

**DEPARTMENT OF NATURAL RESOURCES  
COLORADO WATER CONSERVATION BOARD**

**2010 PROPOSED RULES AND REGULATIONS  
FOR REGULATORY FLOODPLAINS  
IN COLORADO**

**COST, BENEFIT AND  
REGULATORY ANALYSIS**

**October 14, 2010**



**2010 PROPOSED CHANGES FLOODPLAIN RULES  
COST, BENEFIT AND REGULATORY ANALYSIS**

**Table of Contents**

|  | <b>Page No.</b> |
|--|-----------------|
| 1. Introduction.....                                     | 1               |
| 1.1 Purpose.....   | 1               |
| 1.2 Draft Rules .....                                    | 1               |
| 1.3 Statutory Requirements For Rulemaking.....           | 3               |
| 1.4 Contents.....  | 3               |
| 1.5 Affected Parties.....                                | 3               |
| 1.6 Draft Rules Studied .....                            | 4               |
| 2. Background Reference Material .....                   | 5               |
| 2.1 Introduction .....                                   | 5               |
| 2.1.1 Need For Cost-Benefit And Regulatory Analysis..... | 5               |
| 2.1.2 CWCB BCA Focus Group.....                          | 5               |
| 2.2 Need For Higher Standards.....                       | 6               |
| 2.2.1 Concept of “No Adverse Impact” .....               | 7               |
| 2.2.2 Status of Other States .....                       | 10              |
| 2.2.3 Status of Colorado.....                            | 11              |
| 2.3 Benefit Cost History.....                            | 12              |
| 2.3.1 BCA Essential Elements.....                        | 14              |
| 2.3.2 Benefits .....                                     | 20              |
| 2.3.3 Benefits Studied .....                             | 25              |
| 2.3.4 Costs.....   | 26              |
| 2.3.5 Discount Rate.....                                 | 29              |
| 2.4 Colorado At A Glance.....                            | 30              |
| 3. Methodology: .....                                    | 32              |
| 3.1 Introduction .....                                   | 32              |
| 3.2 Qualitative Analysis .....                           | 32              |
| 3.2.1 Background .....                                   | 32              |
| 3.2.2 Schematics.....                                    | 32              |
| 3.2.3 Proposed Rules vs. Existing Rules .....            | 39              |
| 3.3 Quantitative Analysis.....                           | 40              |
| 3.3.1 FEMA BCA Tool .....                                | 40              |
| 3.3.2 Input Data.....                                    | 41              |
| 3.3.3 Discount Rate .....                                | 41              |
| 3.3.4 Project Life (Duration).....                       | 41              |
| 3.3.5 Depth Damage Curves .....                          | 41              |
| 3.3.6 Sample Structures .....                            | 41              |
| 3.3.7 Building Replacement Values .....                  | 42              |
| 3.3.8 Costs .....  | 42              |
| 3.3.9 Concurrent Implementation.....                     | 44              |
| 3.4 Sample Reach Analysis.....                           | 45              |
| 3.4.1 Introduction.....                                  | 45              |
| 3.4.2 Data Collection .....                              | 45              |
| 3.4.3 Method .....                                       | 45              |
| 3.4.4 Limitations .....                                  | 48              |

|  |    |
|--|----|
| 4. Summary: Cost, Benefit, and Regulatory Analysis ..... | 50 |
| 4.1 Synopsis of Unit Analysis .....                      | 50 |
| 4.2 Synopsis of Sample Reach .....                       | 51 |
| 4.3 Conclusions.....                                     | 53 |

**Appendices**

- A. DORA Criteria: Rule Cost Benefit and Regulatory Analysis
  - A.1 Rule 6
  - A.2 Rule 8
  - A.3 Rule 11
- B. Cost Benefit Computations
- C. Proposed Rules and Regulations (Dated September 30, 2010)
- D. ASFPM Whitepaper: Higher Regulatory Standards

| <b>Guide To Acronyms</b> |  |
|--------------------------|--|
| <b>Abbreviation</b>      | <b>Meaning</b>   |
| ASFPM                    | Association of State Flood Plain Managers                  |
| BCA                      | Benefit Cost Analysis                                      |
| BFE                      | Base Flood Elevation                                       |
| CASFM                    | Colorado Association of Stormwater and Floodplain Managers |
| CBO                      | Congressional Budget Office                                |
| CLOMR                    | Conditional Letter of Map Revision                         |
| CFR                      | Code of Federal Regulations                                |
| CRS                      | Community Rating System                                    |
| CWCB                     | Colorado Water Conservation Board                          |
| DFIRM                    | Digital Flood Insurance Rate Map                           |
| DORA                     | Colorado Department of Regulatory Agencies                 |
| FEMA                     | Federal Emergency Management Agency                        |
| FIA                      | Federal Insurance Administration                           |
| FIMA                     | Flood Insurance and Mitigation Administration              |
| FIRM                     | Flood Insurance Rate Map                                   |
| GAO                      | Government Accountability Office                           |
| GIS                      | Geographical Information Systems                           |
| HAZUS-MH                 | Hazards US Multi-Hazard                                    |
| i                        | Discount Rate  |
| IBC                      | International Building Code                                |
| LID                      | Low Impact Development                                     |
| LOMR                     | Letter of Map Revision                                     |
| n                        | Period of time (years)                                     |
| NAI                      | No Adverse Impact  |
| NCEDR                    | National Center for Environmental Decision-Making Research |
| NFIP                     | National Flood Insurance Program                           |
| OMB                      | Office of Management and Budget                            |
| PW                       | Present Worth  |
| UDFCD                    | Urban Drainage and Flood Control District                  |
| USACE                    | US Army Corps of Engineers                                 |

| <b>Terminology</b>    | <b>Definitions</b>   |
|-----------------------|--|
| 100-year Floodplain   | The area of land susceptible to being inundated as a result of the occurrence of a one-hundred-year flood. This term is synonymous with the term "state regulatory floodplain"   |
| 500-year Floodplain   | An area that has a 0-.2 percent change of flooding in any given year   |
| Community             | Any political subdivision in the state of Colorado that has authority to adopt and enforce floodplain management regulations through zoning, including, but not limited to: cities; towns; unincorporated areas in counties; counties; special districts   |
| Encroachment          | Construction, placement of fill, or similar alteration of topography in the floodplain that reduces the area available to convey floodwaters.  |
| Floodway              | Highest hazard portion of the floodplain where floodwater is likely to be deepest and fastest. It is the area of the floodplain that must be kept free of obstructions to allow floodwaters to move downstream   |
| Freeboard             | The vertical distance in feet above a predicted water surface elevation intended to provide a margin of safety to compensate for unknown factors that could contribute to flood heights greater than the height calculated for a selected size flood such as bridge openings and the hydrological effect of urbanization of the watershed.                           |
| No Adverse Impact     | Where the action of one property owner or community does not adversely affect the flood risks for other properties or communities as measured by increased flood stages, increased flood velocity, increased flows, or the increased potential for erosion and sedimentation, unless the impact is mitigated as provided for in a community or watershed based plan. |
| Regulatory Floodplain | Synonymous with the 100-year, or 1% chance, floodplain., unless a Community has adopted a more stringent regulatory floodplain (e.g. 500-year floodplain)  |

## **1. Introduction**

### **1.1. Purpose**

The State of Colorado considers flooding an issue of statewide concern since it can directly affect public health, safety and welfare. The Colorado statute requires State designation and approval of floodplain information prior to local regulation. To provide consistent mappings standards and outline processes for designation the *Rules and Regulations for Regulatory Floodplains in Colorado* was developed and made effective in 1987. This version of the document remained effective until 2005 when the document was revised. The focus of this first revision was on updating regulatory floodplain mapping activities. This revision focuses on defining the regulatory floodplain and floodway and the development that encroaches on these areas.

The purpose of this document is to provide a summary of the benefits of the CWCB's *Draft Rules and Regulations for Regulatory Floodplains in Colorado*, dated September 2010, as it relates to the statutory requirements for rulemaking. The CWCB's proposed rules aim to reduce flood losses through sound flood protection actions, which are implemented at the local level and supported by State and Federal programs. This memorandum will take a qualitative and quantitative analysis approach to determine and summarize the costs and benefits of the proposed changes.

### **1.2. Draft Rules**

The Colorado Water Conservation Board (CWCB) currently has authority over the *Rules and Regulations for Regulatory Floodplains in Colorado*, dated July 2005, which provides standards for regulatory floodplains (floodplains), floodplain activities and floodplain designation. There are currently 18 rules and regulations for floodplains in Colorado. The proposed changes include modification or clarification to the 18 effective Rules and Regulations and the addition of two (2) new Rules and Regulations. See Table 1.2.1. The updated Rules and Regulations can be read in their entirety in Appendix C.

**Table 1.2.1**

Proposed Changes to *Rules and Regulations for Regulatory Floodplains in Colorado*

| <b>Rule</b> | <b>Description</b>  | <b>Modification/ Clarification</b>  |
|-------------|---|---|
| 1           | Title   | Update to current date  |
| 2           | Authority   | Statutory authorities were updated  |
| 3           | Purpose and Scope   | Clarification of which entities must follow rules                                       |
| 4           | Definitions   | Definitions added/ modified for terms used later in document                            |
| 5           | State Regulatory Floodplain   | Clarify floodplain frequency used for regulation  |
| 6           | Critical Facilities   | New Rule*   |
| 7           | Standards for Delineation of Regulatory Floodplain Information                                  | Updates to technical criteria for floodplain mapping                                    |
| 8           | Standards for Regulatory Floodways  | Application of 1/2 foot floodway  |
| 9           | Criteria for Determining the Effects of Flood Control Structures on Regulatory Floodplains      | Allows private ownership if publicly maintained, removes requirement for flood routing  |
| 10          | Criteria for Determining Effects of Levees on Regulatory Floodplains                            | Discourages use of levees, modified maintenance requirements                            |
| 11          | Floodplain Management Regulations   | Requires compliance with NFIP and 1-foot freeboard requirement*                         |
| 12          | Effects of Flood Mitigation Measures and Stream Alteration Activities on Regulatory Floodplains | Introduces LID in design, clarification of when a LOMR is required                      |
| 13          | Process for Designation and Approval of Regulatory Floodplains                                  | Suggests using 500-year floodplain as a planning tool                                   |
| 14          | Designation and Approval of Changes to Regulatory Floodplains                                   | Renumbering of rule only  |
| 15          | Variances   | Renumbering of rule only  |
| 16          | Enforcement of Floodplain Rules and Regulations   | New Rule- violations will be pursued through a Notice of Non-Compliance, issued by CWCB |
| 17          | Incorporation by Reference  | Renumbering of rule only  |
| 18          | Severability  | Renumbering of rule only  |
| 19          | Floodplain Management Considerations  | Modified <i>suggested</i> floodplain management practices                               |
| 20          | Effective Date  | Update to current date  |

### **1.3. Statutory Requirements for Rulemaking**

The Colorado Department of Regulatory Agencies (DORA) C.R.S. Statute 24-4-103(2.5) (a) requires any agency to issue a regulatory analysis prior the adoption of a revised or proposed rule. This analysis is being formally submitted by CWCB. The analysis shall include the following as defined in C.R.S. 24-4-103(4.5) (a):

- A description of the classes of persons who will be affected by the proposed rule, including classes that will bear the costs of the proposed rule and classes that will benefit from the proposed rule
- To the extent practicable, a description of the probable quantitative and qualitative impact of the proposed rule, economic or otherwise, upon affected classes of persons
- The probable costs to the agency and to any other agency of the implementation and enforcement of the proposed rule and any anticipated effects on state revenues
- A comparison of the probable cost and benefits of the proposed rule to the probable costs and benefits of inaction
- A determination of whether there are less costly methods or less intrusive methods for achieving the purpose of the proposed rule
- A description of any alternative methods for achieving the purpose of the proposed rule that were seriously considered by the agency and the reasons they were rejected in favor of the proposed rule.

It is the intent of this analysis to document the above requirements and take into account both short and long-term consequences.

### **1.4. Contents**

The memorandum is structured as follows:

- Section 2, *Methodology*, describes the analysis used to determine the cost benefit and regulatory analysis
- Section 3, *Draft Rules Studied*, detailed descriptions of the rules that required a cost benefit analysis
- Appendix A: Response Meeting DORA Requirements
- Appendix B: Spreadsheet Printout Of Cost Benefit Computations
- Appendix C. Background Data including References

### **1.5. Affected Parties**

The CWCB's *Draft Rules and Regulations for Regulatory Floodplains in Colorado*, dated July 2010, apply to all communities in Colorado. Various communities within the Colorado have already adopted higher standards regarding freeboard requirements and floodway definition. Communities with



these regulations already adopted will not be affected by the revised or proposed rules. These rules will also apply under the following:

- Activities conducted by state agencies
- Federal activities that are fully or partially financed by local or state funds
- Projects or studies for which the Board has made a loan or grant pursuant to section 37-60120(2) and 37-60-121(1)(b)(VII) & (IX)(C), C.R.S. (2009)

## **1.6 Draft Rules Studied**

The CWCB's *Draft Rules and Regulations for Regulatory Floodplains in Colorado*, dated July 2010 is proposing modifications and clarifications to the existing rules as well as introducing two (2) new rules. It is the intent of this memorandum to provide a Cost Benefit and Regulatory Analysis for Rules 6, 8 and 11. These three (3) rules are considered critical changes that will affect multiple communities whereas the other changes are considered administrative or have little to no impact on affected parties. Rule 6 is a new rule which defines critical facilities and protecting these facilities to a higher standard than other structures located in the floodplain. Rule 8 requires new floodways be mapped using a ½ -foot rise criteria opposed the current 1-foot rise criteria. The other key revision is to Rule 11, which requires new construction or substantially damaged structures have a finished floor elevation one (1)-foot above the 100-year flood elevation. In addition to the rule changes the CWCB is suggesting that local governments use the 500-year floodplain designation as a planning tool for critical facilities. This is documented as a suggestion and not a requirement in Rules 5 and 13.

The remaining sections will document the analysis described in Section 2 for these three (3) rules and provide a summary of benefits.

## 2. Background Reference Material

### 2.1 Introduction

The purpose of this document is to provide the reader with a basic understanding of the technical methodology used to support the proposed Colorado Water Conservation Board (“CWCB”) rule changes. This is certainly not an all-inclusive document, nor is all of the material necessarily original. Many of the thoughts and materials presented are from a wide range of recent lectures and presentations made by recognized experts from the Federal Emergency Management Agency (“FEMA”), FEMA contractors, and from published papers on related topics. An extended bibliography is included and the reader is encouraged to delve into the background material as deeply as time allows.

**2.1.1 Need For Cost-Benefit and Regulatory Analysis:** Because of the importance of and interest in this rulemaking, the CWCB staff voluntarily began preparing a Cost-Benefit and Regulatory Analysis in a manner that is in conformance with the Administrative Procedure Act (“APA”). Under the APA, the Department of Regulatory Agencies (“DORA”) may direct an agency engaged in a rule-making to conduct a Cost-Benefit and Regulatory analysis to include a good faith description of the reason for the rule, the anticipated economic benefits and costs, any adverse effects on certain economic sectors and factors, and the costs and benefits of the proposed rule changes. The Executive Director of the Department did not require the CWCB to conduct said analysis.

**2.1.2 CWCB BCA Focus Group:** Assisting the CWCB staff with this endeavor was the consulting engineering firm of ICON Engineering, Inc. (“ICON”). ICON specializes in Colorado drainage and flood control engineering and includes among their client list the CWCB, FEMA, Urban Drainage and Flood Control District (“UDFCD”), US Army Corp of Engineers, Omaha District (“USACOE”), as well as many counties, cities/towns and special districts throughout Colorado. In addition to members of the ICON staff, the assistance of a number of recognized experts in their fields was solicited in the form of a Focus Group that meet periodically to provide input and feedback to the CWCB and ICON staff. Principal participants in the study from ICON, CWCB and the members of the Focus Group are as follows:

**Table 2.1.2 Focus Group Members**

| Name                     | Representing                      |
|--------------------------|-----------------------------------|
| Penn Gildersleeve        | ICON, Consultant to CWCB          |
| Troy Carmann             | ICON, Consultant to CWCB          |
| Tom Browning             | CWCB, Staff                       |
| Kevin Houck              | CWCB, Staff                       |
| Joe Busto                | CWCB, Staff                       |
| Focus Group Members      |                                   |
| Bret Guillory, PE, CFM   | City of Grand Junction            |
| Michael Mueller, PhD     | Natural Resources Economics       |
| Clay Kimmi, PE, CFM      | Weld County Public Works          |
| Pete Magee, PhD          | San Luis Valley GIS/GPS Authority |
| Brooke Buchanan, PE, CFM | FEMA Region VIII                  |

The Focus Group worked towards consensus in all discussions. Where consensus was not possible, the majority rule governed.

## **2.2 Need For Higher Standards**

It is an indisputable fact that our nation is faced with increasing levels of costs and greater potential risk to lives and livelihoods as a result of floods. It is perplexing that this is occurring, despite our best intentions and past regulations. It is even more vexing when one considers the potential impact to future generations and the demands on the use of land and infrastructure as our population increases. It is estimated that the population of the State of Colorado in the year 2050 will double what the population was in 2008. In an article published in the Journal of the American Planning Association, (Vol. 72, No. 4, Autumn, 2006) it was estimated that more than half of the built environment of the United States that we will see in 2025 did not exist in 2000. The combination of urbanization, loss of natural valley storage, and increasing impermeable surfaces when coupled with our innate desire to live and recreate near water are all driving forces that have created an increased risk of loss.

Because flood risk is very much so an economic risk, it is prudent that we take a common sense approach to examining the rules and regulations that have been followed by floodplain managers for the past 40-years. The basis of sustainability mandates that we simply cannot continue to do the same things as we have done in the past. The Federal Emergency Management Agency (FEMA) has stated emphatically that while we as a nation have done a number of positive things (both non-structural and structural), but, even if we perfectly implement current regulations, flood damages will increase.

For the most part, our current approach to floodplain management deals primarily with how to build in a floodplain, not how to minimize future damages and create a sustainable environment. As a consequence, FEMA, and various agencies like the Association of Floodplain Managers (ASFPM) have asked all communities to look towards going beyond the current National Flood Insurance Program (NFIP) minimum standards. In order to understand the significance of this it is important to first have at least a rudimentary understanding of the NFIP, and the current rule standards.

The U.S. Congress established the National Flood Insurance Program (NFIP) with the passage of the National Flood Insurance Act of 1968. The NFIP is a Federal program enabling property owners in participating communities to purchase insurance as a protection against flood losses in exchange for State and community floodplain management regulations that reduce future flood damages. Participation in the NFIP is based on an agreement between communities and the Federal Government. If a community adopts and enforces a floodplain management ordinance to reduce future flood risk to new construction in floodplains, the Federal Government will make flood insurance available within the community as a financial protection against flood losses. This insurance is designed to provide an insurance alternative to disaster assistance to reduce the escalating costs of repairing damage to buildings and their contents caused by floods. The Flood Insurance and Mitigation Administration (FIMA), a component of the Federal Emergency Management Agency (FEMA), manages the National Flood Insurance Program (NFIP). The three components of the NFIP are:

- Flood Insurance
- Floodplain Management
- Flood Hazard Mapping

Nearly 20,000 communities across the United States and its territories participate in the NFIP by adopting and enforcing floodplain management ordinances to reduce future flood damage. In exchange, the NFIP makes federally backed flood insurance available to homeowners, renters, and business owners in these communities.

In addition to providing flood insurance and reducing flood damages through floodplain management regulations, the NFIP identifies and maps the Nation's floodplains. Mapping flood hazards creates broad-based awareness of the flood hazards and provides the data needed for floodplain management programs and to actuarially rate new construction for flood insurance.

Section 1315 of the 1968 Act is a key provision that prohibits FEMA from providing flood insurance unless the community adopts and enforces floodplain management regulations that meet or exceed the floodplain management criteria established in accordance with Section 1361© of the Act. These floodplain management criteria are contained in 44 Code of Federal Regulations (CFR) Part 60, Criteria for Land Management and Use and are the minimum required standards. The emphasis of the NFIP floodplain management requirements is directed toward reducing threats to lives and the potential for damages to property in flood-prone areas. The NFIP Regulations (in 44 CFR 60.1(d)) state that "any flood plain management regulations adopted by a State or a community which are more restrictive than the criteria set forth in this part are encouraged and shall take precedence."

**2.2.1 Concept of "No Adverse Impact:"** Annual flood losses in the United States continue to worsen in spite of 75 years of federal flood control efforts and nearly 40 years of the National Flood Insurance Program. From the early 1900's to the year 2000, flood damage in the United States has tripled, approaching \$6 billion annually. (Source: "*No Adverse Impact: A New Direction In Floodplain Management Policy*", Published in Natural Hazards Review, Nov. 2001, IAAN 1527-6988). This has occurred despite billions of dollars spent on flood control and other structural and non-structural measures.

Contributing to this is the fact that we as a nation continue to build at risk on floodplains and to ignore the impacts of watershed development on other properties. Often, buildings, streets, utilities and other components of modern development previously thought to be protected get flooded because of the actions of others.

Past "flood control" efforts focused on structural projects, such as levees, reservoirs and channelization in an effort to minimize flood damage. The increasing spiral of damages demonstrates that this one-dimensional approach is not doing the job. Efforts to control Mother Nature created an atmosphere where we just asked for more trouble by building in harm's way. Many developments in the watershed increased the amount of runoff

flowing to our rivers and developments in the floodplain obstructed flows or displaced areas needed for flood storage, making things worse.

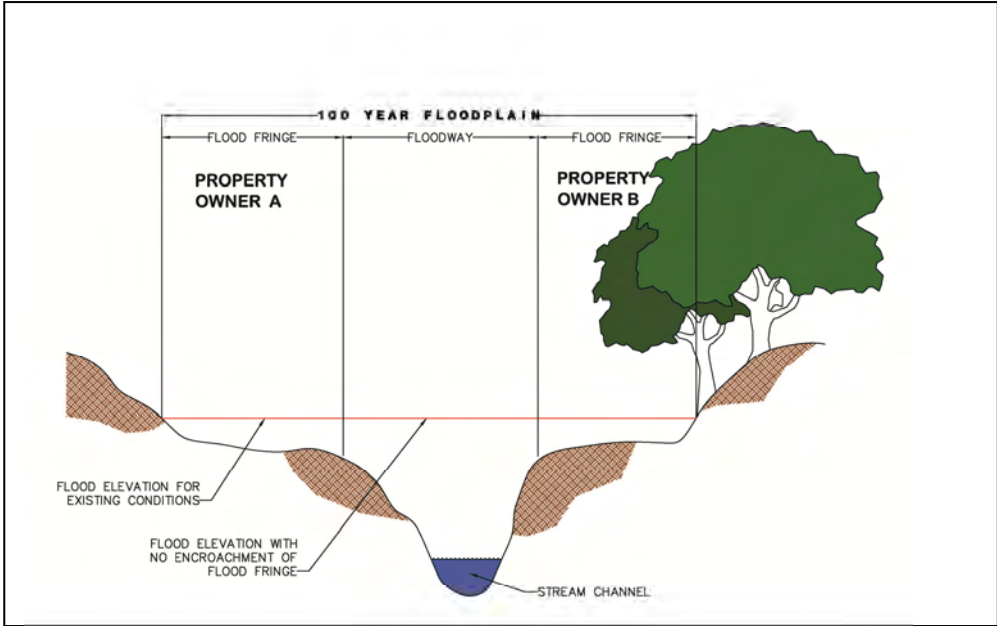
In the 1960's a more balanced strategy was instituted wherein floodplain administrators began to look at both floodwater and the damage-prone development and try to manage both. This broader approach that includes both structural and nonstructural measures is more properly known as "floodplain management" as opposed to the proven inadequacies of "flood control." The NFIP has slowed the increases in flood damage, but it has not stopped or reversed it. The reason is that most communities adopt and enforce only the minimum national and state floodplain management requirements, which focus on protecting new buildings, not what the impact of that construction will do to others.

The NFIP's minimum requirements are just that—minimums! These minimums set construction standards that often do not provide sufficient protection from all local flood hazards nor do they account for the effects of urbanization on future flood levels. They will allow floodwater conveyance areas to be reduced; essential valley storage to be filled; or velocities to be increased; all of which can adversely affect others in the floodplain and watershed.

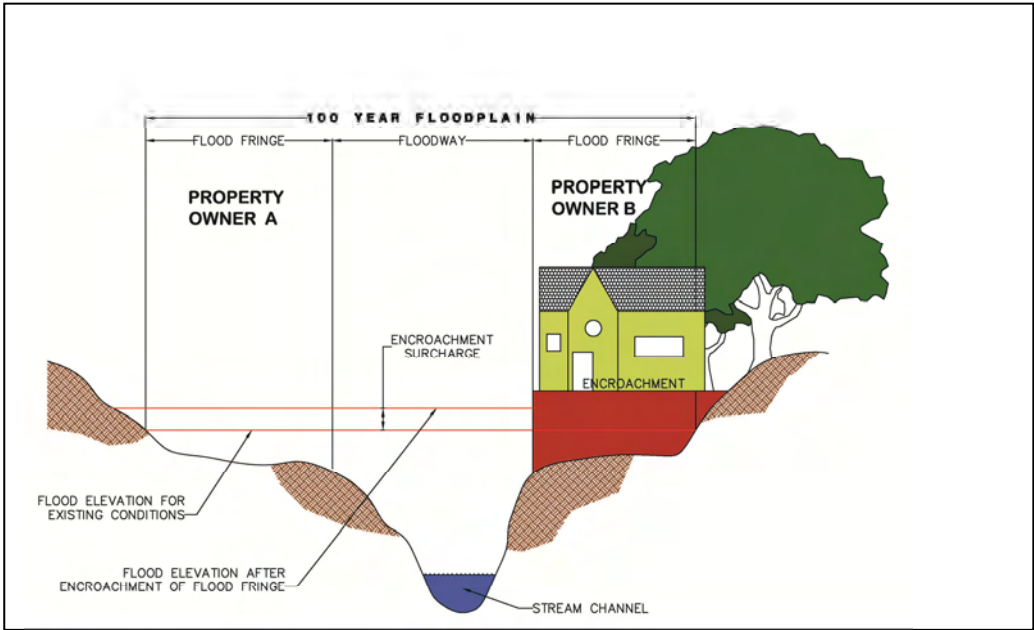
In recognition of the limitations of our current NFIP mandates, FEMA, the ASFPM and others have advocated the concept of No Adverse Impact. No Adverse Impact (NAI) floodplain management is an approach that ensures the action of any community or property owner, public or private, does not adversely impact the property and rights of others. An adverse impact can be measured by an increase in flood stages, flood velocity, flows, the potential for erosion and sedimentation, degradation of water quality, or increased cost of public services. No Adverse Impact floodplain management extends beyond the floodplain to include managing development in the watersheds where floodwaters originate. NAI does not mean no development. It means that any adverse impact caused by a project must be mitigated, preferably as provided for in the community or watershed based plan.

With respect to the proposed Rule changes, the concept of NAI can best be demonstrated by looking at the consequences of allowing floodplain encroachment through allowing the 1-foot rise in the flood stage (as is the minimum NFIP standard and is the current rule in much of Colorado). As demonstrated by the exhibits presented on the following page, the 1-foot rise rule can essentially allow one property owner to legally negatively impact adjoining properties. Through enforcing a 0.0-foot rise, this issue is averted. FEMA has suggested that adopting stricter standards, which include minimizing the allowable rise. In paragraph VII Floodway Rise, page 6 of the publication "A Guide for Higher Standards in Floodplain Management" dated May 10, 2010, ASFPM generally recommends an allowable floodway rise of no more than 0.5 foot and as little as 0.1 foot where vulnerable or critical development exists. By adopting proposed the 0.5-foot rise, the State of Colorado will have approach the guidelines prepared by ASFPM and as suggested by FEMA.

