N[3]	7 mg/L	14 mg/L

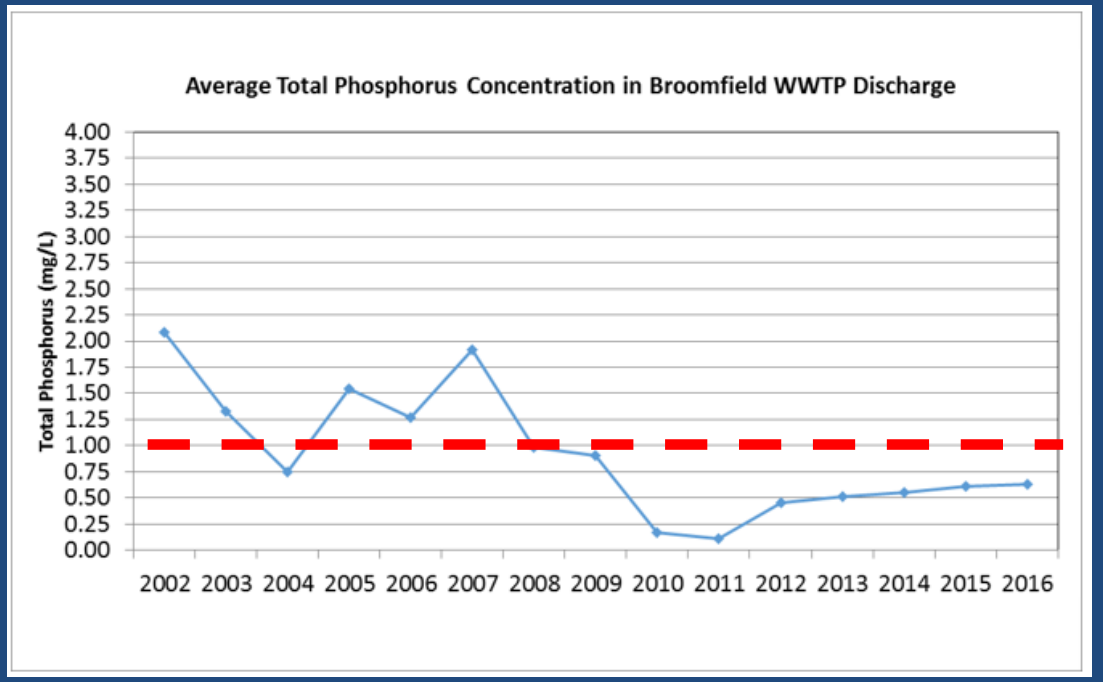
1 Running Annual Median: The median of all samples taken in the most recent 12 calendar months.

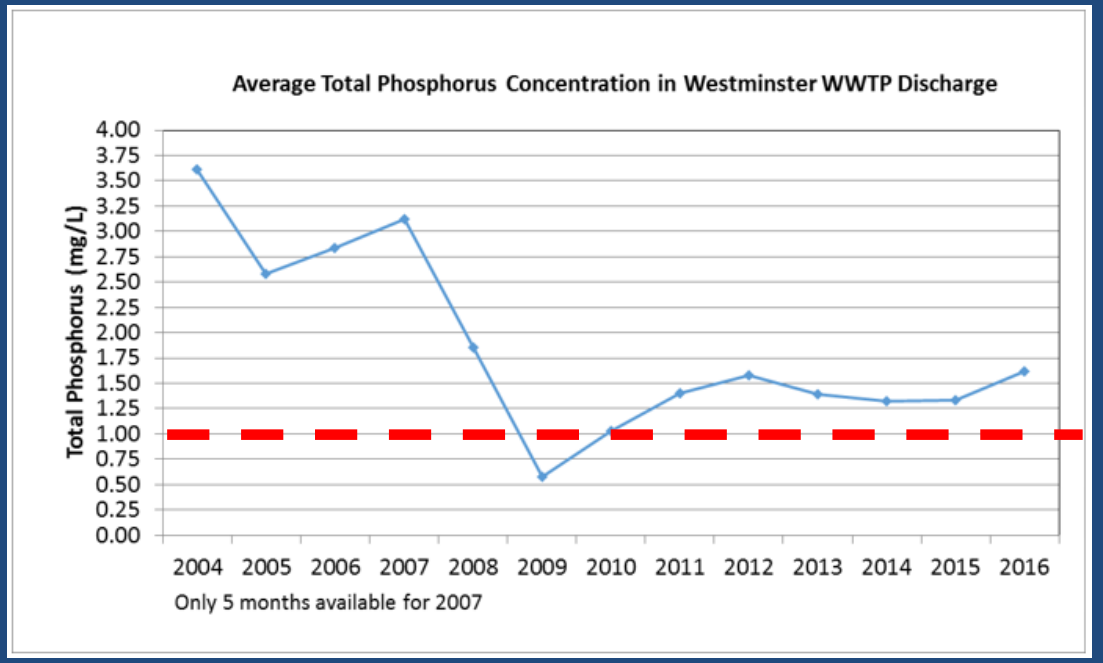
2 The 95th percentile of all samples taken in the most recent 12 calendar months.

3 Determined as the sum of nitrate as N, nitrite as N, and ammonia as N.

Decreases in TP @ Broomfield and Westminster WWTPs

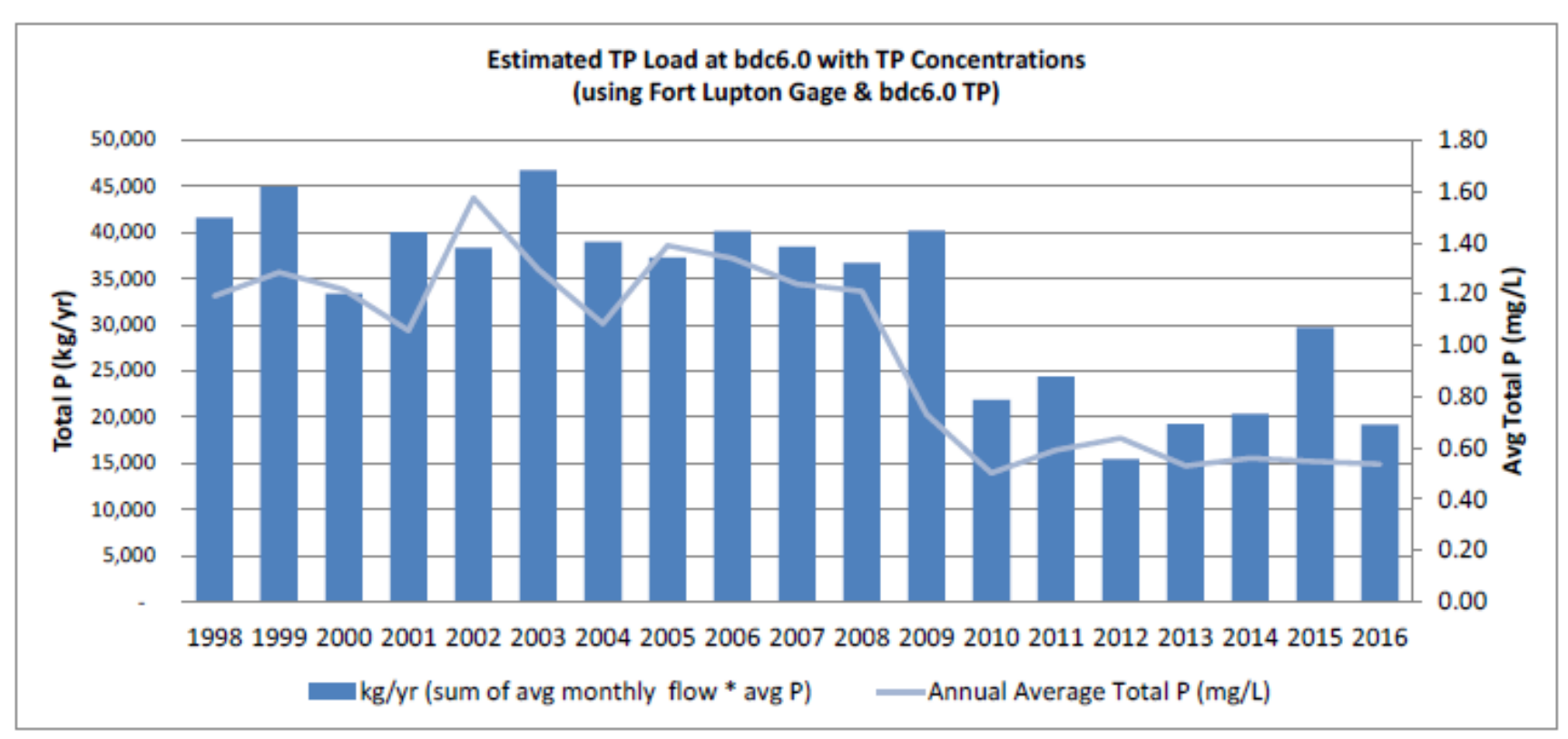
- Biological nutrient removal at Broomfield and Westminster WWTPs.
- No sooner than July 1, 2013, Reg 85 Limits for WWTPs > 2 MGD = 1 mg/L TP as annual median.
- New permits expected in 2018.





TP Load Reductions at bdc6.0

- Barr-Milton TMDL Target 20% load reduction relative to 2004.
- 2016 Load 55-60% lower than 2003-2004.
- Flow variations affect load.
- Missing data affect reliability of estimate during 2016.

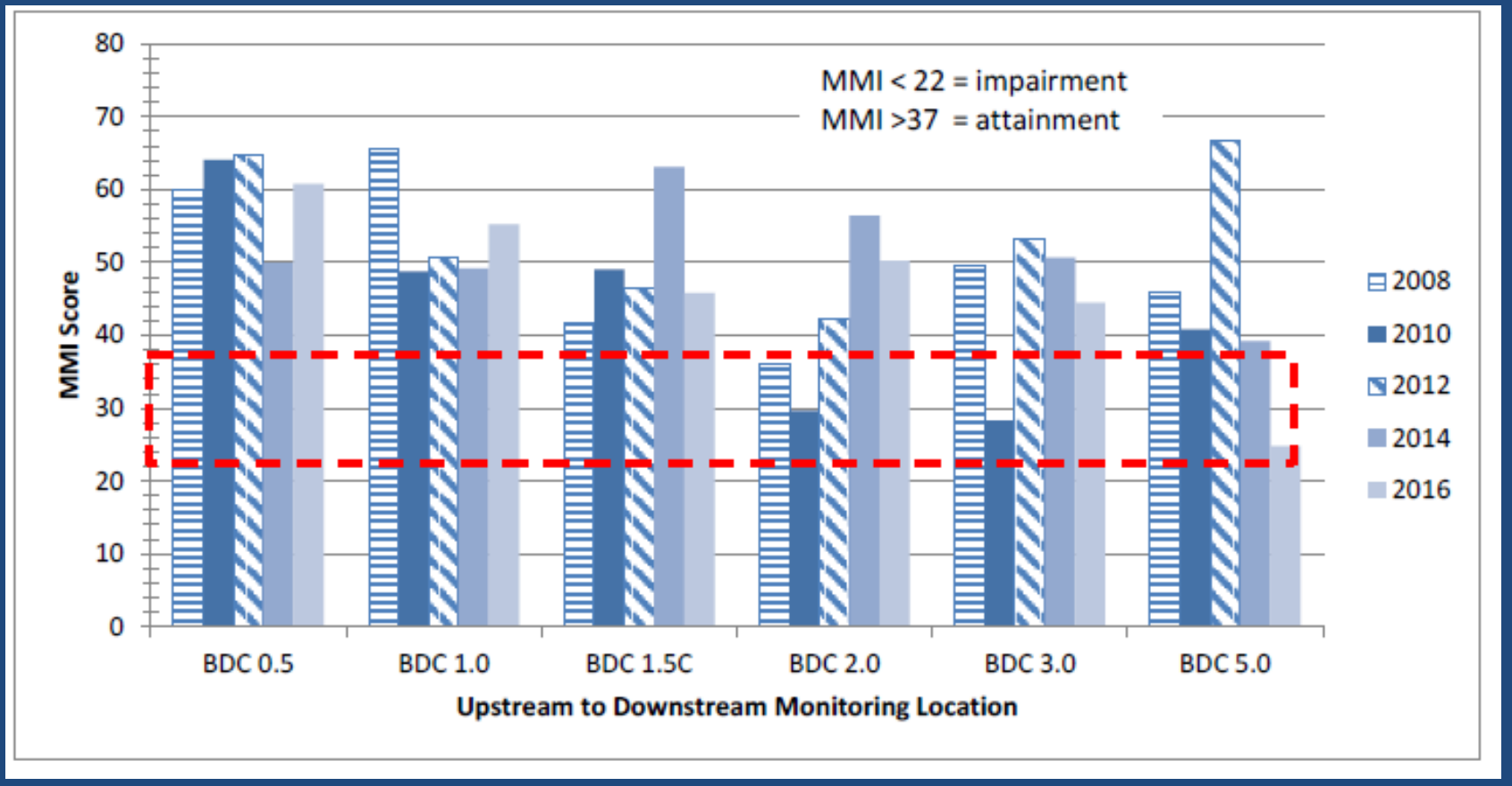


Biennial Biological Monitoring

- 2016 Sampling
- Fish
- “Bugs”
- Habitat
- Overall trends in aquatic life health
  - Over time
  - By location

Big Dry Creek MMI Scores

- Higher scores are better.
- Aquatic life Policy 10-1 attained for all years, all sites except 2016 bdc5.0 is “below attainment & above impairment.”
- Note site-to-site and annual variability.

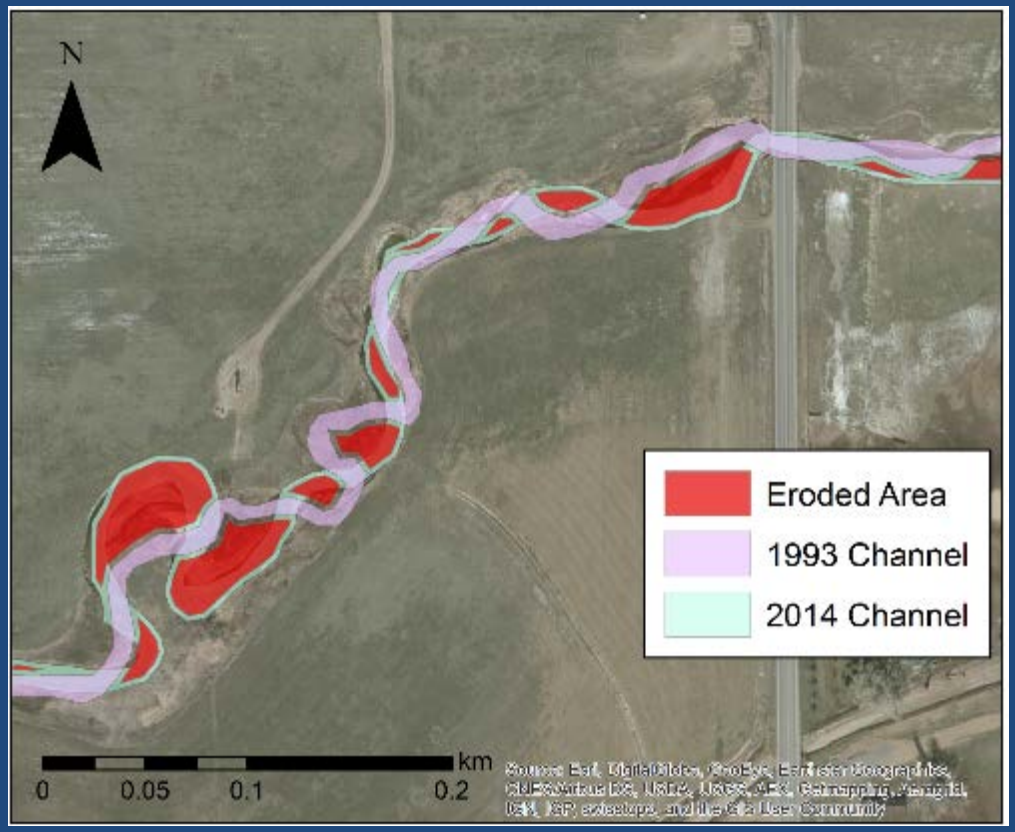


Big Dry Creek Case Study:
CLEAN Center Research Project 4:
Fluvial instability and riparian degradation

Roderick Lammers
Co-PI: Dr. Brian P. Bledsoe, Ph.D., P.E.
Co-PI: Dr. Daniel Baker, Ph.D., P.E.

