COLORADO
Water Conservation Board
Department of Natural Resources

Colorado Hazard Mapping Program (CHAMP) Lessons Learned

Colorado Water Conservation Board (CWCB)
Thuy Patton
June 19, 2018

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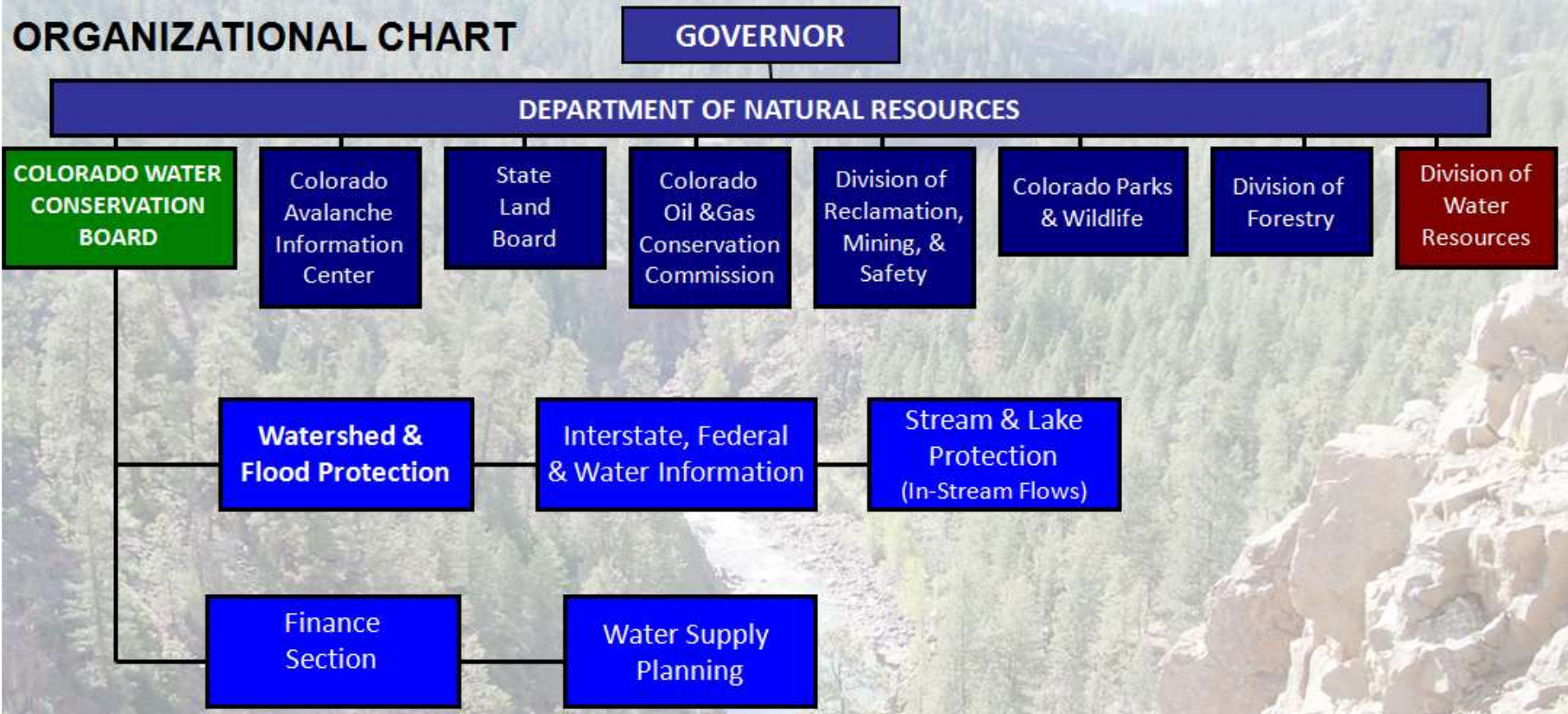
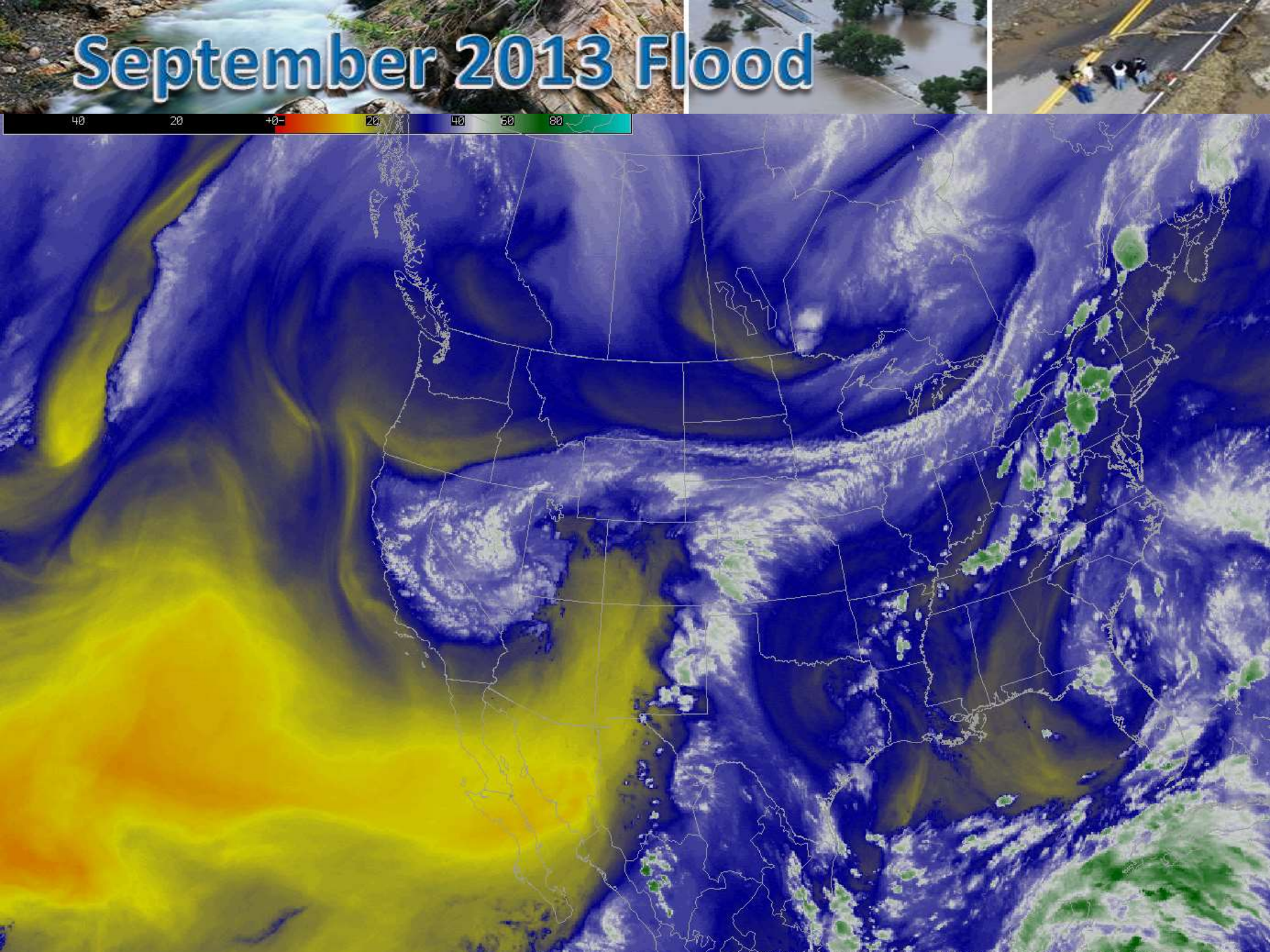
- Agency/CHAMP Background
- Lessons Learned
  - Early Planning Efforts
    - CO Recovery Office - Stream Team
    - LiDAR acquisition
    - Regional hydrology
  - Communication
    - Multiple Stakeholders/Recovery Efforts
    - Outreach and Early Public Engagement
    - Messaging
  - Technical
    - FEMA and Local Review Processes
    - 2D Models
- Conclusion
- Q&A