**Figure 2.2.1**  
**Floodway NAI Implications**



**Property Rights Conundrum:** Assume two property owners on opposite sides of a creek (above). Under the Minimum Standards, Property Owner "B" is allowed to encroach into the flood fringe area, raising the effective flood depth on Property Owner "A" (below). Property Owner "B" has adversely impacted Property A. With a true, No Adverse Impact (NAI) rule, the allowable floodway rise would be 0.0-ft. As a compromise to the Minimum Standard, the CWCB proposed rule change limits the floodway encroachment rise to 0.5-ft. The selected 0.5-ft standard is the maximum amount recommended by ASFPM (See Appendix D).



According to an attorney specializing in floodplain management issues, (personal communications with Ed Thomas, Esq., attorney with Michael Baker Jr., Inc.), our courts have ruled time after time that the only person that has a right to increase the depth of flooding on their property is themselves. However, that land owner is restricted from harming himself, if in doing so he harms others. Our legal community has embraced the concept of “Sic utere tuo ut alienum non laedas” which translates to “use your property so that you do no harm to others.” In our increasingly litigious world, (again, according to Mr. Thomas), No Adverse Impact is a concept that protects the property rights of all. Out of necessity, the floodplain management community is embracing NAI if for no other reason than to reduce personal and professional liability.

**2.2.2 Status Of Other States:** FEMA established as a standard, a maximum allowable floodway surcharge of 1.0 foot. Because the surcharge generally increases as the amount of encroachment increases, setting a limit on the magnitude of the surcharge sets limits on the amount of encroachment that can occur. This can be described further as the channel of a stream plus the portion of the floodplain adjacent to it that must be kept free of encroachment so that the entire 1-percent annual chance flood (100-year flood event) can discharge with no greater than a 1.0-foot increase to the Base Flood Elevation (BFE). The 1.0 foot maximum rise is the FEMA minimum standard. A rise greater than 1.0-foot is not allowed, and a allowable rise of less than 1.0-foot is a standard greater than the minimum FEMA standard. Several states/entities have adopted requirements that limit the allowable encroachment to less than 1.0 foot. These states and their respective standards, as reported in the FEMA document “*Guide for Community Officials*” Chapter 7, Floodway Revisions, (December, 2009) include:

**Table 2.2.2.1  
States Requiring Greater Than Minimum Standards For Floodways – 2009**

| State / Entity | Allowable Floodway Encroachment |
|----------------|---------------------------------|
| New Jersey     | 0.2 foot                        |
| Illinois       | 0.1 foot                        |
| Indiana        | 0.1 foot                        |
| Michigan       | 0.1 foot                        |
| Minnesota      | 0.5 foot                        |
| Wisconsin      | 0.0 foot                        |
| Montana        | 0.5 foot                        |

The Association of State Floodplain Managers (“ASFPM”) periodically completes a national summary of the practice of floodplain management at the state and local levels. They have issued a series of reports that update and supplement previous reports issued in 1989, 1992, 1995 and 2003. ASFPM is currently completing a 2010 update, and unfortunately the most recent data is not currently available. Based upon the 2003 report, 19 states and Washington DC and Puerto Rico have adopted a freeboard standard above the current minimum FEMA standard of at or above the BFE. These states and their respective freeboard standards are:

**Table 2.2.2.2  
States Requiring Greater Than Minimum Standards For Freeboard – 2003**

| State/Entity  | Freeboard Standard*<br>(feet above BFE) |
|---------------|---|
| Alabama       | 1.0                                     |
| Arizona       | 1.0                                     |
| Washington DC | 1.5                                     |
| Georgia       | 1.0                                     |
| Hawaii        | 1.0                                     |
| Indiana       | 2.0                                     |
| Kansas        | 1.0                                     |
| Maryland      | 1.0                                     |
| Maine         | 1.0                                     |
| Michigan      | 1.0                                     |
| Minnesota     | 1.0                                     |
| Montana       | 2.0                                     |
| North Dakota  | 1.0                                     |
| Nebraska      | 1.0                                     |
| Nevada        | 1.0                                     |
| Ohio          | 2.0                                     |
| Oregon        | 1.0                                     |
| Pennsylvania  | 1.5                                     |
| Puerto Rico   | 1.0                                     |
| Tennessee     | 1.0                                     |
| Wisconsin     | 2.0                                     |

\*Freeboard applies to all structures (residential and non-residential) in the floodplain.

Additionally, the 2003 ASFPM report indicates that nine states require protection for Critical Facilities. Of these, six keep critical facilities out of the 500-year floodplain, and two use the 100-year floodplain. These states, and their respective standards, include:

**Table 2.2.2.3  
States Requiring Greater Than Minimum Standards  
For Critical Facilities – 2003**

| State          | Critical Facility Protection Level |
|----------------|------------------------------------|
| Alabama        | 500-year                           |
| Illinois       | 500-year                           |
| Michigan       | 500-year                           |
| Mississippi    | 500-year                           |
| North Carolina | 500-year                           |
| New York       | 100-year                           |
| Ohio           | 500-Year                           |
| Pennsylvania   | 100-year                           |

**2.2.3 Status Of Colorado:** As stated previously, FEMA has encouraged communities to adopt stricter standards than the minimum required under the NFIP. Several



communities within Colorado have already chosen to do so. For purposes of the NFIP regulations, a community could be any state, county, city, town, special district or other entity. Given that Colorado has a very high number of communities (including 269 city/towns and 63 counties), it is somewhat challenging to accurately report on the status of all communities, given the scope limitations of this effort. Table 2.2.3.1 below lists a sample of communities in Colorado that have adopted some form of higher standards either through explicit floodplain ordinances or through adoption of IBC 2006 or newer. However, as an overview, there are approximately 44 Colorado communities that receive discounted insurance rates through the Community Rating System (CRS) as a result of adopting at least a portion of their floodplain regulations to a higher standard than the FEMA NFIP minimum.

### **2.3 Benefit-Cost History**

Benefit-Cost Analysis (BCA) is a tool for organizing data to allow comparing the relative value of alternative public investments. If the value of significant benefits and costs can be expressed in monetary terms, the net value, that is benefits minus costs of the alternatives under consideration can be computed and used to compare which alternative yields the greatest relative advantage. A fair comparison is possible only if it is possible to assign dollar values to all relevant costs and benefits and they are on a common time basis.

Fundamentally, drainage and flood management regulations and infrastructure improvements are geared towards substantially reducing the risk of future flood related damage, hardship, loss or suffering. The underlying principles that define the methodology for comparing the relative merits of differing options that may be employed to achieve lower flood damage risk are fairly well known.

The history of BCA has its theoretical origins dating back to issues of infrastructure appraisal in France in the 19<sup>th</sup> century. Jules Dupuit, a French engineer, wrote about the concepts of BCA in 1848. The British economist, Alfred Marshall built upon these concepts and in 1890 constructed the foundation of modern BCA. In the United States, BCA has its origins in water development projects of the US Army Corps of Engineers (Corps). Since the time of the American Revolution, the Corps has been charged with “preventing destructive floods.” In 1879, Congress created the Mississippi River Commission, headed by an Army engineer and the Corps always had veto power over any decision by the Commission. The Federal Navigation Act of 1936 effectively required Cost-Benefit Analysis for proposed federal waterway infrastructure. This act contained the wording that “the Federal Government should improve or participate in the improvement of navigable waters or their tributaries, including watersheds thereof, for flood-control purposes if the benefits to whomsoever they may accrue are in excess of the estimated costs.” As a part of their role on the Mississippi River, the Corps had to create systematic methods for measuring the benefits and costs. This was given particular emphasis after World War II when there was substantial pressure for “efficiency in Government.” Further refinement resulted with the publishing of the US Water Resources Council “Establishment of Principles and Standards for Planning Water and Related Land Resources” in 1973.

**Table 2.2.3.1**  
**Sample Colorado Communities With Locally**  
**Adopted Higher Standard Floodplain Ordinances**

|                   |
|-------------------|
| Arapahoe County   |
| Eagle County      |
| Jefferson County  |
| Boulder County    |
| Weld County       |
| Brush             |
| Castle Rock       |
| Fort Collins      |
| Grand Junction    |
| Longmont          |
| Steamboat Springs |

In addition to the role of the Corps in developing and applying BCA, FEMA has also played an important part. Although FEMA can trace its beginnings to the Congressional Act of 1803, it wasn't until 1979 that President Carter issued an executive order that merged many of the separate government disaster related responsibilities into a single agency, thus forming FEMA. By definition, FEMA is charged with coordinating the federal government's role in preparing for, preventing, mitigating the effects of, responding to, and recovering from all domestic disasters, whether natural or man-made, including acts of terror. Prior to the establishment of FEMA (and to a degree continuing today), it was common that more than 100 governmental agencies were involved in some aspect of disaster, hazards and emergencies. FEMA has a role in helping States to respond to disasters that easily overwhelm the resources of local entities, and also in providing experts in specialized fields of funding for rebuilding and mitigating against future disasters. Given that there is often great competitiveness in pursuing Federal funding, FEMA has developed a series of software products for conducting BCA's so that comparisons between projects can be made.

Most recently, with the advent of Geographical Information Systems (GIS), FEMA has assisted States in developing a set of data that is linked to available base mapping. The Hazards U.S. Multi-Hazard (HAZUS-MH) is a nationally applicable standardized methodology that estimates potential losses from earthquakes, hurricane winds, and floods. HAZUS-MH uses GIS software to map and display hazard data and the results of damage and economic loss estimates for buildings and infrastructure. It also allows users to estimate the impacts of earthquakes, hurricane winds, and floods on populations. In HAZUS-MH, current scientific and engineering knowledge is coupled with GIS technology to produce estimates of hazard-related damage before, or after, a disaster occurs. HAZUS-MH reflects properties that lie outside of the 100-year FEMA mapped floodplains including areas beyond the 100-year floodplain. This limits the usefulness of HAZUS-MH for this particular Benefit Cost Analysis.

Potential loss estimates analyzed in HAZUS-MH include:

- **Physical damage** to residential and commercial buildings, schools, critical facilities, and infrastructure;
- **Economic loss**, including lost jobs, business interruptions, repair and reconstruction costs; and
- **Social impacts**, including estimates of shelter requirements, displaced households, and population exposed to scenario floods, earthquakes and hurricanes.

In addition to Federal BCA initiatives, within Colorado, one of the first Major Drainageway Master Plans funded by the Urban Drainage And Flood Control District (UDFCD) was a massive study on the Little Dry Creek Basin in Arapahoe County. The Little Dry Creek plan was completed in late 1974 and employed a Benefit/Cost analysis to help prioritize alternative flood control improvements. Subsequently, the UDFCD published a report entitled "Feasibility Evaluation" in 1977. Using the Little Dry Creek study as an example, the Feasibility Evaluation report defined a step by step process that could be utilized to conduct benefit-cost comparisons. The majority of UDFCD funded Master Plans completed in the Denver Metro area were required to compare the relative merits of alternatives using a benefit/cost analysis.

In summary, the history of BCA preparation shows that the means and methods of preparing BCA's have been developed over time by differing agencies, with differing levels of technical expertise using input from a myriad of engineers and economists. It should therefore not be surprising that there are basic disagreements between the various agencies regarding how best to conduct such a study, and on such basic input items as what should be considered a benefit or a cost and what values should be given to the other various parameters that are required to allow a fair comparison of alternatives.

**2.3.1 BCA Essential Elements:** The process of conducting a Benefit-Cost Analysis involves weighing the total expected costs against the total expected benefits of one or more actions in order to choose the best or most profitable option/alternative. In the case of the proposed floodplain rule changes, the options for comparison are the benefits (value of flood related damages averted) if the rule is enacted compared to the cost of implementing the rule (which may include direct construction costs and includes both administrative costs and impacts to land value). For infrastructure and legislative acts related to flooding, a BCA involves determining a number of parameters, which include:

- Flood probability
- Flood Severity
- Expected Damages With and Without Implementation of the Option Under Consideration
- Discount Rate
- Project Useful Lifetime
- Cost of Implementing the Option.

In order to reach a conclusion as to the desirability of a project, all aspects of the project, positive and negative, must be expressed in terms of a common unit. There must be a “bottom line.”

The difference between damages with and without implementation is most often considered to be the damages averted, that is the benefit resulting from the option. These benefits may be both direct (damages to buildings and other facilities such as infrastructure as examples) and indirect (such as changes in gross regional economic product, incomes or employment). Benefits occur over the lifetime of a mitigation project. In the lifetime of a mitigation project, the exposure to flood risk is a consequence that can be determined by engineering analysis of the likelihood of flood damage resulting from inundation of land or an improvement due to various frequencies of flood events. As would be expected, the potential damage from a rare event such as the 100-year flood would be expected to be greater than the damage from a more common event (such as the 1-year, 5-year or 10-year flood), but conversely, by definition, a rare event is much more unlikely to happen than a smaller flood.

A wide range of variables, including non-quantitative ones like quality of life, are often not considered because the value of benefits may be indirect or projected far into the future. This value could be less than the market value due to the difficulty in assigning dollar values to some benefits like preserving open space or improving water quality.

Would the proposed rules provide an increase in open space and water quality enhancement? More than likely, but as with deaths and injuries averted, this benefit cost analysis did not include a monetary value for this benefit. Nevertheless, these are very real benefits and a by-product of the proposed rule changes. Although a dollar amount of the benefit of preserving open space and improving water quality is not included, the report *“A Return On Investment: The Economic Value of Colorado’s Conservation Easements”* prepared by the Trust for Public Land, states that there is a return of \$6 for every \$1 invested through acquiring conservation easements and thus preserving lands by providing a multitude of public benefits such as water supply protection; scenic views; flood control; fish and wildlife habitat; recreation (including hunting, fishing, hiking, bird watching and other outdoor activities); aesthetics; carbon sequestration; dilution of waste water; erosion control; and agricultural crop productions. Further, they have categorized conservation easements and calculated the dollar value of the public benefits provided by these protected lands of various ecosystem types. The estimated annual per acre value of various ecosystems from the Trust for Public Lands report are shown in the following Table 2.3.1.1:

**Table 2.3.1.1**  
**Estimated Annual Per Acre Value of Ecosystem Services By Ecosystem Type**

| <b>Ecosystem Type</b>                      | <b>Ecosystem Service(s)</b>   | <b>Value Per Acre Per Year (2008\$)</b> | <b>Source</b>             |
|--|---|---|---------------------------|
| Barren                                     | None  | N/A                                     |                           |
| Emergent Herbaceous Wetland                | Flood control, water supply; fish and wildlife habitat; recreation; aesthetics  | \$784                                   | Roberts & Leitch, 1997    |
| Woody Wetland                              | Flood control, water supply; fish and wildlife habitat; recreation; aesthetics  | \$784                                   | Roberts & Leitch, 1997    |
| Deciduous Forest                           | Grazing; carbon sequestration; habitat provision  | \$879                                   | Ingraham & Foster, 2008   |
| Evergreen Forest                           | Grazing; carbon sequestration; habitat provision  | \$879                                   | Ingraham & Foster, 2008   |
| Mixed Forest                               | Grazing; carbon sequestration; habitat provision  | \$880                                   | Ingraham & Foster, 2008   |
| Scrub/Shrub                                | Carbon sequestration  | \$610                                   | Ingraham & Foster, 2008   |
| Sagebrush                                  | Dilution of waste water; natural purification of water; erosion control; habitat for fish and wildlife; recreation          | \$82                                    | Loomis et al, 2000        |
| Grassland/Herbaceous                       | Grazing; dilution of waste water; natural purification of water; erosion control; habitat for fish and wildlife; recreation | \$85                                    | Loomis et al, 2000        |
| Shortgrass Prairie                         | Grazing; dilution of waste water; natural purification of water; erosion control; habitat for fish and wildlife; recreation | \$87                                    | Loomis et al, 2000        |
| Open Water                                 | Fresh water regulation and supply; habitat provision  | \$267                                   | Ingraham & Foster, 2008   |
| Developed - Low Intensity Urban/Open Space | Gas and Climate Regulation; Water Regulation  | \$194                                   | McPherson, 1992           |
| Developed - High Intensity Urban           | Gas and Climate Regulation; Water Regulation  | \$194                                   | McPherson, 1992           |
| Altered or Disturbed                       | None  | N/A                                     |                           |
| Agriculture                                | Aesthetics; crop production; grazing  | \$283                                   | Rosenberger & Walsh, 1997 |
| Developed - Oil/Mine/Quarry                | None  | N/A                                     |                           |

Note: All grazing values were estimated by TPL using stocking and lease rates from Colorado State University Extension Agents, and land cover data from TNC.

On flood control projects, a somewhat different problem is presented by the valuation of the benefit of saving human lives. There is reluctance by the general public to place a



dollar value on human life, even if it is recognized that a benefit of a project is in reducing the risk of death. In the case of the proposed rule changes, it may be intuitively obvious that placing more restrictive requirements on building in the floodplain will reduce the exposure to risk of drowning, but assigning a dollar value to this benefit is problematic in that the intent of the analysis is to compare the scenario of with the new rules against that of the old rules. We are not comparing the new rules against no rules. Also, the new rules will be applied primarily to new proposed structures, and the rules apply above and beyond the current FEMA criteria with an emphasis on 100-year flood events. As an example, the new rules address needed free-board above the 100-year event, and the benefit cost analysis is constrained to just analysis of the difference between the current rules and the newly proposed rules. The new rules help limit the risk of new construction exposing a home owner or commercial enterprise from extreme events. However, it is recognized that there is an inherent danger to being caught in any flood event, including the smaller, more common floods.

The risk of flood damage in Colorado is clearly shown in the following Table 2.3.1.2 which was taken from the Colorado Floodplain and Stormwater Criteria Manual dated January 6, 2006.

**TABLE 2.3.1.2  
Major Flood Damages in Colorado**

| <b>Date</b>   | <b>Major Stream or Location</b>          | <b>Deaths</b> | <b>Damages<br/>(In 2003 \$)</b> |
|---------------|--|---------------|---------------------------------|
| May 1864      | Cherry Creek at Denver                   | ?             | \$ 6,570,000                    |
| July 1896     | Bear Creek at Morrison 2                 | 7             | \$ 6,570,000                    |
| Oct. 1911     | San Juan River near Pagosa               | 2             | \$ 6,570,000                    |
| July 1912     | Cherry Creek at Denver                   | 2             | \$ 131,400,000                  |
| June 1921     | Arkansas River at Pueblo                 | 78            | \$ 832,200,000                  |
| May 1935      | Monument Creek at Colorado               | 18            | \$ 56,940,000                   |
| May 1935      | Kiowa Creek near Kiowa                   | 9             | \$ 16,425,000                   |
| May 1942      | South Platte River Basin                 | ?             | \$ 9,307,500                    |
| May 1955      | Purgatoire River at Trinidad             | 2             | \$ 39,420,000                   |
| June 1957     | Western Colorado                         | ?             | \$ 19,710,000                   |
| June 1965     | South Platte River at Denver             | 8             | \$2,409,000,000                 |
| June 1965     | Arkansas River Basin                     | 16            | \$ 225,000,000                  |
| May 1969      | South Platte River Basin                 | 0             | \$ 23,542,000                   |
| Sept. 1970    | Southwest Colorado                       | 0             | \$ 14,454,000                   |
| May 1973      | South Platte River at Denver             | 10            | \$ 425,736,000                  |
| July 1976     | Big Thompson River in Larimer County     | 144           | \$ 93,294,000                   |
| July 1982     | Fall River at Estes Park                 | 3             | \$ 53,742,000                   |
| June 1983     | North Central Counties                   | 10            | \$ 28,744,000                   |
| May-June 1984 | Western/Northwestern Counties            | 2             | \$ 50,918,000                   |
| May-June      | Western Slope                            | 0             | \$ 2,343,000                    |
| July 1997     | Fort Collins and 13 Eastern Counties     | 6             | \$ 318,995,000                  |
| May-June 1999 | Colorado Springs and 12 Eastern Counties | 0             | \$ 101,740,000                  |
| July-Aug 2001 | W. Colorado, Greeley                     | 0             | \$ 4,350,000                    |
| July-Aug 2002 | Prowers Co., E. Colorado                 | 0             | \$ 1,890,000                    |
| May 2003      | Eagle Co.                                | 0             | \$ 2,500,000                    |
| <b>TOTALS</b> |  | <b>352</b>    | <b>\$5,013,781,000</b>          |

Note: Average annual flood damages in Colorado are estimated to be \$50 million. Total estimated losses since 1964 are \$5 Billion (2003 dollars).

This table does not include all the historic flood events which, if included, would significantly increase both the flood damage total and number of deaths. The damages noted in the table above do not include an assigned value to the deaths or injuries.

Could any of these deaths noted from Colorado’s infamous floods have been prevented with better floodplain management? Undoubtedly so. If the proposed rules could be retroactively applied would there have been fewer deaths? Possibly. But more to the point, if the proposed rules are enforced will there be fewer flood related deaths and injuries in the future? That is the goal of implementing higher floodplain standards. But how can this be quantified and then converted to a money value?

There is an abundance of literature on the matter in which the Federal Government has attempted to address this issue. Most commonly, the benefit of preventing a fatality is measured by what is called the Value of a Statistical Life (VSL). The Office of Management and Budget (OMB) in Circular A-4 issued on September 17, 2003, endorses a VSL to be between \$1 million and \$10 million. Since the issuing of the Circular, the OMB has utilized a standard of \$5 million for the value of the benefit a fatality averted. Several federal agencies have adopted VSLs generally following the OMB suggested value range. As examples, the Food and Drug Administration uses a range of \$5 million to \$6.5 Million; EPA uses values as high as \$7 Million; OSHA and the Mine Safety Health Administration has used \$6.8 million; the Department of Agriculture used a range of \$5 million to \$6.5 million; and the Department of Transportation uses a range of \$3.2 million to \$8.4 Million.

Nonfatal injuries are far more common during flood events and yet reliable numbers of injuries are not well documented due primarily to the wide range of severity that can occur. One method of monetizing injuries was introduced by the Department of Transportation in the publication “Treatment of Value of Life and Injuries in Preparing Economic Evaluations” dated January 1993 and since updated without revision. In this publication, the value of preventing injuries was reported as a fraction of the VSL using the Abbreviated Injury Scale (AIS), which categorizes injuries into levels ranging from AIS 1 – minor to AIS 5 – critical. The ratios to VSL are:

**Table 2.3.1.3  
Injuries As a Fraction of VSL**

| MAIS Level | Severity | Fraction of VSL |
|------------|----------|-----------------|
| MAIS 1     | Minor    | 0.0020          |
| MAIS 2     | Moderate | 0.0155          |
| MAIS 3     | Serious  | 0.0575          |
| MAIS 4     | Severe   | 0.1875          |
| MAIS 5     | Critical | 0.7625          |
| MAIS 6     | Fatal    | 1.0000          |

The difficulty in including a value for deaths and/or injuries averted in the Benefit/Cost analysis is twofold: First of all, the dollar benefit of preventing even one death is enormous and likely overpowers the costs identified with enacting the proposed rules, when evaluating the benefits of an individual unit (that is a single residential/commercial

or critical facility). Rather than using the value of a death (or severe injury averted as an over-arching factor, our analysis elected to simply note that there will likely be deaths and injuries averted, but no value was assigned to the benefit. As a result, it should be pointed out that the B/C analysis is necessarily very conservative in that many types of benefits (not the least of which are death and injuries averted) are not factored into the reported numbers.

One of the problems of conducting a BCA is that while the computation of many components of benefits and costs is intuitively obvious, there are others for which intuition fails. As an example, it is usually easier to establish an alternative's cost than it is to determine the dollar value of a benefit. Traditional BCA's do not typically give fair consideration to such factors as distributional effects (that is who pays compared to who benefits) and what has been termed environmental justice wherein a disproportionate share of negative impacts are born by low-income and minority populations and/or small businesses. There can also be significant indirect benefits and costs, that is, benefits or costs that are not directly generated by the investment (mitigation or rule change) but that are the indirect result of that change. Thus calculated benefits, costs and benefit-cost ratios can differ significantly from the project's true value to society. Social and environmental benefits, and the cost of avoiding such impacts should be included in a BCA. However, they are not included herein due to various limitations and constraints.

An obstacle to the BCA is the fact that the benefits and costs are often expressed in money terms but they must be adjusted for the time value of money. This is not just due to the differences in the value of dollars at different times because of inflation. By example, a dollar available five years from now is not as good as a dollar available now. This is owing to the fact that a dollar available now can be invested and earn interest for five years and would be worth more than a dollar in five years. The amount of money that would have to be deposited now so that it would grow to be a certain amount in the future can be determined for any interest rate and corresponding time in the future. This is called the discounted value or present value of a dollar. When the dollar value of a benefit (or cost) at some time in the future is multiplied by the discounted value of a dollar at that time in the future, the result is the discounted present value of the benefit (or cost). The net benefit of the project is just the sum of the present value of the benefits less the present value of the costs. The choice of the appropriate interest rate to use for the discounting must be undertaken with careful thought.

Usually, a cost of an option is a one-time initial expenditure, but the benefits may be realized over time. A BCA must attempt to put all relevant cost and benefits on a common temporal footing. A discount rate is chosen, which is then used to compute all relevant future costs and benefits in present-value terms. Most commonly, the discount rate used for present value calculation is an interest rate derived by financial considerations, or may be assigned by convention. The interest rate can be very controversial.

With regards to the proposed rule changes, it must also be recognized that the impact of the rules is the difference between what the situation in the study area would be with the new rule compared to what it would be under the current rules. Thus it is an



incremental change evaluating just the difference between the existing rule and the proposed rule. It is not the evaluation between the new rule and no rule.

Finally, it must be recognized that the typical flood related BCA starts with defining a particular study area such as a portion of a river, creek gulch, etc. The cost of implementing an improvement and the resulting benefits are then at least arially definable and fixed. It was recognized from the beginning of the study that it would be cost prohibitive to complete an analysis in such a detailed manner simply owing to the magnitude of the potential waterways impacted in Colorado. Consideration was given to performing a BCA on sample streams and then “scaling” the results up to state-wide. This became problematic in that there really isn’t such a thing as a typical drainageway that could serve as a model. Each and every stream is unique, with very site specific characteristics. Accordingly, it was determined that the study should focus on a “unit” basis rather than by studying a specific stream. Schematics of fictional streams were developed to test each of the rules investigated. The concept is to test a number of reasonable situations such as various types of residential and/or commercial applications to determine if the expected benefits and costs are reasonable and can be generally extrapolated to a wider basis such as stream basin wide, county wide and state wide.