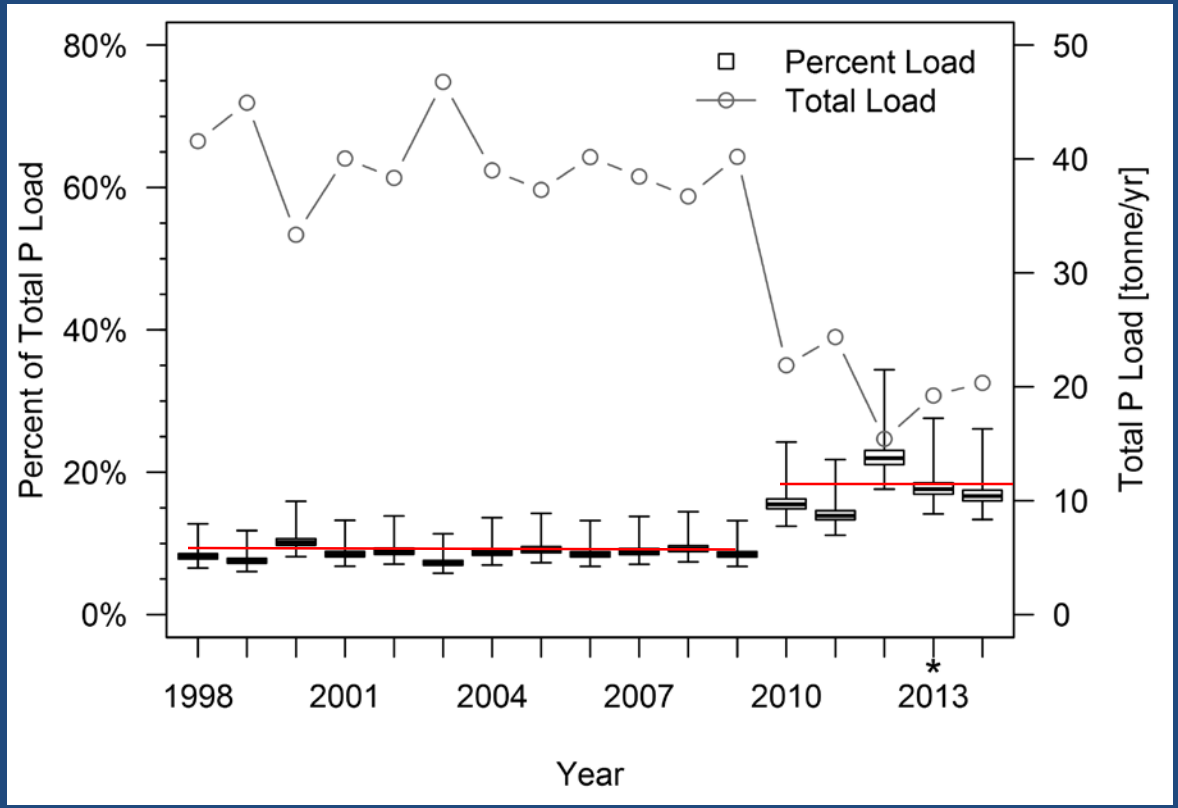
Preliminary results

- Eroded area (satellite imagery)
- Bank heights (field)
- Soil bulk density (US Soil Survey)
- Bank P concentrations (field)



Preliminary results (cont.)

- Historically average of ~10% of total watershed P load
- Recently, contribution percentage may be higher
- Future of channel erosion uncertain



Conclusions

- Know the regulations and the regulatory process.
- Good data are important—helps objective decision-making and common ground.
- Watershed approach can provide holistic view of stream issues and leverage funding.
- If you have a water quality problem, chances are there are groups engaging on your issue and/or resources available to help you.

Questions?

Jane Clary
Wright Water Engineers
303-480-1700
clary@wrightwater.com

Thank you and acknowledgements for selected slides:

- Blake Beyea and Stephanie Baker, Water Quality Control Division Standards Unit
- Trisha Oeth, Esq., Administrator, Water Quality Control Commission

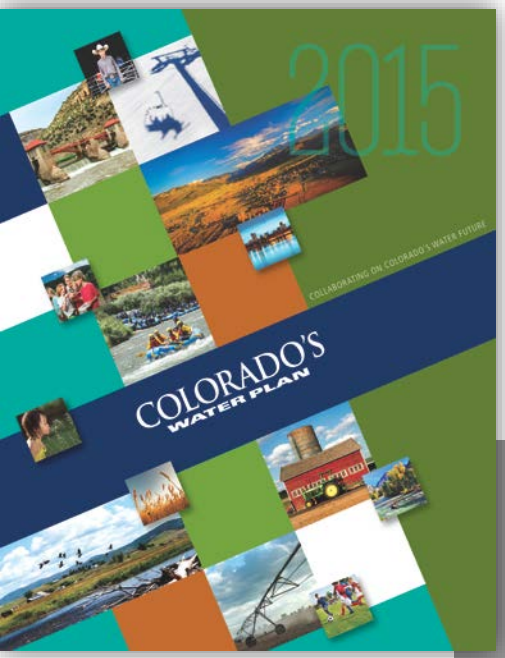
COLORADO'S INSTREAM FLOW PROGRAM OVERVIEW

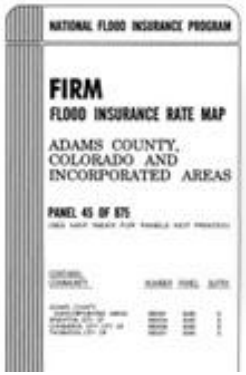
CAFSM Seminar – Current Water Issues on the Western Slope
April 6, 2018 Glenwood Springs, CO

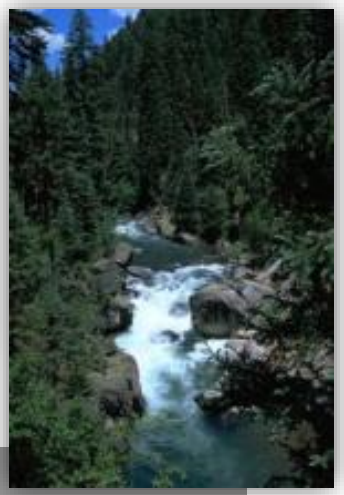
Morrison Creek

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

COLORADO WATER CONSERVATION BOARD







Operations/Programs:

- Water Project Loan Program
- Water Conservation and Drought Planning
- Interstate Compact Protection
- Stream and Lake Protection
- Watershed & Flood Protection
- Decision Support Systems
- Water Supply Planning

DNR
CO
TM

ISF PROGRAM HISTORY

1960s and 70s - Increasing public concern about the impact of human activities on the environment

Toxic Chemicals

1st Earth Day

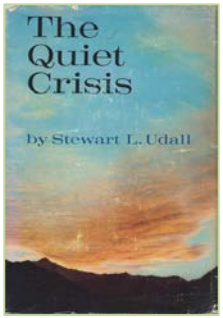
1970 National Environmental Policy Act

1972 Clean Water Act,
Costal Zone Mgt. Act
Marine Mammal Protection Act

1973 Endangered Species Act

1974 Safe Drinking Water Act

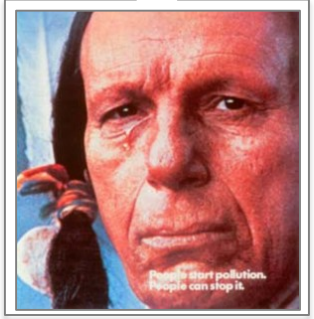
1960's **1970's**



Abuse of Nation's Natural Resources

1964
Wilderness
Preservation Act

1968
Wild and Scenic
Rivers Act



Keep America Beautiful Campaign

Creation of New Federal Agencies

COLORADO IN THE 1970s

- Public concern over dry stream reaches
- No mechanism within the water rights system to keep water within a stream for environmental preservation
- Federal imposition of bypass flows on Fry-Ark project
- Threats of ballot initiative to allow private ISFs

SENATE BILL 73-97

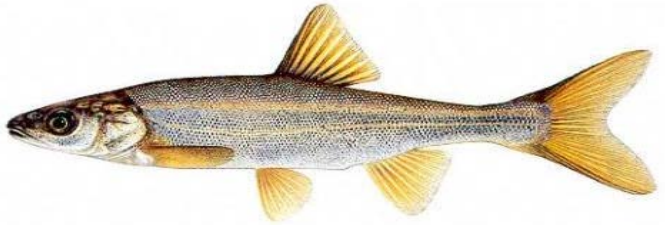
Established Colorado's Instream Flow Program

- Recognized "the need to correlate the activities of mankind with some reasonable preservation of the natural environment"
- Vested the CWCB with the authority "on behalf of the people of the state of Colorado, to appropriate or acquire… such waters of natural streams and lakes as may be required to preserve the natural environment to a reasonable degree."

SENATE BILL 73-97

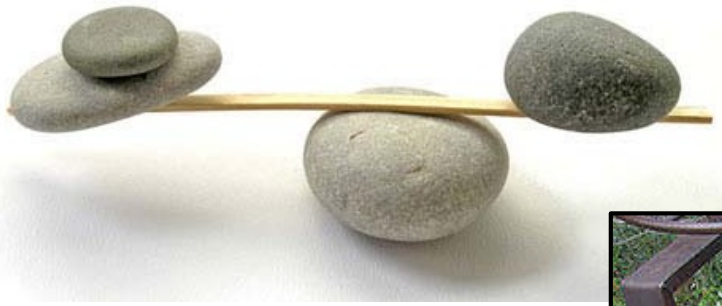
Instream Flow & Natural Lake Level water rights:

- In-channel or in-lake appropriations of water
- For minimum flows between specific points on a stream, or levels on natural lakes
- To preserve the natural environment to a reasonable degree
- Administered within the State's water right priority system
- Entitled to stream conditions existing at time of appropriation
- Made exclusively by CWCB



WHAT DOES THE PROGRAM ACCOMPLISH?

Maintains flows in streams to ensure preservation of the natural environment and achieves a balance with other beneficial uses of water in the state.



Provides regulatory certainty for water users by preserving the doctrine of prior appropriation and operating within the priority system.

ISF PROGRAM AREAS

New Appropriations

Appropriate and adjudicate a new (junior) ISF water right for the minimum required to preserve the natural environment to a reasonable degree

Water Acquisitions

Acquire existing water rights and change to ISF use in amounts CWCB determines appropriate to preserve or improve the natural environment to a reasonable degree

Monitoring and Request for Administration

Actively monitor conditions at stream gages and initiate administrative calls as necessary to ensure ISF rights are met.

Legal Protection

Initiating legal action through Colorado's water courts when necessary to provide 100% protection of the state's decreed ISF rights.

Inter-Section Issues –
DSS, Wild and Scenic, State Water Plan, River Restoration, Stream Management Plans, etc.

ROLE OF ISF PROGRAM IN WATER COMMUNITY

- Coordinate with federal agencies to address their resource protection goals through state-held water rights
- Collaborate with CO Parks and Wildlife, Colorado Water Trust, conservation groups, local governments and others on protecting Colorado's rivers and streams
- Work in partnership with water suppliers to enable water projects to move forward while ensuring protection of the natural environment
- Work with stakeholder groups on Wild and Scenic alternative processes and other projects
- Assist with Water Plan implementation

TWO WAYS CWCB OBTAINS ISF WATER RIGHTS

New Appropriations

- Appropriate and adjudicate a new (junior) ISF water right for the **minimum required to preserve** the natural environment to a reasonable degree.

Water Acquisitions

- Acquire existing water rights for ISF use **in amounts CWCB determines appropriate to preserve or improve** the natural environment to a reasonable degree.

ISF APPROPRIATION PROCESS

- Any ***person*** or ***entity*** may recommend streams or lakes to be considered for appropriation to ***preserve*** the natural environment.

Recommendation Development (Year 1)

- Collect data and quantify flow requirements using standard methodology
- Submit recommendations "in writing and with specificity" at ISF workshop.

Recommendation Processing and Outreach Activities by Staff (Year 2)

- Public Notice in March and November
- Reviews submitted data and performs a detailed water availability analysis
- Perform site visits and collects additional data
- Holds public meetings to get input on recommendations

Board Appropriation Administrative Process (Year 3)

- Staff recommends Board form its intent to appropriate – *typically at the Board's January Meeting.*
- If recommendation contested, staff negotiates settlement or Board holds hearing (ISF Rule 5 notice and comment procedures)
- File application for ISF water right in water court

STATUTORY REQUIREMENTS

The Board must make 3 determinations before applying to water court for an ISF water right:

(1) A natural environment exists

Typically identified by the presence of a coldwater fishery, but other indicators can be used (warm water fishery, riparian vegetation)

(2) Water is available for appropriation

- Determined by water right and hydrologic investigations
- Daily Median hydrology when available –water available 50% of time

(3) No material injury to other water rights will occur

- New appropriations are junior water rights and have no effect on existing senior appropriations
- 37-92-102(3)(b) - Recognition of existing undecreed uses and exchanges

NATURAL ENVIRONMENT

flannelmouth sucker

Colorado cutthroat trout

brook trout

2018 ISF APPROPRIATIONS

Div	Stream	Watershed	County	Length (miles)	Upper Terminus	Lower Terminus	Flow (CFS)
4	Coyote Wash	Upper Dolores	Montrose	10.5	Colorado/Utah Stateline	Confl. Dolores River	0.8 (09/01 - 02/29) 2.2 (03/01 - 08/31)
4	Dutchman Creek	Tomichi	Saguache	6.78	Headwaters	Confl. Owens Creek	0.94 (04/01 - 08/31) 0.84 (09/01 - 03/31)
5	Abrams Creek	Eagle	Eagle	3.95	Headwaters	Mrs. Paye Ditch hdgt	0.75 (05/01 - 09/30)
6	Douglas Creek	Lower White	Rio Blanco	26.3	Confl. E & W Douglas Creeks	Confl. White River	2.7 (03/16 - 06/15) 1.7 (06/16 - 06/30)
6	Lost Creek	Upper White	Rio Blanco	3.64	Confl. Hahn Creek	Confl. Long Park Creek	1.3 (10/01 - 03/31) 2.3 (04/01 - 08/15) 1.8 (08/16 - 09/30)
6	Hahn Creek	Upper White	Rio Blanco	4.71	Headwaters	Confl. Lost Creek	0.75 (11/01 - 04/30) 2.6 (05/01 - 08/31) 1.6 (09/01 - 10/31)

CWCB'S WATER ACQUISITION PROGRAM

CWCB can acquire water:

- in amounts it determines appropriate to preserve or improve the natural environment to a reasonable degree
- by donation, purchase, lease, or other contract
- on a permanent or temporary basis
- from willing water rights owners.

Maroon Creek

CWCB may use any funds available to it for water acquisitions (Construction Fund, Species Conservation Trust Fund)

TYPES OF ISF ACQUISITIONS

Permanent:

- Donation or purchase
- Water right conveyed to CWCB
- Change water right to ISF use (water court)

Contractual Interest:

- Can be for any time period
- Can be flexible to meet water right owner's needs
- CWCB typically applies to water court to obtain a decreed right to use the water for ISF purposes
  - Add ISF as a decreed use
  - Ensure no injury to other water rights on stream

WATER ACQUISITION REVIEW & APPROVAL PROCESS

Using two-board meeting process, CWCB considers these factors:

- Reach of stream where acquired water will be used
- Historical use and return flows
- Location of other water rights on reach
- Potential for material injury to existing decreed water rights
- Effect of proposed acquisition on
  - Interstate compact issues
  - Maximum utilization of waters of state
- Whether water will be available for subsequent use downstream
- Water administration issues, if any

ACQUISITION AGREEMENTS & WATER COURT ACTION

Every transaction requires a written agreement.

- Developed cooperatively with water right owner.
- Outlines the terms and conditions of the conveyance.
- Can address water court responsibilities, streamflow monitoring, protection and enforcement of the conveyed right, and other issues.
- Enforceable by either party as a water matter in water court.

CWCB must obtain a decreed right to use that water for ISF purposes – often a change of water right.

NO INJURY TO OTHER WATER RIGHTS!