ORGANIZATIONAL CHART



"To Conserve, Develop, Protect and Manage Colorado's Water for Present and Future Generations"

http://cwcb.state.co.us


September 2013 Flood
40
20
+0-
20
40
60
80

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Highway Washouts in Estes Park
Photo from Twitter by @KDVR

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Their former home site – nothing left
- Courtesy of Dave Rosenberg

Senate Bill 15-245

NOTE: The governor signed this measure on 5/1/2015.

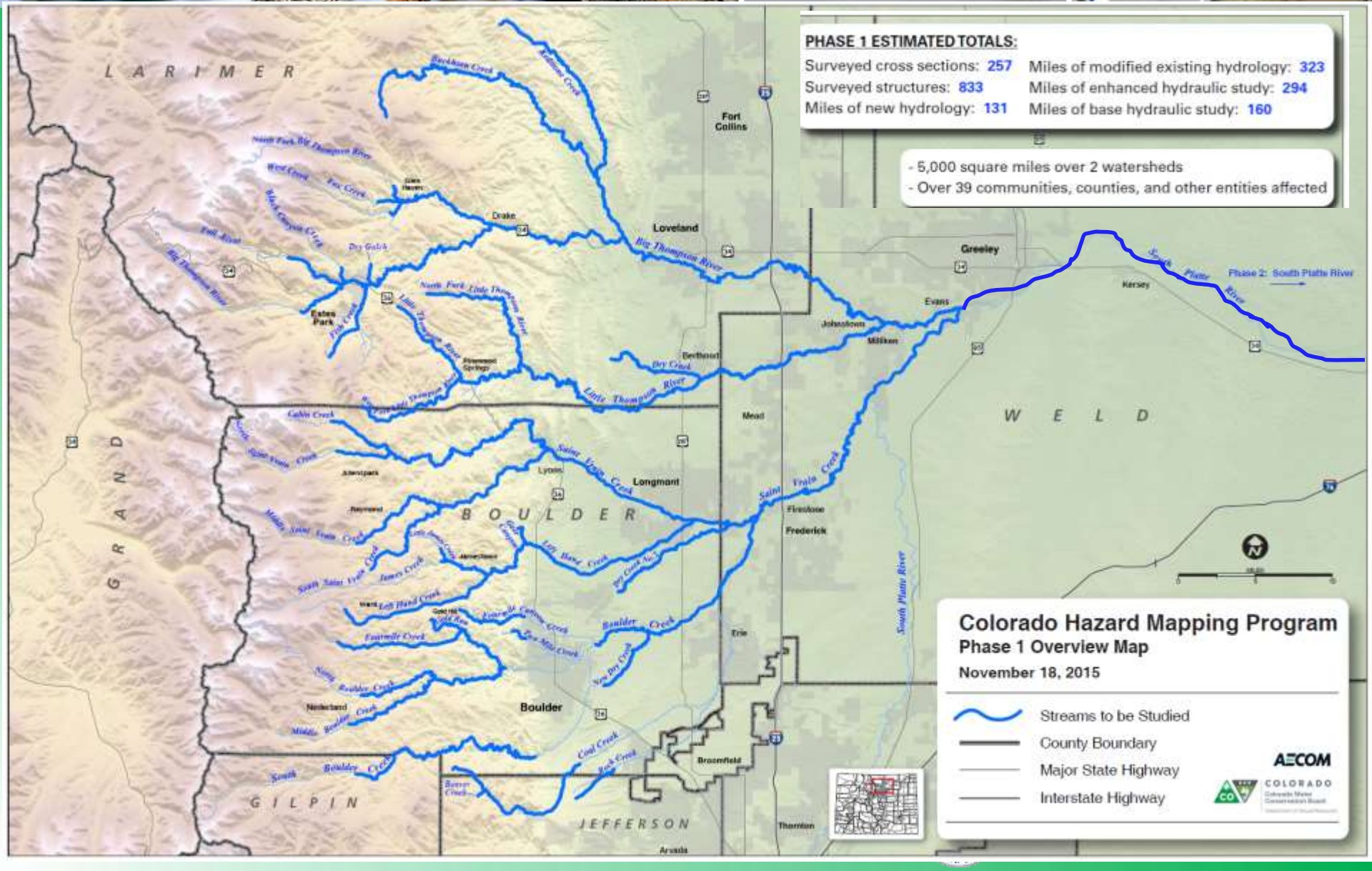
Table 2. Natural Hazard Mapping - Three-Year Estimated Costs.	
Floodplain Mapping Update	$4,465,000
Floodplain Map Digitization	750,000
Erosion Zone Mapping	700,000
Project Management	400,000
Data Collection	555,000
TOTAL	**$6,870,000**

SENATE BILL 15-245

BY SENATOR(S) Grantham, Steadman, Lambert, Cooke, Garcia, Heath, Jones, Kefalas, Kerr, Martinez Humenik, Merrifield, Newell, Roberts, Todd, Cadman;
also REPRESENTATIVE(S) Young, Hamner, Rankin, Becker K., DelGrosso, Fields, Foote, Garnett, Ginal, Kraft-Tharp, Lontine, Melton, Mitsch Bush, Pettersen, Rosenthal, Ryden, Singer, Williams, Hullinghorst.

CONCERNING THE PROVISION OF STATE FUNDING FOR NATURAL HAZARD MAPPING.