**2.3.2 Benefits:** The benefits of a mitigation project are often described as being the elimination and/or reduction of future damages and losses. In other words, benefits are simply avoided damages and losses. For mitigation projects, benefits are usually calculated by estimating future damages and losses under the circumstances of with and without the mitigation measure. In this manner, only the incremental advantage of the mitigation measure is accounted, and residual damages that may still occur even with the mitigation are also accounted. Most mitigation projects, such as elevating a building above the 100-year floodplain do not completely eliminate future damages, but rather only reduce them. An exception to this occurs in the event of acquisition and removal of the structure in which case the future damages may be completely eliminated. It follows that the greater the damages and losses are before mitigation, the greater the potential benefits. A key consideration of adopting standards beyond the FEMA minimum is that the proposed rules address primarily rare flood events which have low annualized damages due to infrequency of occurrence. Categories of avoided damages, that is, benefits are:

SOFT BENEFITS

Increased Public Safety

Maximization of Sustainable Economic Development

Avoidance of Unwise Use of Floodplain and Flood Prone Areas

Protection and Restoration of the Function of Natural Systems and Mitigation of Unavoidable Damage To Natural Systems

AVOIDED PHYSICAL DAMAGES

Damages to buildings, contents and Infrastructure

Outbuildings

Landscaping  
Site Contamination  
Vehicles  
Equipment

#### AVOIDED LOSS-OF-FUNCTION COSTS

Loss of function of buildings  
    Displacement costs for temporary quarters  
Loss of rental income  
Loss of wages  
Disruption time for residents  
Loss of public services  
Loss of net business income  
Economic impacts of loss of function of infrastructure:  
    Road or bridge closures  
    Traffic delays  
    Loss of Utility Services

#### AVOIDED CASUALTIES

Deaths and Injuries To Those Flooded  
Deaths and Injuries To First Responders  
Illnesses

#### AVOIDED EMERGENCY MANAGEMENT COSTS

Emergency operations center costs  
Evacuation or rescue costs  
Security costs  
Temporary protective measure costs  
Debris removal and cleanup costs  
Other management costs

#### AVOIDED INDIRECT LOSSES

Tourism  
Regional Economics

#### INSURANCE CONSIDERATIONS

CRS Rating  
Policy Fee Reductions  
Liability

#### INDIRECT OR SECONDARY BENEFITS

Local or regional employment  
Changes in employment levels  
Economic growth or development  
Tourism  
Future tax revenues

### Additional Considerations

- Minimization of adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area must be used;
- Maximization of positive social effects that stem from a proposed project;
- Development of projects within the context of the watershed in which they are located;
- Avoided criminal justice costs for disaster-related crime (e.g., looters).

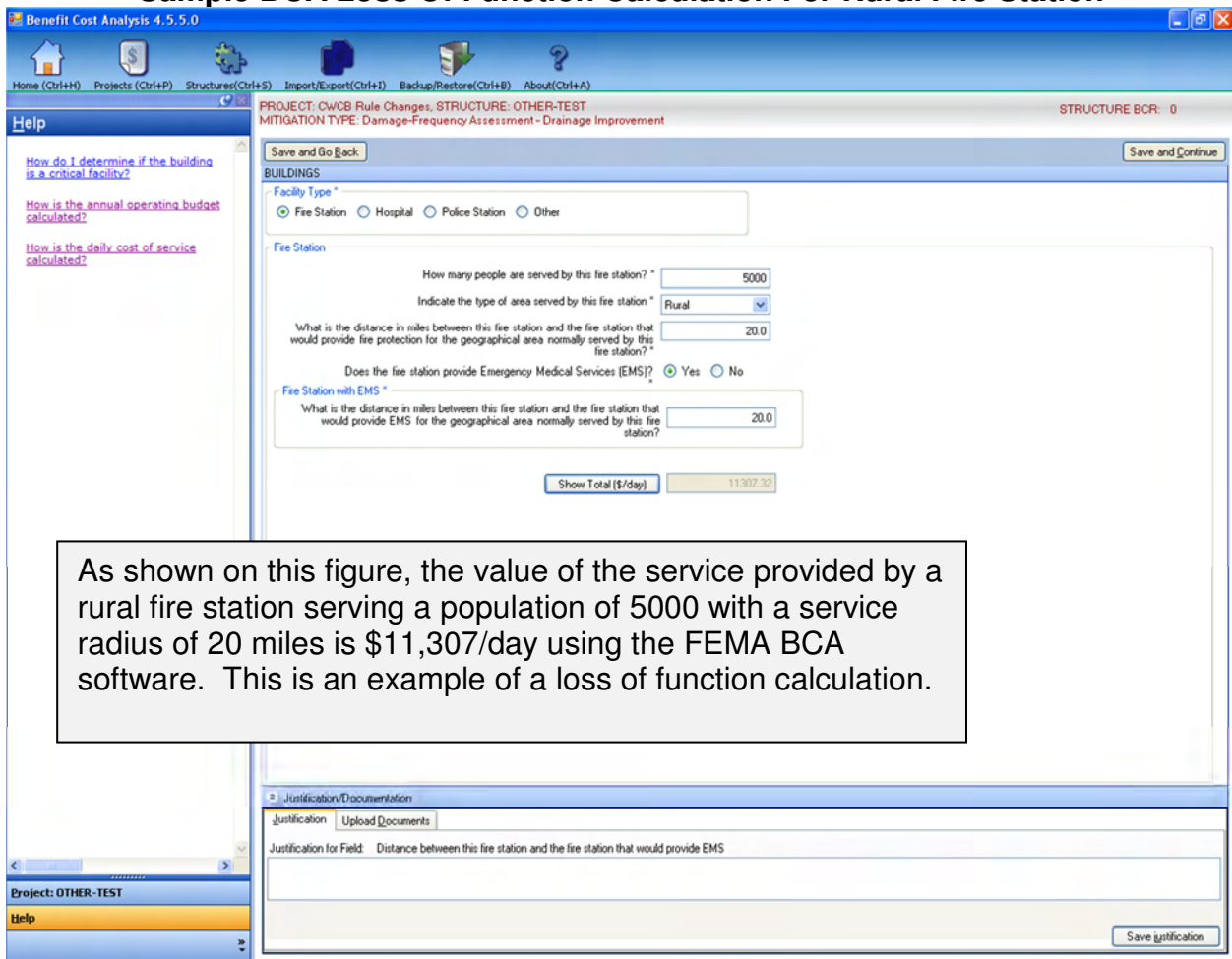
The fallacy of conducting a benefit-cost analysis without consideration of protection of Public Safety, can best be described with a simple example: A \$2 million project protecting a \$4 million home is considered to have the same benefit-cost ratio as the same \$2 million project protecting forty \$25,000 homes and the families that live in these structures. If protection of public safety is considered to be an objective, then the benefits of providing protection to these families would have to be considered in the final accounting. Further, it follows that in consideration of public safety, it is important to closely examine the 100-year level of flood protection that has become our national de facto standard. Our nation's recent experience with the failure of flood control levees provides a stark reminder that flood control measures designed to minimum standards will, over time, be subject to failure. Two recent studies conducted for FEMA have indicated that a reasonable level of protection should be at the 500-year or standard project flood level. These studies resulted in the reports entitled "*The National Levee Challenge: Levees and the FEMA Flood Map Modernization Initiative*" conducted by the Interagency Levee Policy Review Committee (Interagency 2006); and the report "*Assessing the Adequacy of the National Flood Insurance Program's 1 Percent Flood Standard*" by the Water Resource Collaborative at the University of Maryland (Galloway 2006).

It should be pointed out that loss-of-function impacts are sometimes as important as or even more important than the direct physical damages. For example, the loss of function of a hospital or fire station or other facility critical to the emergency response and recovery during and immediately after a disaster may have a much greater economic impact on the community than simply the repair costs for the physical damages. Similarly, loss of electric power or potable water service has a much larger economic impact on a community than simply the costs to repair damage to the electric power or water systems. Unfortunately, most of the sub-categories of loss-of-function impacts are difficult to understand and to calculate than the more self-evident physical damage sub-categories. As a result, loss-of-function impacts have often been only partially counted or not counted at all when conducting cost-benefit analysis of hazard mitigation projects.

Loss of function damages occur when facilities are damaged to the point that the normal function of the facility is disrupted. They are also applicable when there are indirect damages, such as a bridge becoming impassible to emergency vehicles due to damage to the bridge. For important community operations, loss of function is often the most severe impact of a hazard event, so correctly counting the losses and the benefits of avoiding some or all of them is critically important. Past studies completed for the UDFCD have utilized a simple multiplier of physical damage as a means of determining

the monetary value of the loss of function for utilities. The FEMA BCA v.4.5.5 software has a built-in default values for such losses. As an example, the costs for utilities not provided are calculated on the basis of the impact per person per day that the utility is out of service. The default values are: electrical service - \$126/person/day; potable water - \$93/person/day; and for waste water - \$41/person/day. The FEMA BCA software has a built-in calculator to help determine the total economic value for the functional downtime of critical facilities such as fire station, hospital, and police station. These costs are based on the number of people affected, and the distance from the service provided. In addition, the fire station has different values for urban, suburban and rural stations. A sample of the BCA output for a rural fire station is shown below. For our analysis, we did not include any loss of function values, with the sole exception of the case of a hospital (critical facility) in the floodplain, wherein the FEMA default value was used.

**Figure 2.3.2.1**  
**Sample BCA Loss Of Function Calculation For Rural Fire Station**



With respect to Death and Injury, for many types of mitigation projects, such as the proposed rule changes, life safety benefits are difficult to assign, and may not be significantly greater as a result of the incremental advantage of the rules. This does not

mean that in the event of a flood event that there will not be potential deaths, but rather that the additional risk of death resulting from, say a 1-ft increase above the 100-year event are not easily quantifiable.

Regarding the reduction in insurance costs, there are essentially twelve questions that flood insurance determination companies use to establish a rate for a particular property:

1. In what community is the property located?
2. Community Status – Regular or Emergency Program?
3. In what flood zone is the building located?
4. What is the building's date of construction (DOC)?
5. Is the building pre-FIRM or post-FIRM?
6. Is an Elevation Certificate required?
7. What is the occupancy of the building?
8. How many floors in the building (including basement/enclosure)?
9. Does the building have a basement/enclosure?
10. What is the replacement cost of the building?
11. How much insurance is required?
12. What deductible has the client requested?

Answers to these questions establish the physical characteristics of the subject property and the probability of experiencing a flood event. The proposed flood rules provide several advantages to property owners when it comes to their insurance rating. First is the Community Rating System (CRS) program. The National Flood Insurance Program's CRS is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. The CRS program offers a graduated scale of activities that communities can authorize within their jurisdiction. These are floodplain management activities that aim to reduce flood losses, facilitate accurate insurance rating, and promote the awareness of flood insurance. As communities adopt more and more of the CRS activities there is a flood insurance premium discount provided to all residents of that community. These proposed rules will provide all communities in Colorado a higher regulatory standard that communities can readily apply to the CRS program to earn easily quantified CRS automatic points. The automatic points can help communities increase their CRS standing which can lead to reduced flood insurance premiums for every policy holder in the community. The FEMA publication "CRS Credit For Higher Regulatory Standards" dated September, 2002 discusses the fact that when communities go beyond the minimum standards for floodplain management, the CRS can provide discounts up to 45% off flood insurance premiums. Please keep in mind that the CRS is a part of the NFIP, and as such is not a CWCB program. The actual discount for flood insurance premiums will need to be applied for and processed through FEMA, likely on a community by community basis and the actual discounts vary.

Second, these proposed flood rules will provide compliant property owners with a basis for improved flood insurance rating on their structure. Flood Insurance rates are defined in part on the elevation of the first floor of the structure. With the freeboard

requirements, these proposed rules allow property owners to document a 1 foot or 2 foot freeboard above the base flood elevation. The insurance premiums continue to decrease as freeboard increases.

Finally, liabilities following a flood event can be reduced by all affected parties when these proposed rules are in effect. When fewer structures, people, and businesses are affected by a flood event the insurance companies are subject to fewer claims.

**2.3.3 Benefits Studied:** Of all of the above listed benefits, by far the easiest benefit to monetize is the sub-category of Avoided Physical Damages to buildings, contents and Infrastructure. FEMA has adopted Depth-Damage Data from various sources including the USACE and the Federal Insurance Administration (FIA), which easily allows computation of percent damage of building value for varying depth of flood inundation. An example of this data is shown on the following table:

**Table 2.3.3.1  
Sample Depth-Damage Data (USCOE)**

| USCOE Values  |                                       |                          |                              |                            |                           |             |       |
|---|---------------------------------------|--------------------------|------------------------------|----------------------------|---------------------------|-------------|-------|
| Residential Building-GENERIC (% of replacement value) | 1 Story Without Basement              | 2 Story Without Basement | Spilt Level Without Basement | 1 or 2 Story With Basement | Split Level With Basement | Mobile Home | Other |
|   | Percent Damaged (% of Building Value) |                          |                              |                            |                           |             |       |
| Flood Depth (ft)                                      | 0                                     | 0                        | 0                            | 4                          | 3                         | 0           | 0     |
| -8  | 0                                     | 0                        | 0                            | 8                          | 5                         | 0           | 0     |
| -7  | 9                                     | 5                        | 3                            | 11                         | 6                         | 8           | 0     |
| -6  | 14                                    | 9                        | 9                            | 15                         | 16                        | 44          | 0     |
| -5  | 22                                    | 13                       | 13                           | 20                         | 19                        | 63          | 0     |
| -4  | 27                                    | 18                       | 25                           | 23                         | 22                        | 73          | 0     |
| -3  | 29                                    | 20                       | 27                           | 28                         | 27                        | 78          | 0     |
| -2  | 30                                    | 22                       | 28                           | 33                         | 32                        | 80          | 0     |
| -1  | 40                                    | 24                       | 33                           | 38                         | 35                        | 81          | 0     |
| 0   | 43                                    | 26                       | 34                           | 44                         | 35                        | 82          | 0     |
| 1   | 44                                    | 29                       | 41                           | 49                         | 44                        | 82          | 0     |
| 2   | 45                                    | 33                       | 43                           | 51                         | 48                        | 82          | 0     |

These depth-damage relationships for the various types of buildings are built into the FEMA benefit cost analysis software program.

**2.3.4 Costs:** For this study, “costs” are defined as the resources, such as land, labor and material, expended on complying with the regulations by both the entity charged with enforcement of the regulations and also by the user of the improvement (which is this case is most usually an individual property owner). Cost may also be thought of as “dis-benefits.” Similarly to the benefits, there are a several categories of costs with additional sub-groups that are intrinsic to implementing any flood management regulations. The primary category and easiest to monetize are the initial construction costs associated with complying with the rules. Secondary costs can include costs to administer the regulations and other impacts resulting from the rules which may include changes in land use and associated zoning implications.

Costs are generally easier to measure than benefits and easier to value as they represent goods or services that are usually traded for money, such as labor, land and materials. Typical cost categories are:

- Initial Construction Costs
- Secondary Costs
  - Continuing costs
  - Treatment of Revenues, Taxes and Other Transfers
  - Rehabilitation Costs
  - “End of Project” Costs

**Initial Construction Costs:** A project’s initial costs are those that are incurred during the design and construction process. They can include any of the following:

- Planning, Preliminary Engineering, And Project Design
- Floodplain Permitting
- Environmental Permitting Project-Related Staff Training
- Final Engineering
- Land Acquisition
- Construction Costs (Including Improvements To Existing Facilities)
- Equipment Required For Project Operation (Such As Floodproofing Measures)
- Decommission Costs For Facilities No Longer Needed

Typically, a mitigation project involves construction of a project. For this particular analysis, general cost estimates were developed to reflect the costs associated with designing and building a new structure at a designated height above the Base Flood Elevation (BFE). For residential structures, the increase in structure elevation is 1-foot above the BFE, while structures such as hospitals and commercial buildings are set at 2-feet above the BFE. Since the previous building requirements mandated that all structures be built at or above the BFE, the estimated costs only considered the incremental elevation increase as required by the proposed rule change.

The estimated cost of structural fill includes; purchase, transport, placement, compaction, fine grading, and engineering services associated with placement of the structural fill. For small residential sites, the total cost for structural fill was estimated at \$50 per cubic yard. For larger commercial sites, an economy of scale was factored into the estimated cost of \$40 per cubic yard.

The volume of structural fill was determined based on the size of the ground floor of each structure, the height above the BFE that the structure is raised, and a 10H:1V out slope of fill that ties back into the original pre rule-change design grade (i.e. the BFE).

Since the proposed rule change generally affects new construction, costs such as temporary relocation, loss of income, landscaping, and utility relocation have not been included. Since the required elevation of the proposed structure is known prior to the start of planning and/or design efforts, the additional cost of these items are considered negligible for new construction. Similarly, the vast majority of the costs associated with the planning, engineering and project design, and permitting are costs that would be required both with and without the new regulations.

#### Residential – Standard

For a typical 1,000 square foot residential structure, approximately 68 cubic yards of structural fill is required for a total cost of \$3,400.

#### Residential – Luxury

For a 4,000 square foot luxury residential structure, (assuming that the ground floor of the structure includes 2,500 square feet), approximately 181 cubic yards of structural fill is required for a total cost of \$6,850.

#### Commercial – Hospital

For a 15,000 square foot hospital complex (1<sup>st</sup> floor size), approximately 1534 cubic yards of structural fill is required for a total cost of \$61,360.

#### Commercial – Industrial

For a 20,000 square foot industrial structure (1<sup>st</sup> floor size), approximately 1959 cubic yards of structural fill is required for a total cost of \$78,360.

The concept of using fill to elevate new structures is a form of floodproofing that is widely practiced throughout the United States, and is the only type of floodproofing for residential structures that FEMA recognizes. There are a wide number of other types of floodproofing option for commercial structures which include; raising the structure on posts, piles piers or walls; flood shields; “waterproofing” openings; and floodways/levees. Although currently out of print and soon to be revised, there is an excellent description of floodproofing measures in the FEMA produced document *“Floodproofing Non-Residential Structures,”* FEMA-102 dated May, 1986. This document discusses that floodproofing measures have primary and secondary costs. Primary costs include the costs of the basic floodproofing elements: fill, columns floodwalls, levees, and closures. Secondary costs include activities required to assure that the primary floodproofing elements function properly (such as providing access to buildings , interior drainage, backflow prevention, and training of staff to operate the measures).

For purposes of this study, it is assumed that the lowest cost option available to a structure owner will be implemented, and this is likely to be raising the structure on fill.



**Secondary Costs:** Included in this category are the: continuing costs; changes in revenues, taxes and other transfers; and rehabilitation costs. Continuing costs include operation and maintenance as well as agency costs to implement the mitigation program. With respect to the continuing costs, for the most part there are negligible differences costs between the before and after case, that is with the current regulations and with the proposed regulations. It could be argued that if a building was floodproofed (as opposed to raising) then there might be some additional costs associated with training staff to operate floodproofing equipment and to keep the equipment operational. It could also be said that there is some additional cost associated with training agency staff in implementing the new regulations. However, in all cases, these costs would be quite small and not a determining factor in the BCA analysis. With respect to revenue generated from changes in the tax basis of a structure, it is acknowledged that some properties will, under the new regulations, be determined to be in the 1/2-ft floodway where previously the property was in the floodplain but not in a defined floodway. While this could change the zoning of the property with respect to tax levies, it would also be argued that the tax standing of the surrounding property would have an enhanced tax position. Accordingly, it was decided to exclude any potential costs differences due to tax revenue change. (See the discussion on the study reach for more on this issue).

Rehabilitation costs are future costs particularly related to cost of repairs and improvements beyond those of routine maintenance. Examples of this would be in the case of a building within the floodplain that is substantially damaged, or it is desired to substantially improve the building.

By FEMA definition, Substantial Damage means damage of any origin sustained by a structure whereby the cost of restoring the structure to its before damage condition would equal or exceed 50 percent of the market value or replacement cost of the structure before the damage occurred. (Note: The cost of the repairs must include all costs necessary to fully repair the structure to its "before damage" condition.) Substantial Improvement means any reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds 50 percent of the market value of the structure before the "start of construction" of the improvement. If a building is "substantially damaged" or "substantially improved", it must be brought into compliance with the effective rules and regulations. It is therefore possible that an existing structure, permitted under the current regulations could be impacted by the proposed regulations.

Structures are substantially improved in one of five ways: 1) Rehabilitations – improvements made to an existing structure which does not affect the external dimensions of the structure; 2) Additions – improvements that increase the square footage of a structure; 3) Reconstruction – cases where an entire structure is destroyed by damage or is purposefully demolished or razed and a new structure is built on the old foundation or slab; 4) Substantial Damage – structures that are considered substantially damaged due to a disaster, and the damages are repaired (recognized as improvements); 5.) Improvements that exceed 1 and 2 above but that do not hydraulically impede the floodway or floodplain. Obviously, there are a number of

directions that could be taken in the special instances of substantially damaged and substantially improved structures, and all of these are specific to a particular structure. Costs for such rehabilitations will range widely and are well beyond the scope of this study. It should be pointed out, however, that part of the purpose of the NFIP is to encourage people with structures in the floodplain to purchase flood insurance. A properly insured structure may have no increase due the new regulations. The Standard Flood Insurance Policy has a provision that will pay the policy holder to comply with a State or local floodplain management law or ordinance affecting repair or reconstruction of a structure suffering flood damage.

**2.3.5 Discount Rate:** When it comes to stemming the increasing losses from natural disasters, there is no more valuable option than mitigation. Evaluating the true effectiveness of an alternative mitigation project (or in this case, evaluating the effectiveness of a proposed rule change), requires assumptions regarding the time value of money. In comparing one potential mitigation measure against another, it is important to compare apples to apples, that is, use the same discount rate for both options. In general, the lower the discount rate, the higher the economic benefit of the mitigation measure. For federally funded mitigation projects, the function of a discount rate is to measure the “opportunity costs” of withdrawing resources from private use to be used instead in the public sector. In the case of a regulatory action, such as the rules changes, the function of the discount rate is to express the social rate of time preference, which is simply the discount individuals want for waiting a year for a dollar rather than having the dollar today. Because the government programs and impacts of regulation typically occur over a long period of time (50- to 100-years), the problem becomes identifying the appropriate rate which captures long-term social opportunity costs. To do this, we start first with reviewing discount rates typically used on projects.

The Federal economic oversight agencies have differing views on what the appropriate discount rate should be. This is demonstrated by the following table:

**Table 2.3.5.1  
Federal Agency Discount Rates**

| Agency  | Acronym | Discount Rate |
|---|---------|---------------|
| Congressional Budget Office <sup>1</sup>                                | CBO     | 2%            |
| National Center for Environmental Decision-Making Research <sup>2</sup> | NCEDR   | 1.5 – 3%      |
| Government Accountability Office <sup>3</sup>                           | GAO     | 3%            |
| US Army Corps of Engineers <sup>4</sup>                                 | USACE   | 4.375%        |
| Office of Management and Budget <sup>5</sup>                            | OMB     | 7%            |

<sup>1</sup>Discount Rate based on the real yield of Treasury debt.

<sup>2</sup>Based upon a valid intergenerational useful life.

<sup>3</sup>Based on yield of Treasury debt tied to maturity of projected length of project.

<sup>4</sup>Average yield in 2010 on interest bearing marketable securities with 15-years maturity.

<sup>5</sup>Based upon US Treasury borrowing rate.

FEMA’s benefit-cost analysis software program requires analysis of the future benefits of projects all brought back to a present worth value. To do this, a project’s benefits are

multiplied by a net present value coefficient based upon a defined discount rate and an assumed project life. In order to provide a national consistency in comparing mitigation alternatives that are competing for limited funding, FEMA is required to adopt the discount rate as adopted by the Office of Management and Budget (OMB). As shown above, the OMB has mandated a 7% discount rate as defined in the OMB Circular A-94, Section 8.b.1. In a white paper entitled “Discount Rate”, dated 05/17/08, the ASFPM has noted that the OMB has not changed its prescribed rate since 1992 and has requested a national discussion to define an appropriate rate. ASFPM believes:

1. FEMA should approach OMB to seek a reassessment of the regulations governing benefit-cost analyses, and;
2. FEMA should, in conjunction with OMB, convene a task force of national economic experts to discuss national benefit-cost analysis policies.

Based upon input from the Focus Group, a discount rate of 4.375% commiserate with the USACE, was selected for use as the discount rate to be utilized in the CWCB rules Cost-Benefit and Regulation analysis.

## 2.4 Colorado At A Glance

The enormity of the effort required to conduct a detailed cost – benefit and regulatory analysis on each of the riverine basins within Colorado is demonstrated on the following exhibit. We have estimated that Colorado has approximately 2,300 miles of waterways that have detailed floodplain studies conducted for communities that have not already adopted stricter standards than the proposed rule changes. It became quickly apparent that a means of streamlining the analysis would be required. This is relatively easy due to the fact that if it can be shown that if a favorable cost benefit relationship exists for one building of a certain classification, then the same relative relationship should exist for all such building classifications. Furthermore, it is not necessary to define all of the benefits that would result from the rule changes, but rather it is only necessary to show that adequate benefits likely exist that outweigh the expected costs.

Table 2.4.1 which follows presents a summary of data presented in the draft report “Flood Hazard Mitigation Plan For Colorado” dated September, 2010. The source of local risk assessment information was from available local hazard mitigation plans. State level risk assessment was based on available HAZUS flood analyses and supplemented with an analysis of flood insurance claims data. Counties most at risk were determined following an evaluation of: displaced population, building loss, per capita loss, repetitive loss, NFIP claims and claims monies paid out. Note that the HAZUS-MH data was not used directly for the BCA analysis.

**Table 2.4.1 Colorado’s Flood Risk**

|                            |                          |
|----------------------------|--------------------------|
| 2000 Population            | 4,389,123                |
| 100-Year Building Count    | 65,000                   |
| Value of Buildings Exposed |                          |
| Structures                 | \$326,119,302,000        |
| Contents                   | \$212,202,645,000        |
| <b>Total</b>               | <b>\$538,321,947,000</b> |
| Estimated 100-Year Damage  |                          |
| Structures                 | \$2,015,753,000          |
| Contents                   | \$2,930,051,000          |
| <b>Total</b>               | <b>\$4,945,804,000</b>   |

Colorado Proposed Floodplain Rule Changes:

## What Waterways Are Most Impacted?

The Big Picture: The intent is that all the rule changes would apply statewide, but not all of the rules directly impact all areas of the state.

Subset Area 1: Colorado has approximately **50,000** miles +/- of rivers, creeks, gulches and other waterways

Subset Area 2: Approximately **37,243** miles of these waterways have FEMA designated floodplains

Subset Area 3: Of the FEMA designated floodplains, approximately **2,575** miles have detailed studies with designated BFE's and defined floodways (detailed studies)

Subset Area 4: Of those floodplains with detailed studies, some already meet or exceed the proposed new rule standards leaving approximately **2300** miles of waterways that meet only the FEMA minimum standards.

**However, keep in mind that in general, the rules will not be retroactively applied to existing structures, only to proposed new or substantially damaged existing structures and new substantial improvements or additions to existing structures that are in Subset Area 4.**

Colorado has about 103,730 square miles of land and about 371 square miles of water area (0.36%)

As of 2008-02-01, the [U.S. Board on Geographic Names](#) had identified 5,564 natural streams in Colorado

There are estimated to be 250,000 people living in 65,000 homes along with 15,000 commercial, industrial, and business structures in identified floodplains.

Detailed studies include an analysis that depicts the 1% annual chance floodplain, Base Flood Elevations, cross-section locations, stream stations, and non-encroachment widths.

Sample communities that have already adopted some stricter standards than the FEMA minimum standards include:

*Fort Collins*

*Boulder*

*Cherry Hills Village*

*Arapahoe County*

*Eagle County*

*Grand Junction*

## 3. Methodology

### 3.1 Introduction

This benefit cost analysis considers both qualitative and quantitative approaches. The qualitative analysis is useful to identify the key issues of the analysis. These key issues are then evaluated within the quantitative process. The result is a methodology that provides a benefit cost analysis for the three primary rule changes: Rule 6, Rule 8, and Rule 11.