LONG-TERM LOAN OR LEASE EXAMPLES

Pitkin County

- Long-term loan of up to 3.83 cfs for Maroon Creek and the Roaring Fork River
- Trust Agreement with option to add more water rights in future

Rocky Mountain National Laboratory

- 99 - year lease for $10 per year to protect unique glacial ponds and habitat for neotenic salamanders

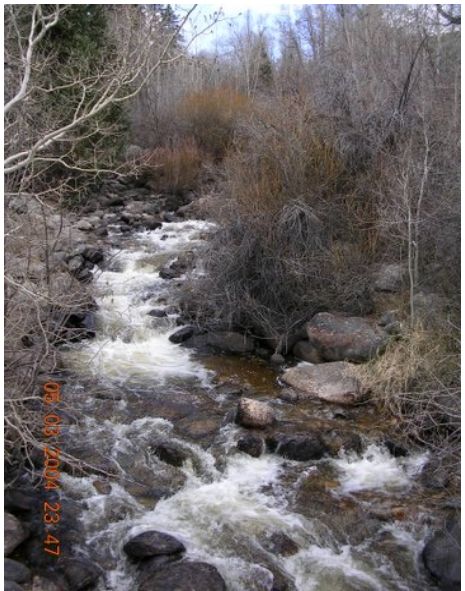
PERMANENT ACQUISITION EXAMPLES

Hat Creek Ditch

- Vail Associates donated water right to CWT, who donated it to CWCB
- Changed to ISF use on Hat Creek and East Brush Creek (.9 – 2 cfs)
- CWT sold HCU to Town of Eagle for use d/s of ISF reach

Peabody No. 1 Ditch

- Retiring rancher sold land to USFS and later sold water right to CWT.
- CWT donated water right to CWCB for ISF use to preserve and improve 14 miles of the Blue River above Green Mountain Reservoir.
- After ISF use, HCU credits remarketed to Colorado River District for downstream augmentation uses.



TEMPORARY LOANS & LEASES OF WATER FOR ISF USE

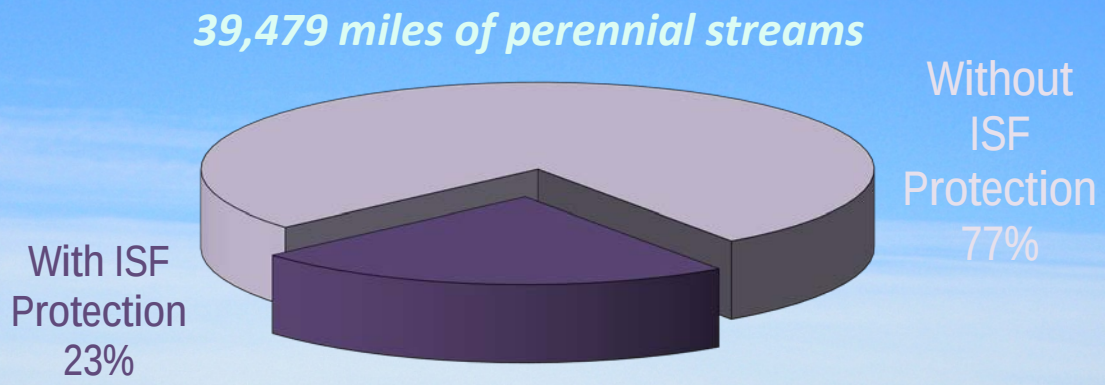
- Limited to
  - ISF use for a period of 120 days
  - 3 years of use over a 10 year period
- Can be used on any stream where CWCB currently holds an ISF right, up to decreed amount
- **No water court change case** – State and Division Engineer can approve ISF use if no injury to other water rights
- Expedited approval process

TEMPORARY LOAN EXAMPLE

Coats Bros Ditch, Tomichi Creek (Gunnison Basin)

- Maintain agricultural use (165 acres of irrigated hay and pasture) while providing water to restore flow to Tomichi Creek
- Water Trust, CWCB identify annual need for water – owner decides annual and seasonal implementation
- Temporary split-season lease - Irrigation through July 1 or August 1, followed by ISF use.
- CWCB, CO Water Trust, and Trout Unlimited

ISF PROGRAM STATISTICS



Appropriated

Instream flow water rights on

- over 1,600 stream segments,
- covering 9,352 miles of stream,
- and 480 natural lakes

Acquired

Over 26 water right donations or long-term contracts for water totaling

420 cfs and 9,340 AF

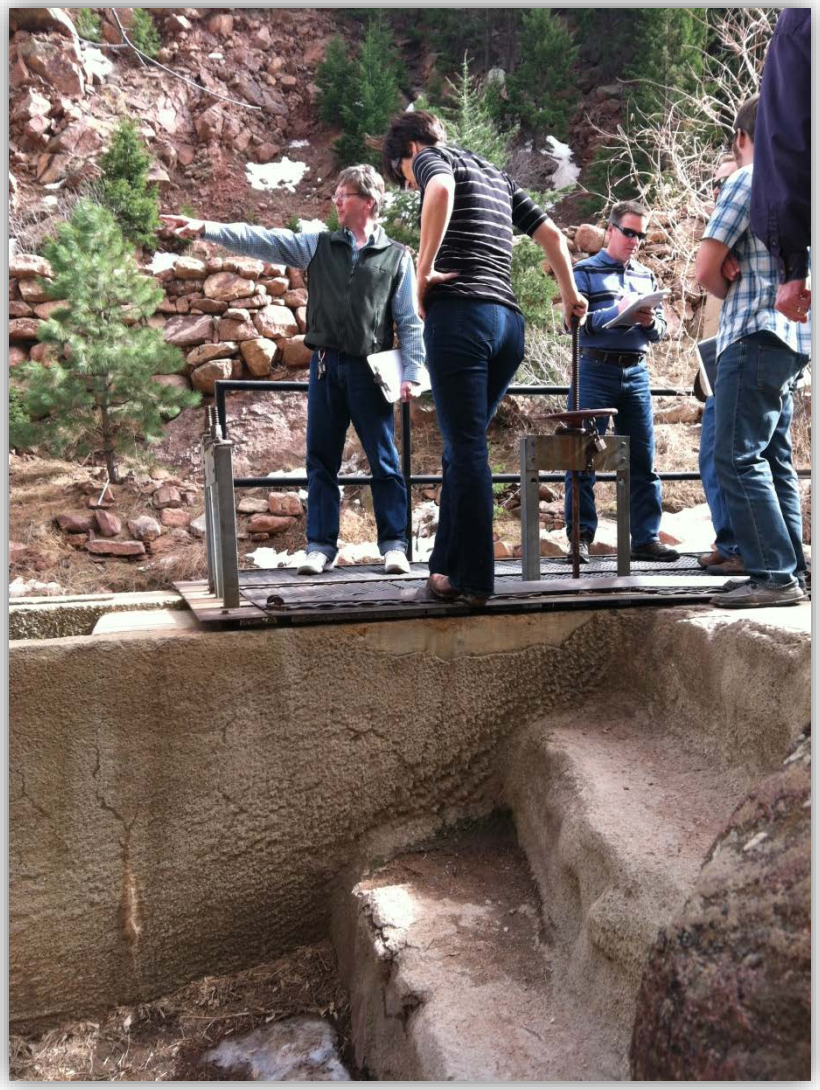
High Creek Fen – Park County

LEGAL PROTECTION

ISF water rights are adjudicated and administered within Colorado's priority system, like all other water rights in the state.

All decreed water rights are entitled to stream conditions as they existed at the time of appropriation.

CWCB has standing in Water Court to ensure changes to senior rights do not alter stream conditions in a way that injures decreed ISF water rights.



Eldorado Artesian Springs – South Boulder Creek

LEGAL PROTECTION

CWCB staff:

- reviews water court resumes each month for applications that could injure ISF water rights
- files statements of opposition to such applications
- works with the AG's Office to negotiate terms and conditions to include in water court decree that protect the ISF

Injury can result from:

- Plans for augmentation
- Changes of water rights
- Inundation

Aldasoro Ranch Homeowners

MONITORING AND ENFORCEMENT

Crystal River Satellite Monitoring gage

CWCB installs new stream gages and cooperates with USGS and DWR on existing stream gages.

Real time monitoring by over 150 gages via the DWR / CWCB flow alert system—sends email alerts to staff.

Staff gages and interested stakeholders also alert staff to observed or suspected low flow conditions.

Staff coordinates with the DWR on low flow conditions and places administrative calls for ISF water rights when warranted.

UPPER COLORADO WILD & SCENIC STAKEHOLDER GROUP

- **Goal**: Create a river management plan alternative for BLM and USFS to consider as part of planning process – would be an alternative to a finding of suitability for W&S

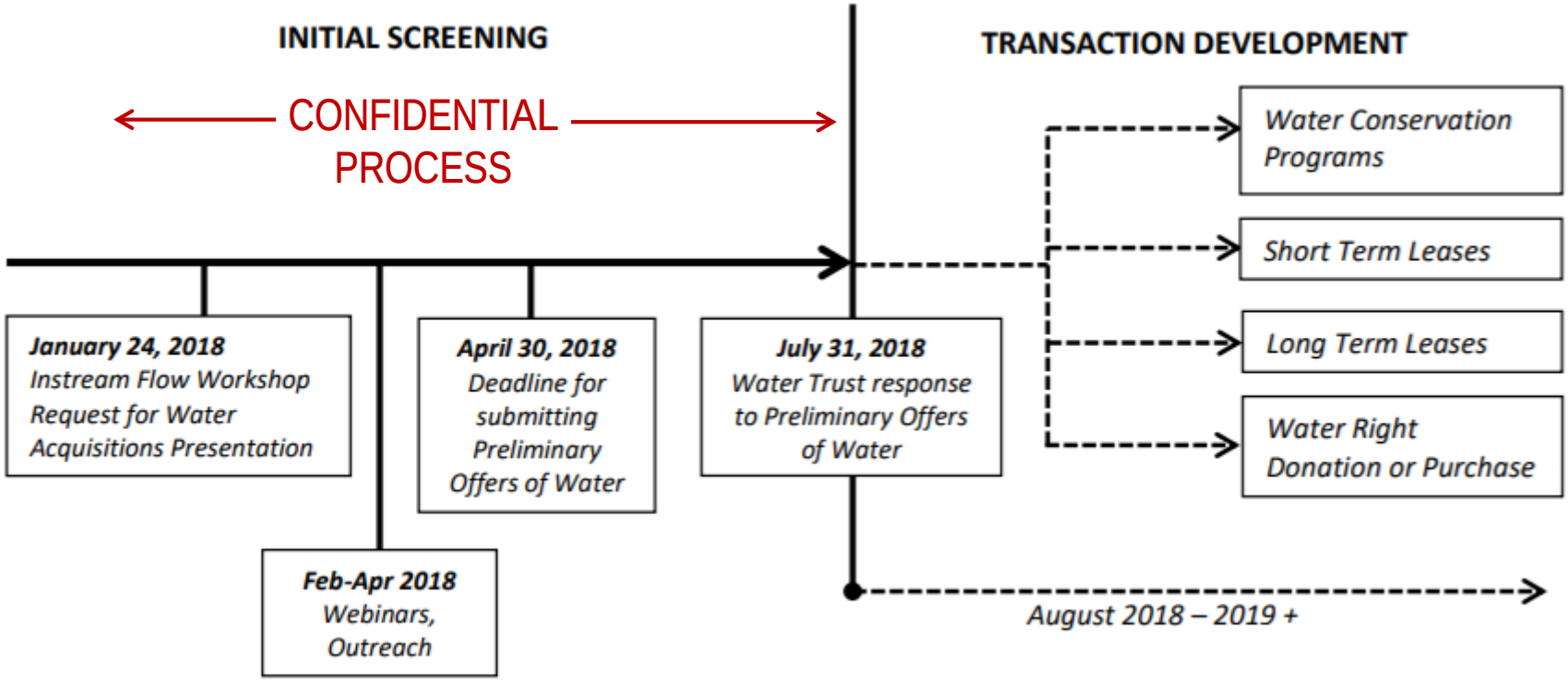
- **Participants**: local governments, water users, environmental and recreation interests, landowners, state agencies
- Focus on two flow-related ORVs: recreational fishing and recreational boating
- Stakeholder group developed ISF recommendations for base flows on three reaches of Colorado River:
  - Blue River to Piney River
  - Piney River to Cabin Creek
  - Cabin Creek to just u/s of Eagle River

- CWCB appropriated three ISFs in 2011; decreed in 2013. Flow rates range from 500 – 900 cfs.
- BLM & USFS preferred alternative includes the SG Management Plan Alternative. (2015)

Request for Water Acquisitions Pilot Process

- CWCB partnering with Colorado Water Trust on process
- To **invite voluntary water offers** from willing water rights owners to benefit streamflows
- To **provide a user-friendly mechanism** for water rights owners to explore working with CWCB and the Colorado Water Trust on water transactions
- To **streamline transaction processes** and utilization of resources
- To **facilitate implementation** of Colorado's Water Plan objectives
- To **add flows to river segments in need** while coordinating with agricultural and other uses

REQUEST FOR WATER ACQUISITIONS PILOT PROCESS



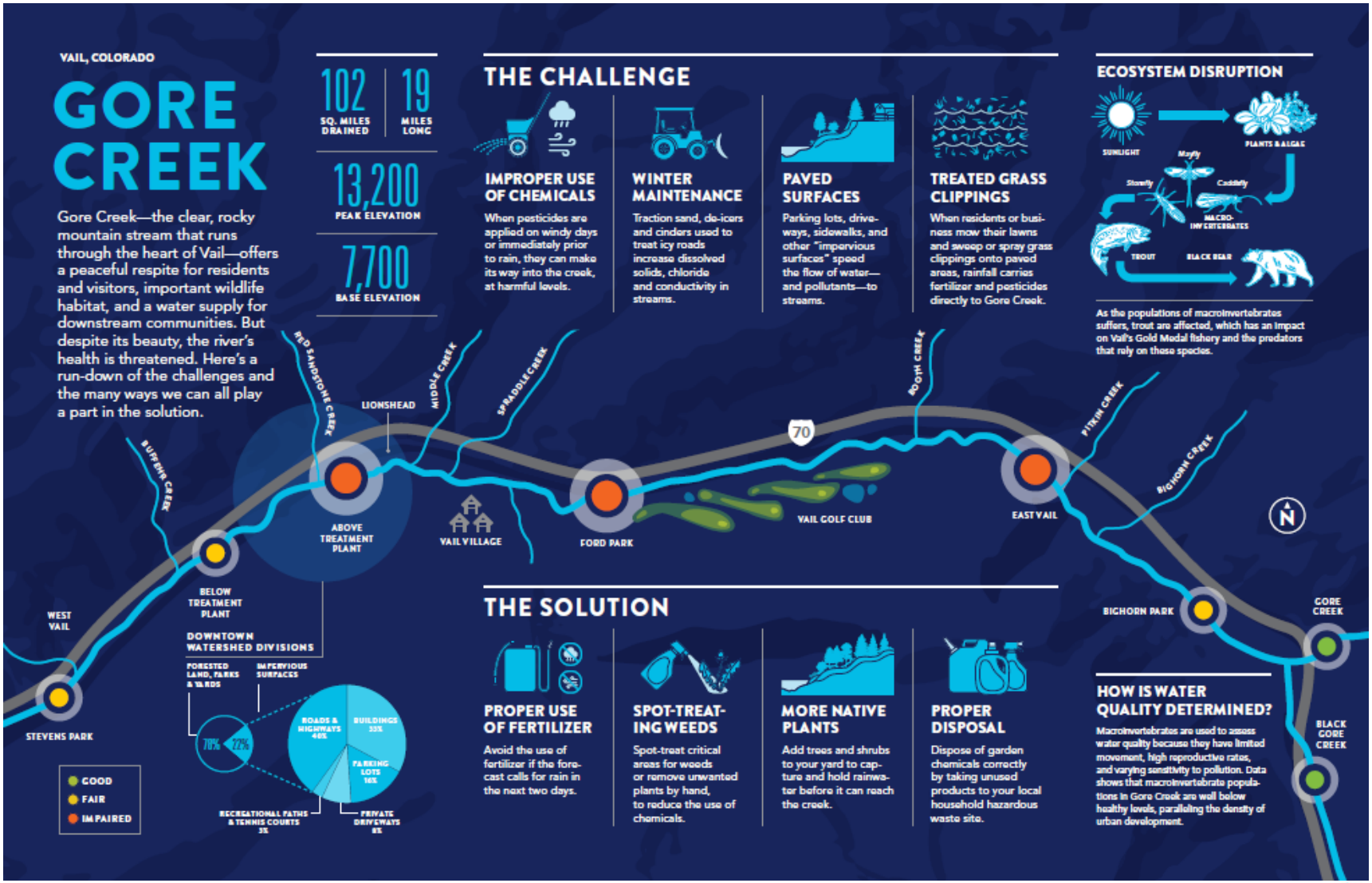
Submitting an inquiry or preliminary offer of water DOES NOT commit you to completing a project with the Water Trust or Water Conservation Board.