CHAMP PHASE 1 & 2



PHASE 1 ESTIMATED TOTALS:

Surveyed cross sections: 257	Miles of modified existing hydrology: 323
Surveyed structures: 833	Miles of enhanced hydraulic study: 294
Miles of new hydrology: 131	Miles of base hydraulic study: 160

- 5,000 square miles over 2 watersheds
- Over 39 communities, counties, and other entities affected

Colorado Hazard Mapping Program

Phase 1 Overview Map

November 18, 2015

- Streams to be Studied
- County Boundary
- Major State Highway
- Interstate Highway

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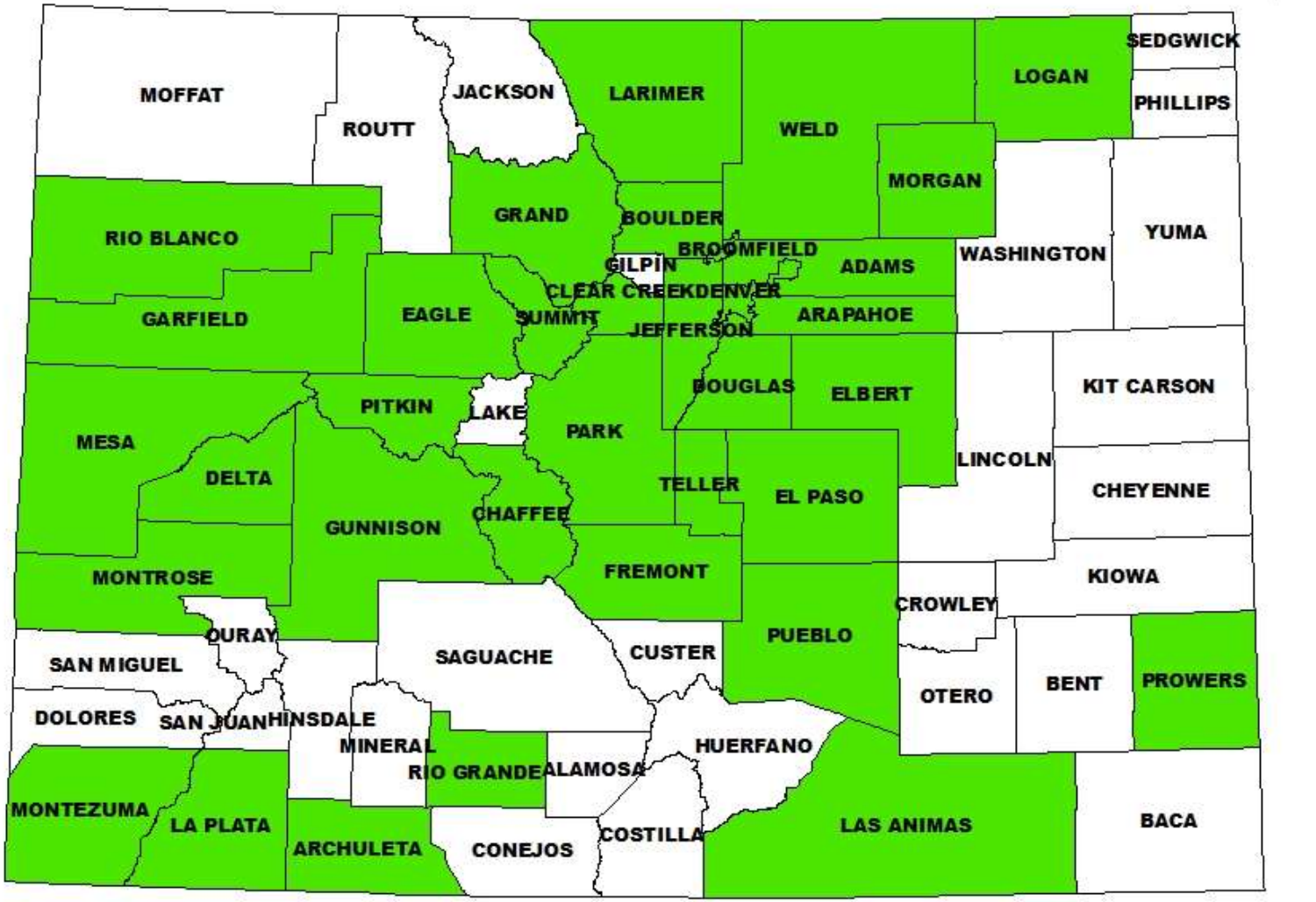
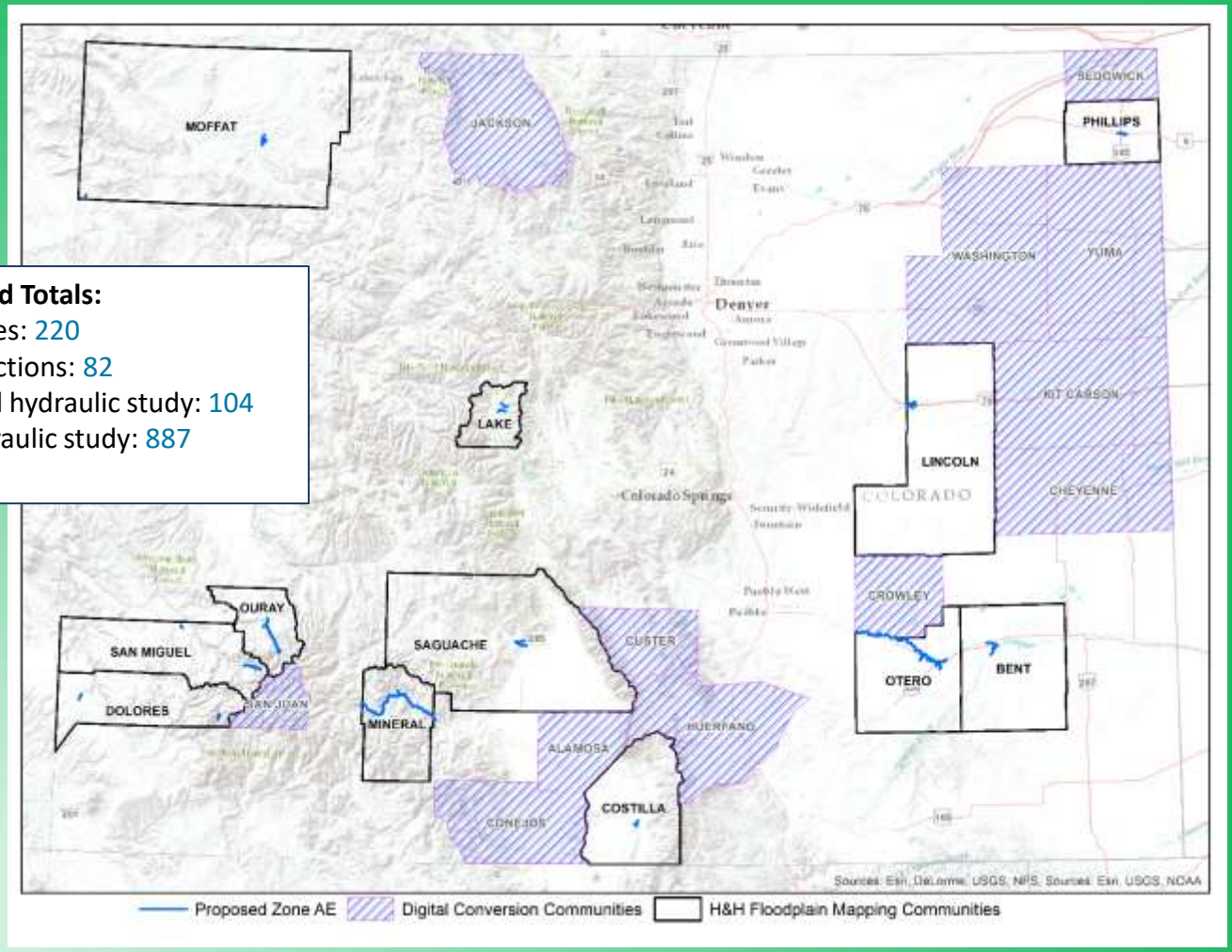
MODERNIZED VS. UNMODERNIZED



Phase III Estimated Totals:
Surveyed structures: 220
Surveyed cross-sections: 82
Miles of enhanced hydraulic study: 104
Miles of base hydraulic study: 887



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EARLY PLANNING EFFORTS

COLORADO STREAM RECOVERY – "STREAM TEAM" STEERING COMMITTEE

US Army Corps of Engineers

COLORADO Colorado Water Conservation Board Department of Natural Resources

COLORADO Geological Survey

Colorado Division of Water Resources Department of Natural Resources

COLORADO Department of Transportation

FEMA

COLORADO Department of Public Health & Environment

COLORADO Division of Homeland Security & Emergency Management Department of Public Safety

COLORADO Department of Local Affairs

USGS science for a changing world

NRCS

wood.