### 3.2. Qualitative Analysis

**3.2.1 Background:** The qualitative analysis began with the first published version of the proposed rules in approximately April 2010. The statewide scope of the proposed rules was determined to be too large and variable for a full scale analysis within the timeframe and budget for this study. Also, a fundamental principal of the entire analysis was linked to the fact that the rules are not retroactively enforced on existing structures. (New construction of substantial improvements to existing structures is affected by the proposed rules.) That reduces the amount of existing structure or floodplain data that can be reliably aggregated, analyzed, and extrapolated statewide.

Ultimately, the analysis settled towards a generic methodology that could be used for a given unit on a given floodplain. Another fundamental concept of the analysis was the difference between proposed rule and existing rule. The analysis needed to consider the existing rules as the baseline. The impacts of the new rule were measured off that baseline. Therefore, consideration of a schematic floodplain and the impacts of the proposed rules over the existing rules provided a foundation for this portion of the analysis.

**3.2.2 Schematics:** Figures 3.2.2.1 and 3.2.2.2 provide a schematic floodplain with unique locations identified across the exhibits. The schematic floodplain is intended to represent the different areas within a typical floodplain in terms of regulation. The schematic drawings assume that a floodway meeting minimum FEMA standards has been defined, however please note that as discussed in Section 2.4, the majority of Colorado's waterways do not have designated BFE's and floodways. The size, shape, and orientation are not specifically representative of actual floodplain delineations.

Figure 3.2.2.1 identifies three classifications of structure/property. Property A is outside of the 100-year floodplain; Property B is within the floodplain but outside of a defined floodway, while Property D is within a defined floodway. Table 3.2.2.1 defines the impact of the existing rules for each property classification and for three categories of structures: Critical Facility; Commercial and Residential.

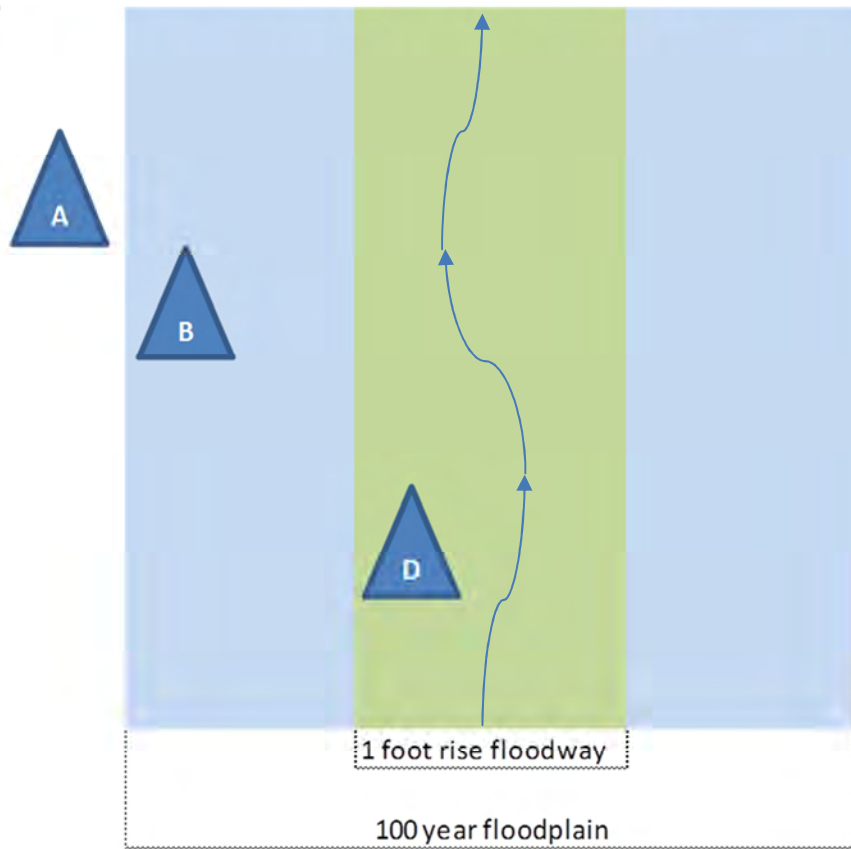
Figure 3.2.2.2 demonstrates that under the proposed rules, it is possible that once a 1/2-foot rise floodway is determined, that the width of the floodway will likely expand, and a fourth classification of structure/property will occur. Property Classification "C" are properties that under the existing rules would be considered Property B's but are now within the expanded definition of the floodway using the 1/2-foot determination, hence the

new classification. Table 3.2.2.2 defines the impact of the proposed rules for each property classification and for the same three structure category.

Please note that the property classifications (“a” through “d”) are defined only for discussion purposes with this study and are not official classifications under the existing or proposed rules.

Upon examining an aerial photograph of a segment of an actual floodplain (see the following Figure 3.2.2.3) it becomes obvious that there can be a confusing array of improvements that are impacted by floods. This impact occurs whether the floodplains are administered under the existing floodplain rules or those being proposed. This impact occurs to those buildings nearest the actual channel, particularly those in the floodway, and extends out to include all of the buildings in the floodplain but also indirectly impacts structures and those that inhabit them well beyond the defined limits of a flood. To order to categorize the potential levels of impact, this analysis utilized the schematic representations of differing building classifications as shown on Figures 3.2.2.1 and 3.2.2.2.

## Flood Hazard Areas – Existing Rules



**Figure 3.2.2.1 Schematic Floodplain Under Existing Rules**  
Structure locations A, B and D are all possible under this scenario.

**Table 3.2.2.1  
Schematic Building Classifications Under Existing Rules**

Impact of Existing Rules

| If the proposed ** structure is a: |                   |   |   |   |
|------------------------------------|-------------------|---|---|---|
|                                    | Critical Facility | Commercial  | Residential   |   |
| That is built at location:         | A                 | no regulation                                       | no regulation                                       | no regulation                                       |
|                                    | B                 | 0' freeboard<br>(must build at<br>or above the BFE) | 0' freeboard<br>(must build at<br>or above the BFE) | 0' freeboard<br>(must build at<br>or above the BFE) |
|                                    | D                 | 0' freeboard<br>0.00' rise                          | 0' freeboard<br>0.00' rise                          | 0' freeboard<br>0.00' rise                          |

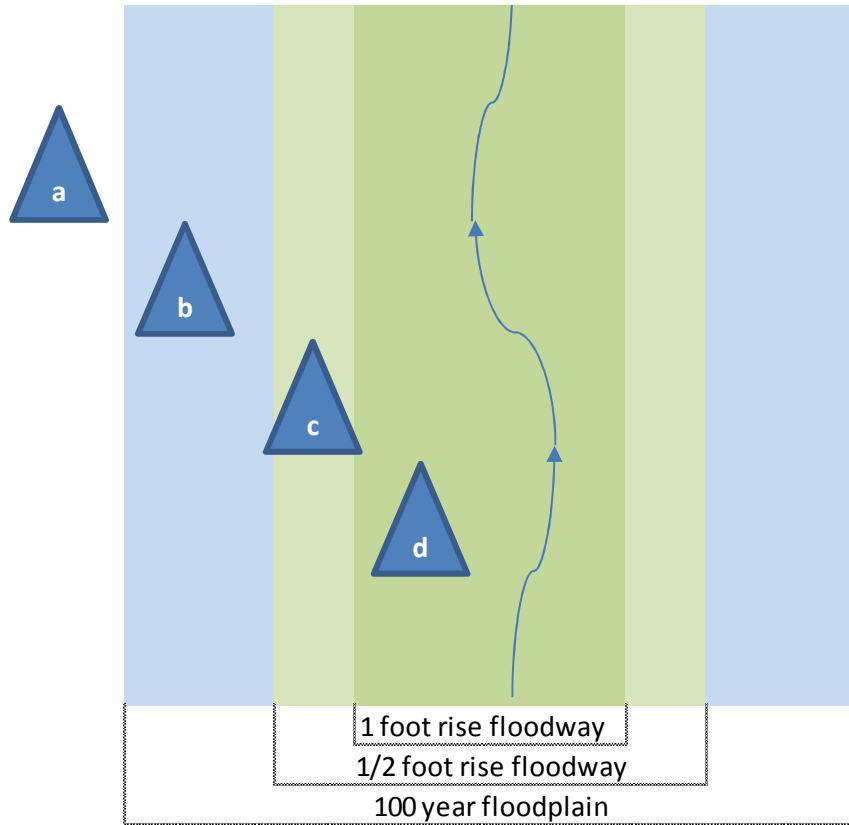
*\*\* there is no impact on existing structures at any location, until they are substantially improved at which time they must meet the current regulations*

Definitions:

" **0.00 ' rise** "Development in a floodway must prove that the structure does not cause any rise in flood elevations. If construction is proposed in the floodway and the hydraulic model shows that the flood elevation increases even 0.01-foot because of the proposed construction then the construction is no allowed.



## Flood Hazard Areas – Proposed Rules



**Figure 3.2.2.2 Schematic Floodplain Under Proposed Rules**  
Structure locations a, b, c and d are all possible under this scenario.

**Table 3.2.2.2  
Schematic Building Classifications Under Proposed Rules**

Impact of Proposed Flood Rules\*

| If the proposed** structure is a: |                   |   |   |   |
|-----------------------------------|-------------------|---|---|---|
|                                   | Critical Facility | Commercial  | Residential   |   |
| That is built at location:        | a                 | <i>no change from existing rules</i>                        | <i>no change from existing rules</i>                        | <i>no change from existing rules</i>                        |
|                                   | b                 | 2' freeboard  | 1' freeboard  | 1' freeboard  |
|                                   | c                 | 0.00' rise and 2' freeboard ***                             | 0.00' rise and 1' freeboard***                              | 0.00' rise and 1' freeboard***                              |
|                                   | d                 | 2' freeboard<br><i>(in addition to existing 0.00' rise)</i> | 1' freeboard<br><i>(in addition to existing 0.00' rise)</i> | 1' freeboard<br><i>(in addition to existing 0.00' rise)</i> |

\* for communities with FEMA or CWCB designated Base Flood Elevations

\*\* there is no impact on existing structures at any location, until they are substantially improved at which time they must meet the regulations

\*\*\* The proposed floodway rule (Rule 8) only applies when a floodway has been adopted; if there is no adopted floodway, locations c and d have the same requirements at location b.

Definitions:

" **0.00' rise** " Development in a floodway must prove that the structure does not cause any rise in flood elevations. If construction is proposed in the floodway and the hydraulic model shows that the flood elevation increases even 0.01-foot because of the construction, then the construction is not allowed.



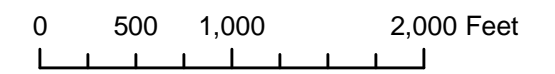
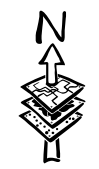
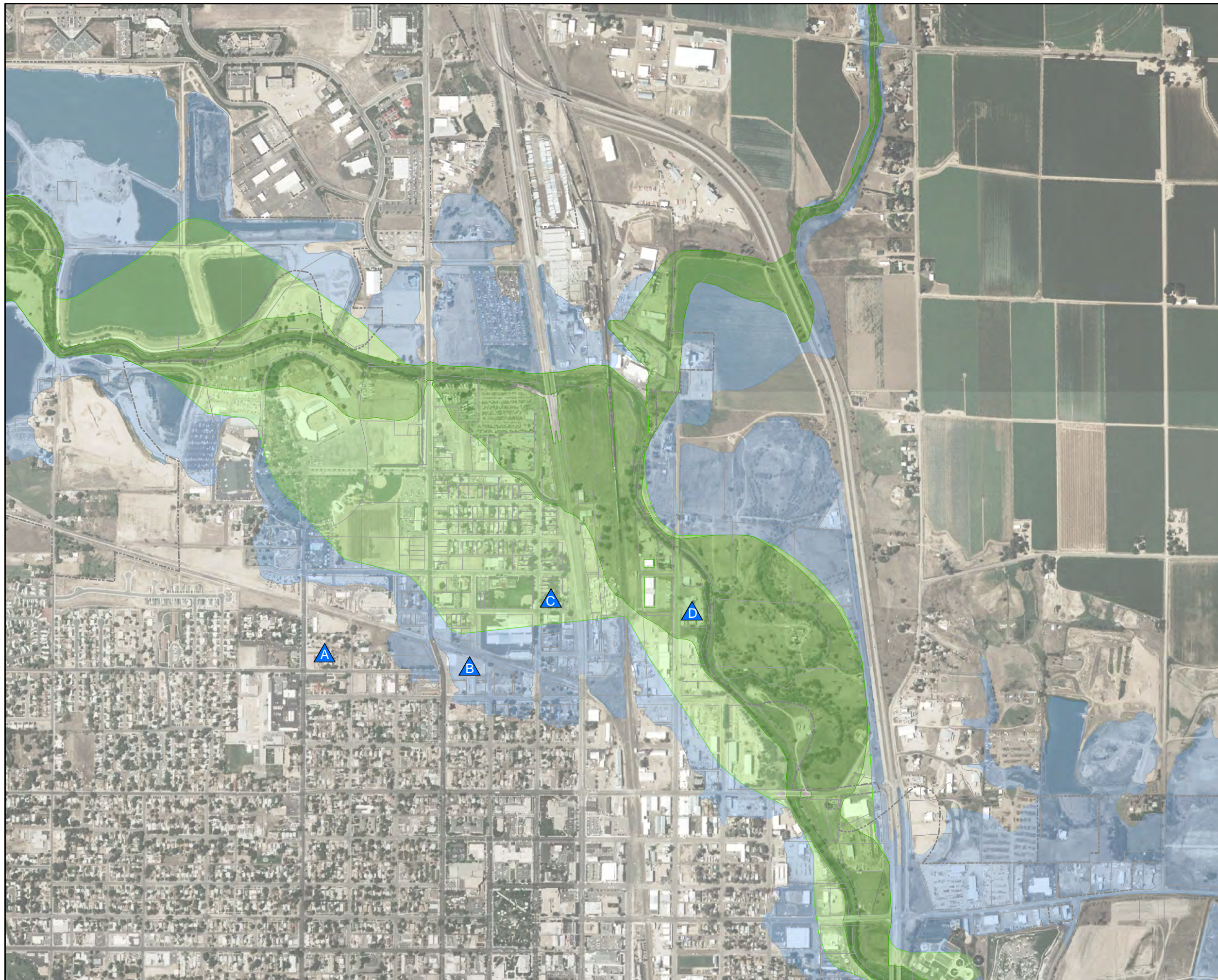
# Figure 3.2.2.3 CWCB Proposed Flood Rules

Sample Reach

**Legend**

**Flood Hazard Area**

- 1 foot rise floodway
- 1/2 foot rise floodway
- 100 year floodplain





**3.2.3 Proposed Rules vs. Existing Rules:** This delta-based analysis focused on the difference in cost for implementing the new rules versus the existing rules. Many of the costs of implementation and management of the new rules are already costs within the existing rules. The proposed rules are enhancing the existing floodplain management concepts that are already well established across the state. The qualitative analysis determined several of the similarities between the existing and proposed rules. The differences were also identified and ultimately became part of the quantitative benefit cost analysis.

For Rule 6, Critical Facilities, the existing requirement is to build at or above BFE. This requires an engineering analysis and typical floodplain management efforts to confirm the proposed improvements and their compliance with the base flood elevation. The proposed rule requires the same engineering analysis, but raises the regulatory elevation two feet above the base flood elevation. There are incrementally increased design and construction costs and averted damage benefits associated with the elevation (or flood proofing) of the structure to be included in the quantitative analysis. However, certain aspects, such as the design costs are only marginally affected, that is, the engineering effort for a 1-foot freeboard is not significantly greater than for a 2 foot freeboard.

For Rule 8, 1/2-foot regulatory floodway, the regulatory floodway criteria (0.00-foot rise) are expanded laterally beyond the existing 1-foot regulatory floodway limits. (A 1/2-ft floodway is typically, but not always wider than a 1' floodway.) The qualitative analysis considers the cost of compliance and the impact to the affected properties. There is no change in the required engineering analysis for a *proposed* development. Under the existing rules, any proposed development site within any regulatory floodplain is required to complete an analysis to verify that the project impact is equal or less than 1 foot. Under the proposed rules, any proposed development site within any regulatory floodplain is required to complete an analysis to verify that the project impact is equal or less than 1/2-foot. Therefore, the new cost of compliance for a proposed structure with the new rule is effectively zero since the same hydraulic modeling must be completed in either case. This results in an undefined benefit cost ratio for the proposed structure. This is explained in greater detail within the quantitative analysis.

For an *existing* structure anywhere in the floodplain (location a, b, c, or d), there is a specific benefit to the 1/2-foot floodway rule: decreased flood depths from allowed encroachments. The existing 1' floodway regulation allows a property adjacent to a given existing structure to encroach (build, fill, change, etc.) upon the floodplain provided the impact (increase in flood depth) on adjacent properties is less than 1 foot. A project that raises the floodplain 11.9 inches would be acceptable. By enforcing a 1/2-foot floodway, the allowable rise in the flood elevations is less than 1/2 foot (6 inches). Therefore, the 1/2-foot floodway serves to protect all existing structures within the floodplain to a greater degree.

The Focus Group discussed the possibility of devaluation of lands within the new 1/2-foot floodway – the area shown on the previous schematics for Location c. The concern

over decreased property values relates to the requirement of a 0.00-foot rise for any improvements built within the floodway. In order to meet this 0.00-foot rise, or No-Rise criteria, it is difficult, but not impossible, to design a structure that can be modeled without an impact of even a hundredth of a foot. However, qualitatively there are two main conciliatory benefits for the potential devaluation of the ½-foot floodway: improved adjacent land values and alternative profitable land uses.

**Improved Adjacent Land Values.** The ½-foot floodway specifically reduces flood risk and damages to all structures in and immediately adjacent to a floodplain. This reduced risk has stated soft and hard benefits as previously discussed, not the least of which is increased land value. Property abutting open space and natural areas is a frequently advertised amenity and benefit that not all development sites can offer.

**Alternative Profitable Land Uses.** The No-Rise criterion does not at all prohibit any development or land use change. For example, golf courses, conservation easements, parks, trails, natural areas, lakes, ponds, utility easements, and many other uses are allowed.

**Other Considerations.** In rural communities there is the potential that a decreased valuation of land resulting from the ½-foot floodway rule could be a benefit due to the attendant decrease in taxes to be paid, and the off-setting increase in available funds for alternate use. Previous sections of this report have identified many other soft and hard benefits that are considered in qualitative evaluation of these proposed rules. Significant additional benefits of natural floodplain functions and riparian habitat have been identified by a variety of groups interested in natural resource conservation.

For Rule 11, 1-foot freeboard, the existing requirement is to build at or above BFE. The analysis between existing and proposed rules is nearly identical to the discussion previously for Rule 6 – the only difference between the height of freeboard.

### **3.3 Quantitative Analysis**

The quantitative analysis focused on the three primary rule changes, the benefit of averted damages, and the costs of compliance with the new rules.

**3.3.1 FEMA BCA Tool:** The Federal Emergency Management Agency’s software program “FEMA BCA 4.5.5” was utilized to compute the averted damages. The program is built to compute benefits and costs for flood hazard mitigation projects. Values for flood hazards, discount rate, structure, mitigation costs, and project expected life parameters are input. The output is averted damages as benefits divided by the mitigation costs to get a benefit-cost ratio.

For this application, the program was utilized to compute various scenarios of the proposed rules compared to the existing rules. In terms of the software functions, the pre-project condition was built to a “before proposed rule” parameters and the post-project condition was built to a “with proposed rule” parameters. For example, for Rule 6, Critical Facilities, this was input as an Industrial building built at the BFE as the pre-project condition and then an Industrial building built at BFE + 2 as the post-project condition.

**3.3.2 Input Data:** The FEMA software program input requires an actual flood hazard profile to accurately represent flood depths across a range of flood frequencies. The proposed flood rules analysis utilized an effective FEMA profile as the source for channel thalweg and flood depths at various frequencies. The sample location was the Cache La Poudre River, just upstream of Greeley.

**3.3.3 Discount Rate:** As discussed previously, the discount rate is a key component of any benefit cost analysis. The FEMA BCA tool does not allow direct alteration of the federal Office of Management and Budget (OMB) discount rate. Therefore, this analysis utilized the averted damages output from the FEMA BCA tool and computed the benefit cost ratio separately based on present worth computations. This analysis utilized the United States Army Corp of Engineer's 2010 discount rate of 4.375%. This rate is considered to be conservative in that many technical arguments could be offered that the discount rate should be in the range of 1% to 2%, given the public good nature of flood protection and the long time horizon of the analysis. The uniform series present worth factor for that discount rate was calculated as:

$$PW = \frac{(1+i)^n - 1}{i(1+i)^n}$$

*Where  $i = 4.375\%$ , for  $n = 30$  years and 100 years*

**3.3.4 Project Life (Duration):** Any benefit cost analysis annualizes the benefits and costs over a time interval. For flood damage analyses, the duration of the analysis is uniquely linked to the probability of flood events. Though rare, large damage storm events still have an annual chance of recurrence. And more importantly, smaller storms with a high annual chance of recurrence still have damages that add up over time. For this analysis, there were two project life durations selected: 30 year and 100 year to establish a reasonable bounds evaluation.

The 30 year duration is useful for comparison to the term of a typical residential home mortgage. It becomes a relatable frame of reference for a property owner to perceive the risk to the investment. However, it is not a particularly valid period to compare to the useful life of a structure or property.

A 100 year duration is appropriate for more accurately representing the useful life of a structure or a property. However, it is not as relatable as a frame of reference for a property owner as they are not likely to live that long at one property.

Other frequencies can be run through the model as needed.

**3.3.5 Depth Damage Curves:** The FEMA BCA tool utilizes the FIA and USACE depth damage curves depending on building type to compute annualized flood damages across a given project expected life or project duration. The curves are established for a variety of building types. Further information related to the sample structures selected for this analysis is included below.

**3.3.6 Sample Structures:** The qualitative analysis identified two building types for further analysis: residential and commercial. As the quantitative analysis developed, it

became evident that a total of four structures could be more representative of the variety of building types encountered in a typical floodplain. The four structures that were selected for this analysis are:

- Standard Residential. 1000 square feet. Single story. This structure was selected as a simple and scalable example that can represent the baseline concepts of the analysis.
- Luxury Residential. 4000 SF. Multi-story. This structure was selected as exemplary of a high end residential structure that can provide the analysis a near bounding limit of residential impacts.
- Commercial Hospital. A hospital was selected as one of the commercial properties to expose the specific benefits of flood protection for critical facilities. The FEMA BCA tool considers factors such as the number of beds and distance between example site and hospital to compute the averted damages of having the structure flood proofed or elevated.
- Commercial Industrial. An industrial building was selected as the other commercial property to show the benefits of flood protection for a non-critical commercial building. This structure becomes a useful reference comparison to the critical facility when considering the additional emergency services of a structure directly serving the community in and following a flood event.

The representative structures are certainly not inclusive of the varieties of residential and non-residential buildings possible within Colorado. The residential structures cover both small and large square footage, single and multi-story, and as noted likely bound the limits of residential impacts. The non-residential structures cover critical and non-critical, but obviously don't cover the wide range of possible industry architectures. Given the limitations of a statewide analysis, the selected structures are considered appropriate and representative.

### **3.3.7 Building Replacement Values:**

The building replacement value is input to the FEMA BCA tool to determine reconstruction and recovery costs for each building type. These values are subject to economic variability over time and community. However, when utilized for the relative difference between pre-rule and post-rule scenarios it is a consistent value for each building type. These costs were estimated from a variety of construction cost estimating tools such as RS Means construction cost index and Building Value websites. These costs can be adjusted for various zip codes if necessary to expand the benefit cost analysis comparison between specific communities.

**3.3.8 Costs:** Within the context of this analysis, these costs are considered to be the costs to design and physically construct improvements to comply with the proposed rules. As stated previously, there are no new administrative fees or costs compared to the existing rules. These are one-time costs to comply with the requirements of the proposed rules. Given the multiplicative variability of the methods of compliance (earth fill, structural foundation, flood-proofing, etc), site specific conditions (slope, soils, zoning, etc), and building type (architecture, materials, accessibility, etc) this analysis attempted to select a common approach that trends towards the minimum cost of

compliance. As an example, elaborate or ornate floodwalls were not utilized in favor of a uniform earthen fill to create needed freeboard. The benefit cost analysis then compares a one-time initial cost annualized over a 30 or 100 year useful life compared to averted damages from recurrent flood damages over that same time period.

This analysis can also be interpreted from a maximum bounding condition perspective. Any specific scenario can compute all reasonable costs of compliance for the selected recurrence interval. Provided those costs of compliance are below the total benefits, the benefit cost ratio is still equal to or greater than 1.0.

**3.3.8.1 Rule 6 Costs:** For Rule 6, Critical Facilities, the two foot freeboard requirement was considered to increase construction cost of the foundation elements of a common commercial building. Given that a foundation for a structure at the BFE is substantially similar to a foundation for a building 2 feet higher, this analysis assumed an extension of existing foundation materials. Additional fill and building orientation was assumed to achieve access to the elevated first floor. These costs would apply to either a new proposed critical facility or a proposed substantial improvement to an existing critical facility.

Flood-proofing is a FEMA allowed equivalent to elevating for non-residential structures and could be utilized to comply with proposed Rule 6. Flood-proofing costs are available for a variety of flood-proofing methods. The proposed freeboard rules provide an interesting offset to the flood-proofing costs in terms of an insurance rating. When a flood-proofed structure is rated for insurance it is rated 1 foot below the flood-proofed elevation. By adding 2 feet of freeboard for critical facilities (and 1 foot for all other structures) the flood-proofed elevation is above (or at) the BFE. The result is a reduction in flood insurance premium. Additional information on flood-proofing is available in the appendix.

**3.3.8.2 Rule 8 Costs:** For Rule 8, the ½' floodway, the costs are more difficult to quantify. This analysis evaluated costs for the ½' floodway rule in three ways: first, quantitatively as a cost of compliance for the new rule and second, qualitatively in terms of land valuation; and thirdly, tax revenue loss to community. And, as explained above, this analysis also considered the benefits and costs to both existing and proposed structures for this rule. The ½' floodway provides benefits to ALL structures within a floodplain.

For cost of compliance of the new ½' floodway rule, there is no physical change, alteration, or revision required for *existing* structures to comply. As noted above, the existing structure, no matter the location a, b, c, or d in the schematic floodplain, incurs no cost to benefit from the regulation reducing the allowable increase in flood depths. Furthermore, the benefits (avoided damages) are HIGHER for existing structures compared to proposed structures for this rule. (The proposed structures are already subject to the 1' freeboard rule and therefore remain ½' above the BFE and already avoid damages.)

This rule only affects a sub-set of proposed structures in the floodplain: a proposed structure in a Zone AE floodplain with a defined ½' floodway. A proposed structure in a



Zone A floodplain or a Zone AE floodplain with an existing 1' floodway is not affected by this rule. A proposed structure in the Zone A or AE floodplain has to prove no rise greater than 1 foot, regardless of location a, b, or c in the schematic floodplain. If a structure is proposed in the existing Zone AE 1' floodway, then it must comply with the existing no-rise criteria.

Quantifying costs for design and construction of a sub-set of **proposed** structures that meet the No-Rise criteria when neither the structure nor the floodway yet exist is extraordinarily abstract. On the other hand, it is reasonable to assume that those costs will far exceed the benefits for a single structure as considered in this building unit analysis. Unfortunately, it is equally abstract to compute the net benefits of a ½' floodway for a given stream reach analysis. The potential totals of existing and proposed structures for any given stream reach could vary from zero to hundreds. The permutations of the combination of existing and proposed structures would inevitably lead to divergent conclusions. However, for the purposes of establishing a boundary condition on that scenario, a conceptual estimate of the benefit cost for a stream reach is provided in the appendix.