QUESTIONS?

Vail's Approach to Restoring an Impaired Waterway

Pete Wadden
Watershed Education Coordinator
pwadden@vailgov.com
970.479.2144 | lovevail.org

Status of Gore Creek



Has been on Clean Water Act 303d list for low aquatic life since 2012

Lovevail.org

Three sources of contamination

Landscaping practices

- Bright green turf requires a lot of water and chemicals at 8,150 ft

What is causing impairment in Gore Creek?

Landscaping practices

- Pesticide use

Town of Vail set the example and promoted its successes.

- Reduced foliar pesticide use by 92% from 2014 to 2016
- Has held workshops to encourage homeowners and landscapers to do the same

Foliar pesticide application

- That might be too much. . .

Three sources of contamination

Vail
1980

- Rapid development over 50 year period
- An impaired creek almost seems inevitable when considered through that lens (in retrospect)

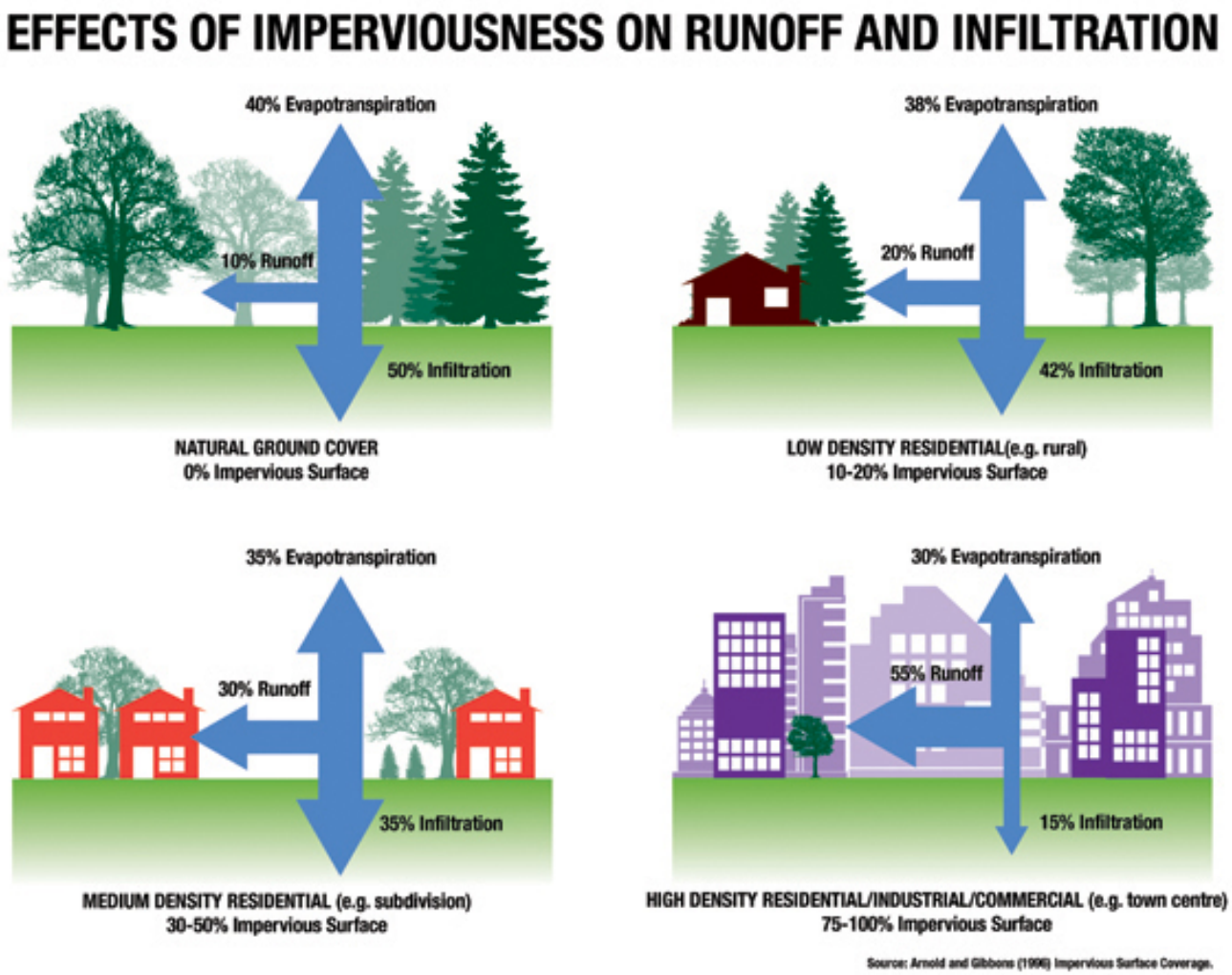
Three sources of contamination

Increased impervious surfaces

- Speeds runoff, eliminates filtration
- Faster water carries more pollutants

- Rapid development over 50 year period
- An impaired creek almost seems inevitable when considered through that lens (in retrospect)

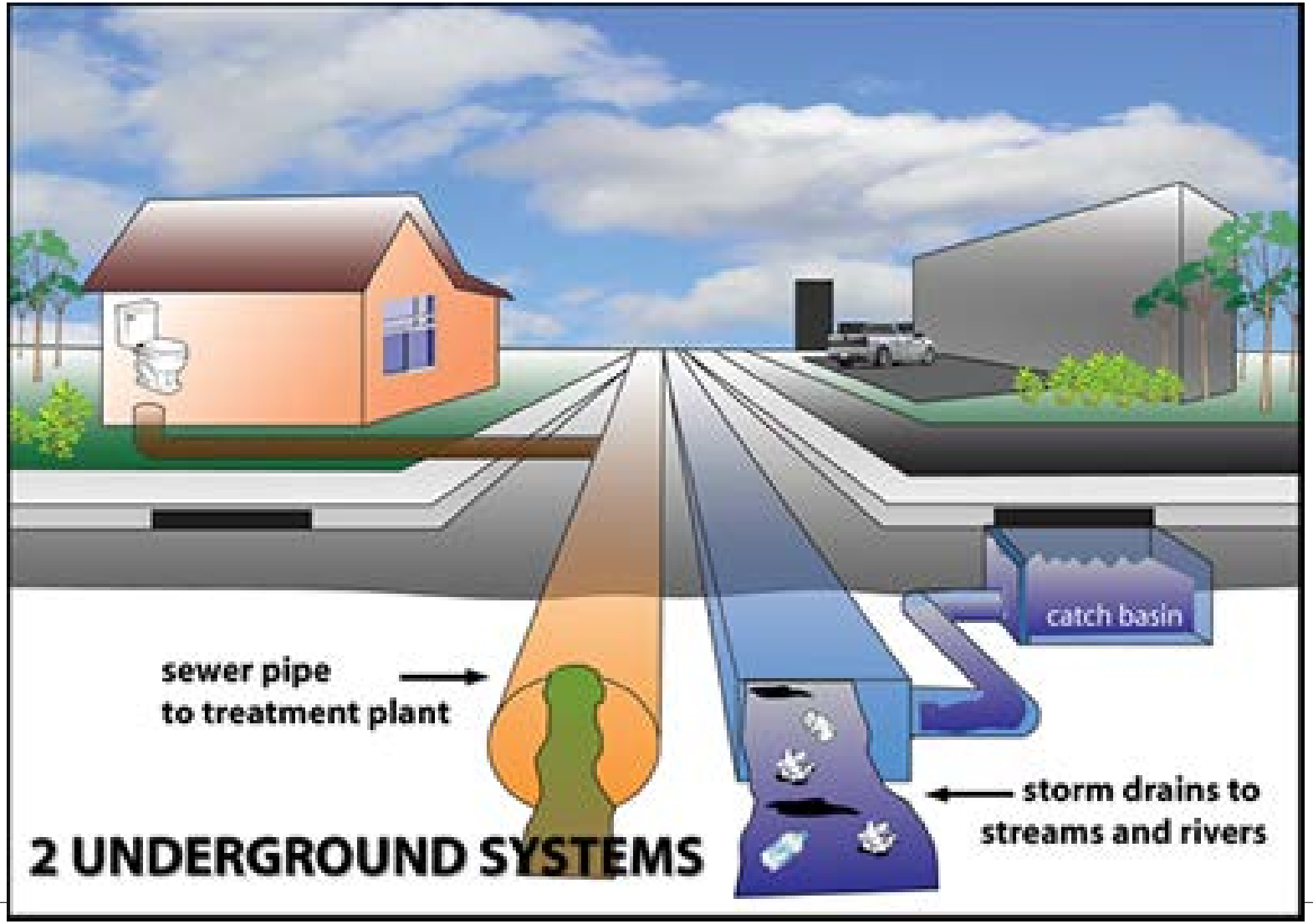
Impacts of Impervious Surfaces



As impervious surfaces in a watershed increase, stormwater has less opportunity to infiltrate.

Only 3% of Gore Creek watershed is developed, but urbanization is concentrated along the creek, increasing impact.

Most people don’t know



If it has an open grate, it doesn’t get filtered (storm sewers and sanitary sewers are different).

Education is needed in Vail

In 2016 people dumped:

- Cement

People don’t know where the water goes.

Education is needed in Vail

In 2016 people dumped:

- Cement
- Cooking grease

People don’t know where the water goes.

Lovevail.org

Education is needed in Vail

In 2016 people dumped:

- Cement
- Cooking grease
- Paint

People don’t know where the water goes.

Lovevail.org

Education is needed in Vail

In 2016 people dumped:

- Cement
- Cooking grease
- Paint
- Window Cleaner

People don’t know where the water goes.

Lovevail.org

Education is needed in Vail

In 2016 people dumped:

- Cement
- Cooking grease
- Paint
- Window Cleaner
- 120 hot dogs

Down storm drains in Vail

People don’t know where the water goes.

Lovevail.org

Three sources of contamination

- Untreated stormwater
- Stormwater dumping

Raise awareness

Newspaper ads and articles

Lovevail.org

Raise awareness

Outreach and events

- Nothing works like to-face

Foster Responsibility

Gave people the tools and motivation to contribute to your community-wide effort

Vail offers a free, annual workshop for landscape contractors

Lovevail.org

Community Action

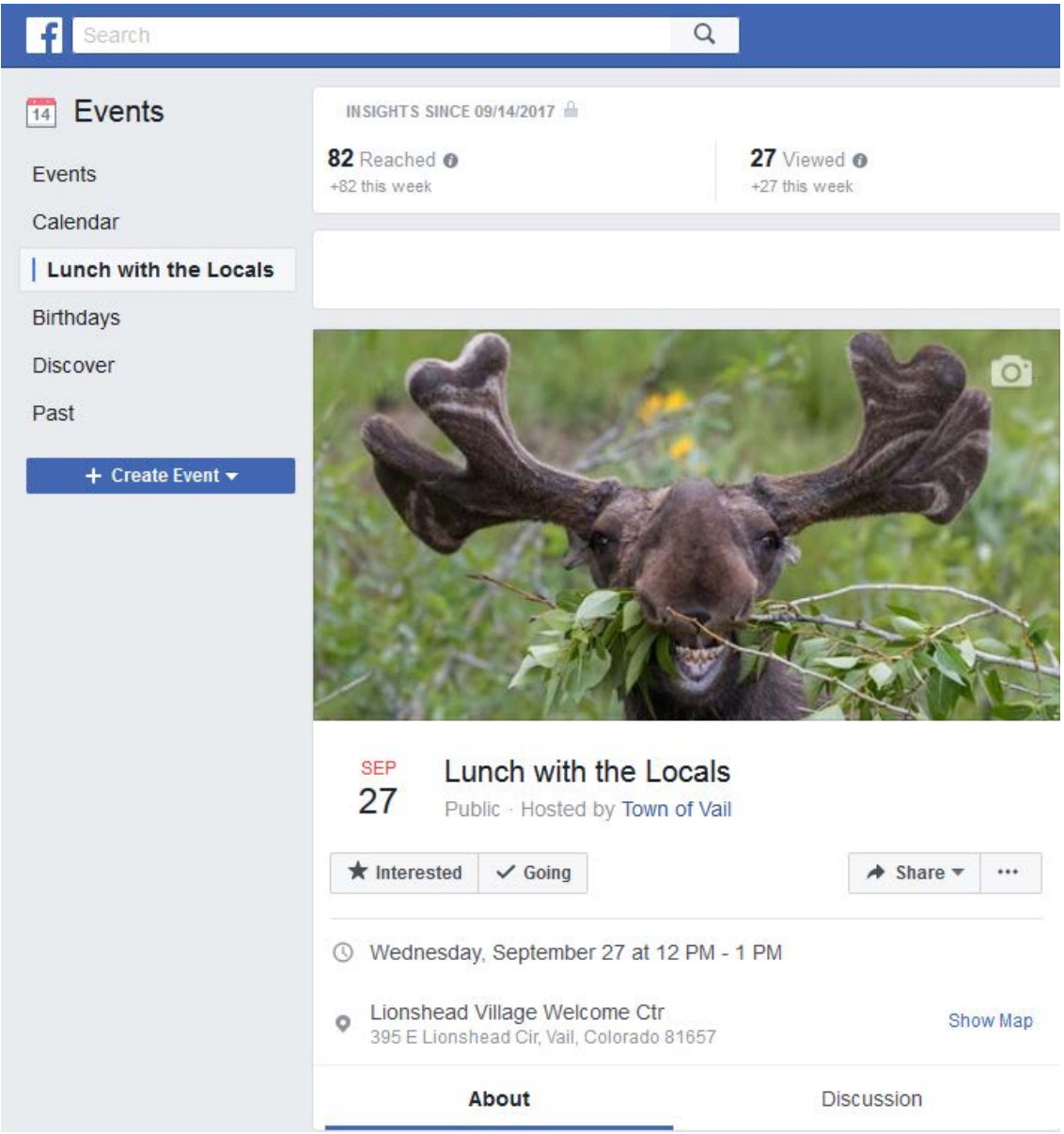
Volunteer events

- Get people involved
- Raise awareness
- Make them feel empowered
- Create community ambassadors
- Create sense of ownership, accomplishment and community
- You may get some actual work done