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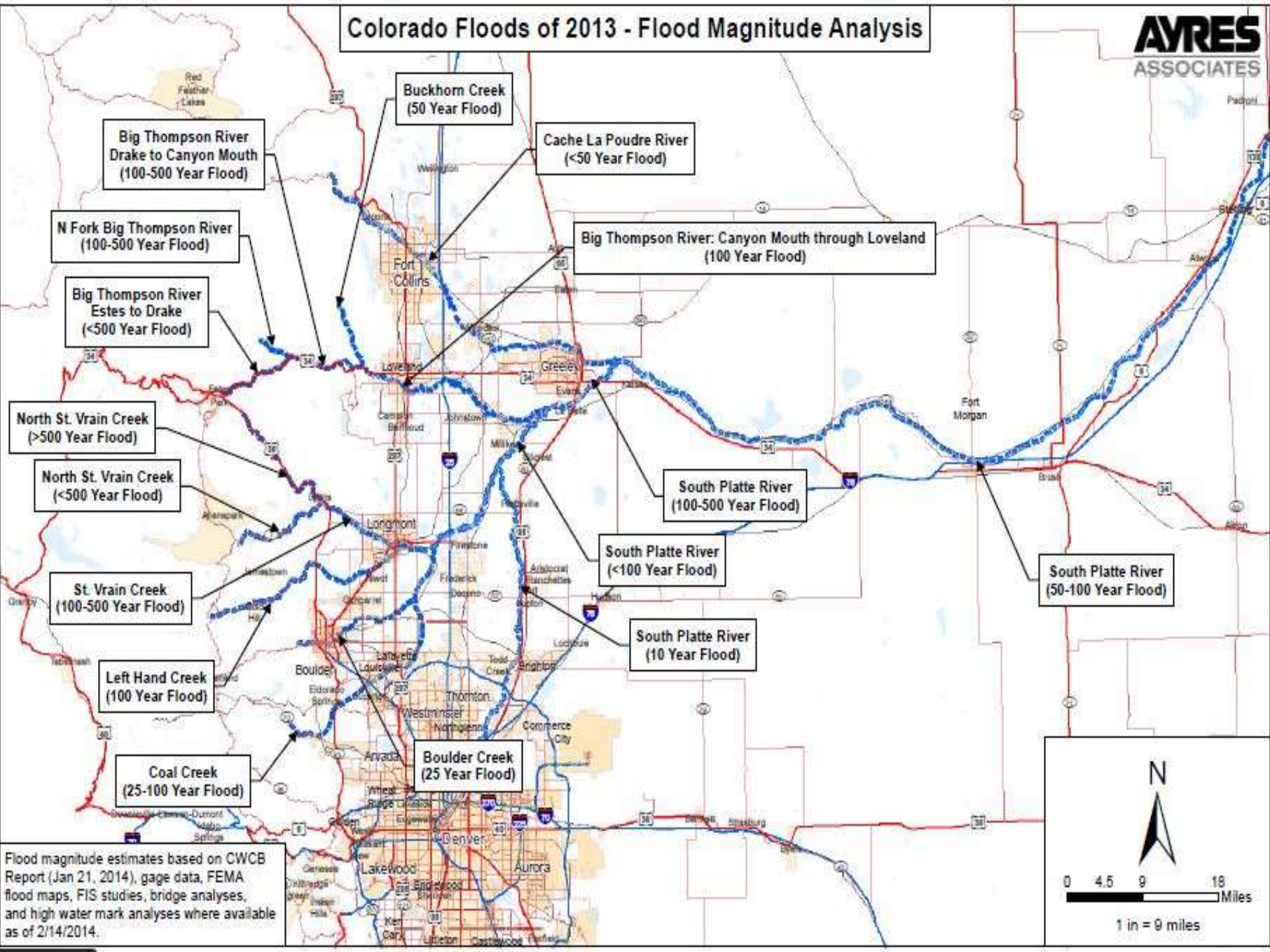
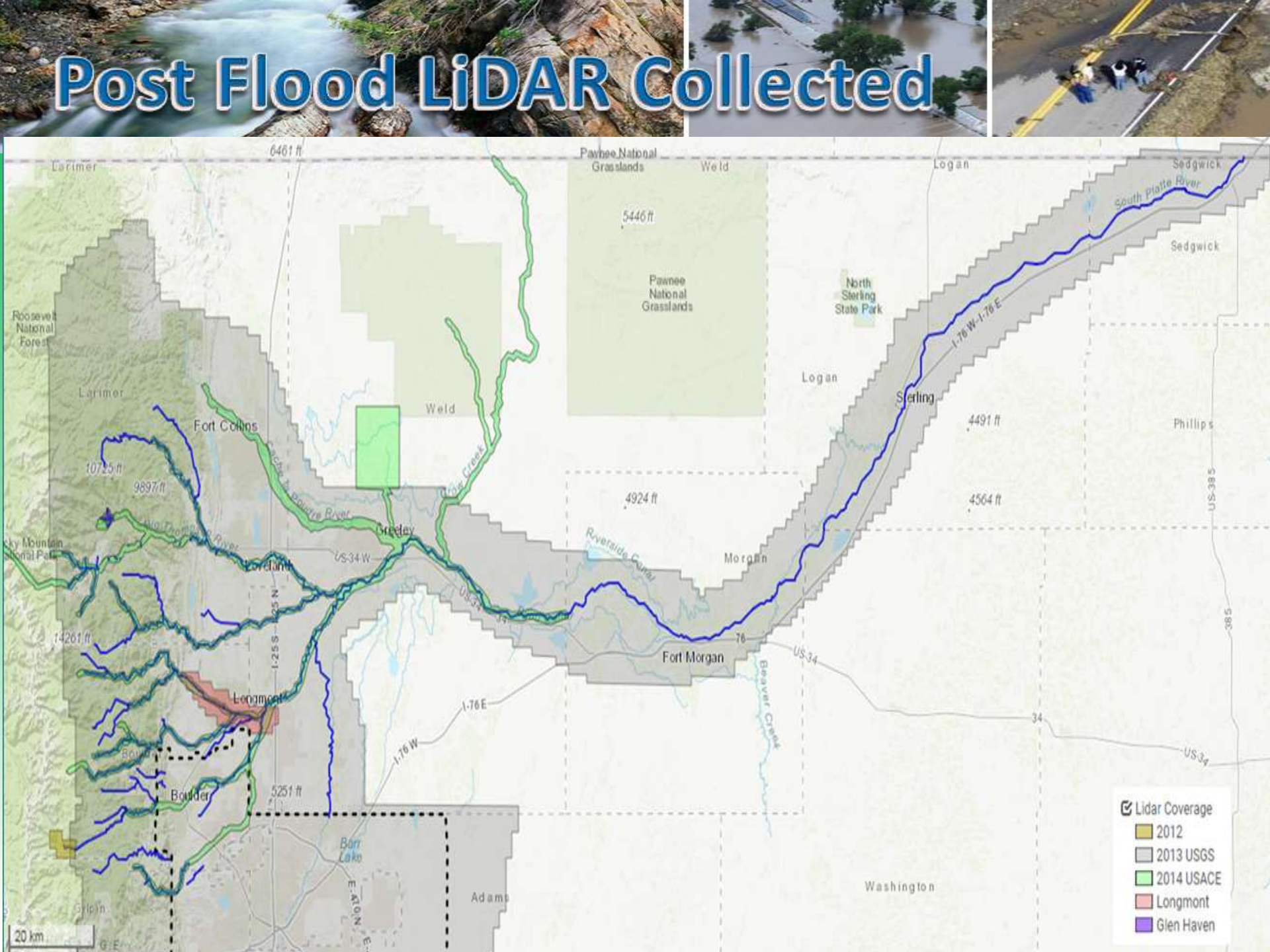
FEMA