**3.2.8.3 Rule 11 Costs:** For Rule 11, 1 foot freeboard for construction within a defined floodplain, the cost assumptions were similar to that of Rule 6 for critical facilities. Empirical information on historical compliance with the existing rule of building at the BFE indicates that structural fill is a common method. So, for the proposed rules, elevating the first floor of the structure was assumed based on structural fill. Other methods are available, but given the relatively low impact to access and functionality of a 1 foot elevation rise, structural fill seems most logical for most residential scenarios.

Interestingly, there is an established minimum-cost compliance technique for this rule that can be utilized in nearly any residential situation and many commercial scenarios. Excavated material from the foundation is often exported from the site at a cost to the owner. With very little design change, the first floor elevation is raised to comply with the proposed rule and the excavated foundation material is utilized as on-site backfill at the perimeter of the structure. The backfill provides frost-protection, positive drainage, and other common requirements of the building code as well as compliance with the new rule – with the additional benefit of a construction cost savings.

Similarly, for a non-critical commercial building affected by Rule 11, structural fill is assumed to be a common method of compliance. However, flood-proofing is another acceptable method for commercial structures to comply with this rule. Additional flood-proofing information is discussed under Rule 6 above and within the appendix.

A subsequent iteration of the analysis for this rule could compute benefits for a commercial structure against the costs to flood-proof the building in compliance with the freeboard requirements.

**3.3.9 Concurrent Implementation:** It is important to note that the quantitative analysis would be different if either of the freeboard rules were excluded. The benefits of the ½ foot floodway rule include the freeboard requirements for proposed structures. This

analysis is partially invalidated without the concurrent implementation of the proposed rules.

### **3.4 Sample Reach Analysis**

**3.4.1 Introduction:** Through the course of the unit analysis there was feedback from the Focus Group to that it would be advisable to test the unit analysis concept by actually conducting a BCA on a sample stream reach in a community. Early iterations of the analysis identified community based and sample geography based approaches. Then further investigation of the variables related to the application of freeboard to the locations of existing, but especially future, structures concluded that a schematic unit analysis was more appropriate. However, the ½-foot floodway regulation (Rule 8) is not as dependent on specific locations particularly of existing structures. Therefore, it was determined that a sample reach could evaluate the benefits and costs of Rule 8.

The purpose of the sample reach analysis is to evaluate the benefits and costs of implementing a ½-foot floodway standard. The analysis considers existing structures and currently vacant land within a modeled ½-foot floodway for a sample stream reach.

**3.4.2 Data Collection:** Weld County officials provided GIS spatial datasets for use in the sample stream reach analysis. This included a full detail flood hazard delineation for the Cache La Poudre River, a point file of buildings in the floodplain, and County Assessor information on a parcel basis trimmed to the flood hazard area. The Colorado Water Conservation Board (CWCB) provided access to the 2007 HEC-2 hydraulic model completed by the US Army Corps of Engineers for the Cache La Poudre River.

From that data, it was determined that the sample reach would be approximately 2.5 miles of the Cache La Poudre River on the west (upstream) side of Greeley. The reach is generally bound on the upstream, west by North 25<sup>th</sup> Avenue downstream to East 8<sup>th</sup> Street. This is also roughly FEMA cross section AC to FEMA cross section N. The reach is approximately 1-mile of unincorporated County jurisdiction and 1.5-miles of City jurisdiction.

**3.4.3 Method:** The sample reach analysis started with review and formatting of the collected data. The hydraulic modeling and parcel data initial work were completed concurrently. The FEMA BCA analysis followed compilation of both hydraulic model and parcel data.

**Hydraulic Model:** The HEC-2 hydraulic model was imported into HEC-RAS. This provides improved processing time and floodway modeling routines. However, there is a known difference in the bridge processing routines. Due to time constraints, the bridge parameters were not re-modeled. The ½' floodway encroachments were computed, tabulated, and plotted on a workmap. A modified output table was produced to show cross sections; 10, 50, 100, and 500 year discharges; and minimum channel elevation.

**Parcel Data:** The assessor data was filtered to include the area of interest. Parcel data was spatially joined to cross sections for the purposes of assigning water surface elevations from the model's output table. The output table data was assigned to parcels on a nearest proximity basis. The parcel data was then organized to match the import template for the FEMA BCA software. This required a unique identifier, building type, total square footage, building replacement value as improvements assessed value, and basic address information (zip code, state, etc.).

The parcel data was also organized to identify vacant parcels as those without a point from the supplied building shapefile. The vacant parcels were summarized to identify three locations (similar to the schematic floodplain example): existing 1' floodway, proposed 1/2' floodway, and 100 year floodplain. If a parcel was more than 50% within a certain zone (1', 1/2' or 100 year) it is assumed that will be the dominating land use restriction. Therefore, several parcels cross a portion of either or both the 1' or 1/2' floodway, but are assigned to only one of the categories. Similarly, there are parcels that extended into the floodways but are estimated to have more than half of the land area in the 100 year floodplain and are attributed accordingly for the purposes of this analysis.

The building data was then joined with the parcel data to link the water surface elevations, channel elevation, and structure value information to each structure.

There were some changes made to the parcel and building information based on preliminary review of the data set. These included revisions to total square footage of buildings that were listed as 1 square foot. The small area led to extraordinarily high costs per square foot that would incorrectly skew the results. These 1 square foot buildings were adjusted to 499 square foot buildings as a minimum floor area based very roughly on aerial photo investigation. The addresses were simplified to all Colorado addresses in an attempt to resolve import errors. Tax exempt parcels were highlighted for easy identification later in the process. Finally, the structure name was modified to remove special characters that conflicted with the automated import.

**FEMA BCA:** The combined parcel, building, and water surface elevation data was imported into the FEMA BCA software. The building information is an automated import routine and populated the structures in the FEMA BCA tool. The flood hazard information must be manually entered for each structure.

**BCA Procedure:** As noted, the procedure is partially automated through the FEMA BCA tool. The building information was auto-populated and resulted in approximately 239 structures in the model. Then each individual structure was input with flood hazard information.

The first few pages of the structure information were setup with typical information on type of project, source of data, and answers to basic setup questions.

The project life was set to 100 years. This is assumed to fairly represent the service life of a typical structure in the floodplain. A 30-year analysis was also conducted for comparison purposes.

The FEMA BCA tool automatically defaults to a 7% discount rate. Therefore, damages averted and costs related to land use were computed and tabulated at the 4.375% discount rate in a separate spreadsheet similarly to the process followed for the Unit Analysis discussed previously.

The first floor elevation was set to the Base Flood Elevation (BFE). This was done for two reasons. First, it follows the assumption that existing structures are built compliant with existing rules – built at or above the BFE. Second, time and scope prohibited collection or compilation of survey grade finished floor elevations.

The minimum channel elevation was set per the output table from the HEC-RAS duplicate model.

The discharges and water surface elevations for the 10, 50, and 500 year storm events were entered exactly as shown on the output table from the HEC-RAS model. The water surfaces and discharges were set equal for both before and after mitigation.

The 100 year water surface was set at BFE + 1' for the before mitigation scenario and BFE + 1/2' for the post mitigation scenario. This provides the model with a flood depth of 1' to replicate a 1' floodway encroachment over the structure and a 1/2' flood depth to replicate a 1/2' floodway encroachment.

NOTE: It is important to note that this method does not attribute damages from the smaller flood events to the individual structures. Although it is likely that smaller events can have an impact on flood fringe structures in an encroached scenario, this analysis does not include those events in the computation of averted damages.

The elevation of the structure is set to 0.

The depth damage curves are set to the default curve selected by the FEMA BCA software. For example, single family residential structures are run on the USACE generic DDF, while mobile homes are run on the Flood Insurance Administration DDF. Note that for computation of the structure and contents damage, no basements were assumed.

The FEMA BCA tool determines the damages to structures before mitigation and the damages to the structures after mitigation. Although the term mitigation implies some action, in fact, there is no action required by the existing building owners assumed in this analysis. The terminology is an artifact of the process to compute damages averted between two floodway scenarios. The difference of the damages averted is the benefit of implementing the 1/2' floodway, Rule 8.

The FEMA BCA version 4.5.5. utilizes a discount rate of 7%. In order to compute the present worth of the damages averted, the annual benefit dollars are multiplied by the present worth factor for 4.375%, which is previously noted as 22.5414. This is the sum of the benefits as damages averted for the implementation of a ½-foot floodway across the sample reach.

The costs of the implementation are computed in a relative manner based on existing parcel data. The vacant parcels within the existing 1' floodway were used as a basis for value of land within a floodway. Based on the provided assessed land values and area of the vacant parcels in the 1' floodway, an average value per acre was computed. This value is assigned as the reduced value for the parcels placed in the ½-foot floodway. Computing the difference between the ½-foot floodway parcels existing value in the 100 year floodplain and the reduced value provides a cost for the implementation of Rule 8 for vacant parcels in the ½-foot floodway.

There are no costs for non-vacant parcels. The cost of substantial improvement or reconstruction following a disaster for an existing structure is as variable as new construction and therefore beyond the scope of this analysis. Furthermore, since a substantial improvement or repair must comply with all flood rules, the focused conclusions of this sample reach analysis for Rule 8 are not sufficient. A unit analysis for the individual structure would be more appropriate.

The change in tax revenue to the County as a result of a potential change in the assessed values of properties was included as an additional item of cost in the stream reach analysis. Since assessed valuation for the properties was by Weld County for the study reach, it was fairly straight forward to determine the average assessed value of vacant lands that are located first within the 100-year floodplain and then also those lands within the current floodway as determined under the current 1-foot rise rule. A third tabulation was then made of property that would be in the newly created ½-foot footway under the proposed rules. These structure locations correspond to the previously discussed schematic structures b, d, and c, respectively (reference is made to Figure 3.2.2.2). For the study reach, the total assessed land value for each category was determined on a per-acre basis. The difference in tax revenue was determined by multiplying the difference in assessed value under the existing and the proposed rule using an estimated average mil levy of 75.0 (again taken from assessor's office data). A present worth for this difference was then determined for the assumed project life(s), using the same discount rate as was used to determine the present worth of the benefits.

Note that the tax revenue may go down as a result of assessing property within the floodway at a lower rate, however, there is an argument that this lowering of taxes would result in additional money being made available to the impacted property owners. Although this is a secondary benefit of the rule change, the monetary value of the benefit was not taken into consideration in the analysis.

**3.4.4 Limitations:** There are no computations for benefits or costs for proposed or future structures in this sample reach analysis. Since a future structure would be

governed by the freeboard rules, the reduction in encroached flood depth from 1-foot to ½-foot is already accounted for in the unit analysis. This sample reach analysis can be considered an existing conditions run – any future development would increase the benefits incrementally for each structure built.

The assignment of water surface elevations across the buildings and parcels is limited by the time, scope, and availability of detailed survey data. The averaging of elevations across parcels based on the nearest cross section is the best available method of analysis at this time. Until a grid-based analysis can be completed, any solution to assigning water surface elevations will incur some level of interpolation to the individual structures. The individual parcels cover large enough areas that future refinements to this analysis would consider variation across the parcel topography.

An alternative to monetizing the impact to the vacant (developable) parcels within the ½-foot floodway might have been to consider engineering and design fees instead of comparing land values. However, given the wide range of modeling and design assumptions that can be made, estimating a cost of compliance based on fees was considered too variable, and also this would be duplicative of the land value comparison. The affected parcels can either be devalued and not developed or engineered for development, but not both. For this analysis, the devaluation of floodway parcels were calculated for the cost in the sample reach.

Finally, it must be noted that the sample reach analysis assumes that at some point in time there will be a need to conduct the ½-foot floodway determination. There are no immediate plans to conduct such a study on the subject reach, but rather this reach was simply chosen due to the data that was made available to the study team.

The sample reach only considered the Cache La Poudre flood hazards and structures therein. Tributary flood hazards were not included.

## **4 Summary Cost – Benefit and Regulatory Analysis**

### **4.1 Synopsis Of Unit Analysis**

As discussed in Section 2.4, the magnitude of the number of drainage systems within the State of Colorado presents an immense challenge in order to conduct a traditional benefit-cost analysis. Accordingly, this study used several simplifying assumptions in order to conduct the analysis in as timely and economical manner as possible. A number of potential methods were examined that could have been utilized as the basis of the analysis. A hybrid analysis format was determined to be the best system. This hybrid procedure follows the general methods of the FEMA benefit-cost procedure.

In theory, the overall benefit cost ratio of the proposed rule changes for the entire state of Colorado is the summation of all the benefits for each county divided by the total overall costs (B/C) for implementing the improvements for each county. The individual County B/C ratio is the summation of total benefits and costs for each drainage system within the County. The drainage system B/C ratio is the summation of the benefits for each stream reach divided by the costs for each stream reach. The stream reach B/C ratio is the sum of all benefits for individual building or lots (unit) divided by the total of the costs to implement for each building or lot. The B/C ratio for an individual unit is the sum total of all identified benefits for the unit divided by the cost to that unit.

Mathematically, if the benefit-cost ratio for an individual unit is greater than 1.0, then the rule is beneficial in that the benefits exceed the costs. Also mathematically, if the B/C ratio for an individual unit is greater than 1.0, then it follows that the benefit-cost ratio of the sum total of all units within a particular stream reach will be greater than 1 and that as a consequence, the B/C ratio for the entire drainageway, for each county and for the state will be greater than one.

As a second simplification, it is reasoned that it is not necessary to define and monetize the value of all benefits to show that the benefit ratio is greater than one. If certain benefits are not included but the ratio is still greater than one, the conclusion is that if all the benefits had been included, then the B/C ratio would only have been greater than the ratio derived by including only a portion of the benefits. For this reason, benefits that are known to exist, but difficult or impossible to precisely quantify, such as deaths and injuries avoided, are intentionally left out of the computations.

Similarly, it is recognized that there is a wide range of alternative mitigation measures that could be taken such as building structures using raised earthen fill; floodproofing of non-residential buildings; and combinations of these measures. For the analysis, only the raised earthen fill was studied. It should be noted that since both floodproofing and elevation are acceptable methods of protecting all non-residential structures, it can be assumed that property owners will generally elect the method resulting in the lowest cost. Therefore, if it can be demonstrated that earthen fill elevation produces a benefit-cost ratio greater than 1, it can be assumed that when floodproofing methods are also considered, the ratio would be at least that same value, and possibly higher.

Estimates of costs required to elevate the land surrounding the structures were made based upon an assumed import of earthen material to raise a structure pad having a usable flat surface with 10:1 side slopes. Volume of fill required was then calculated for two different assumed size residential structures and for an assumed commercial structure (hospital). The cost for the fill is considered to be inclusive of: clearing and grubbing; stripping and removal/replacement of topsoil; obtaining, and hauling and placement of compacted fill.

Additional simplifying assumptions are as follows:

- The BCA computes only the net benefit cost ratio between the scenario using the existing rules and regulations in comparison with the scenario of the same flood event under the proposed rules.
- It is assumed that existing buildings meet current rule requirements.
- A discount rate of 4.375% is utilized.
- The analysis was completed for 30-year and 100-year periods.
- To test the economy of Rule 6 (new Critical Facilities requiring 2-feet of freeboard above the 100-year floodplain) the BCA Benefits are limited to averted physical damages to non-residential buildings and contents and also a FEMA BCA default allowance for loss of service.
- To test the economy of Rule 8 (Floodway allowable rise of ½-foot rather than the existing 1-foot) a comparison was made between the physical damage to the structure and contents for two structure options:
  - A first floor elevation at the BFE with a flood elevation of one-foot above BFE to simulate a fully encroached floodway condition under the existing rule;
  - A first floor elevation at the BFE with a flood elevation of ½-foot above the BFE to simulate a fully encroached floodway condition under the proposed rule.
- To test the economy of Rule 11 (1-foot of freeboard above the 100-year flood elevation for all new construction, repair/expansion to substantially damaged structures, or new substantial additions) a comparison was made between the physical damage to the structure and contents for two structure options:
  - A first floor elevation at the BFE with a flood elevation of one-foot higher to simulate the damage resulting from a flood event without the freeboard compared to:
  - A first floor elevation at the BFE with a flood elevation at the BFE to simulate the damage resulting from a flood event with the freeboard.

Table 4.1 Summary BCA which follows presents the results of the various scenarios.

## 4.2 Synopsis of Test Reach

In order to provide a “real life” example of the BCA application to an actual stream system, a river reach where data was available was studied in greater detail. The selected reach is located on the Cache le Poudre River located within and upstream of the City of Greeley. This reach was selected based on several criteria including:



available assessor information, flood hazard data, hydraulic models, mix of county and city land areas, and mix of residential and non-residential structures.

The sample reach is used to study only Rule 8 for several reasons. The sample reach is used to evaluate the impact of the rule spatially across the flood hazard area. Rule 6 and 11 affect new construction in the form of future buildings, re-construction of substantially damaged buildings, and substantial improvements to existing structures. Given the information available, it is impossible to predict where that future construction or re-construction would occur. Therefore, the Rule 8 sample reach analysis did not compute benefits or costs for future buildings. Furthermore, for purposes of the analysis, all new construction is assumed to be compliant with all three new rules (6, 8, and 11). Once a building meets the freeboard requirement, the benefits of Rule 8 are limited to damages avoided for a finished floor elevation at BFE or at + ½-foot above BFE. Although these compound benefits from Rule 6 and 8 (or Rule 8 and 11 in the case of critical facilities) are still quantifiable, the uncertainty related to how many future structures would be affected was reason enough to simplify the analysis to benefits from existing structures.

The Rule 8 sample reach analysis considered the land value impacts from the new rule. Assessed land values were taken from the Weld County assessor data and averaged to dollars per acre. Referring to the schematic floodplain locations, under the new rules, a vacant parcel with greater than 50% of its land area within the new ½-foot floodway (Schematic Location “c”) was considered to have the same value as a vacant parcel within the existing 1-foot floodway.

When the unit approach (individual buildings) and sample reach approach are considered in combination, the benefit-cost analysis is complete in full. The unit approach can be used to evaluate any future structures or construction for Rules 6 and 11. The sample reach approach can be used to evaluate existing structures and land within the ½-foot floodway for Rule 8.

The comparison of the benefits for all the existing structures in the sample reach floodplain against the cost to the vacant parcels provides the benefit-cost ratio for Rule 8. Due to time constraints and magnitude of the analysis, approximately 25% (that is 90 structures out of 352) of the structures within the study reach were input into the FEMA BCA model. The percentage breakdown of types of structures (residential, commercial, light industrial, etc.) matched the overall reach composition. It should be noted that the study reach has several high value light industrial structures that were excluded from analysis as these structures biased the analysis due to high flood damage and consequently resulted in a high benefit-cost ratio. Excluding these structures from the analysis allows the sample reach analysis to be more applicable to a greater range of reaches in rural and/or emerging development areas. It should be noted, however, that inclusion of these structures would have resulted in a higher benefit-cost ratio for the studied reach. Although not all the benefits (damages to structures avoided) were incorporated into the study reach, the cost impact of all the parcels within the ½-foot floodway was included. For this reason, it is felt that the overall benefit-cost ratio for the subject reach would have been much higher had all the benefits been incorporated.

### 4.3 Conclusions

As shown on Table 4.1.1, the benefit cost analysis of the three studied rules indicates that adoption of the rules will result in a benefit/cost ratio of greater than one for the assumed 100-year project life. It can be pointed out that for the Rule 6 freeboard associated with the Commercial Industrial category the computed value resulted in a value slightly less than 1.0 for the 30-year project life. However, as stated earlier, although all anticipated costs are included in the analysis, not all benefits were considered in the computations; if all of the benefits as discussed herein were included, it is certain that all of the benefit cost ratios for any assumed project life would exceed 1.0, in some cases substantially so.

**Table 4.1.1  
BCA Summary**

|                       | Rule 6:<br>Critical<br>Facilities<br>2' freeboard | Rule 8:<br>½' floodway | Rule 11:<br>1' freeboard |
|-----------------------|---|------------------------|--------------------------|
|                       | 30-year Project Life                              |                        |                          |
| Residential Standard  | n/a   | n/a                    | 1.4                      |
| Residential Luxury    | n/a   | n/a                    | 2.6                      |
| Commercial Hospital   | 2.1   | n/a                    | n/a                      |
| Commercial Industrial | 0.9   | n/a                    | n/a                      |
| Sample Reach          | n/a   | 1.2                    | n/a                      |
|                       | 100-year Project Life                             |                        |                          |
| Residential Standard  | n/a   | n/a                    | 1.9                      |
| Residential Luxury    | n/a   | n/a                    | 3.6                      |
| Commercial Hospital   | 2.9   | n/a                    | n/a                      |
| Commercial Industrial | 1.3   | n/a                    | n/a                      |
| Sample Reach          | n/a   | 1.6                    | n/a                      |

## **APPENDIX A**

### **DORA CRITERIA: RULE COST, BENEFIT AND REGULATORY ANALYSIS**

- A.1 Rule 6**
- A.2 Rule 8**
- A.3 Rule 11**

## **A.1 RULE 6 COST BENEFIT AND REGULATORY ANALYSIS**

In performing a cost-benefit analysis, each rulemaking entity must provide the information requested for the cost-benefit analysis to be considered a good faith effort. The cost-benefit analysis must be submitted to the Office of Policy, Research and Regulatory Reform at least five (5) days before the administrative hearing on the proposed rule. For all questions, please attach all underlying data that supports the statements or figures stated in this cost-benefit analysis.

**DEPARTMENT:** Natural Resources **AGENCY:** Colorado Water Conservation Board

**CCR:** \_\_\_\_\_ **DATE:** \_\_\_\_\_

### **RULE TITLE OR SUBJECT:**

### **RULE 6: CRITICAL FACILITIES**

#### Benefits of the Proposed Rule(s)/Amendment(s)

1. Please provide the statutory authority, and detailed statements indicating the need for the proposed changes. *(This statement should include specific issues such as specific changes in statutes or the subject matter area, market failure, a compelling public need, risks to the health, safety or welfare of Coloradans, lack of efficient and effective performance of an important government function, or other specific problem(s) that are being addressed by the proposed rule(s).)* Please include the number of complaints you received (if any) that spurred you to take regulatory action.

These Rules are promulgated pursuant to the authority granted the Colorado Water Conservation Board (Board or CWCB) in sections 37-60-106(1)(c), 37-60-106(1)(e), 37-60-106(1)(f), 37-60-106(1)(g), 37-60-106(1)(h), 37-60-106(1)(k), 37-60-108, 30-28-111(1) & (2), 31-23-301(1) & (3), 24-65.1-202(2)(a)(l) and 24-65.1-302(1)(b)&(2)(a) and 24-65.1-403(3) and 24-4-103, C.R.S. (2009).

The Colorado statute requires State designation and approval of floodplain information prior to local regulation. This proposed change is needed to further minimize damages to public and private assets from flooding. Specifically, this rule increases protection of critical facilities from flood hazards and related damages.

Critical facilities are defined by Rule 4 of this set of proposed rules. The definition is: a facility structure, infrastructure, property, equipment, or service, that if flooded may result in severe consequences to public health and safety or interrupt essential services and operations for the community at any time before, during, or after a flood.

Protection of these critical facilities from flood hazard damages has a dual benefit: preserving the facility and its service to the community. This dual benefit is reflected in the 2 foot above base flood elevation freeboard requirement, whereas other structure freeboard requirements are only 1 foot above base flood elevation. Critical facilities will serve the general public at large and the ability to continue that level of service before, during, and after a flood event is essential to reduce flood liabilities, rescue, response, and recovery.

An essential point to recognize in consideration of this rule is the extent of the impact of damage to critical facilities: geographic, temporal, and financial. Where damage to an individual structure is limited to the structure's immediate location within the floodplain, damage to critical facilities can extend well beyond the floodplain limits. Consider an emergency response facility without the proposed rule that is impacted by a flood event. The impact of any delay or damage to this structure results in an immediate delay and damage to all citizens within the potential service area of that facility, even those citizens well outside of a defined floodplain. Furthermore, it is entirely likely that flood damage to a critical facility can reduce important service to the community for a period much longer than the actual flood event. Finally, the cost of repairs and reconstruction for the critical facility are extended across the entire community.

There is no record of specific complaints that spurred this proposed rule. However, there is well documented records of annual flood damages that can be reduced in future years with the implementation of these rules. Public comments, while not quantified have been received for years regarding the public's concern about the allowance to build important facilities in known hazardous areas. These comments typically increase in the days and weeks following a flood disaster anywhere in the Country.

2. Please list the top three benefits of the proposed regulation; explain how the proposed regulation results in the expected benefits; and if the proposed regulation reduces or eliminates the problem(s) listed above.
  1. Limiting damage to a critical facility protects the overall community population, not just the citizens within a defined floodplain.
  2. Limiting damage to a critical facility ensures uninterrupted response and service to the overall community population during a flood event.
  3. Limiting damage to a critical facility helps control costly repairs to large public or private infrastructure and facilities.

3. What, in your estimation, would be the consequence of taking no action, thereby maintaining the status quo?

Without this rule, future critical facilities and substantial improvements to existing critical facilities could be constructed within a known high hazard area without any additional protection. A two-foot freeboard requirement offers a statistically relevant level of protection above the status quo. Without that freeboard, the probability of damage to a critical facility remains at the same level as all other structures within a floodplain. This effectively places the same level of protection on any structure within a floodplain. The very definition of critical facilities indicates that additional protection is of great benefit to the greater public good.

4. Please describe market-based alternatives or voluntary standards that you considered in place of the proposed regulation and state the reason(s) for not selecting those alternatives. How many small businesses did you talk to about the proposed regulation?

Voluntary land use restrictions for critical facilities enforced by local governments may not be as effective as a proposed floodplain rule. A land use restriction (zoning restriction) may not be sufficient to support all varieties of critical facilities. For instance, a hospital and emergency response facility may be sufficiently planned on land compatible with a 2 foot freeboard requirement. However, other industrial land uses may allow critical facilities within a defined floodplain. Therefore, the most universal approach to protecting all critical facilities specifically addresses the hazard with a freeboard requirement for any facility.

Public open houses to discuss the rules addressed the questions and concerns of many stakeholders affected by this rule. Although there was no specific accounting of small businesses, it is known that several small businesses from a large variety of affected industries were present at the open houses.

#### Impact of Proposed Rule(s)/Amendment(s)

5. Please describe the government costs to be incurred because of the proposed regulation (*Examples include collection; paperwork; filing; recordkeeping; audit, inspection and training costs, etc.*), and state your estimates (in dollars) of the costs that will be incurred.

There are no additional government costs to be incurred because of this proposed regulation. This proposed regulation simply changes the existing enforcement of construction at or above the base flood elevation to construction at or above 2 feet above the base flood elevation. The existing state floodplain rules already require communities to manage their floodplains and floodways. Therefore, adjusting the freeboard requirement does not incur additional cost.

6. Please provide the number and types of entities or small businesses that will be required to comply with the proposed rule(s). Please provide the source of data used (*i.e., program data, NAICS code statistics, etc.*).

Existing facilities that are substantially improved and future development of new critical facilities within the floodplain will be required to comply with this proposed rule. It is not possible to estimate what the types of development will be and therefore not possible to determine the number or types of entities required to comply with this proposed rule.

However, it is reasonable to assume that a significant number of businesses directly related to critical facility operation and maintenance will be positively affected by this proposed regulation. The preservation of service of a critical facility before, during, and after a flood event has a net positive effect on the economic viability of the facility and the businesses built to serve that facility with operations and maintenance. In addition, these facilities often have critical impacts to public health, safety, and welfare, so these will be positively impacted by this proposed rule.