Lovevail.org

Love VAIL GORE CREEK

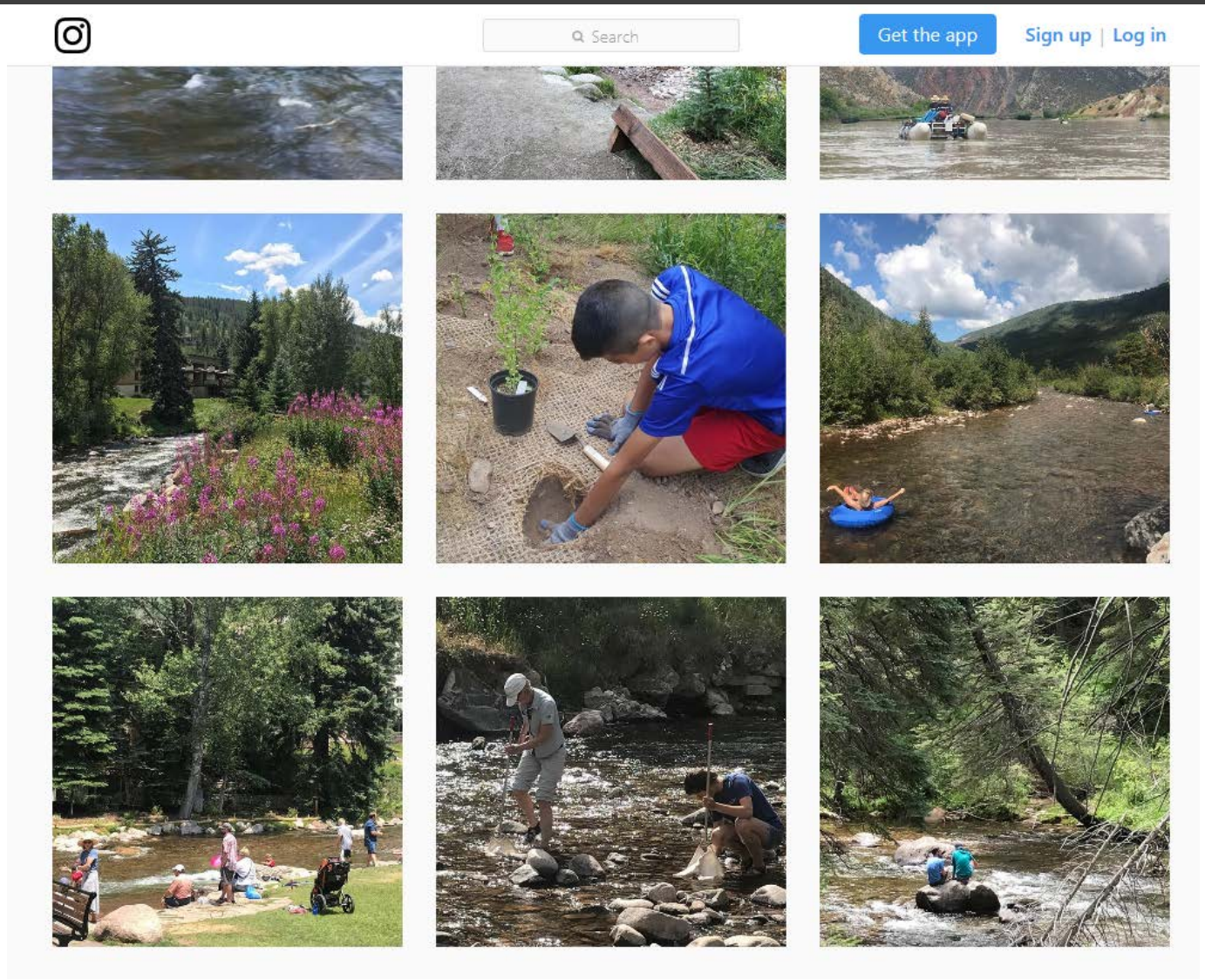
Social media



- Restore the Gore is active on Instagram and Facebook
- Town of Vail also has a Twitter account

Lovevail.org

Social media



Restore the Gore is active on Instagram and Facebook, Town of Vail also has a Twitter account

Specific Programs

- Stormwater art installation
- Restore the Gore stickers
- Gore Creek Spill Hotline

RESTORE THE GORE

Lovevail.org

Love VAIL GORE CREEK

Specific Programs

Project Re-Wild

Specific Programs

Lunch with the Locals

Come enjoy a complimentary lunch and listen to a presentation on the history of the Clean Water Act and how the designation of Gore Creek as an impaired waterway impacts our community. Experts from the Town of Vail, Walking Mountains Science Center, and Eagle River Watershed Council will be on hand to answer questions about what residents can do to help Restore the Gore. There will also be native seed mixes, stickers and informational brochures given away to attendees.

walking mountains science center

Eagle River Watershed Council

SUNDAE

Love VAIL GORE CREEK

TOWN OF VAIL

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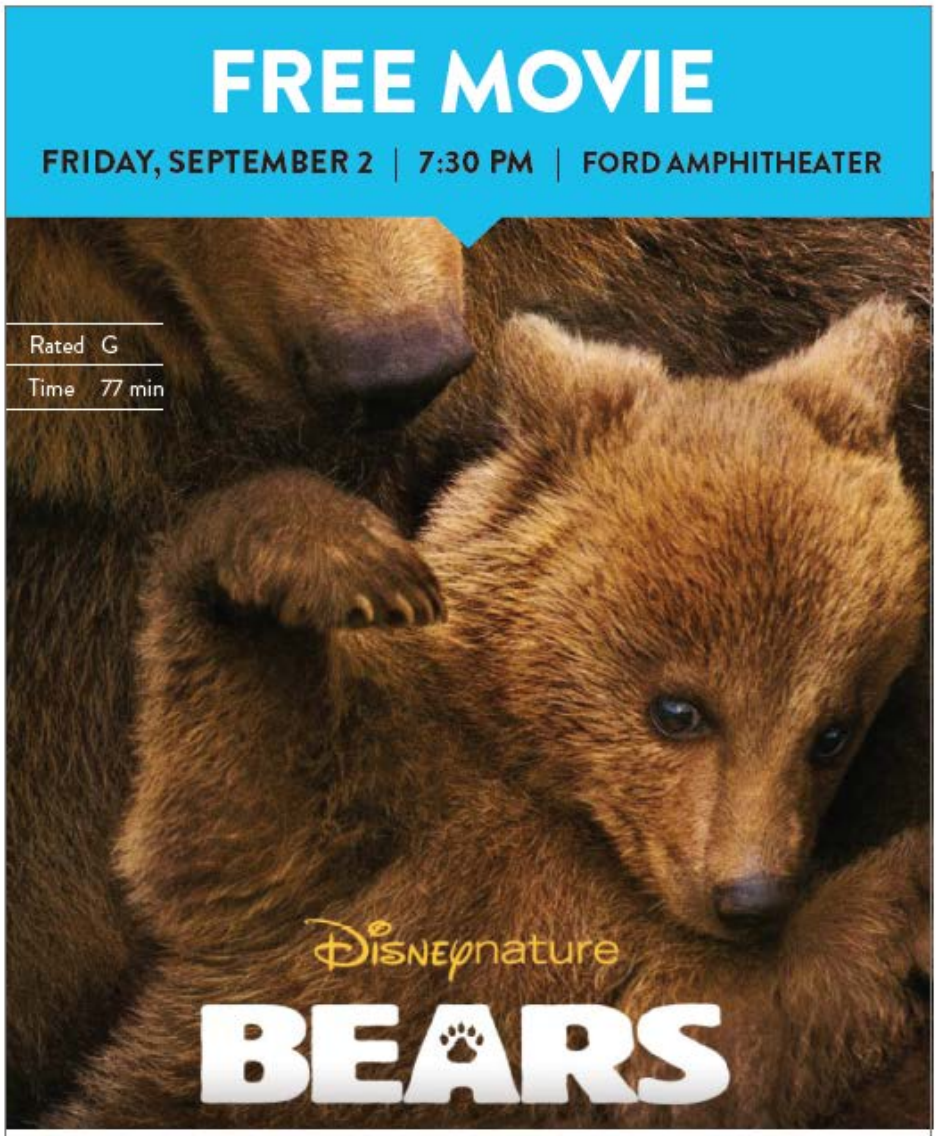
Love VAIL GORE CREEK

Specific Programs

Summer Nature Film



Pete Wadden

Watershed Education Coordinator

pwadden@vailgov.com

Lovevail.org

BIG RIVER DROUGHT CONTINGENCY PLANNING

Colorado River District

Protecting Western Colorado Water Since 1937


Colorado River District
Protecting Western Colorado Water Since 1937
MOFFAT
ROUTT
GRAND
RIO BLANCO
GARFIELD
EAGLE
SUMMIT
PITKIN
MESA
DELTA
MONTROSE
GUNNISON
SAGUACHE
OURAY
HINSDALE
Green River
Little Snake River
Yampa River
White River
Colorado River
Eagle River
Roaring Fork River
Gunnison River
Taylor River
Uncompahgre River
Elkhead Reservoir
Wolford Reservoir
Grand Lake
Granby Reservoir
Williams Fork Reservoir
Green Mountain Reservoir
Blue River
Dillon Reservoir
Turquois Lake
Twin Lakes
Taylor Reservoir
Blue Mesa Reservoir
Ridgeway Reservoir
Craig
Steamboat Springs
Meeker
Kremmling
Granby
Silverthorne
Vail
Glenwood Springs
Aspen
Grand Junction
Delta
Montrose
Gunnison
Ouray
Lake City
Fort Collins
Denver
Colorado Springs
Pueblo
You are here
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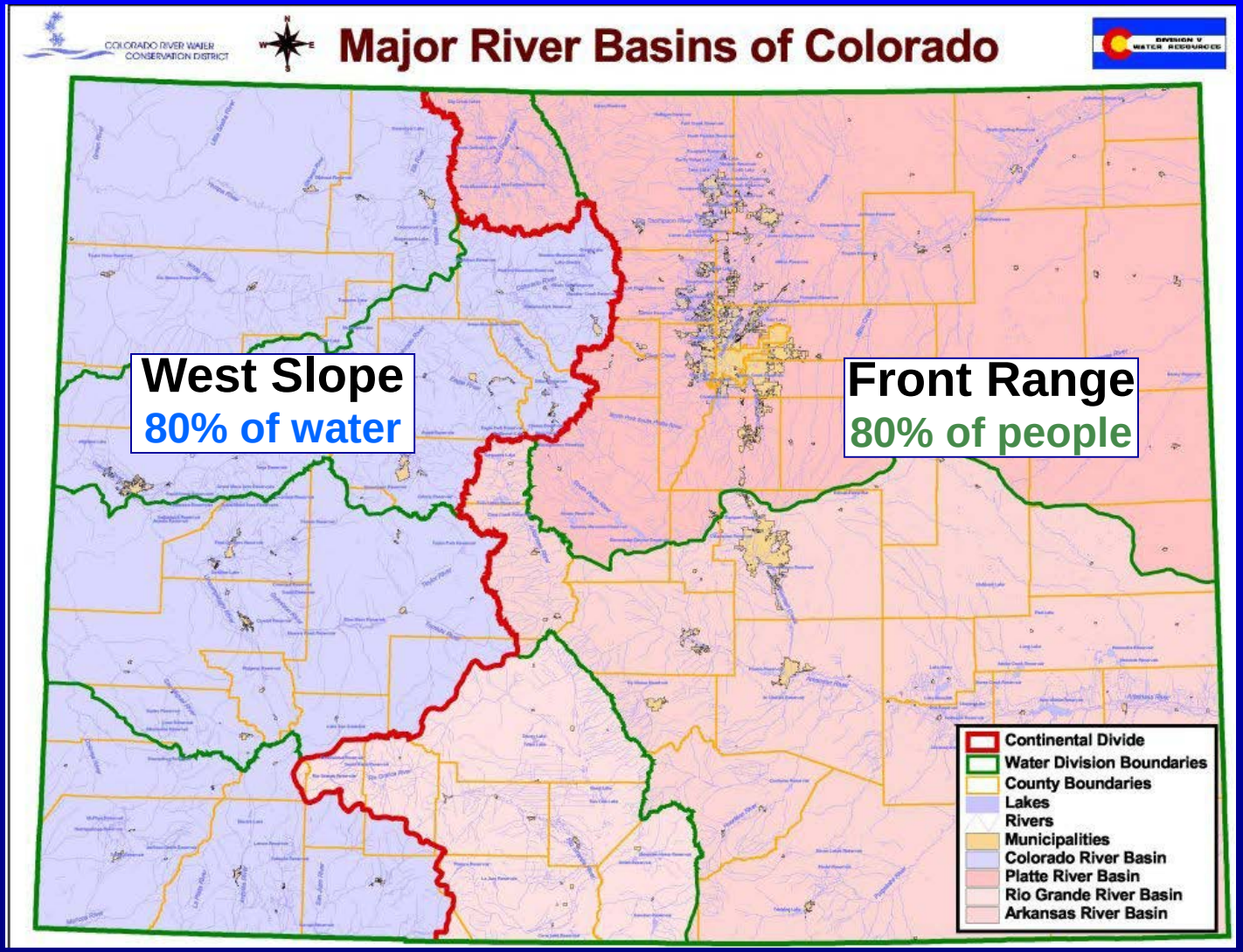
Disparity of People and Water



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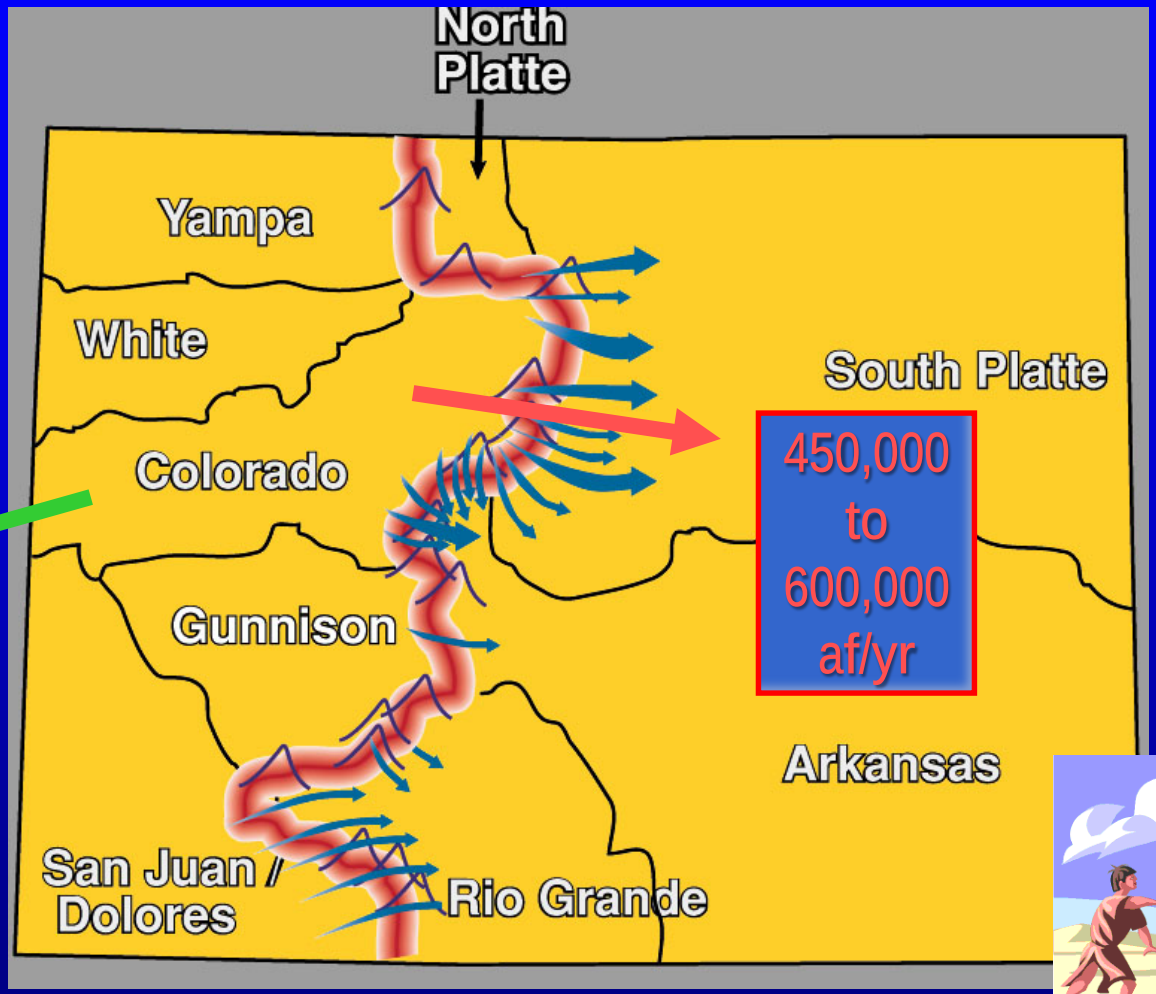
Transmountain diversions (to east) and downstream demands (to west)