AECOM

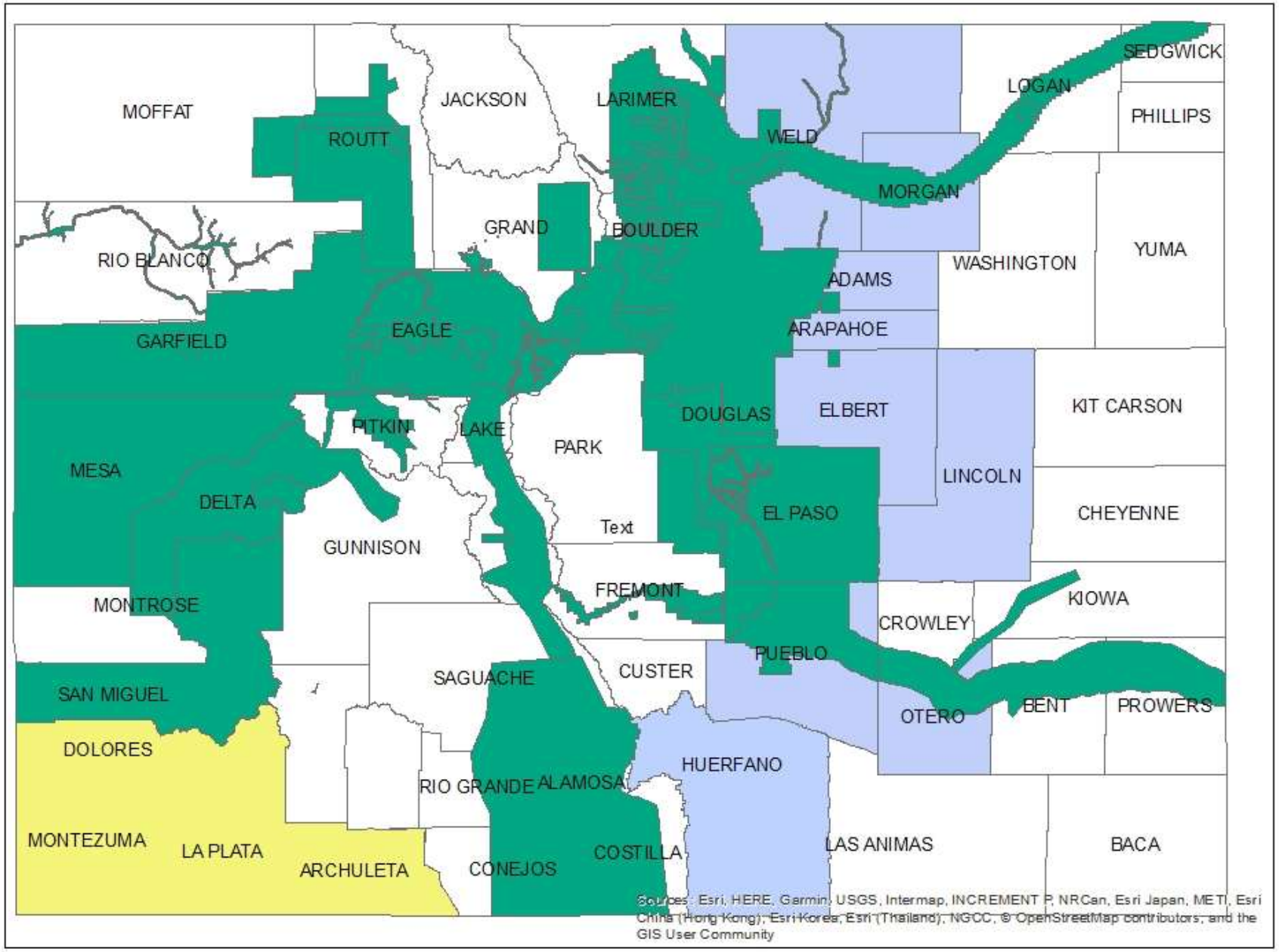
Colorado Floods of 2013 - Flood Magnitude Analysis



Flood magnitude estimates based on CWCB Report (Jan 21, 2014), gage data, FEMA flood maps, FIS studies, bridge analyses, and high water mark analyses where available as of 2/14/2014.


Post Flood LiDAR Collected
6461 ft
Larimer
Pawnee National Grasslands
Weld
Logan
Sedgwick
South Platte River
5446 ft
Pawnee National Grasslands
North Sterling State Park
Roosevelt National Forest
Larimer
Logan
Sterling
I-76 W-I-76 E
Sedgwick
Weld
Fort Collins
10725 ft
9897 ft
Cache la Poudre River
Big Thompson River
Crow Creek
4924 ft
4491 ft
Phillips
4564 ft
US-385
Greeley
Loveland
US-34 W
Riverside Canal
Morgan
14261 ft
Fort Morgan
US-34
Beaver Creek
Longmont
I-76 E
I-76 W
34
US-34
Boulder
5251 ft
Barr Lake
Adams
Washington
Griffin
E-470
20 km
Lidar Coverage
2012
2013 USGS
2014 USACE
Longmont
Glen Haven