7. Does the proposed regulation create barriers to entry (*i.e., licensing, permit or educational requirements*)? If so, please describe those barriers and why those barriers are necessary.

The proposed rule does not create barriers to entry. The proposed rule only increases the existing regulation on floodplain development. There are no new permits or license requirements.

8. Explain the additional requirements with which small business owners will have to comply (*i.e., will they need to purchase new equipment or software to meet the requirement(s); are there training costs; are there new disclosure/filing requirements they will have to provide to the state; are there transactional costs, paperwork costs, recordkeeping, etc.*). Please state your estimates (in dollars) of the compliance costs by types listed.

There are no additional requirements with which small business owners will have to comply. This proposed rule will not require any new equipment, training, filing requirements, paperwork costs, etc for small businesses.

9. Please state whether the proposed regulation contains different requirements for different sized entities or different geographic regions, and explain why this is, or is not, necessary. (*For example, an audit fee (as a percentage of assets) for a bank examination is lower based upon a higher level of assets due to marginal cost savings and water usage is more restricted in geographic regions with less water storage or supplies because demand far outpaces supply.*)

This proposed rule does not discriminate based on size of entity or geographic region. This rule applies to any regulated floodplain and defined critical facility – regardless of size of the regulating community, size of the floodplain, or geographic location of the community or floodplain. Base flood elevations, and thus the freeboard above that elevation, are computed based upon hydraulic characteristics of each flood source (stream). The base flood elevations are not computed based on population or geographic location. Therefore, it is not necessary to implement this rule with any size or geographic discrimination.

10. Please describe your understanding of the ability of small business owners to implement changes required by the proposed regulation, and state the average estimated cost of implementation. (*For example, if a proposed rule required all business in a particular sector to utilize a specific software application, a small business owner may have a difficult time implementing the software if the software is expensive to purchase or if their existing computers are not able to run the software.*)

The ability and cost for small businesses to implement this proposed rule is outlined in greater detail within the benefit cost analysis appendix. A benefit cost analysis was completed for a proposed critical facility constructed under the new regulation. Based on that analysis, it is evident that the additional cost of compliance is outweighed by the benefits of damages avoided. Therefore, the cost of implementation when considered with the cost of non-compliance (flood damage and recovery) over an extended service life of a critical facility, is a net savings.

11. Please state if the proposed regulation will force the cessation of business by any existing businesses, and the impact the cessation will have on the economy including but not limited to the number of employees losing their jobs, the economic losses by the businesses and the estimated economic ripple the cessation will have on suppliers, consumers or buyers.

This proposed rule does not force cessation of business by any existing businesses. Therefore, there is no cessation impact analyzed for this proposed rule. In fact, this rule is more likely to ensure preservation of existing businesses and an overall benefit to the economy based on the ripple effect of reduced flood damages, more rapid response, and more rapid recovery based on safer Critical Facilities built in the future.

12. Does the proposed regulation restrict consumer choice (*i.e., availability of goods or services; price increases; etc.*)? If so, please describe those restrictions.

This proposed rule does not restrict consumer choice. In the case where a critical facility is considering two locations, one within a floodplain and one outside of the floodplain, neither location is excluded by this rule. The site within the floodplain area requires additional freeboard above the base flood elevation, but that does not restrict development of that particular location.

13. Please state the estimated impact (in dollars) the proposed regulation will have on sales, employment or tax revenue.

This proposed rule is not expected to have measurable impacts on sales, employment, or tax revenue on a statewide basis. The impact of this proposed rule on sales is undetermined. Property sales are not expected to have any net impacts from this proposed rule since it creates value by reducing flood risk.

14. Please identify all other small business sector(s) that the proposed regulation(s) may impact, and state the estimated financial impact the proposed regulation will have on each small business sector.

This proposed rule is likely to impact the consulting civil engineering community, insurance industry, flood proofing industry, and real estate industry in a positive manner. However, the financial impact will not change from the existing rule since these small businesses would have been involved in the floodplain analysis, regulation, operation, and re-sale of the property even without the freeboard requirement.

## **A.2 RULE 8 COST BENEFIT AND REGULATORY ANALYSIS**

In performing a cost-benefit analysis, each rulemaking entity must provide the information requested for the cost-benefit analysis to be considered a good faith effort. The cost-benefit analysis must be submitted to the Office of Policy, Research and Regulatory Reform at least five (5) days before the administrative hearing on the proposed rule. For all questions, please attach all underlying data that supports the statements or figures stated in this cost-benefit analysis.

**DEPARTMENT:** Natural Resources **AGENCY:** Colorado Water Conservation Board

**CCR:** \_\_\_\_\_ **DATE:** \_\_\_\_\_

### **RULE TITLE OR SUBJECT:**

#### **RULE 8 – STANDARDS FOR REGULATORY FLOODWAYS**

#### Benefits of the Proposed Rule(s)/Amendment(s)

1. Please provide the statutory authority, and detailed statements indicating the need for the proposed changes. *(This statement should include specific issues such as specific changes in statutes or the subject matter area, market failure, a compelling public need, risks to the health, safety or welfare of Coloradans, lack of efficient and effective performance of an important government function, or other specific problem(s) that are being addressed by the proposed rule(s).)* Please include the number of complaints you received (if any) that spurred you to take regulatory action.

These Rules are promulgated pursuant to the authority granted the Colorado Water Conservation Board (Board or CWCB) in sections 37-60-106(1)(c), 37-60-106(1)(e), 37-60-106(1)(f), 37-60-106(1)(g), 37-60-106(1)(h), 37-60-106(1)(k), 37-60-108, 30-28-111(1) & (2), 31-23-301(1) & (3), 24-65.1-202(2)(a)(I) and 24-65.1-302(1)(b)&(2)(a) and 24-65.1-403(3) and 24-4-103, C.R.S. (2009).

The Colorado statute requires State designation and approval of floodplain information prior to local regulation. This proposed change is needed to further protect public and private assets from damage due to flooding. Specifically, this rule protects existing and proposed structures from adverse impacts caused by floodplain development. This rule is unique from the other proposed rules because it benefits both existing and proposed structures.

This rule is specifically needed to reduce the damages caused by ALLOWABLE encroachment into the existing regulatory floodplain. Under the current rules, a property owner on the left bank of a stream can build within the floodplain and cause up to 1 foot of increased depth on his neighbor's property on the opposite bank. By adopting this proposed rule, that damage that occurs will be reduced by 6 inches of allowable surcharge instead of 12 inches.

There is no record of specific complaints that spurred this proposed rule. However, there is well documented records of annual flood damages that can be reduced in future years with the implementation of these rules. General complaints from communities regarding the lack of a uniform standard and the resulting difficulties in portraying floodways on multi-community floodplain maps have been received.

2. Please list the top three benefits of the proposed regulation; explain how the proposed regulation results in the expected benefits; and if the proposed regulation reduces or eliminates the problem(s) listed above.



1. Protection against increased flood damages from encroachments due to floodplain development.
2. Protection of existing as well as proposed structures.
3. Increased public safety by decreasing flood depths for private, public, residential, and commercial structures.

This proposed rule creates these benefits by expanding the regulatory floodway to a boundary that reflects a ½ foot surcharge for the 1% annual chance flood event. By reducing the allowed surcharge depth to 6 inches, the problems identified above are reduced. Elimination of damages from flood hazards is not anticipated; however there will be a reduction of damages.

3. What, in your estimation, would be the consequence of taking no action, thereby maintaining the status quo?

Maintaining the 1 foot floodway instead of implementing this proposed ½ foot floodway rule will continue to permit excessive damage to existing structures from future development without recourse and through no fault of the existing property owners. As future development occurs, the proposed rule aims to limit the impact of that future development on adjacent properties. Without the proposed rule, the adverse impact that increases flood risk will not be reduced.

4. Please describe market-based alternatives or voluntary standards that you considered in place of the proposed regulation and state the reason(s) for not selecting those alternatives. How many small businesses did you talk to about the proposed regulation?

Market based alternatives and voluntary standards were considered as alternatives to this proposed rule, but were not selected for a variety of reasons. An example of a market based alternative is the National Flood Insurance Program (NFIP). Structures within a FEMA designated special flood hazard area are subject to flood insurance premiums for any federally backed mortgage. The rates are based upon the depth of flooding at the structure. The NFIP has been in effect in Colorado for over four decades with frequent rate increases and map changes. However, despite the increased cost of compliance with the insurance requirement, development within the floodplain has continued to rise. Therefore, the NFIP and other market based alternatives are not considered viable alternatives to this proposed rule.

An example voluntary standard for residential structures is flood proofing. Structures can be designed and built or in some cases modified to include elements that reduce the damages caused by flood waters. These elements include elevated structures, flood vents, seepage control, check valves on wet utilities, etc. Flood proofing is a reasonable means of protecting a structure, but it does not reduce encroachment or other adverse impacts within the floodplain. Therefore, a voluntary measure that benefits only the flood proofed structure without any benefit to the adjacent properties was not considered a viable alternative to this proposed rule.

#### Impact of Proposed Rule(s)/Amendment(s)

5. Please describe the government costs to be incurred because of the proposed regulation (*Examples include collection; paperwork; filing; recordkeeping; audit, inspection and training costs, etc.*), and state your estimates (in dollars) of the costs that will be incurred.

There are no additional government costs to be incurred because of this proposed regulation. This proposed regulation simply changes the existing enforcement of a 1' floodway to a ½' floodway. The existing state floodplain rules already require communities to manage their floodplains and floodways. Therefore, adjusting the depth of encroachment does not incur additional cost. In addition, this proposed regulation only deals with future studies that would incorporate a floodway anyway. And the CWCB staff will assist community officials with ordinance updates, administration, and compliance.

6. Please provide the number and types of entities or small businesses that will be required to comply with the proposed rule(s). Please provide the source of data used (*i.e., program data, NAICS code statistics, etc.*).

All existing structures that are substantially improved and future development within the floodplain will be required to comply with this proposed rule when new floodway information is adopted. It is not possible to estimate what the types of development will be and therefore not possible to determine the number or types of entities required to comply with this proposed rule.

Furthermore, this proposed rule defines a regulatory mechanism (a ½' floodway) that does not currently exist in many cases. The ½' floodway will be defined in the future only if there is a new hydraulic analysis that includes a floodway determination. In the meantime, estimates of the area affected by a future ½' floodway range from approximately 50 to 67% of an existing 1% annual chance (100yr) floodplain.

It is certain that this rule will not affect all existing and future structures within the 1% annual chance floodplain. On a statewide basis, the area regulated by the ½' floodway will be by definition less than the area of the 1% annual chance floodplain.

The source data used for this analysis is the effective FIRM data for the State of Colorado, conventional estimates of floodway widths for flood sources in the Rocky Mountain region, and HAZUS Level I analysis data published in the Draft State of Colorado Floodplain Mitigation Plan.

It is important to note that the goal of this proposed regulation is uniform public safety standards which are not targeted to small businesses.

7. Does the proposed regulation create barriers to entry (*i.e., licensing, permit or educational requirements*)? If so, please describe those barriers and why those barriers are necessary.

The proposed rule does not create barriers to entry. The proposed rule only increases the existing regulation on floodplain development. There are no new permits or license requirements.

8. Explain the additional requirements with which small business owners will have to comply (*i.e., will they need to purchase new equipment or software to meet the requirement(s); are there training costs; are there new disclosure/filing requirements they will have to provide to the state; are there transactional costs, paperwork costs, recordkeeping, etc.*). Please state your estimates (in dollars) of the compliance costs by types listed.

There are no additional requirements with which small business owners will have to comply. This proposed rule will not require any new equipment, training, filing requirements, paperwork costs, etc for small businesses.

Compliance with State and local floodplain regulations will be required or exists today with higher standards. The benefit cost analysis was completed to describe those benefits.

9. Please state whether the proposed regulation contains different requirements for different sized entities or different geographic regions, and explain why this is, or is not, necessary. (*For example, an audit fee (as a percentage of assets) for a bank examination is lower based upon a higher level of assets due to marginal cost savings and water usage is more restricted in geographic regions with less water storage or supplies because demand far outpaces supply.*)

This proposed rule does not discriminate based on size of entity or geographic region. This rule applies to any regulated floodplain that is re-studied to include a floodway analysis – regardless of size of the regulating community, size of the floodplain, or geographic location of the community or floodplain. Floodways are computed based upon hydraulic characteristics of each flood source (stream). The floodways are not computed based on population or geographic location. Therefore, it is not necessary to implement this rule with any size or geographic discrimination.

10. Please describe your understanding of the ability of small business owners to implement changes required by the proposed regulation, and state the average estimated cost of implementation. *(For example, if a proposed rule required all business in a particular sector to utilize a specific software application, a small business owner may have a difficult time implementing the software if the software is expensive to purchase or if their existing computers are not able to run the software.)*  
The ability and cost for small businesses to implement this proposed rule is identical to the ability and cost to implement the existing rule. This rule replaces a 1' floodway with a ½' floodway. Both analyses require the same technical processes, source data, and output products.
11. Please state if the proposed regulation will force the cessation of business by any existing businesses, and the impact the cessation will have on the economy including but not limited to the number of employees losing their jobs, the economic losses by the businesses and the estimated economic ripple the cessation will have on suppliers, consumers or buyers.  
This proposed rule does not force cessation of business by any existing businesses. Therefore, there is no cessation impact analyzed for this proposed rule.
12. Does the proposed regulation restrict consumer choice (*i.e., availability of goods or services; price increases; etc.*)? If so, please describe those restrictions.  
This proposed rule does not restrict consumer choice. In the case where a prospective home or property buyer is choosing between locations, one in and one out of the ½' floodway, both choices are still available to the prospective buyer.
13. Please state the estimated impact (in dollars) the proposed regulation will have on sales, employment or tax revenue.  
This proposed rule is not expected to have significant impacts on sales, employment, or tax revenue. The impact of this proposed rule on sales is undetermined. Sales, of homes or property, are not expected to have any net impacts from this proposed rule since it creates value by reducing flood risk in some homes while other homes mitigate construction methods to avoid non-compliance with the ½ floodway rule.
14. Please identify all other small business sector(s) that the proposed regulation(s) may impact, and state the estimated financial impact the proposed regulation will have on each small business sector.  
This proposed rule is likely to impact the consulting civil engineering community, insurance industry, flood proofing industry, and real estate industry. However, the financial impact will not change from the existing rule since these small businesses would have seen the same results from a 1' floodway as the ½' floodway.

### **A.3 RULE 11 COST BENEFIT AND REGULATORY ANALYSIS**

In performing a cost-benefit analysis, each rulemaking entity must provide the information requested for the cost-benefit analysis to be considered a good faith effort. The cost-benefit analysis must be submitted to the Office of Policy, Research and Regulatory Reform at least five (5) days before the administrative hearing on the proposed rule. For all questions, please attach all underlying data that supports the statements or figures stated in this cost-benefit analysis.

DEPARTMENT: Natural Resources AGENCY: Colorado Water Conservation Board

CCR: \_\_\_\_\_ DATE: \_\_\_\_\_

#### **RULE TITLE OR SUBJECT:**

#### **RULE 11: FLOODPLAIN MANAGEMENT REGULATIONS**

#### **Benefits of the Proposed Rule(s)/Amendment(s)**

1. Please provide the statutory authority, and detailed statements indicating the need for the proposed changes. *(This statement should include specific issues such as specific changes in statutes or the subject matter area, market failure, a compelling public need, risks to the health, safety or welfare of Coloradans, lack of efficient and effective performance of an important government function, or other specific problem(s) that are being addressed by the proposed rule(s).)* Please include the number of complaints you received (if any) that spurred you to take regulatory action.

These Rules are promulgated pursuant to the authority granted the Colorado Water Conservation Board (Board or CWCB) in sections 37-60-106(1)(c), 37-60-106(1)(e), 37-60-106(1)(f), 37-60-106(1)(g), 37-60-106(1)(h), 37-60-106(1)(k), 37-60-108, 30-28-111(1) & (2), 31-23-301(1) & (3), 24-65.1-202(2)(a)(I) and 24-65.1-302(1)(b)&(2)(a) and 24-65.1-403(3) and 24-4-103, C.R.S. (2009).

The Colorado statute requires State designation and approval of floodplain information prior to local regulation. This proposed change is needed to further protect public and private assets from damage due to flooding. Specifically, this rule protects proposed structures within a floodplain from flood hazard damages.

Flooding is America's #1 natural disaster. Flood damages to structures and impacts on citizens have measureable impact on the overall community – the effects are not limited to the area within a floodplain. This proposed rule aims to elevate structures 1 foot above a flood elevation caused by a statistically relevant storm event (1% annual chance storm event or base flood). The additional elevation of a structure above the base flood elevation is known as freeboard.

The freeboard requirement for structures within a floodplain provides several benefits to the individual property owner. First, the structural damage is reduced because the base flood water level does not reach the habitable space of the structure. Water damage to interior habitable spaces is eliminated during standard regulatory flood events. Damage to utility and other below grade utilities is also reduced since the water depths and duration are reduced. Second, the inhabitants of that structure are less susceptible to harm during and after a flood event. Although some services may be limited or temporarily shut off (gas, electric, transportation, etc.), the home remains a dry shelter with full access to its contents. Lastly, the individual property receives the benefit of reduced flood insurance premiums based upon the freeboard above the base flood elevation. A freeboard requirement provides property owners with reduced damages, reduced risk to health and safety, and reduced insurance costs.

There is no record of specific complaints that spurred this proposed rule. However, there is well documented records of annual flood damages that can be reduced in future years with the implementation of these rules.

2. Please list the top three benefits of the proposed regulation; explain how the proposed regulation results in the expected benefits; and if the proposed regulation reduces or eliminates the problem(s) listed above.
  1. Limiting damage to individual structures protects the overall community population, not just the citizens within a defined floodplain.
  2. Limiting damage to individual structures protects the human health and safety of the occupants during and after a flood event.
  3. Limiting damage to individual structures provides a financial benefit to the property owners in terms of reduce flood insurance premiums.

3. What, in your estimation, would be the consequence of taking no action, thereby maintaining the status quo?

Without this rule, future structures and substantial improvements to existing structures would be constructed within a known high hazard area. A 1 foot freeboard requirement offers a statistically relevant level of protection above the status quo. Without that freeboard, the probability of damage impacts a larger population of residents in a floodplain. This impact is magnified by the additional burden on emergency response, utility restoration, and other public services. Elevating a structure provides the inhabitants an opportunity to weather the storm without outside assistance. Similarly, after the flood event, the recovery and restoration of a structure with freeboard is measurably more manageable and likely does not require the assistance of outside agencies.

4. Please describe market-based alternatives or voluntary standards that you considered in place of the proposed regulation and state the reason(s) for not selecting those alternatives. How many small businesses did you talk to about the proposed regulation?

A market based alternative to a freeboard requirement could be a mandatory emergency service fee requirement for residential structures built in a floodplain. The additional fee for construction within the floodplain could increase the desirability of property outside of the floodplain area. Other voluntary, incentive based fee reductions or permit exceptions could be enacted for properties outside the floodplain and have a similar effect. However, these alternatives would have significant disadvantages over the proposed rule. For the market based alternatives, the property owners that still build within the floodplain area at the base flood elevation have fewer damages averted compared to the freeboard requirement. These damages would require additional rescue and restoration resources compared to an elevated structure. The emergency service fee requirement would only assist in the financial recovery aspect of the flood event. The voluntary measures would not provide any assistance or additional resources to the structures within a floodplain area. A freeboard requirement provides a physical barrier between the structure and the flood damages. Market based or voluntary alternatives can change over time and their effectiveness is likely to erode.

Public open houses to discuss the rules addressed the questions and concerns of many stakeholders affected by this rule. Although there was no specific accounting of small businesses, it is known that several small businesses from a large variety of affected industries were present at the open houses.

#### Impact of Proposed Rule(s)/Amendment(s)

5. Please describe the government costs to be incurred because of the proposed regulation (*Examples include collection; paperwork; filing; recordkeeping; audit, inspection and training costs, etc.*), and state your estimates (in dollars) of the costs that will be incurred.

There are no additional government costs to be incurred because of this proposed regulation. This proposed regulation simply changes the existing enforcement of construction at or above the base flood elevation to construction at or above 1 foot above the base flood elevation. The existing state floodplain rules already require communities to manage their floodplains and floodways. Therefore, adjusting the freeboard requirement does not incur additional cost.

6. Please provide the number and types of entities or small businesses that will be required to comply with the proposed rule(s). Please provide the source of data used (*i.e., program data, NAICS code statistics, etc.*).

All existing structures that are substantially improved and future new development within the floodplain will be required to comply with this proposed rule. It is not possible to estimate what the types of development will be and therefore not possible to determine the number or types of entities that will be required to comply with this proposed rule.

However, based on land use plans, masterplans, and past development history within the State the property in the vicinity of water courses tends to be desirable. Furthermore, the FEMA models for statewide flood damages (HAZUS-MH Level 1) use census block data to generate potential damages to existing structures. A fraction of those existing structures could be assumed to be substantially improved over time in order to estimate that portion of the structures that would be impacted by this rule. From that estimated number of structures, rough assumptions on the entities and small businesses that would support the design, construction, and compliance for the substantial improvements could be made. But regardless, the guess of number of existing structures that will substantially improve is just that and moreover, remains a fraction of the total structures that may be developed as new construction.

It may be more reasonable to assume that there are no additional entities or businesses affected by the proposed rule (build at or 1 foot above the BFE) compared to the existing rule (build at or above BFE).

7. Does the proposed regulation create barriers to entry (*i.e., licensing, permit or educational requirements*)? If so, please describe those barriers and why those barriers are necessary.

The proposed rule does not create barriers to entry. The proposed rule only increases the existing regulation on floodplain development. There are no new permits or license requirements.

8. Explain the additional requirements with which small business owners will have to comply (*i.e., will they need to purchase new equipment or software to meet the requirement(s); are there training costs; are there new disclosure/filing requirements they will have to provide to the state; are there transactional costs, paperwork costs, recordkeeping, etc.*). Please state your estimates (in dollars) of the compliance costs by types listed.

There are no additional requirements with which small business owners will have to comply. This proposed rule will not require any new equipment, training, filing requirements, paperwork costs, etc for small businesses.

9. Please state whether the proposed regulation contains different requirements for different sized entities or different geographic regions, and explain why this is, or is not, necessary. (*For example, an audit fee (as a percentage of assets) for a bank examination is lower based upon a higher level of assets due to marginal cost savings and water usage is more restricted in geographic regions with less water storage or supplies because demand far outpaces supply.*)

This proposed rule does not discriminate based on size of entity or geographic region. This rule applies to any structure in a regulated floodplain – regardless of size of the regulating community, size of the floodplain, or geographic location of the community or floodplain. Base flood elevations, and thus the freeboard above that elevation, are computed based upon hydraulic characteristics of each flood source (stream). The base flood elevations are not computed based on population or geographic location. Therefore, it is not necessary to implement this rule with any size or geographic discrimination.

10. Please describe your understanding of the ability of small business owners to implement changes required by the proposed regulation, and state the average estimated cost of implementation. *(For example, if a proposed rule required all business in a particular sector to utilize a specific software application, a small business owner may have a difficult time implementing the software if the software is expensive to purchase or if their existing computers are not able to run the software.)*

The ability and cost for small businesses to implement this proposed rule is outlined in greater detail within the benefit cost analysis appendix. A benefit cost analysis was completed for two proposed residential structures constructed under the new regulation. Based on that analysis, it is evident that the additional cost of compliance is outweighed by the benefits of damages avoided. Therefore, the one-time cost of implementation when considered with the cost of non-compliance (flood damage and recovery) over an extended service life of a residential structure is a net savings.

11. Please state if the proposed regulation will force the cessation of business by any existing businesses, and the impact the cessation will have on the economy including but not limited to the number of employees losing their jobs, the economic losses by the businesses and the estimated economic ripple the cessation will have on suppliers, consumers or buyers.

This proposed rule does not force cessation of business by any existing businesses. Therefore, there is no cessation impact analyzed for this proposed rule. In fact, this rule is more likely to ensure preservation of existing businesses and an overall benefit to the economy based on the ripple effect of limited flood damages, rapid response, and rapid recovery.

12. Does the proposed regulation restrict consumer choice (*i.e., availability of goods or services; price increases; etc.*)? If so, please describe those restrictions.

This proposed rule does not restrict consumer choice. In the case where a prospective property owner is considering two locations, one within a floodplain and one outside of the floodplain, neither location is excluded by this rule. The site within the floodplain area requires additional freeboard above the base flood elevation, but that does not prohibit development of that particular location.

13. Please state the estimated impact (in dollars) the proposed regulation will have on sales, employment or tax revenue.

This proposed rule is not expected to have significant impacts on sales, employment, or tax revenue. The impact of this proposed rule on sales is undetermined. Property sales are not expected to have any net impacts from this proposed rule since it creates value by reducing flood risk.

14. Please identify all other small business sector(s) that the proposed regulation(s) may impact, and state the estimated financial impact the proposed regulation will have on each small business sector.

This proposed rule is likely to impact the consulting civil engineering community, insurance industry, flood proofing industry, and real estate industry. However, the financial impact will not change from the existing rule since these small businesses would have been involved in the floodplain analysis, regulation, operation, and re-sale of the property even without the freeboard requirement.