Colorado River District

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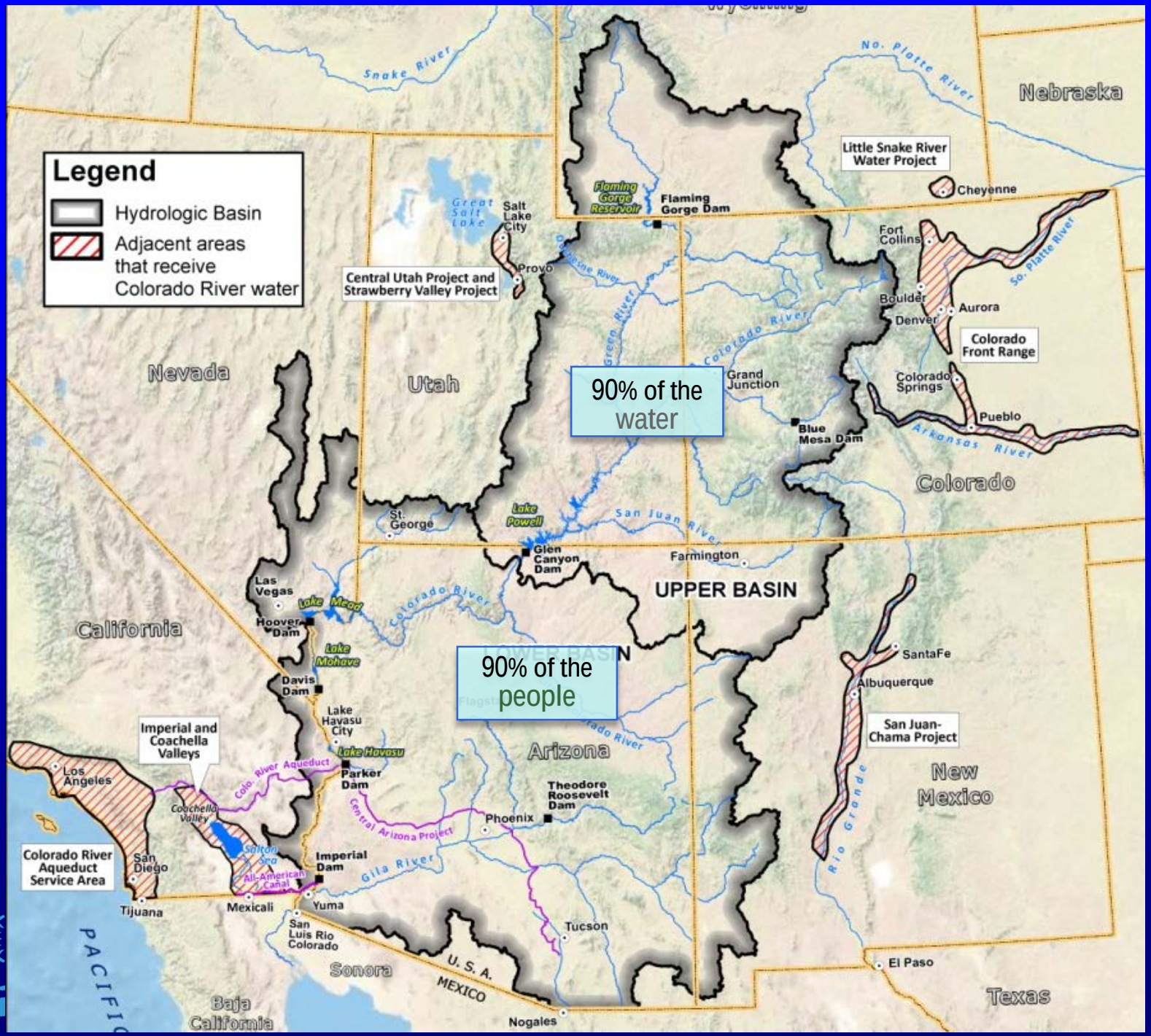
Colorado River Basin Today

- Seven Basin States
- Almost 300,000 square miles
- 35 Million People and growing
- Up to 5.5 Million Irrigated Acres
- 10 Autonomous / Sovereign Tribes
- 2 Countries


Legend
Hydrologic Basin
Adjacent areas that receive Colorado River water
90% of the water
90% of the people
UPPER BASIN
LOWER BASIN
Snake River
No. Platte River
Nebraska
Little Snake River Water Project
Cheyenne
Flaming Gorge Reservoir
Flaming Gorge Dam
Great Salt Lake
Salt Lake City
Provo
Central Utah Project and Strawberry Valley Project
Fort Collins
So. Platte River
Boulder
Denver
Aurora
Colorado Front Range
Green River
Colorado River
Grand Junction
Colorado Springs
Pueblo
Blue Mesa Dam
Arkansas River
Nevada
Utah
Colorado
St. George
Lake Powell
San Juan River
Glen Canyon Dam
Farmington
Las Vegas
Lake Mead
Hoover Dam
California
Lake Mohave
Davis Dam
Lake Havasu City
Lake Havasu
Parker Dam
Imperial and Coachella Valleys
Los Angeles
Colo. River Aqueduct
Coachella Valley
Salton Sea
All-American Canal
Colorado River Aqueduct Service Area
San Diego
Tijuana
Mexicali
Imperial Dam
Yuma
Gila River
Central Arizona Project
Arizona
Theodore Roosevelt Dam
Phoenix
Tucson
SantaFe
Albuquerque
San Juan-Chama Project
New Mexico
Rio Grande
El Paso
Texas
San Luis Rio Colorado
Sonora
U. S. A.
MEXICO
Baja California
Nogales
PACIFIC

1922 Colorado River Compact

- Divides Colorado River (incl tributaries), into Upper & Lower Basins and defines Divisions
- Boundary between the two basins is Lee Ferry, Arizona
- Lower Division: Nevada, California & Arizona
- Upper Division: Wyoming, Colorado, New Mexico & Utah
- Arizona, Utah and New Mexico have lands within both basins

Law of the River Allocations

- 7.5 MAF to Upper Basin (by %'s to CO, UT, WY, NM)[1]
- 7.5 MAF to Lower Basin (4.4 CA; 2.8 AZ; 0.3 NV)[2]
- 1.0 MAF additional to Lower Basin[3]
  - (*i.e.,* tributary development, e.g., Little Colorado and Gila Rivers in AZ)
- 1.5 MAF to Mexico[4]

17.5 MAF Total Allocated 'on paper'

[1] 1922 Colorado River Compact, 1948 Upper Colorado River Compact
[2] Colorado River Compact, 1929 Boulder Canyon Project Act, 1964 AZ v. CA
[3] 1922 Colorado River Compact
[4] Treaty of 1944

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Colorado River Compact of 1922

Colorado, like all Upper Division states, shares obligations to the Lower Division

III (d) **the Upper Division shall "not cause the flow of the river at Lee Ferry to be depleted below an aggregate of 75,000,000 acre-feet for any ten consecutive years."**

III (c) **regarding Mexico…the Upper Division must "deliver at Lee Ferry water to supply one-half of the deficiency so recognized in addition to that provided in paragraph (d)."**

Current Use Estimates

	MAF/ year
Upper Basin uses incl. reservoir evap.	4.0 - 4.5
Lower Basin State Allocations	7.5 - 7.5
Lower Basin reservoir evap. (and other losses)	1.0 - 1.5
Lower Basin tributaries	2.0 - 2.5
Total Lower Basin	10.5 - 11.5
Subtotal	14.5 - 16.0
Add Mexico	1.5 1.5
TOTAL	16.0 – 17.5

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Hydrology comparison

average natural inflows at Lee Ferry

- 2000-2015 — 12.4 MAF/year
- 2000-2004 — 9.4 MAF/year
- 2005-2015 — 13.8 MAF/year
- 1930-2015 — 13.9 MAF/year
- Basin Study [CC] — 13.7 MAF/year

CC = climate change

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Data from Reclamation's Naturalized Flows database

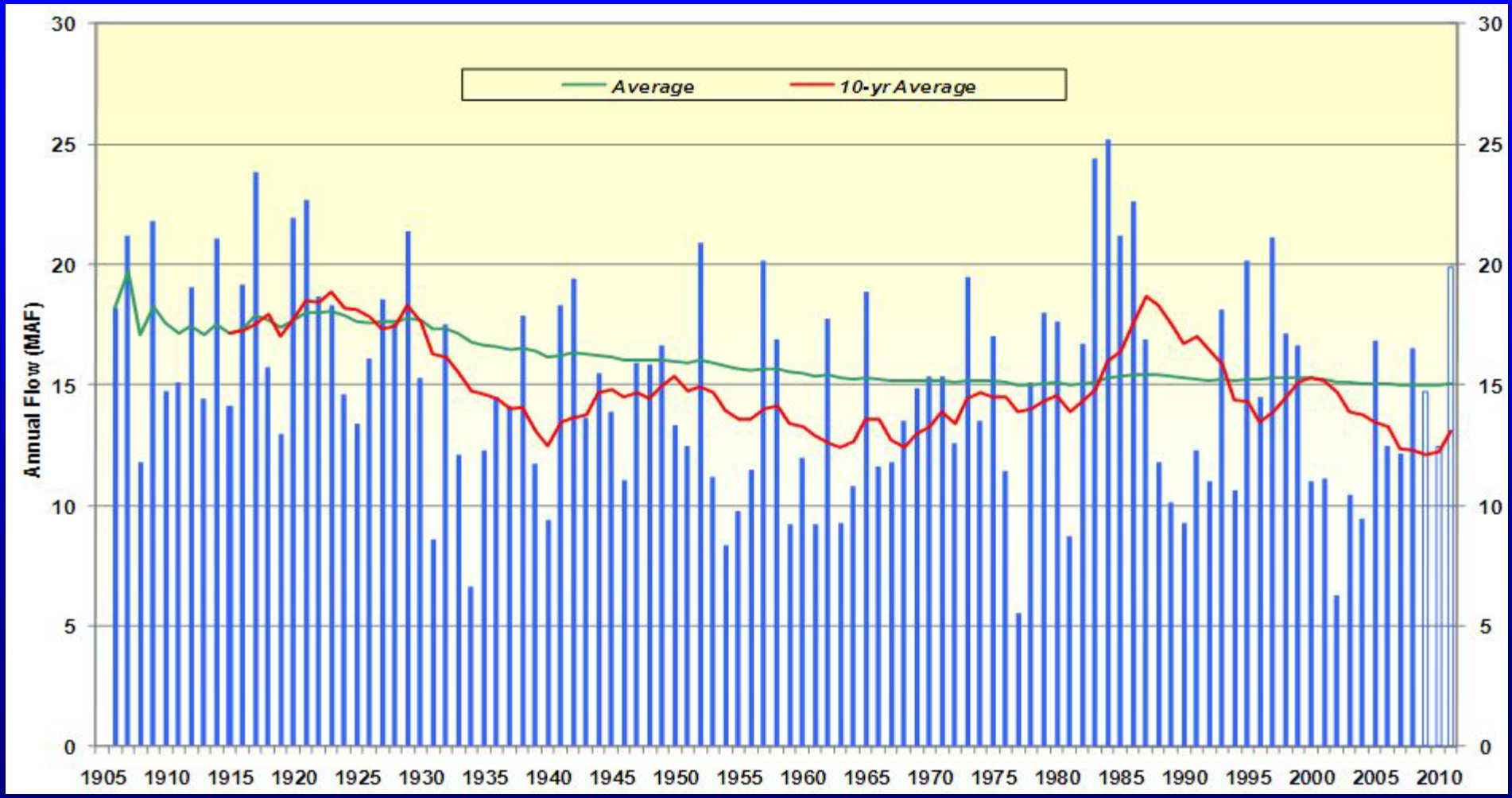
Water Budget at Lake Mead

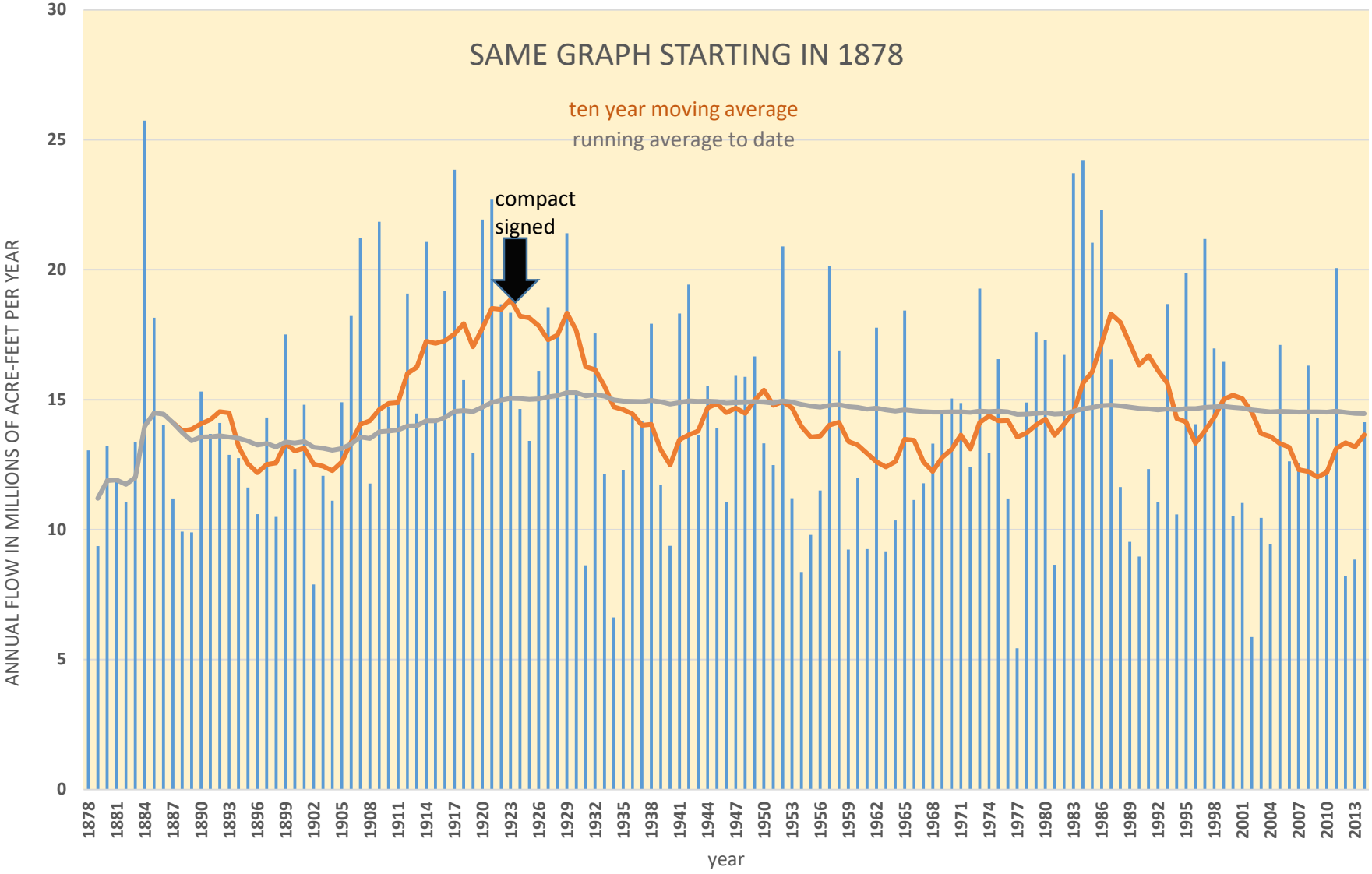
- Inflow = 9.0 maf
  (release from Powell + side inflows)
- Outflow = - 9.6 maf
  (AZ, CA, NV, and Mexico delivery
  + downstream regulation and gains/losses)
- Mead evaporation losses = - 0.6 maf
- Balance = - 1.2 maf

Given basic apportionments in the Lower Basin, the allotment to Mexico, and an 8.23 maf release from Lake Powell, Lake Mead storage declines about 12 feet each year

RECLAMATION

Colorado River at Lees Ferry, AZ Natural Flow




SAME GRAPH STARTING IN 1878
ten year moving average
running average to date
compact
signed
ANNUAL FLOW IN MILLIONS OF ACRE-FEET PER YEAR
30
25
20
15
10
5
0
1878
1881
1884
1887
1890
1893
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1968
1971
1974
1977
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
year

Lake Powell Releases

- Controlled by the 2007 Interim Guidelines
- Based on storage levels in both Powell & Mead
- What happens in the LB impacts Powell and what happens in the UB impacts Mead
- As long as Powell has storage - NO compact problems for UB

Lake Powell Operational Tiers (subject to April adjustments or mid-year review modifications)		
Lake Powell Elevation (feet)	Lake Powell Operational Tier	Lake Powell Active Storage (maf)
3,700	**Equalization Tier** equalize, avoid spills or release 8.23 maf	24.32
3,636 – 3,666 (see table below)	**Upper Elevation Balancing Tier** release 8.23 maf; if Lake Mead < 1,075 feet, balance contents with a min/max release of 7.0 and 9.0 maf	15.54 – 19.29 (2008 – 2026)
3,575	**Mid-Elevation Release Tier** release 7.48 maf; if Lake Mead < 1,025 feet, release 8.23 maf	9.52
3,525	**Lower Elevation Balancing Tier** balance contents with a min/max release of 7.0 and 9.5 maf	5.93
3,370		0