Current and Proposed LiDAR in CO - June 2018





COMMUNICATION

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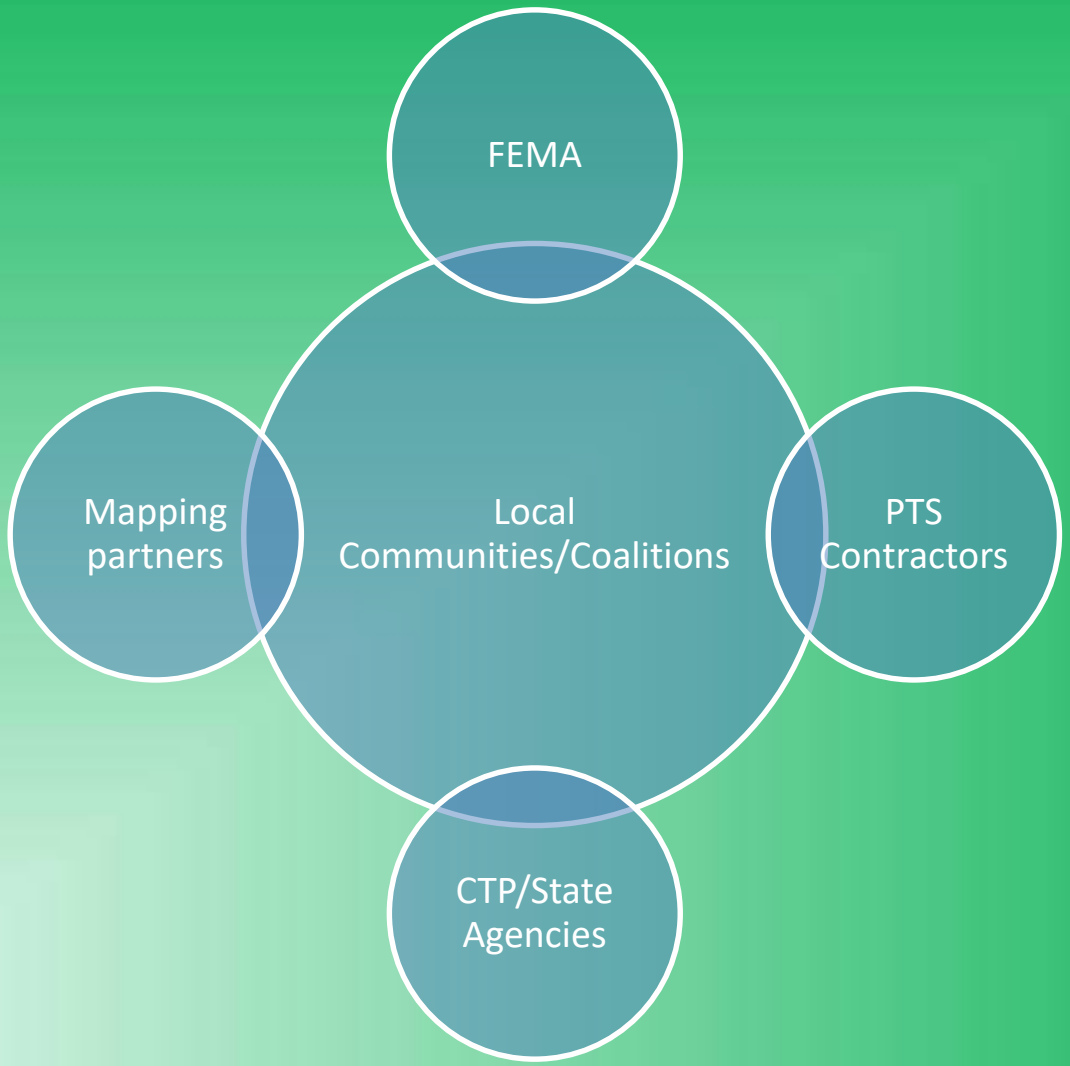
"And you want to achieve resiliency too?"

Early engagement

Early outreach meeting – local homeowner provided photos and video.
Added additional cross section and refined the delineation.

Partnerships



Documentation

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

1313 Sherman Street, Room 721
Denver, CO 80203

Sample survey memo

May 9, 2017

TO: Colorado Property Owners

After extensive flooding in Colorado in September 2013, the state established the Colorado Recovery Office to manage state and local response to the floods, including long-term planning and resiliency efforts. As part of these efforts, the Floodplain Management Subcommittee recommended a hazard mapping project that would reflect actual, updated conditions in Colorado and provide a framework for land use and other decision-making in areas likely to be affected by future flooding, erosion, and debris flow events. The recommended hazard mapping project would update floodplain mapping in certain watersheds most affected by the September 2013 flooding. The Colorado Water Conservation Board (CWCB) is the lead agency coordinating these updates and the mapping contractor working with the CWCB is AECOM, a well-qualified, nationally recognized engineering firm with expertise in floodplain mapping to conduct the field surveys and remote sensed measurements of structures in and near the floodplains in your community. The State has been in contact with your county and municipal officials to inform them of this project and to obtain their input regarding past flooding in your community.

While surveying, surveyors defined above will make every effort to stay on public lands and right of ways. It may be necessary, however, for the surveyors to enter your property for short periods of time. Should this occur, an employee from AECOM or an employee of the state will make a bona fide, good faith attempt to contact you in advance to seek permission. The surveyors will respect your property and will not interfere with your use of it. Upon request, the surveyors will identify themselves by driver's license or state identification and this letter of introduction from the CWCB.

If you have any questions or comments, please feel free to contact me at (303) 866-3441 ext 3230. If you know of affected individuals who have not received this notice, please let us know. Thank you for your cooperation.

Sincerely,

Thuy Patton

Thuy Patton
Floodplain Mapping Coordinator

P 303.866.3441 F 303.866.4474 www.cwcb.state.co.us
John W. Hickenlooper, Governor | Bob Randall, DNR Director | Lauren Ris, CWCB Acting Director

FACT SHEET/STUDY MEMO

Project Name:	Colorado Hazard Mapping Program – Phase 1		
Regarding:	Coordination of Project Scope	*Date:*	August 13, 2015
Community	City of Boulder in Boulder County		
Community Contact(s)	[redacted]		
Project Contacts:	[redacted]		

This memo documents the Colorado Water Conservation Board (CWCB) is coordinating with the appropriate community contacts regarding the scope and methodology of the Colorado Hazard Mapping Program (Project). The Project will take multiple years to complete, so it is important to have a record of this coordination. This memo serves to show the communities have reviewed and agree with the study methodology by signing at the bottom, and is for documentation purposes only. A summary of the Project is described below.

Project Objective

The Project involves conducting new flood hazard analyses and special flood hazard area delineations for streams particularly affected by the September 2013 flood event in the St. Vrain and Big Thompson HUC-8 watersheds (IDs 10190005 and 10190006, respectively). The resulting products and deliverables are expected to form the basis for a subsequent regulatory update for all studied streams under the Federal Emergency Management Agency's (FEMA's) Risk Mapping, Assessment, and Planning (MAP) Program. This regulatory update is not scoped or funded at this time. Throughout this process, CWCB and their consultant, AECOM, plan to coordinate with Federal, State, and local government entities as well as other relevant stakeholders to collaborate on project efforts, increase flood awareness, and assist in identifying risk mitigation actions.