## **APPENDIX B**

### **COST BENEFIT COMPUTATIONS**



**30 Year Project Useful Life****BFE +1, Rule 11****BFE +2, Rule 6**

Finished Floor Raise Above BFE (ft)  
 Size of Structure (sf)  
 Building Replacement Value (BRV, \$/sf)  
**Total Annual Benefits of Finished Floor Raise**  
  
**Present Value** (4.375% Discount, 30yr)  
**Costs** (Estimated Present Value, One Time Cost)  
**Benefit-Cost Ratio**

| Residential Standard | Residential Luxury |
|----------------------|--------------------|
| +1                   | +1                 |
| 1,000                | 4,000              |
| \$105                | \$145              |
| <b>\$287</b>         | <b>\$1,091</b>     |
|                      |                    |
| <b>\$4,744</b>       | <b>\$18,035</b>    |
| \$3,400              | \$6,900            |
| <b>1.40</b>          | <b>2.61</b>        |

| Commercial Hospital | Commercial Industrial |
|---------------------|-----------------------|
| +2                  | +2                    |
| 15,000              | 20,000                |
| \$145               | \$145                 |
| <b>\$7,910</b>      | <b>\$4,419</b>        |
|                     |                       |
| <b>\$130,761</b>    | <b>\$73,051</b>       |
| \$61,400            | \$78,400              |
| <b>2.13</b>         | <b>0.93</b>           |

**100 Year Project Useful Life****BFE +1, Rule 11****BFE +2, Rule 6**

Finished Floor Raise Above BFE (ft)  
 Size of Structure (sf)  
 Building Replacement Value (BRV, \$/sf)  
**Total Annual Benefits of Finished Floor Raise**  
  
**Present Value** (4.375% Discount, 100yr)  
**Costs** (Estimated Present Value, One Time Cost)  
**Benefit-Cost Ratio**

| Residential Standard | Residential Luxury |
|----------------------|--------------------|
| +1                   | +1                 |
| 1,000                | 4,000              |
| \$105                | \$145              |
| <b>\$287</b>         | <b>\$1,091</b>     |
|                      |                    |
| <b>\$6,469</b>       | <b>\$24,593</b>    |
| \$3,400              | \$6,900            |
| <b>1.90</b>          | <b>3.56</b>        |

| Commercial Hospital | Commercial Industrial |
|---------------------|-----------------------|
| +2                  | +2                    |
| 15,000              | 20,000                |
| \$145               | \$145                 |
| <b>\$7,910</b>      | <b>\$4,419</b>        |
|                     |                       |
| <b>\$178,302</b>    | <b>\$99,610</b>       |
| \$61,400            | \$78,400              |
| <b>2.90</b>         | <b>1.27</b>           |

**NOTE: The Benefit-Cost Ratio considers *only* benefits from avoided physical damages to buildings and contents. Additional benefits are listed within the report text, but not included in the computation.**

---

**30 Year Project Useful Life**

---

**1/2 Foot Floodway, Rule 8**  
(for an existing structure built at BFE)

---

Finished Floor Raise Above BFE (ft)  
Size of Structure (sf)  
Building Replacement Value (BRV, \$/sf)  
**Total Annual Benefits of 1/2 Foot Floodway Rule**

| Existing Residential Standard | Existing Residential Luxury | Existing Commercial Hospital | Existing Commercial Industrial |
|-------------------------------|-----------------------------|------------------------------|--------------------------------|
| +0.0                          | +0.0                        | +0.0                         | +0.0                           |
| 1,000                         | 4,000                       | 15,000                       | 20,000                         |
| \$105                         | \$145                       | \$145                        | \$145                          |
| <b>\$117</b>                  | <b>\$437</b>                | <b>\$3,091</b>               | <b>\$1,540</b>                 |

**Present Value** (4.375% Discount, 30yr)  
**Costs** (Estimated Present Value, One Time Cost)  
**Benefit-Cost Ratio**

|                |                |                 |                 |
|----------------|----------------|-----------------|-----------------|
| <b>\$1,934</b> | <b>\$7,224</b> | <b>\$51,098</b> | <b>\$25,458</b> |
| *              | *              | *               | *               |
| n/a            | n/a            | n/a             | n/a             |

---

---

**100 Year Project Useful Life**

---

**1/2 Foot Floodway, Rule 8**  
(for an existing structure built at BFE)

---

Finished Floor Raise Above BFE (ft)  
Size of Structure (sf)  
Building Replacement Value (BRV, \$/sf)  
**Total Annual Benefits of 1/2 Foot Floodway Rule**

| Existing Residential Standard | Existing Residential Luxury | Existing Commercial Hospital | Existing Commercial Industrial |
|-------------------------------|-----------------------------|------------------------------|--------------------------------|
| +0.0                          | +0.0                        | +0.0                         | +0.0                           |
| 1,000                         | 4,000                       | 15,000                       | 20,000                         |
| \$105                         | \$145                       | \$145                        | \$145                          |
| <b>\$117</b>                  | <b>\$437</b>                | <b>\$3,091</b>               | <b>\$1,540</b>                 |

**Present Value** (4.375% Discount, 100yr)  
**Costs** (Estimated Present Value, One Time Cost)  
**Benefit-Cost Ratio**

|                |                |                 |                 |
|----------------|----------------|-----------------|-----------------|
| <b>\$2,637</b> | <b>\$9,851</b> | <b>\$69,675</b> | <b>\$34,714</b> |
| *              | *              | *               | *               |
| n/a            | n/a            | n/a             | n/a             |

\* Discussion of costs for this rule are provided in report text.

**For additional information, see also the Sample Reach analysis.**

---

**30 Year Project Useful Life**

---

**1/2 Foot Floodway, Rule 8**  
(for a proposed structure built at BFE +1)

---

Finished Floor Raise Above new BFE (ft)  
Size of Structure (sf)  
Building Replacement Value (BRV, \$/sf)  
**Total Annual Benefits of 1/2 Foot Floodway Rule**

| Proposed Residential Standard | Proposed Residential Luxury | Proposed Commercial Hospital | Proposed Commercial Industrial |
|-------------------------------|-----------------------------|------------------------------|--------------------------------|
| +0.5                          | +0.5                        | +0.5                         | +0.5                           |
| 1,000                         | 4,000                       | 15,000                       | 20,000                         |
| \$105                         | \$145                       | \$145                        | \$145                          |
| <b>\$69</b>                   | <b>\$281</b>                | <b>\$1,338</b>               | <b>\$723</b>                   |

**Present Value** (4.375% Discount, 30yr)  
**Costs** (Estimated Present Value, One Time Cost)  
**Benefit-Cost Ratio**

|                |                |                 |                 |
|----------------|----------------|-----------------|-----------------|
| <b>\$1,141</b> | <b>\$4,645</b> | <b>\$22,119</b> | <b>\$11,952</b> |
| *              | *              | *               | *               |
| n/a            | n/a            | n/a             | n/a             |

---

---

**100 Year Project Useful Life**

---

**1/2 Foot Floodway, Rule 8**  
(for a proposed structure built at BFE +1)

---

Finished Floor Raise Above new BFE (ft)  
Size of Structure (sf)  
Building Replacement Value (BRV, \$/sf)  
**Total Annual Benefits of 1/2 Foot Floodway Rule**

| Proposed Residential Standard | Proposed Residential Luxury | Proposed Commercial Hospital | Proposed Commercial Industrial |
|-------------------------------|-----------------------------|------------------------------|--------------------------------|
| +0.5                          | +0.5                        | +0.5                         | +0.5                           |
| 1,000                         | 4,000                       | 15,000                       | 20,000                         |
| \$105                         | \$145                       | \$145                        | \$145                          |
| <b>\$69</b>                   | <b>\$281</b>                | <b>\$1,338</b>               | <b>\$723</b>                   |

**Present Value** (4.375% Discount, 100yr)  
**Costs** (Estimated Present Value, One Time Cost)  
**Benefit-Cost Ratio**

|                |                |                 |                 |
|----------------|----------------|-----------------|-----------------|
| <b>\$1,555</b> | <b>\$6,334</b> | <b>\$30,160</b> | <b>\$16,297</b> |
| *              | *              | *               | *               |
| n/a            | n/a            | n/a             | n/a             |

\* Discussion of costs for this rule are provided in report text.

---

**30 Year Project Useful Life**

---

---

**1/2 Foot Floodway, Rule 8  
Sample Reach**

---

**Benefits**

Annual Benefits from BCA per structure

\$151

Annual Benefits for Sample Reach (352 structures)

\$53,018.24

**Total Benefits Present Value** (4.375% Discount, 30yr)**\$876,450****Costs**

Land Value Impact to Property Owner (One Time Cost)

\$652,078

Reduced Tax Revenue to County

\$80,847

**Total Costs Present Value** (4.375% Discount, 30yr)**\$732,924****Benefit-Cost Ratio****1.20**

---

---

**100 Year Project Useful Life**

---

---

**1/2 Foot Floodway, Rule 8  
Sample Reach**

---

**Benefits**

Annual Benefits from BCA per structure

\$151

Annual Benefits for Sample Reach (352 structures)

\$53,018.24

**Total Benefits Present Value** (4.375% Discount, 100yr)**\$1,195,105****Costs**

Land Value Impact to Property Owner (One Time Cost)

\$652,078

Reduced Tax Revenue to County

\$110,241

**Total Costs Present Value** (4.375% Discount, 100yr)**\$762,318****Benefit-Cost Ratio****1.57**

---

Note: Discussion of sample reach analysis provided in report.

## **APPENDIX C**

**PROPOSED RULES  
DATED SEPTEMBER 30, 2010**

# Floodplain Rules and Regulations

## Statement of Basis and Purpose

### Proposed Basis and Purpose for CWCB floodplain Rules and Regulations:

1. These Rules are promulgated to carry out the authority and responsibilities of the Colorado Water Conservation Board (“the Board” or “CWCB”) pursuant to sections 24-4-103, 24-65.1-403(3), 24-65.1-101(1)(c)(I), 24-65.1-202(2)(a)(I), 24-65.1-302(2)(a), 30-28-111(1)–(2), 31-23-301(1) & (3), 37-60-106(1), 37-60-106(1)(c)–(g), (j), (k), C.R.S. (2010). The General Assembly has deemed the designation of floodplains a matter of statewide importance and interest and gave the CWCB the responsibility for the designation of the 100-year and 500-year floodplains and to assure public health, safety, welfare and property by limiting development in the 100-year and 500-year floodplains. §§ 24-65.1-202(2)(a)(I), 24-65.1-302(1)(b)&(2)(a), 24-65.1-403(3), 24-65.1-101 and 24-65.1-404(3), C.R.S. (2010).
2. The Rules will help the CWCB carry out its statutory mission to devise and formulate methods, means, and plans for the prevention of flood damages. § 37-60-106(1)(c).
3. The purpose of the Rules is to provide uniform standards for regulatory floodplains in Colorado, to provide standards for activities that may impact regulatory floodplains in Colorado, and to stipulate the process by which floodplains will be designated and approved by the CWCB. These Rules will also assist the CWCB and Colorado communities in developing sound floodplain management practices and in assisting with the implementation of the National Flood Insurance Program.
4. Implementing a sound flood protection program is necessary to reduce flood damages because flooding is the most devastating natural disaster in terms of both property damage and human fatalities in Colorado.
5. The General Assembly gave the CWCB the authority to prevent flood damages and regulate and designate floodwater runoff channels or basins. §§ 37-60-106(1)(c), 37-60-106(1)(e), 37-60-106(1)(f), 37-60-106(1)(g), 37-60-106(1)(h), 37-60-106(1)(k), 37-60-108. The CWCB, in cooperation and coordination with local governments, ensures proper regulation of floodplains.
6. Floodplain administration is an area of state interest. §§ 24-65.103(7) & 24-65.1-202(2)(a), C.R.S. (2010). The General Assembly gave local authorities broad authority to plan for and regulate land use within their jurisdictions, including regulation of development in hazardous areas and regulating on the basis of impacts to the communities and surrounding areas. §§ 29-20-102(1) & 29-20-104(1)(a)&(g), C.R.S. (2010). County planning commissions may establish, regulate and limit uses on or along any storm or floodwater runoff channel or basin that has been designated and approved by the CWCB in order to lessen or avoid flood damage. § 30-28-111(1), C.R.S. (2010). The governing body of municipalities may establish, regulate and limit uses on or along any storm or floodwater runoff channel or basin that has been designated and approved by the CWCB in order to lessen or avoid flood damage. § 31-23-301(1), C.R.S. (2010). Thus, all federal agencies using local or state funds, and all private, local or state entities conducting activities on or along any storm or floodwater runoff channel or basin shall abide by all state and federal regulations and applicable local regulations on or along any storm or floodwater runoff channel or basin that has been designated and approved

by the CWCB. Such activities shall also be in conformance with FEMA Regulations 44 C.F.R. § § 59, 60, 65, and 70 (2009).

7. Domestic water and sewage systems, such as wastewater treatment facilities or water treatment facilities, any systems of pipes, structures and facilities through which wastewater is collected for treatment, are areas of state interest. § 24-65.1-104(5), C.R.S. (2010). Similarly, the site selection and construction of major new domestic water and sewage treatment systems and major extension of existing domestic water and sewage treatment systems are also areas of state interest as determined by local governments. § 24-65.1-203(1)(a), C.R.S. (2010). Structures, such as domestic water and sewage systems, in the floodplain shall be built and designed to incorporate flood protection devices, consider proposed intensity of use and the structure's effects on the acceleration of floodwaters and any potential significant hazards to public health and safety or to property. § 24-65.1-202(2)(a)(I)(A), C.R.S. (2010). Shallow wells, solid waste disposal sites, and septic tanks and sewage disposal systems shall be protected from inundation by floodwaters. § 24-65.1-202(2)(a)(I)(A), C.R.S. (2010).
8. The Rules apply throughout the State of Colorado, without regard to whether a community participates in the National Flood Insurance Program. The Rules also apply to activities conducted by state agencies. §§ 24-65.1-301(1), 24-65.1-403(3)(a), 24-65.1-404(3), 24-65.1-501, 31-23-301 and 30-28-111(1), C.R.S. (2010).
9. The Rules incorporate new standards for critical facilities that, if flooded, may result in severe consequences to public health and safety or interrupt essential services and operations for the community at any time before, during, and after a flood. These Rules are proposed for promulgation in recognition that such critical facilities must be protected to a higher standard from flood damages. § 37-60-106(1)(c). Further, the General Assembly has required that building of structures in the floodplain must be designed in terms of the availability of flood protection devices, proposed intensity of use, effects on the acceleration of floodwaters, potential significant hazards to public health and safety or to property, and other impact of such development on downstream communities such as the creation of obstructions during floods. § 24-65.1-202(2)(a)(I)(A), C.R.S. (2009). Finally, floodplains shall be administered so as to minimize significant hazards to public health and safety or to property. § 24-65.1-202(2)(a)(I)(A).
10. The Rules provide for procedures for and conditions of proposed variances from the Rules if such variance is for good and sufficient cause and will not increase flooding or threaten public safety.
11. The Rules contain standards and specifications for approximate and detailed regulatory floodplain determinations in Colorado. The 2005 Rules contained detailed standards within Appendix A, Appendix B, and Appendix C. These Appendices have been omitted as incorporation into the Rules, but are still available as a reference tool.
12. The Rules will provide the necessary steps for floodplain mapping partners to follow in order to have county and community flood hazard information designated and approved by the CWCB so that statutory requirements can be met.
13. The Rules will assist communities and other floodplain mapping partners with developing and providing accurate regulatory floodplain information for use in wise floodplain management activities. The Rules provide for a process whereby all affected communities have the

opportunity to review, analyze, and object to the floodplain studies if not based on technically accurate and sound scientific data.

14. The Rules provide for the CWCB's review of the results of the hydrologic analyses, hydraulic analyses, and floodplain delineations in a published floodplain study report. The Rules provide that a qualified Colorado registered professional engineer in good standing shall direct or supervise the floodplain mapping studies and projects within the regulatory floodplain and that such floodplain maps, reports and project designs within the regulatory floodplain shall be certified and sealed by the Colorado registered professional engineer of record.
15. The Rules provide that designation and approval of floodways shall be considered, as requested by the local governing entity, as part of the designation and approval of corresponding regulatory floodplains. The Rules provide criteria for determining the effects of dams, levees, stormwater detention, irrigation facilities, flood mitigation measures and stream alteration activities on or in regulatory floodplains in order to quantify peak flood discharges and to assess the effects of flooding conditions that would result.
16. The Rules set forth the process and procedures for the CWCB to designate and approve regulatory floodplains. The 100-year flood shall be the basis for all designation and approvals by the Board, for zoning and land use purposes, of regulatory floodplains in Colorado, except where critical facilities are affected, in which the 500-year flood may be considered only if requested by the local jurisdiction.
17. The Rules provide the process and procedures for the CWCB to designate and approve changes to regulatory floodplains resulting from development, watershed changes, new or better technical information, or other factors, subject to the same criteria as required for an original approval and designation.
18. The Rules will provide additional information and recommendations, above and beyond the 100-year floodplain requirements, that can serve communities in need of technical, regulatory, and administrative information in order to allow for safe and reasonable floodplain development that will lead to better protection of Colorado citizens and their property.
19. The Rules will increase the quantity of statewide uniform credit for the Community Rating System, a program within FEMA's National Flood Insurance Program that provides flood insurance discounts for flood programs that exceed federal minimum standards. This will serve to make flood insurance premiums more affordable statewide for the citizens of Colorado.
20. The Rules establish freeboard for all new and substantially changed structures statewide. Freeboard tends to compensate for the many unknown factors that could contribute to flood heights greater than the height calculated for a selected size flood and floodway conditions, such as debris blocking bridge openings, inherent uncertainty in hydrologic and hydraulic models, rainfall in excess of design events, legal encroachments into the floodplain, and the hydrological effect of urbanization of the watershed. Freeboard results in substantially safer construction and significantly lower flood insurance rates due to lower flood risk. This standard will not apply to existing mapping, but rather, it will be in effect for future mapping and studies. This new standard does not result in any new requirements.



21. The Rules provide for a uniform statewide floodway criteria. Current minimum standards set by the National Flood Insurance Program allow for encroachment into the floodplain that raises base flood elevations by one foot. While legally permissible in most cases, this encroachment results in increased risk to neighboring property owners without recourse that may result in lower property values and increased liability for the permitting communities. Some local communities in Colorado have already successfully adopted and implemented a ½ foot surcharge, as proposed by these Rules. However, due to the non-uniform surcharge criteria between neighboring communities, this higher local regulation is difficult to enforce near community boundaries and is often unable to be reflected on countywide floodplain maps due to the non-uniform regulations. While this regulation only applies to future activities, it has the potential to provide benefits for both existing and future facilities by limiting higher flood depths impacting these structures due to encroachment. This regulation has the net effect of lowering flood elevations on nearby properties, thus increasing the safety and property value of these positively impacted properties.
22. These Rules apply higher standards to regulations and processes that currently exist, including requirements to: 1) follow all state and federal regulations, 2) obtain a local permit for development in the floodplain (where applicable), 3) elevate or floodproof structures to a safe elevation, and 4) get a local determination of when substantial changes occur. These Rules do not change the current need to obtain a local permit for development in the floodplain and do not alter how substantial change determinations are made by local governments. Identification of a structure as a critical facility does not create a new regulatory nexus nor does it prevent its occupation in the floodplain; rather it simply requires an additional foot of freeboard when designed and constructed.
23. These Rules contain provisions that will require many local ordinances to be updated to be consistent with these rules. A transition period of three years beginning from the effective date of these rules will be in effect during which all local governments may follow current local ordinances but must undertake activities to come into compliance with these Rules. Following this transition period, all floodplain activities shall be in conformance with these Rules. In addition, communities may, at their sole discretion, allow un-built projects that were previously permitted by the local government, prior to the adoption date of the local ordinance for which these Rules are incorporated, to be built and therefore considered to be in compliance with these Rules. Communities may also, at their sole discretion, permit and allow projects for which a valid CLOMR was issued prior to the adoption date of the local ordinance for which these Rules are incorporated.
24. These Rules reduce expenditure of public money for costly flood control structures. In many cases, proper application of these Rules may reduce, or in some cases, eliminate the need for these costly public expenditures due to wiser use of floodplain areas and safer development within them.
25. These Rules minimize the need for response and rescue efforts associated with flooding and generally undertaken at the expense of the general public. While these Rules actually regulate only structures and facilities in the regulatory floodplain, response and rescue efforts associated with flooding affect all residents of a community in terms of cost and reduced availability of these services during and following a flood to non-floodplain areas. Depending on the circumstances for a particular flood event, the cost of these services can be enormous and, in

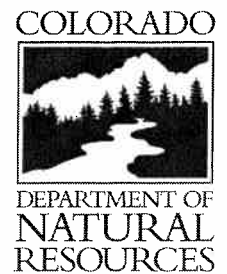
worst cases, can impact the financial viability of a community.

26. These Rules minimize business interruptions. While there is a tangible cost of complying with these Rules, it often pales in comparison to the lost business income, tax revenue, and employment that are often experienced following flood events. There are many examples, both from Colorado and around the nation, of a damaging flood impacting the financial stability of a community or region for long periods. While disaster assistance may be available following some events, it is often not sufficient to fully restore services, especially to individuals and businesses. These Rules reduce the risk of flooding to future infrastructure and therefore lessen the vulnerability of communities to losses and economic risk.
  
27. These Rules minimize expenses to taxpayers for costly disaster bailouts, relief efforts, and recovery programs. Disaster assistance only benefits those directly affected by a flood disaster but the costs are shared by entire communities, the state as a whole and, in some cases, the entire nation. Application of these Rules places responsibility and costs on property owners most likely to be directly affected by a flood event. These costs are often low compared to costs experienced during flood events. These Rules reduce the risk of flooding to future infrastructure and therefore lessen the vulnerability of communities and the State to costly and avoidable post-flood activities.
  
28. These Rules are not to be applied retroactively. These Rules are in effect for future construction, substantial changes to existing construction, and new additions. Substantial change determinations are already made by local governments, and the process for this decision is not altered by these Rules.

DEPARTMENT OF NATURAL RESOURCES  
COLORADO WATER CONSERVATION BOARD

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

**September 30, 2010**



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

## **COLORADO WATER CONSERVATION BOARD DEPARTMENT OF NATURAL RESOURCES**

### **TABLE OF CONTENTS**

| <b>Rule</b> | <b>Title</b>  | <b>Pages</b> |
|-------------|---|--------------|
| 1           | Rules and Regulations for Regulatory Floodplains in Colorado                                    | 3            |
| 2           | Authority   | 3            |
| 3           | Purpose and Scope   | 3            |
| 4           | Definitions   | 4            |
| 5           | The State Regulatory Floodplain   | 11           |
| 6           | Critical Facilities   | 11           |
| 7           | Standards for Delineation of the Regulatory Floodplain Information                              | 15           |
| 8           | Standards for Regulatory Floodways  | 18           |
| 9           | Criteria for Determining the Effects of Flood Control Structures on Regulatory Floodplains      | 19           |
| 10          | Criteria for Determining the Effects of Levees on Regulatory Floodplains                        | 20           |
| 11          | Floodplain Management Regulations   | 22           |
| 12          | Effects of Flood Mitigation Measures and Stream Alteration Activities on Regulatory Floodplains | 23           |
| 13          | Process for Designation and Approval of Regulatory Floodplains                                  | 25           |
| 14          | Designation and Approval of Changes to Regulatory Floodplains                                   | 26           |
| 15          | Variances   | 27           |
| 16          | Enforcement of Floodplain Rules and Regulations   | 28           |
| 17          | Incorporation by Reference  | 28           |
| 18          | Severability  | 29           |
| 19          | Recommended Activities for Regulatory Floodplains   | 29           |
| 20          | Effective Date  | 31           |

Note: Statement of Basis and Purpose follows last page of Rules

## RULES AND REGULATIONS FOR REGULATORY FLOODPLAINS IN COLORADO

- Rule 1.** **Title:** The formal title of the previous Rules and Regulations was "Rules and Regulations for the Designation and Approval of Floodplains and of Storm or Floodwater Runoff Channels in Colorado" as approved in 1988. The title for these Rules and Regulations was revised in 2005 to "Rules and Regulations for Regulatory Floodplains in Colorado," and amended here under the same title (referred to herein collectively as the "Rules" or individually as "Rule"). These Rules supersede both the 2005 and the 1988 Rules.
- Rule 2.** **Authority:** These Rules are promulgated pursuant to the authority granted the Colorado Water Conservation Board (Board or CWCB) in sections 24-4-103, 24-65.1-101(1)(c)(I), 24-65.1-202(2)(a)(I), 24-65.1-302(2)(a), 24-65.1-403(3), 30-28-111(1)–(2), 31-23-301(1)–(3), 37-60-106(1), and 37-60-106(1)(c)–(g), (j), (k), C.R.S. (2010).
- Rule 3.** **Purpose and Scope:**
- A. **Purpose.** The purpose of these Rules is to provide uniform standards for regulatory floodplains (or floodplains) in Colorado, to provide standards for activities that may impact regulatory floodplains in Colorado, and to stipulate the process by which floodplains will be designated and approved by the CWCB. Rules for 100-year floodplains are of statewide concern to the State of Colorado and the Colorado Water Conservation Board in order to prevent flooding and the negative impacts of floods, as well as to assure public health, safety, welfare and property by limiting development in floodplains. These Rules will also assist the CWCB and communities in Colorado to develop sound floodplain management practices and implement the National Flood Insurance Program (NFIP). These Rules shall apply throughout the State of Colorado, without regard to whether a community participates in the National Flood Insurance Program. These Rules shall also apply to activities conducted by state agencies and to Federal activities that are fully or partially financed by state funds. These Rules also apply to projects or studies for which the Board has made a loan or grant pursuant to sections 37-60-120(2) and 37-60-121(1)(b)(VII), (IX)(C).
- B. **Scope**
- (1) **Zoning.** These Rules apply to all floodplain information developed for zoning and for floodplain permitting purposes for waterways in the State of Colorado by, but not limited to, individuals, corporations, local government agencies, regional government agencies, state government agencies, Indian tribes, and federal government agencies.
  - (2) **Subdivisions.** These Rules generally apply to the local approval of subdivision drainage reports that provide 100-year floodplain information. Local governments should ensure that site-specific floodplain delineations, intended for regulatory purposes when they are prepared, for development activities are consistent with floodplain information designated and approved by the Board.
  - (3) **Dam Failure floodplain.** These Rules do not apply to the identification of the area potentially inundated by the catastrophic or sudden failure of any man-made structure such as a dam, canal, irrigation ditch, pipeline, or other artificial channel.

**Rule 4. Definitions:** The following definitions are applicable to these Rules and Regulations for Regulatory Floodplain in Colorado:

| <b><u>Term</u></b>                        | <b><u>Definition</u></b>   |
|---|--|
| <b>100-year Flood</b>                     | A flood having a recurrence interval that has a one-percent chance of being equaled or exceeded during any given year (1-percent-annual-chance-flood). The terms "one-hundred-year flood" and "one percent chance flood" are synonymous with the term "100-year flood." The term does not imply that the flood will necessarily happen once every one hundred years.   |
| <b>100-year Floodplain</b>                | The area of land susceptible to being inundated as a result of the occurrence of a one-hundred-year flood.   |
| <b>500-year Flood</b>                     | A flood having a recurrence interval that has a 0.2-percent chance of being equaled or exceeded during any given year (0.2-percent-chance-annual-flood). The term does not imply that the flood will necessarily happen once every five hundred years.   |
| <b>500-year Floodplain</b>                | The area of land susceptible to being inundated as a result of the occurrence of a five-hundred-year flood.  |
| <b>Addition</b>                           | Any activity that expands the enclosed footprint or increases the square footage of an existing structure.   |
| <b>Alluvial Fans</b>                      | A fan-shaped sediment deposit formed by a stream that flows from a steep mountain valley or gorge onto a plain or the junction of a tributary stream with the main stream. Alluvial fans contain active stream channels and boulder bars, and recently abandoned channels. Alluvial fans are predominantly formed by alluvial deposits and are modified by infrequent sheet flood, channel avulsions and other stream processes. |
| <b>Approximate Floodplain Information</b> | Floodplain information that significantly reduces the level of detail for topographic mapping or hydraulic calculations to arrive at floodplain delineations without a comparison of water surface profiles with a topographic map of compatible accuracy. The level of detail for hydrology is consistent with that of detailed floodplain information.   |

|   |  |
|---|--|
| <b>Base Flood</b>   | Is synonymous with 100-year flood and is a flood having a one percent chance of being equaled or exceeded in any given year.   |
| <b>Base Flood Elevation (BFE)</b>                         | The elevation shown on a FEMA Flood Insurance Rate Map for Zones AE, AH, A1-A30, AR, AR/A, AR/AE, AR/A1-A30, AR/AH, AR/AO, V1-V30, and VE that indicates the water surface elevation resulting from a flood that has a one percent chance of equaling or exceeding that level in any given year. |
| <b>Basin</b>  | The total land surface area from which precipitation is conveyed or carried by a stream or system of streams under the force of gravity and discharged through one or more outlets.  |
| <b>Channel</b>  | The physical confine of stream or waterway consisting of a bed and stream banks, existing in a variety of geometries.  |
| <b>Channelization</b>                                     | The artificial creation, enlargement or realignment of a stream channel.   |
| <b>Code of Federal Regulations (CFR)</b>                  | The codification of the general and permanent Rules published in the Federal Register by the executive departments and agencies of the Federal Government. It is divided into 50 titles that represent broad areas subject to Federal regulation.  |
| <b>Colorado Floodplain and Stormwater Criteria Manual</b> | The Manual prepared by the CWCB to aid local officials and engineers in the proper regulation and design of flood protected facilities. The Manual is advisory, rather than regulatory, in purpose.  |
| <b>Community</b>  | Any political subdivision in the state of Colorado that has authority to adopt and enforce floodplain management regulations through zoning, including, but not limited to, cities, towns, unincorporated areas in the counties, Indian tribes and drainage and flood control districts.         |
| <b>Conditional Letter of Map Revision (CLOMR)</b>         | FEMA's comment on a proposed project, which does not revise an effective floodplain map, that would, upon construction, affect the hydrologic or hydraulic characteristics of a flooding source and thus result in the modification of the existing regulatory floodplain.                       |
| <b>Critical Facility or Critical Facilities</b>           | Means a structure or related infrastructure, but not the land on which it is situated, as specified in Rule 6, that if   |

flooded may result in significant hazards to public health and safety or interrupt essential services and operations for the community at any time before, during and after a flood. *See* Rule 6.