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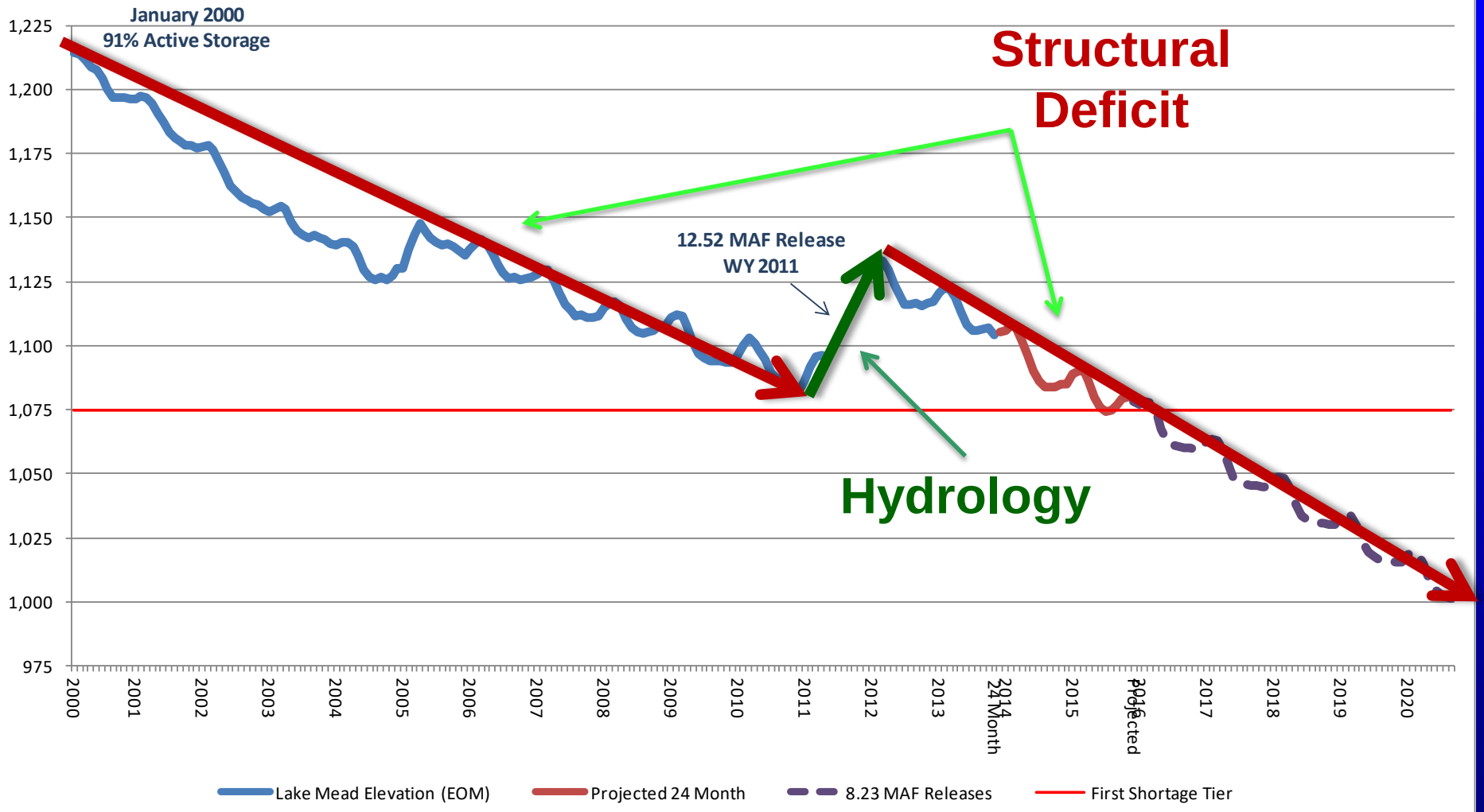
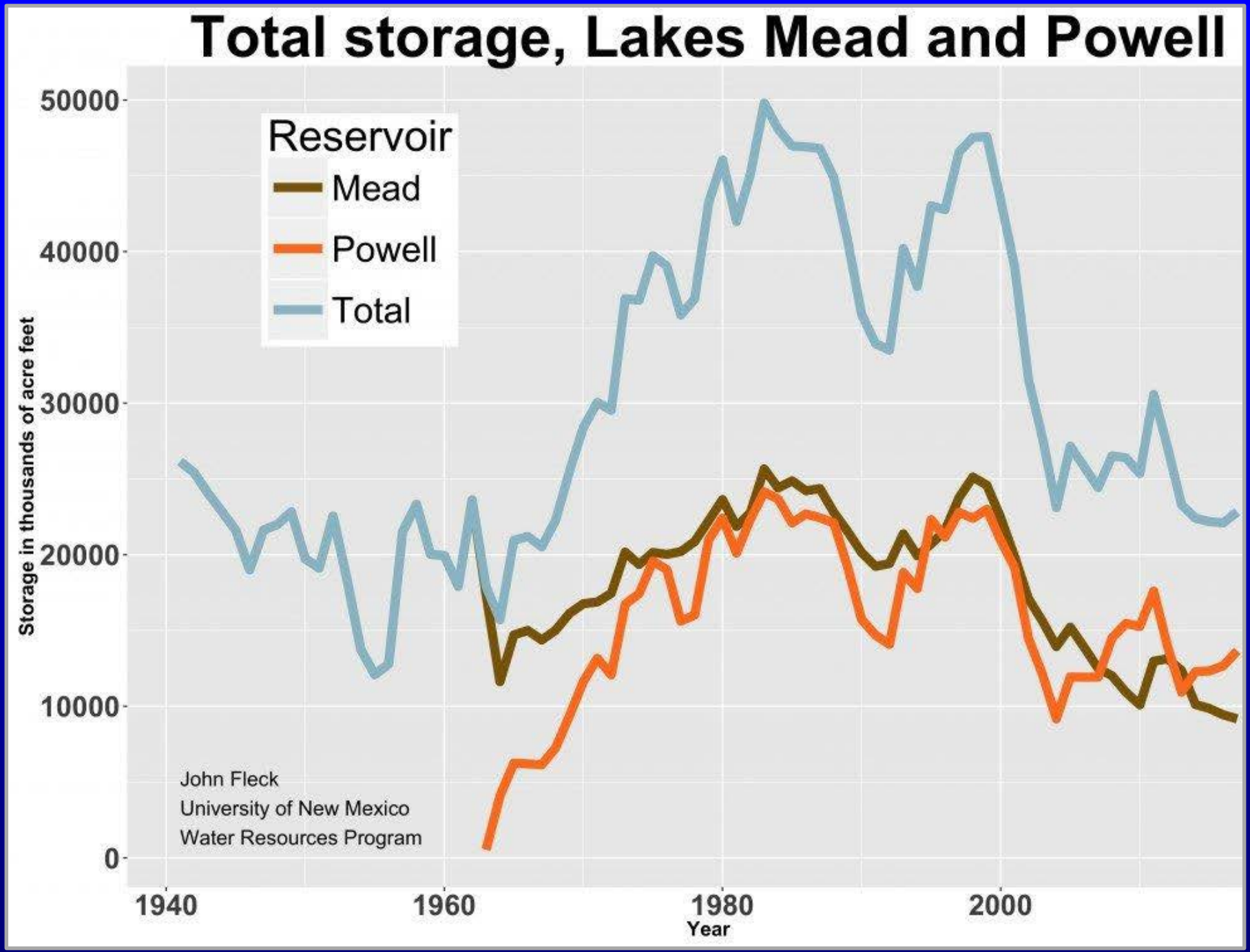
Lake Mead Elevation Since 2000




Total storage, Lakes Mead and Powell
Reservoir
Mead
Powell
Total
50000
40000
30000
20000
10000
0
Storage in thousands of acre feet
1940
1960
1980
2000
Year
John Fleck
University of New Mexico
Water Resources Program

Contingency Planning

Challenge from US Department of Interior:

- What if the current drought were to continue?
- Have a plan in place by 2015 (MOA or similar)

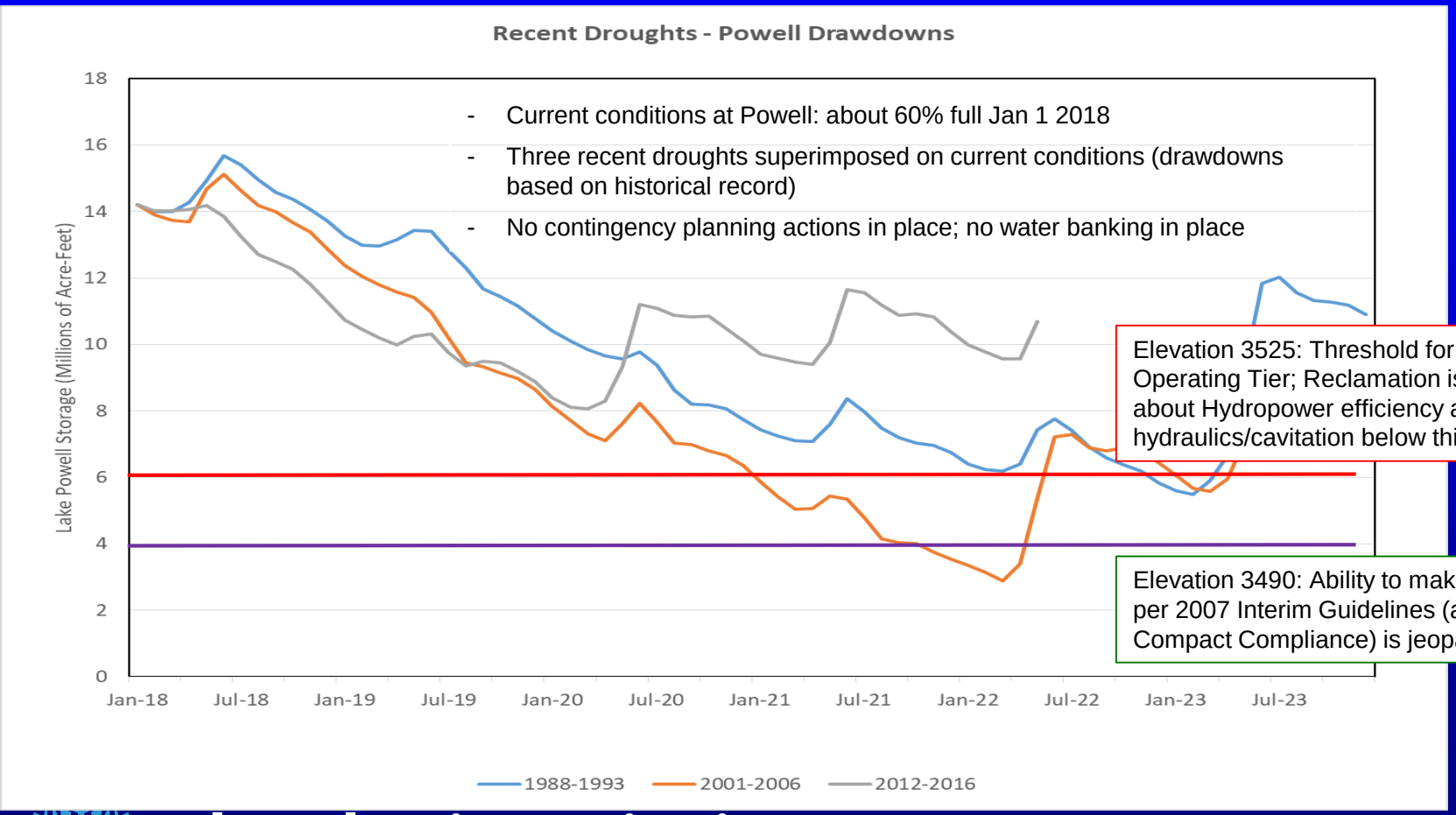
The Goal:

- Identify actions to reduce risk of losing power production or being unable to deliver water

Possible Solutions:

- Extended Operation of CRSP reservoirs
- Demand Management
- Cloud seeding / other augmentation approaches

What if drought periods of past 25 years repeated?



Contingency Planning

Why do we need one?

The Colorado River Basin has been in a prolonged drought since 2000

Who is taking the lead?

The 7 Colorado River basin states & US Bureau of Reclamation

Who in Colorado is actively involved?

The Colorado River District, Southwestern Water Conservation District, Colorado Water Conservation Board, The Nature Conservancy and Front Range Water Council are jointly investigating the feasibility of a water bank.

Basics of Contingency Planning

1. Extended operations

Federal reservoirs upstream of Lake Powell – Flaming Gorge, Aspinall and Navajo Reservoirs – would release additional water for storage and use in Lake Powell.

2. System augmentation

Enhanced cloud seeding and accelerated removal of non-native vegetation such as tamarisk.

3. Demand management

Additional conservation by municipal and irrigation users and deficit irrigation or fallowing by agricultural users.

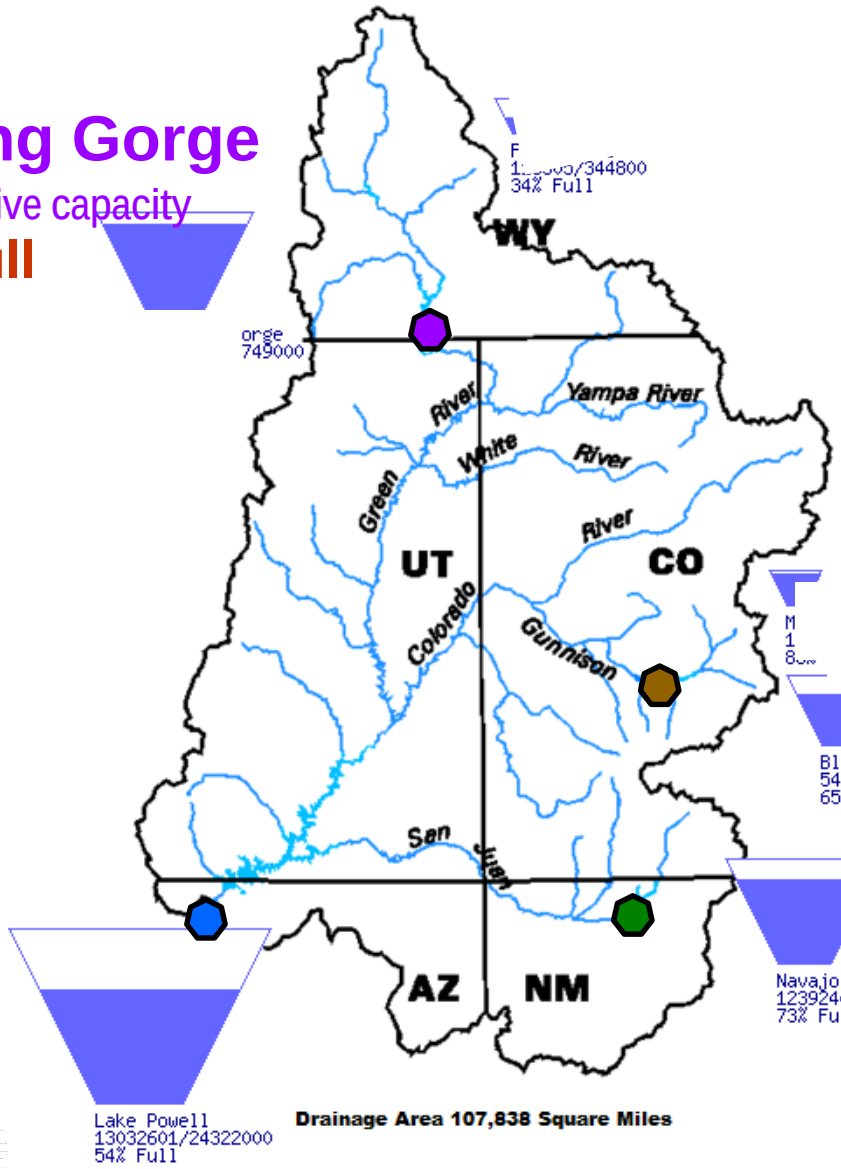
Colorado River Storage Project Units (CRSP)

Flaming Gorge

3.7MAF active capacity

85% full

CRSP Acts of 1956 & 1968 authorized construction of facilities for long-term regulation & development of Colorado River water resources