General Project Approach

The following methodology will be applied to studying the selected streams in the St. Vrain and Big Thompson watersheds, except where deviations are specifically noted in the community-specific section below. All studies will be conducted using FEMA's applicable Guidelines and Standards for Flood Hazard Mapping. Project activities, including field surveys, will commence in the summer of 2015, except for reaches that will be studied starting in the fall of 2016 due to ongoing construction and recovery efforts.

The project tasks vary based on the study level of each stream. The scoped streams and their study levels are shown on the enclosed Scoping Map. Enhanced Level studies include survey and field reconnaissance and will eventually result in special flood hazard area delineations with plotted base flood elevations and regulatory floodways. Base Level studies do not incorporate field reconnaissance or survey data, rely exclusively on topographic data for terrain information, and will eventually result in model-backed special flood hazard areas without plotted base flood elevations. The Project tasks generally include the following sequence:

- Field Survey and Reconnaissance – Task will include the following for enhanced reaches (base level studied reaches are not surveyed):
  - Documenting the condition and types of hydraulic structures, such as bridges and culverts, and estimating associated parameters to include Manning coefficients
  - Surveying structure dimensions and adjacent cross sections
  - Surveying the channel and special flood hazard areas along cross sections spaced approximately 2,000 to 3,000 feet apart in the plains and mountains, respectively, where structure spacing allows
- Topographic Data – Task will include generating terrain models using topographic data from:
  - USACE 2014 LiDAR where available, collected in October 2014
  - USGS 2013 LiDAR elsewhere, collected from October 2013 through January 2014
- Hydrology – Task will include:
  - Using CDOT post flood hydrologic analyses where available and modifying it to include the "1% plus" and 4% flow rates per FEMA specifications
  - Calculating new peak flood flows for the 10%, 4%, 2%, 1%, "1% plus" and 0.2% annual chance events for streams not included in the CDOT post-flood hydrology analyses

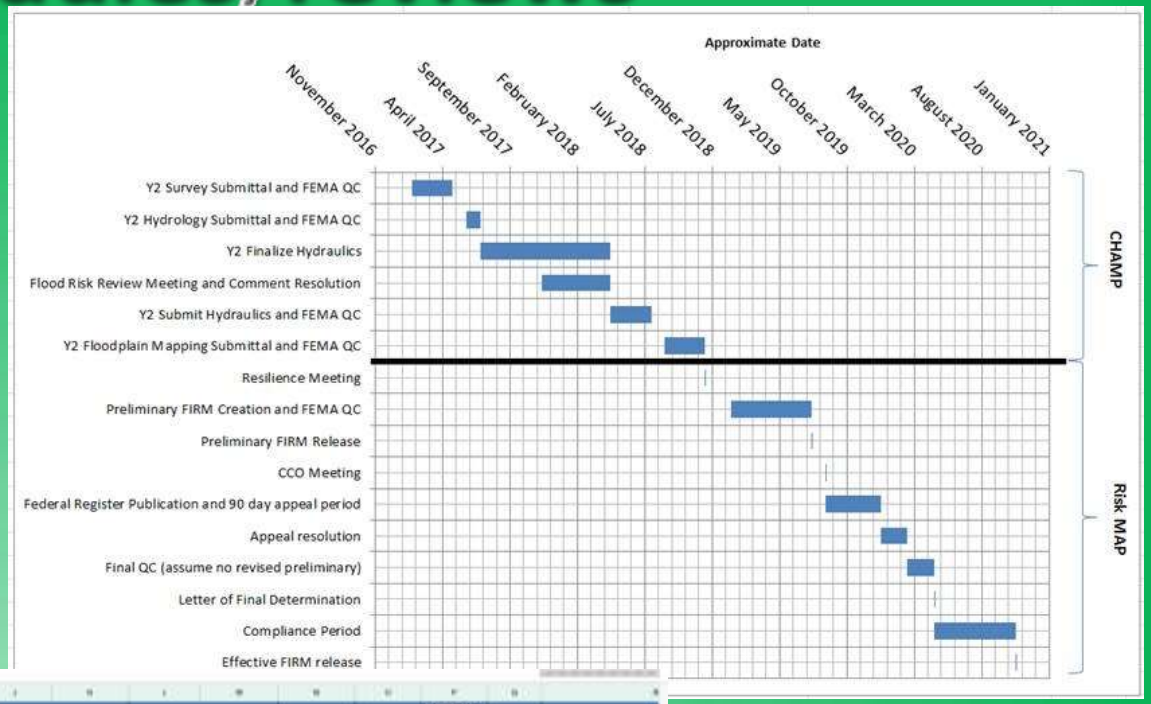
Crafting the Message

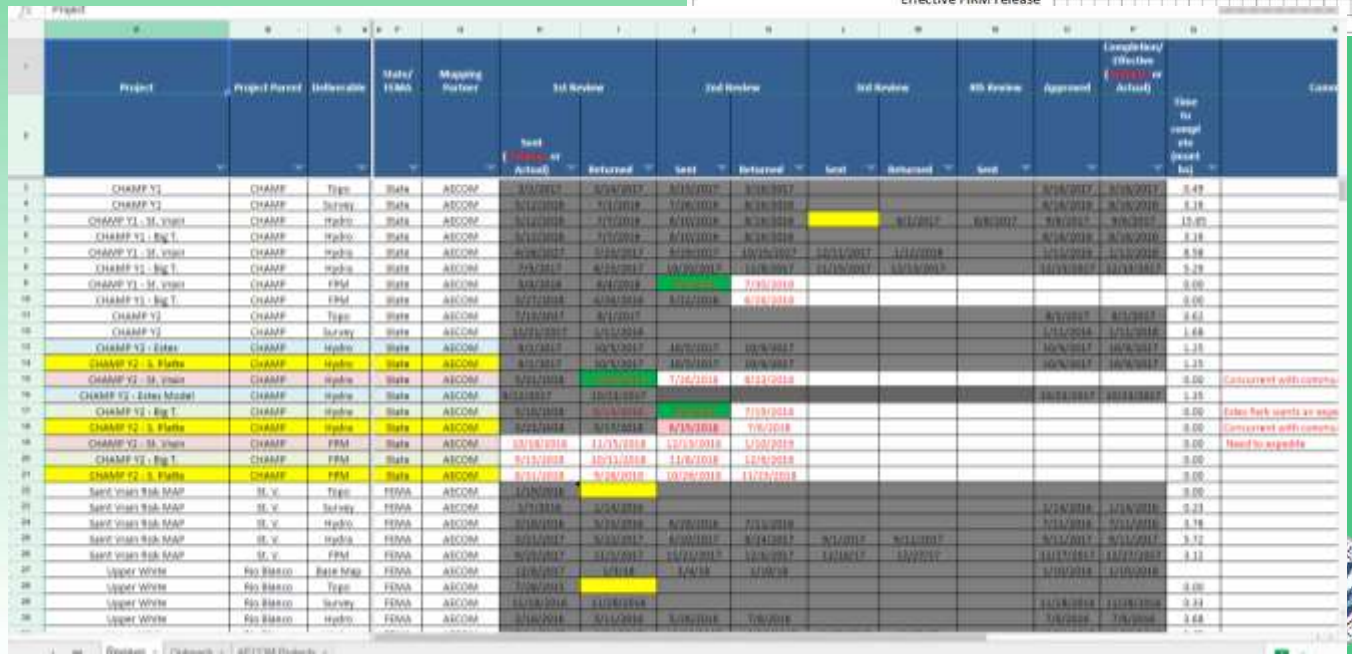
- Re-State their concerns and how you have addressed them
- Remember what you are being judged against… the last big flood
  - How do your design floods compare to the flood of record in the project area?
  - How can you use this to help them understand the proposed project?
- Say what you know
  - Engineers have a tendency to qualify their answers to the point that they bring confusion and – in some instances – distrust (“he/she won’t give us a straight answer”)