Blue Mesa

0.84MAF active capacity

65% full

Navajo

1.7 MAF active capacity

73% full

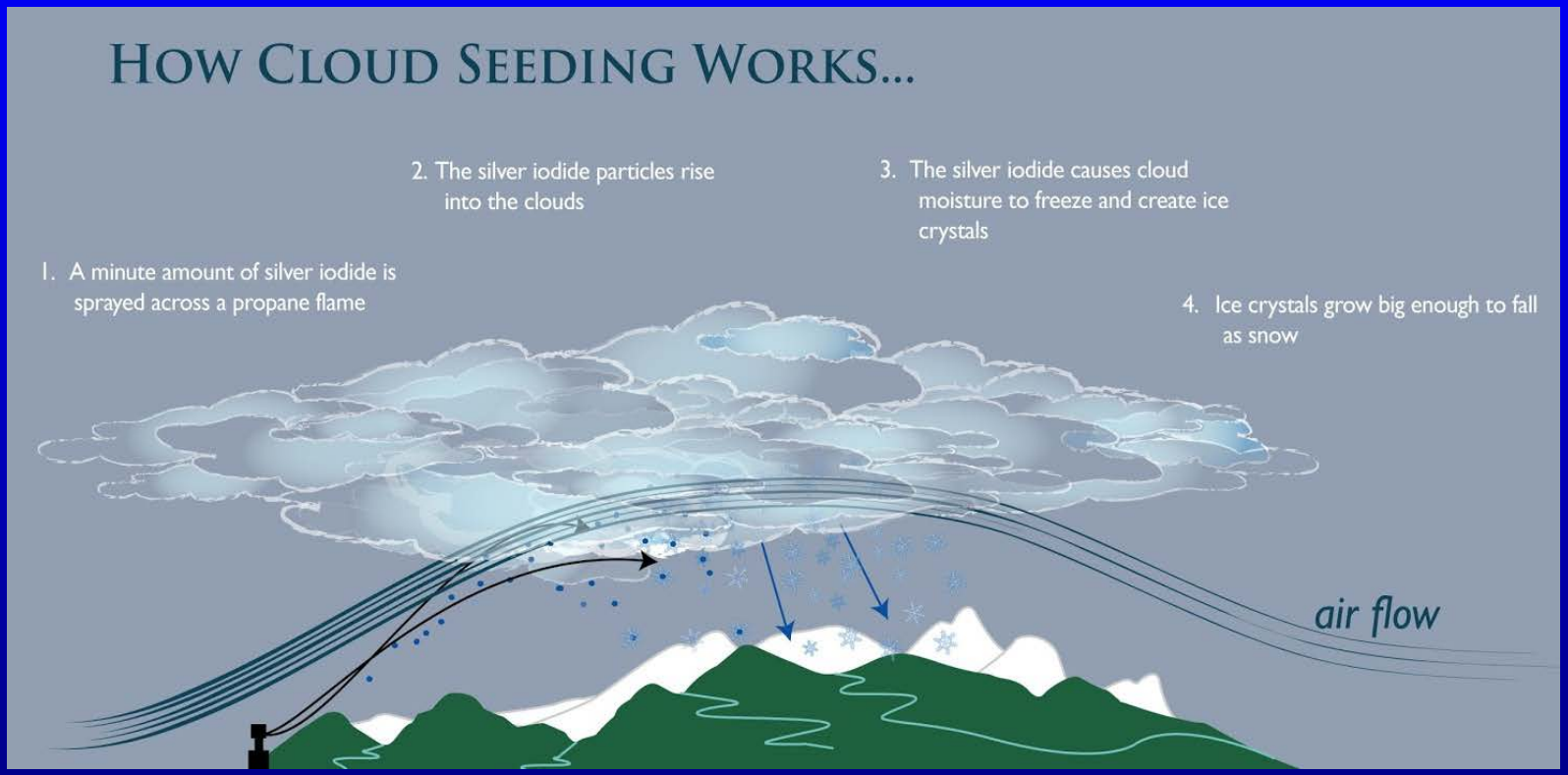
SOURCE: USBR UPPER COLORADO REGION

LEVELS AS OF 3/25/2018

Lake Powell

26 MAF active capacity **54% full**

Augmentation (weather modification)



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Cooperative Demand Management

- Creating an arsenal of flexible approaches ~
  - to reduce risk of shortages
  - to protect historical water uses

Cooperative Demand Management

Lower Basin:

- **Increasingly reduced deliveries from Lake Mead as water level drops.**

Upper Basin

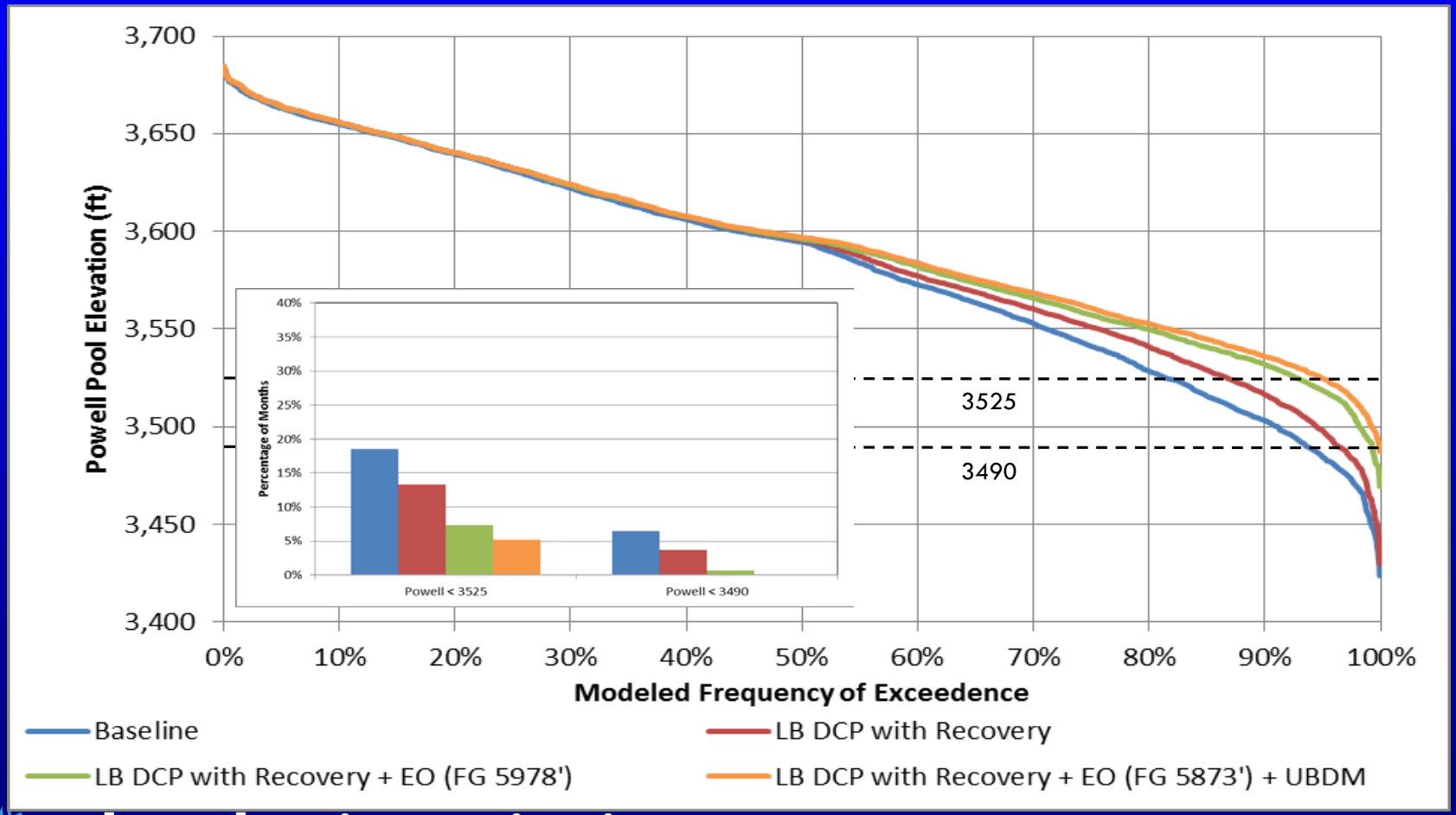
- **Reducing Consumptive Use**
  - **Agriculture**
  - **Municipal & Industrial**
  - **Trans-mountain Diversions**

Lower basin DCP Conservation schedule

Lake Mead Elevation	AZ (2007)	AZ (Plan)	AZ Total	NV (2007)	NV (Plan)	NV Total	CA (2007)	CA (Plan)	CA Total	USBR	Mexico Minute 319*	Total
1,090-1,075	0	192,000	192,000	0	8,000	8,000	0	0	0	100,000	0	300,000
1,075-1,050	320,000	192,000	512,000	13,000	8,000	21,000	0	0	0	100,000	50,000	683,000
1,050-1,045	400,000	192,000	592,000	17,000	8,000	25,000	0	0	0	100,000	70,000	787,000
1,045-1,040	400,000	240,000	640,000	17,000	10,000	27,000	0	200,000	200000	100,000	70,000	1,037,000
1,040-1,035	400,000	240,000	640,000	17,000	10,000	27,000	0	250,000	250000	100,000	70,000	1,087,000
1,035-1,030	400,000	240,000	640,000	17,000	10,000	27,000	0	300,000	300000	100,000	70,000	1,137,000
1,030-1,025	400,000	240,000	640,000	17,000	10,000	27,000	0	350,000	350000	100,000	70,000	1,187,000
<1,025	480,000	240,000	720,000	20,000	10,000	30,000	0	350,000	350000	100,000	125,000	1,325,000

DCP Outcomes

- Powell and Mead are operationally coupled through the ‘07 Guidelines
- Neither Basin can completely mitigate its own risk: The best solutions require participation by both Upper and Lower Basins.



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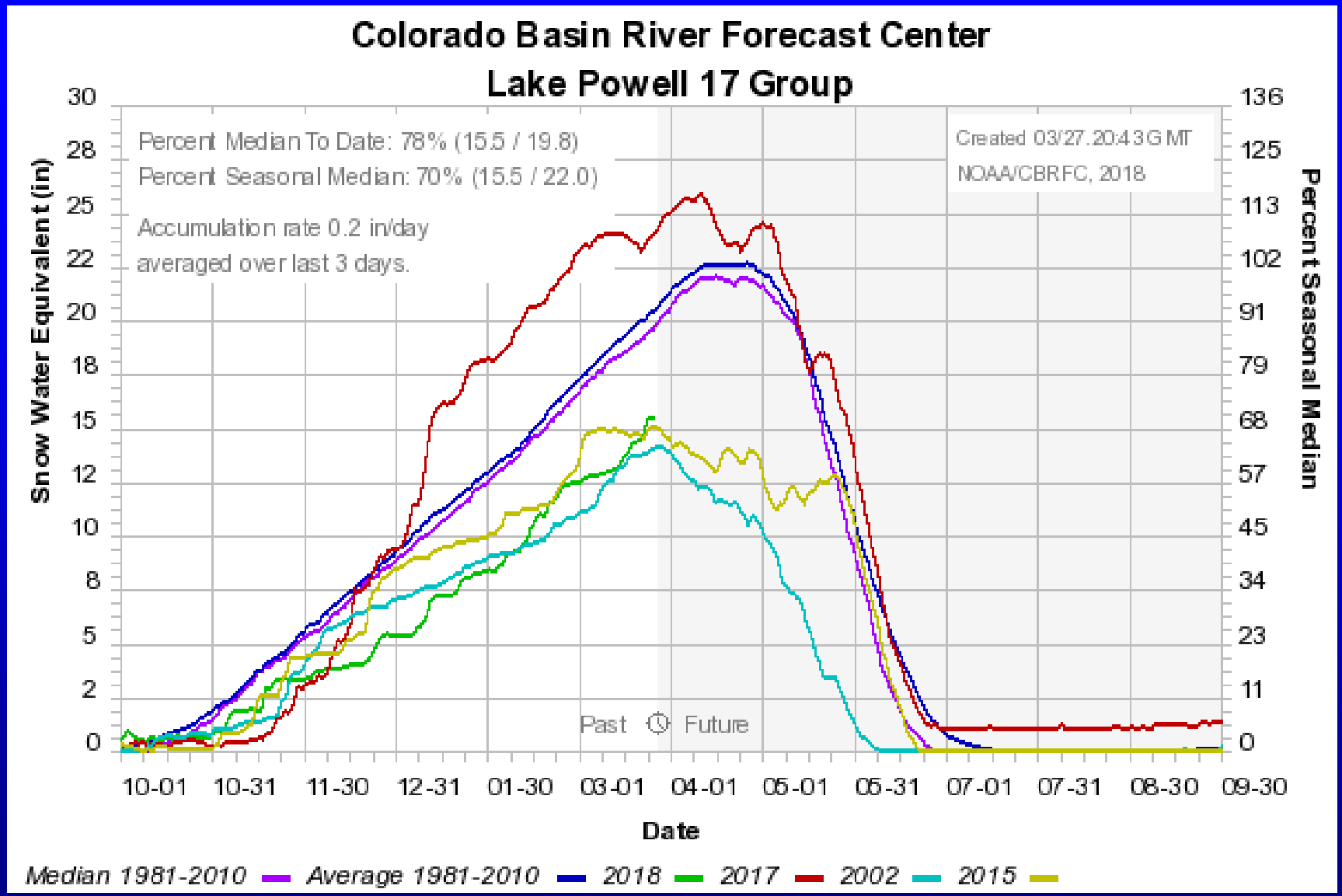
Preliminary Results – Not for Distribution



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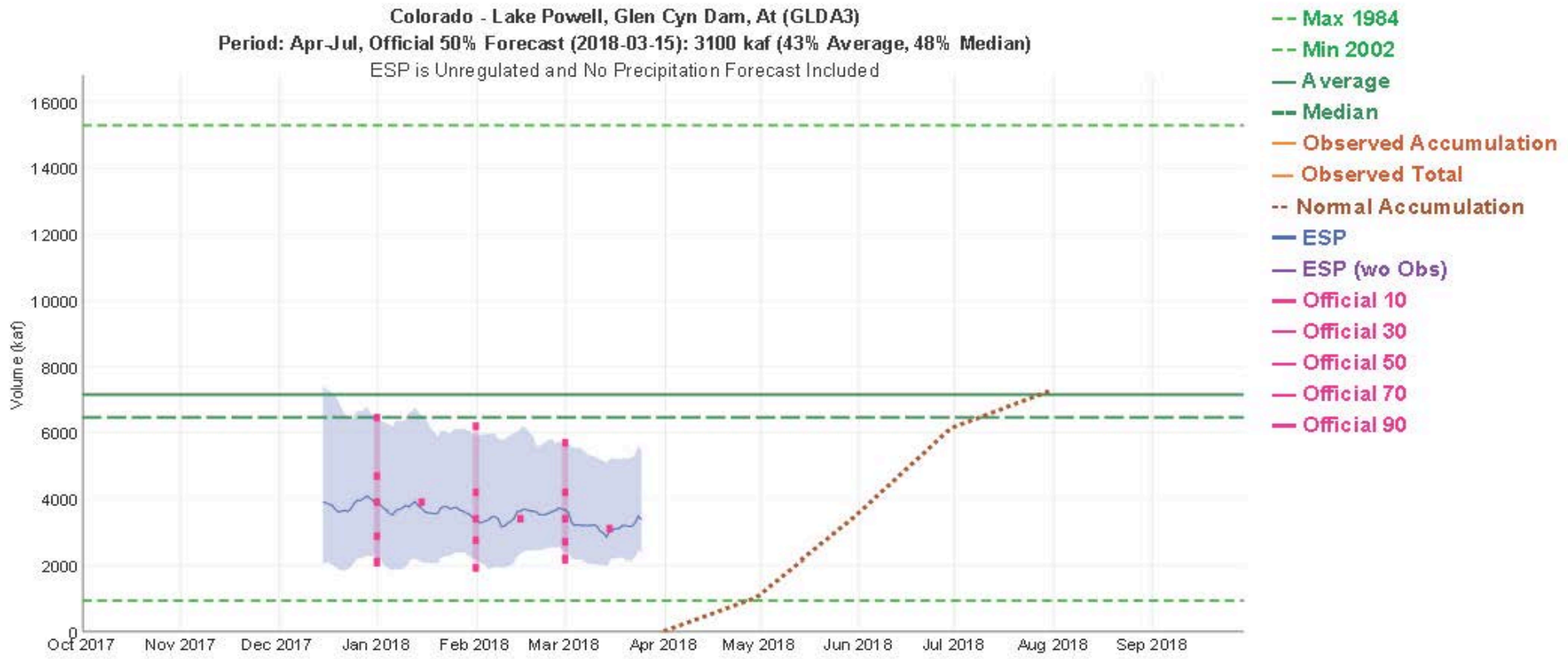
Water Supply Forecast



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