TECHNICAL

Various schedules/reviews





FEMA AECOM

2D Mo

- Limited guic
  developmer
  floodways
- Current regu
  floodplain s
  setup for 1D
- Software ca
  expensive
- Less univers
  understood
  difficult to n
  use 2D resu

AECOM

Technical Memorandum

To:	Thuy Patton, Colorado Water Conservation Board (CWCB) Floodplain Mapping Coordinator and Corey Elliott, CWCB Hazard Mapping Coordinator		
From:	Rigel Rucker, Deputy Project Manager and Tom Wright, 2D Hydraulics		
Date:	January 25, 2017 – Revised May 1, 2017		
Project Title:	Colorado Hazard Mapping Program (CHAMP)	**Project Number:**	60436665
Subject:	Calculating 2-Dimensional (2D) Floodways for Use on Regulatory Flood Insurance Rate Maps (FIRMs) and Flood Insurance Studies (FIS)		

Overview

An approach is needed to develop floodways for new studies using 2D models, unsteady flow models, or mixed 1-Dimensional (1D)/2D models (all generally referred to as unsteady flow models in this document). This document outlines a suggested procedure that can create reproducible results in these situations.

Although 2D model use is not new, its use has only become more frequent recently, especially with the release of HEC-RAS 5.0, which includes 2D capabilities at no cost, which are supported and continuously updated by the Army Corps of Engineers' Hydraulic Engineering Center. HEC-RAS has been the primary software tool used for the nation's floodplain mapping efforts since its release in 1997. Current guidance and procedures related to floodways were created for, and are more applicable to 1D steady state flow modeling. Ideally, the following options should be considered in order to comply with existing guidance, where appropriate:

1. Remove floodways from FIRMs where 2D analyses are conducted. Communities would then be required to manage development by maintaining models, or requiring developers to do so and verify that a cumulative surcharge in the floodplain is not resulting from new development.
2. Develop a procedure to generate floodways in 1D, 1D/2D or 2D unsteady flow models.
3. Develop and calibrate a steady state 1D model using the results of the 2D model that can then be used to generate a floodway. The 2D model will then become backup information for the regulatory model.

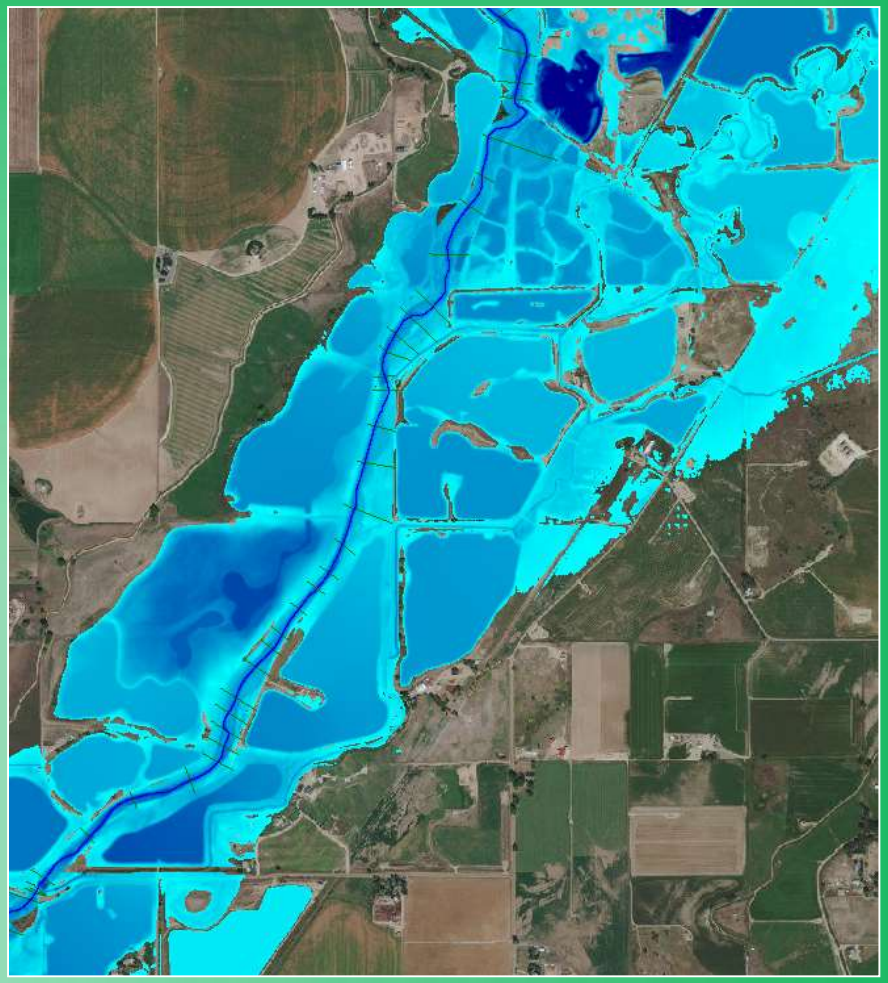
Option 1 can be costly and prohibitive for communities that lack resources. Option 3 requires use and maintenance of multiple models; changes in the floodplain would require reconsidering the effects of future encroachments, which is not efficient, confusing to the end user, and time consuming/costly. Potential disputes through the review and approval cycle as to what constitutes a calibrated 1D model could also arise and this memo does not attempt to address that definition. In addition for Option 3, a floodway would be developed on a separate steady state 1D model that does not include the detail or results that were included in the original 2D model. In other words, the 1D floodway would not necessarily be reflective of what would be calculated for a floodway in a 2D model.

For CHAMP, it has been determined that floodways should be produced on all streams. For this reason and the reasons above, this document will focus on Option 2. It should be noted that the other options should be considered, in order (1 to 3), especially if Option 2 does not produce appropriate results. It is also recommended that additional consideration be given to determining a more cost-effective, efficient way to maintain floodways in real time and/or developing guidance based on new technology. This would likely entail discussion with FEMA about modification of standards, use of an available grid system that can be modified to determine impacts based on development, updated tools from software developers, and/or development of accepted guidance and tools to help make the revised floodway procedure more efficient.

CO DNR

MA AECOM

Best available information



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Take Aways

- Success is not by Accident
- Opinions can change
- Set realistic goals
- Adapt and collaborate
- Establish Partnerships
- Community Resiliency

THANK YOU!

Thuy Patton

Colorado Water Conservation Board

Thuy.patton@state.co.us

303-866-3441 ext. 3230

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