**Debris Flow**

Movement of mud, water, and other materials downward over sloping terrain. The flow typically consists of a mixture of soil, rock, woody debris and water that flows down steep terrain.

**Designation and Approval**

Certification by formal action of the Board that technical information developed through scientific study using accepted engineering methods is suitable for local governments making land use decisions under statutorily authorized zoning powers.

**Detailed Floodplain Information**

Floodplain information prepared utilizing topographic base mapping, hydrologic analysis, and hydraulic calculations to arrive at precise water surface profiles and floodplain delineations suitable for making land use decisions under statutorily authorized zoning powers.

**Development**

Any man-made changes to improved or unimproved real estate, including, but not limited to, buildings or other structures, mining, dredging, filling, grading, paving, excavation or drilling operations.

**DFIRM Database**

Database (usually spreadsheets containing data and analyses that accompany DFIRMs). The FEMA Mapping Specifications and Guidelines outline requirements for the development and maintenance of DFIRM databases.

**Digital Flood Insurance Rate Map (DFIRM)**

FEMA digital floodplain map. These digital maps serve as “regulatory floodplain maps” for insurance and floodplain management purposes.

**Federal Register**

The official daily publication for Rules, proposed Rules, and notices of Federal agencies and organizations, as well as executive orders and other presidential documents.

**FEMA**

Federal Emergency Management Agency.

**FEMA Guidelines & Specifications for Flood Hazard Mapping Partners**

Floodplain mapping specifications published by FEMA. The FEMA Guidelines and Specifications for Flood Hazard Mapping Partners (2009) are incorporated herein by reference and available for viewing at [www.fema.gov/fhm/dl\\_cgs.shtm](http://www.fema.gov/fhm/dl_cgs.shtm) and for inspection at the CWCB offices at 1313 Sherman Street, Room 721,



Denver CO 8020. The regulations may also be examined at any state or federal publications depository library. The FEMA Mapping Specifications and Guidelines incorporated herein by reference are only those in existence at the time of the promulgation of these Rules and Regulations for Regulatory Floodplains in Colorado and do not include later amendments to or editions of the incorporated material.

**"Flood" or "Flooding"**

A general and temporary condition of partial or complete inundation of normally dry land areas from:

1. The overflow of water from channels and reservoir spillways;
2. The unusual and rapid accumulation or runoff of surface waters from any source; or
3. Mudslides or mudflows that occur from excess surface water that is combined with mud or other debris that is sufficiently fluid so as to flow over the surface of normally dry land areas (such as earth carried by a current of water and deposited along the path of the current.

**Flood Contour**

A line shown on a map joining points of equal elevation on the surface of floodwater that is perpendicular to the direction of flow.

**Flood Control Structure**

A physical structure designed and built expressly or partially for the purpose of reducing, redirecting, or guiding flood flows along a particular waterway.

**Flood Insurance Rate Map (FIRM)**

A FIRM is the official map of a community on which FEMA has delineated both the special hazard areas and the risk premium zones applicable to the community.

**Flood Mitigation Project**

A project within or adjacent to a flooding source that is specifically intended to reduce or eliminate the negative impacts caused by excessive floodwaters through improvement of drainage, flood control, flood conveyance or flood protection.

**Floodplain**

The area of land that could be inundated as a result of a flood, including the area of land over which floodwater would flow from the spillway of a reservoir.

**Floodplain Management**

The operation of an overall program of corrective and preventive measures for reducing flood damage, including, but not limited to, zoning or land-use

regulations, flood control works, and emergency preparedness plans.

**Floodplain Management Regulations**

Zoning ordinances, subdivision regulations, building codes, health regulations, land-use permits, special purpose ordinances (floodplain ordinance, grading ordinance, or erosion control ordinance) and other applications of regulatory powers. The term describes state/local regulations that provide standards for flood damage preservation and reduction.

**Floodplain Maps**

Maps that show in a plan view the horizontal boundary of floods of various magnitudes or frequencies. Such maps include, but are not limited to, Flood Hazard Boundary Maps (FHBM), Flood Insurance Rate Maps (FIRM), and Digital Flood Insurance Rate Maps (DFIRM) published by FEMA, Flood Prone Area Maps published by the U.S. Geological Survey (USGS), Flooded Area Maps published by the U. S. Army Corps of Engineers (COE), Floodplain Information Reports published by the CWCB or others, Flood Hazard Area Delineations (FHAD) published by the Urban Drainage and Flood Control District (UDFCD), and other locally adopted floodplain studies and master plans.

**Floodplain Studies**

A formal presentation of the study process, results, and technical support information developed for floodplain maps.

**Floodway**

The channel of a river or other watercourse and the adjacent land areas that must be kept free of obstructions in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height.

**Foreseeable Development**

The potential future development of, or changes in, the land uses that are likely to take place during the period of time covered by a community's adopted master land use plan or comprehensive community plan, or if no time period is specified, over a 20-year period. If there is no adopted community plan, then potential development patterns based on zoning, annexations, and other relevant factors should be evaluated.

**Freeboard**

The vertical distance in feet above a predicted water surface elevation intended to provide a margin of safety to compensate for unknown factors that could contribute to flood heights greater than the height calculated for a

selected size flood such as debris blockage of bridge openings and the increased runoff due to urbanization of the watershed.

**Geographic Information Systems (G.I.S.)**

Computer software that utilizes databases and terrain mapping to store and display spacial and tabular data, such as floodplains, as layers (e.g. political boundaries, roadways, structures, topographic information) for natural resource management and other uses.

**Hydraulic analysis**

The determination of flood elevations and velocities for various probabilities based on a scientific analysis of the movement and behavior of floodwaters in channels and overbank areas.

**Hydrologic Analysis**

The computation of the peak rate of flow, or discharge in cubic feet per second, for various selected probabilities for streams, channels, or watersheds based on a scientific analysis of the physical process.

**Letter of Map Revision (LOMR)**

An official revision to the currently effective FEMA map. It is issued by FEMA and changes flood zones, delineations, and elevations.

**Letter of Map Revision Based on Fill (LOMR-F)**

FEMA's modification of the Special Flood Hazard Area (SFHA) shown on the Flood Insurance Rate Map (FIRM) based on the placement of fill outside the existing regulatory floodway.

**Levee**

An artificial structure or land feature that has been designed and is operated, wholly or in part, for the purpose of containing, controlling, or diverting the flow of water.

**Low Impact Development (LID)**

Development design/construction strategy that maintains the predevelopment hydrologic regime to the extent possible. The goal of LID is to mimic the natural runoff hydrograph as much as practicable in terms of magnitude, frequency, duration, timing, and rate of change of stream flows. LID focuses on small scale stormwater retention and detention, reduced impervious areas, and increased runoff periods.

**Material Safety Data Sheet (MSDS)**

A form with data regarding the properties of a particular substance. An important component of product stewardship and workplace safety, it is intended to

provide workers and emergency personnel with procedures for handling or working with that substance in a safe manner, and includes information such as physical data (melting point, boiling point, flash point, etc.), toxicity, health effects, first aid, reactivity, storage, disposal, protective equipment, and spill-handling procedures.

**Mitigation**

The process of preventing disasters or reducing related hazards. Structural Mitigation, includes, but is not limited to, flood proofing structures, diverting floodwaters, detention ponds, floodwalls or levees. Nonstructural Mitigation includes, but is not limited to, education, planning, and design of flood prevention measures, emergency preparedness plans, elevating relocating structures, purchasing property for open space, or early flood warning detection systems.

**National Flood Insurance Program (NFIP)**

FEMA's program of flood insurance coverage and floodplain management administered in conjunction with the Robert T. Stafford Disaster Relief and Emergency Assistance Act. The NFIP has applicable Federal regulations promulgated in Title 44 of the Code of Federal Regulations. The U.S. Congress established the NFIP in 1968 with the passage of the National Flood Insurance Act of 1968.

**Post-Wildfire Hydrology**

Methodologies and calculations developed to account for the increased stormwater runoff following forest fires. Post-wildfire hydrology is typically evaluated every 3 to 5 years to assess the need for further revision based on watershed recovery, forest re-growth, and other factors.

**Provisionally Accredited Levee (PAL)**

A levee that FEMA has previously credited with providing protection from a 1-percent-chance-annual-flood on an effective FIRM or DFIRM, for which FEMA is awaiting data and/or documentation that will show the Levee's compliance with Levee certification requirements of the NFIP regulations.

**Regulatory Floodplain**

Floodplain Maps, Profiles, and related information for flood hazard areas that have been designated and approved by the CWCB. *See* Rule 5.

**Residual Risk**

The threat to the areas behind levees that may still be at risk for flooding. Although the probability of flooding may be lower because a levee exists, the consequence to

personal safety and property is much higher should a levee overtop or fail.

**Stream Alteration Activity**

Any manmade activity within a stream or floodplain that alters the natural channel, geometry, or flow characteristics of the stream.

**Substantial Change**

Any improvement to, or rehabilitation due to damage of, a structure for which the activity performed equals or exceeds 50% of the pre-improvement or pre-damaged value of the structure. The value of the structure shall be determined by the local jurisdiction having land use authority in the area of interest.

**Threshold Planning Quantity (TPQ)**

A quantity designated for each chemical on the list of extremely hazardous substances that triggers notification by facilities to the State that such facilities are subject to emergency planning requirements.

**Topography**

Configuration (relief) of the land surface elevation; the graphic delineation or portrayal of that configuration in map form, as by lines of constant elevation called contour lines.

**Water Surface Profile**

A graph that shows the relationship between the vertical elevation of the top of the floodwater and of the streambed with the horizontal distance along the stream channel.

**Rule 5. Regulatory Floodplain:** The Regulatory Floodplain in Colorado is the 100-year floodplain. However, the CWCB will Designate and Approve 500-year floodplain information but only at the written request of a local authority having land use jurisdiction. In addition, previously designated floodplain areas that have been removed from FEMA’s effective regulatory floodplain by a Letter of Map Revision based on Fill (LOMR-F) shall remain within the Regulatory Floodplain for all activities affected by Rule 11(c). All Designated and Approved Regulatory Floodplain information can be used by local authorities having land use jurisdiction for the purpose of local regulation. The General Assembly has deemed the designation of floodplains a matter of statewide importance and interest and gave the CWCB the responsibility for the designation of Regulatory Floodplains and to assure protection of public health, safety, welfare and property by protecting development in the Regulatory Floodplains. §§ 24-65.1-101, 24-65.1-202(2)(a)(I), 24-65.1-302(1)(b), (2)(a), 24-65.1-403(3), 24-65.1-404(3).

**Rule 6. Critical Facilities:**

A. **Definition.** “Critical Facility,” for floodplain purposes, means a facility, structure(s), infrastructure, property, equipment or service, that if flooded may result in severe consequences to public health and safety or interruption of essential services and operations for the

community at any time before, during and after a flood. Critical Facilities are classified under the following categories: (1) Essential Services; (2) Hazardous Materials; (3) At-risk Populations; and (4) Vital to Restoring Normal Services.

- (1) *Essential services facilities* include public safety, emergency response, emergency medical, designated emergency shelters, communications, public utility plant facilities and equipment, and transportation lifelines.

*These facilities consist of:*

- a. *Public safety (police stations, fire and rescue stations, emergency vehicle and equipment storage, and, emergency operation centers);*
- b. *Emergency medical (hospitals, ambulance service centers, urgent care facilities having emergency treatment functions, and non-ambulatory surgical facilities but excluding clinics, doctors offices, and non-urgent care medical facilities that do not provide these functions);*
- c. *Designated emergency shelters;*
- d. *Communications (main hubs for telephone, broadcasting equipment for cable systems, satellite dish systems, cellular systems, television, radio, and other emergency warning systems, but excluding towers, poles, lines, cables, and conduits);*
- e. *Public utility plant facilities for generation and distribution ( hubs, treatment plants, substations and pumping stations for water, power and gas, but not including towers, poles, power lines, buried pipelines, transmission lines, distribution lines, and service lines); and*
- f. *Air Transportation lifelines (airports (municipal and larger), helicopter pads and facilities serving emergency functions, and associated infrastructure (aviation control towers, air traffic control centers, and emergency equipment aircraft hangars).*

Specific exemptions to this category include wastewater treatment plants (WWTP) and hydroelectric power generating plants and related appurtenances due to the occurrence of those facilities being located near streams and rivers. WWTP and hydroelectric plant owners are encouraged to meet the spirit of Rule 6(D) when practicable in order to protect their own infrastructure and to avoid system failures during extreme flood events. Emergency restoring plans for WWTP and hydroelectric plant facilities following major flood events should be considered as a prudent addition to operation and maintenance plans for those facilities.

Public utility plant facilities may be exempted if it is demonstrated to the satisfaction of the local authority having jurisdiction that the facility is an element of a redundant system for which service will not be interrupted during a flood. At a minimum, it shall be demonstrated that redundant facilities are available (either owned by the same utility or available through an intergovernmental agreement or other contract) and connected, the alternative facilities are either located outside of the 100-year floodplain or are compliant with this rule, and an operations plan is in effect that states how redundant systems will provide service to the affected area in the event of a flood. Evidence of ongoing redundancy shall be provided to the local authority on an as-needed basis upon request by that local authority.

- (2) *Hazardous materials facilities* include facilities that produce or store highly volatile, flammable, explosive, toxic and/or water-reactive materials.

*These facilities may include:*

- a. *Chemical and pharmaceutical plants (chemical plant, pharmaceutical manufacturing);*
- b. *Laboratories containing highly volatile, flammable, explosive, toxic and/or water-reactive materials;*
- c. *Refineries;*
- d. *Hazardous waste storage and disposal sites; and*
- e. *Above ground gasoline or propane storage or sales centers.*

Facilities shall be determined to be Critical Facilities if they produce or store materials in excess of threshold limits. If the owner of a facility is required by the Occupational Safety and Health Administration (OSHA) to keep an MSDS on file for any chemicals stored or used in the work place, AND the chemical(s) is stored in quantities equal to or greater than the Threshold Planning Quantity (TPQ) for that chemical, then that facility shall be considered to be a Critical Facility. The TPQ for these chemicals is: **either** 500 pounds **or** the TPQ listed (**whichever is lower**) for the 356 chemicals listed under 40 C.F.R. § 302 (2010), also known as Extremely Hazardous Substances (EHS); **or** 10,000 pounds for any other chemical. This threshold is consistent with the requirements for reportable chemicals established by the Colorado Department of Health and Environment. OSHA requirements for MSDS can be found in 29 C.F.R. § 1910 (2010). The Environmental Protection Agency (EPA) regulation “Designation, Reportable Quantities, and Notification,” 40 C.F.R. § 302 (2010), *available at* [http://www.access.gpo.gov/nara/cfr/waisidx\\_03/40cfr302\\_03.html](http://www.access.gpo.gov/nara/cfr/waisidx_03/40cfr302_03.html), and OSHA regulation “Occupational Safety and Health Standards,” 29 C.F.R. § 1910 (2010), *available at* [http://www.access.gpo.gov/nara/cfr/waisidx\\_99/29cfr1910\\_99.html](http://www.access.gpo.gov/nara/cfr/waisidx_99/29cfr1910_99.html), are incorporated herein by reference and include the regulations in existence at the time of the promulgation of these Rules, but exclude later amendments to or editions of the regulations.

Specific exemptions to this category include: a) Finished consumer products within retail centers and households containing hazardous materials intended for household use, and agricultural products intended for agricultural use. b) Buildings and other structures containing hazardous materials for which it can be demonstrated to the satisfaction of the local authority having jurisdiction by hazard assessment and certification by a qualified professional that a release of the subject hazardous material does not pose a major threat to the public. d) Pharmaceutical sales, use, storage, and distribution centers that do not manufacture pharmaceutical products.

These exemptions shall not apply to buildings or other structures that also function as Critical Facilities under another category outlined in this Rule 6(A).

- (3) *At-risk population facilities* include medical care, congregate care, and schools.

*These facilities consist of:*

- a. *Elder care (nursing homes);*
- b. *Congregate care serving 12 or more individuals (day care and assisted living);*

c. *Public and private schools (pre-schools, K-12 schools), before-school and after-school care serving 12 or more children);*

(4) *Facilities vital to restoring normal services including government operations.*

*These facilities consist of:*

a. *Essential government operations (public records, courts, jails, building permitting and inspection services, community administration and management, maintenance and equipment centers);*

b. *Essential buildings for public colleges and universities (dormitories, offices, and classrooms only);*

**B. Identification of Critical Facilities.** It is the responsibility of the local jurisdiction having land use authority to identify and confirm that specific structures in their community meet the criteria outlined in Rule 6(A) and are deemed to be Critical Facilities. All structures that are named or that clearly meet the intent of Rule 6 shall be deemed Critical Facilities by that jurisdiction. For those structures for which it is unclear or otherwise ambiguous if the criteria are met, the local jurisdiction shall have the sole discretion to determine if the structure is a Critical Facility. Local jurisdictions, as is always the case, may adopt ordinances that regulate to higher standards or that include additional facilities within the definition of Critical Facilities. Critical Facilities that are also designated as historic structures (determinations by the State Historic Preservation Office) are exempt from these requirements.

Required identification of critical facilities shall be limited to owner-occupied structures. Local jurisdictions may, at their sole discretion, include leased facilities in their identification of Critical Facilities. In addition, structures that contain Critical Facilities in the upper floors above Base Flood Elevation in a multi-use, multi-story building are not required to be identified as Critical Facilities if all floors below the Base Flood Elevation do not function as Critical Facilities.

**C. 500-year Flood Events.** The CWCB acknowledges that flooding does occur above and beyond 100-year (1% annual chance) events. Communities are encouraged to regulate development of Critical Facilities within the 500-year floodplain, when available.

**D. Protection of Critical Facilities.** All new Critical Facilities, Substantial Changes to Critical Facilities, and new Additions to Critical Facilities, shall be regulated to a higher standard than those structures not determined to be Critical Facilities. This Rule 6(d) shall not be applied to use changes unless a Substantial Change is involved, and shall not be applied retroactively to existing Critical Facilities. The higher standard for Critical Facilities shall be as follows: For Critical Facilities located within the 100-Year Floodplain, the structure shall be protected according to Rule 11(B) herein, with the exception of a freeboard of two feet substituted for the standard one-foot freeboard. The *International Building Code* (2006) and *Flood Resistant Design and Construction* (ASCE 24) (2005) can be used as reference tools for this standard, but are not incorporated by reference herein.



For the purposes of this Rule 6(D), protection shall include one of the following:

- a) Location outside the Regulatory Floodplain; or
- b) Elevation or Flood-proofing of the structure so that it is protected to the level indicated in this Rule 6(D).

All other rules and regulations governing structures not deemed Critical Facilities remain in effect and unchanged.

- E. **Ingress and Egress for New Critical Facilities** shall, when practicable as determined by the local jurisdiction having land use authority, have continuous non-inundated access (ingress and egress for evacuation and emergency services) during a 100-year flood event. This criterion is also recommended, but not required, for changes to existing Critical Facilities and use changes involving existing structures whose classification changes to Critical Facilities.
- F. For all Critical Facilities, the Variance procedure outlined in Rule 15 herein remains available and may be considered when deemed necessary and appropriate by the local jurisdiction having land use authority over the Critical Facility.

**Rule 7. Standards for Delineation of Regulatory Floodplain Information:**

- A. **Intent of this Rule.** This Rule contains standards for approximate and detailed floodplains. All floodplain information intended to be used by local jurisdictions for the purpose regulating flood hazard areas, with the exception of local stormwater drainage reports, CLOMR, LOMR, and LOMR-F submittals, and supporting documentation submitted to FEMA, shall be provided to the CWCB for designation and approval in order to enable local governments to regulate floodplains appropriately. The standards in this rule reference, and incorporate herein, the FEMA Guidelines and Specifications for Flood Hazard Mapping Partners. Whenever such a reference is made, it includes the FEMA Guidelines and Specifications for Flood Hazard Mapping Partners material in existence at the time of the promulgation of these Rules, but excludes later amendments to or editions of the material.
- B. **Level of Detail.**
  - (1) Approximate Floodplain Information will be based on detailed hydrology computed for 100-year floods. Hydraulic information shall be produced using approximate, field, or limited techniques and best available topographic/survey data.
  - (2) Detailed Floodplain Information will be based on detailed hydrologic and hydraulic determinations for 100-year floods. Flood profiles and floodplain delineations for 100-year flood and other frequencies, if any, shall be plotted, preferably using a digital method. The CWCB shall designate and approve 100-year floodplain information, and 500-year information but only at the request of a local authority having land use jurisdiction.

- C.       **Base Mapping.** Base mapping for floodplain studies shall meet the minimum standards as set forth in FEMA Guidelines and Specifications for Flood Hazard Mapping Partners, as incorporated herein by reference.
- D.       **Topography and Surveys.** Topographic and field survey information for floodplain studies shall meet the minimum standards as set forth in FEMA Guidelines and Specifications for Flood Hazard Mapping Partners, as incorporated herein by reference.
- E.       **Geographic Information Systems (GIS).** GIS information for floodplain studies in Colorado shall meet the minimum standards as set forth in FEMA Guidelines and Specifications for Flood Hazard Mapping Partners, as incorporated herein by reference.
- F.       **Hydrology.** Hydrologic analyses for floodplain studies in Colorado shall be completed using the information set forth in FEMA Guidelines and Specifications for Flood Hazard Mapping Partners, as incorporated herein by reference. The Colorado Floodplain and Criteria Manual may be used as a reference document to aid in this analysis. In addition, hydrology studies must comply with the following:
- (1)      All floodplain studies, regardless of the level of detail, (e.g., approximate or detailed) shall utilize detailed hydrologic information. The CWCB recognizes existing and future watershed conditions for the purposes of computing flood hydrology. The CWCB may evaluate future watershed conditions, in addition to existing conditions when Foreseeable Development is expected.
  - (2)      Any new study to evaluate hydrologic information and/or design storm criteria shall be completed in such a way that it is scientifically defensible and technically reproducible.
  - (3)      All jurisdictions and communities affected by revised hydrologic data, due to their geographic proximity to the affected stream reach within a particular watershed, are encouraged to participate in the update process, and shall be given the opportunity by the study sponsor to review and comment on the revised information. Opponents to the revised information may present technically accurate and sound scientific data to the CWCB that clearly demonstrates that the information in question is inaccurate pursuant to Rule 12. The CWCB shall make the final determination regarding disputes.
  - (4)      Within any given watershed, or hydrologic subregion, consistency in hydrologic data and runoff methodology shall be pursued to the extent possible through cooperation of all affected jurisdictions and entities.
- G.       **Detailed Hydraulic Method.** Hydraulic analyses for floodplain studies in Colorado shall be completed using protocols set forth in FEMA Guidelines and Specifications for Flood Hazard Mapping Partners, as incorporated herein by reference.
- H.       **Floodplain Delineations.** Floodplain delineations shall be completed using protocols set forth in FEMA Guidelines and Specifications for Flood Hazard Mapping Partners, as incorporated herein by reference, and shall, at a minimum, comply with the technical quality assurance standards as follows:

- (1) The flood elevations and the floodplain delineations on the maps must correlate reasonably to the best available topographic information for the stream and adjacent corridor and must meet an acceptable level of technical accuracy.
- (2) The planimetric features on the floodplain maps (including, but not limited to, streets and highways, stream centerlines, bridges and other critical hydraulic features, corporate limits, section lines and corners, survey benchmarks) must be consistent with the best available aerial photographs or other suitable information for the stream and the adjacent corridor, as determined through prevailing industry practices, and must meet an acceptable level of technical accuracy.

I. **Special Floodplain Conditions.** There are a number of special floodplain conditions, or natural flood hazards, in Colorado that fall outside of the standard riverine environment. Studies for the 100-year flood involving special conditions shall be completed using protocols set forth in FEMA Guidelines and Specifications for Flood Hazard Mapping Partners, as incorporated herein by reference. The special conditions are:

- (1) Alluvial Fan and Debris Flow floodplains located within foothill and mountainous regions of Colorado shall be considered on a case-by-case basis.
- (2) Post-wildfire hydrology shall be evaluated on a case-by-case basis in forested areas immediately following moderate to intense wildfires resulting in approximately 15% or greater burn area of the affected watershed. Interim flood advisory maps, based on burned watershed conditions, shall be produced at the request of the local governing authority or by Board initiative. The interim floodplain maps shall show increased runoff from hydrophobic soils and lack of vegetation. The post-wildfire maps shall be evaluated every 3 to 5 years to assess the need for further revision based on watershed recovery, forest re-growth, and other factors.
- (3) Ice jam flooding shall be considered within stream reaches where this phenomenon is known to occur. Ice jam flooding may be analyzed utilizing methodologies available through the U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory (CRREL), located in Hanover, New Hampshire.

J. **Written reports and maps.** The results of the hydrologic analyses, hydraulic analyses, and floodplain delineations shall be summarized in a written report and submitted to the CWCB. All Approximate and Detailed Floodplain Information that is presented to the CWCB for designation and approval shall be properly titled, dated, organized, and bound as a stand-alone document. In addition to the hard copy final report, the CWCB requires that a digital copy of the final report be submitted in MS Word and PDF formats. All pertinent technical backup data such as GIS files, and hydrologic and hydraulic models shall also be provided to the CWCB in acceptable digital formats. The CWCB shall electronically distribute to interested parties, to the extent possible, pertinent study information. Access to original GIS information shall be provided to local governments and other authorized users through a secure and protected website or other secure means.

- (1) The Regulatory Floodplain maps shall show, at a minimum, the flood boundaries, the location of all cross sections used in the hydraulic analysis, the reference line drawn down the center of the floodplain or low flow channel, and a sufficient number of flood contours in order to reconstruct the flood water surface profiles.

- (2) New Physical Map Revisions requested by local jurisdictions or involving local jurisdictions should include detailed 500-year floodplain information when practicable.
- (3) Flood contours, or Base Flood Elevations, shall be shown as wavy lines drawn perpendicular to the direction of flow of floodwater and shall extend completely across the area of the mapped Regulatory Floodplain. Each flood contour shall indicate its elevation to the nearest whole foot.
- (4) The Regulatory Floodplain map scale shall be 1-inch equals 1000 feet or such map scale showing greater detail. FEMA map panels may also be published at 1 inch equals 500 feet, 1 inch equals 1,000 feet or 1 inch equals 2000 feet.
- (5) Where discrepancies appear between Regulatory Floodplain maps and water surface profiles, any regulatory water surface profile designated and approved by the Board shall take precedence over any corresponding flooded area map for the same stream reach or site location, unless a profile error is identified and substantiated.

**K. Contractor Qualifications**

- (1) Qualified engineers licensed in Colorado shall direct or supervise the floodplain mapping studies and projects pertaining to the Regulatory Floodplain. All floodplain maps, reports and project designs pertaining to the Regulatory Floodplain, except those prepared by federal agencies, shall be certified and sealed by the Colorado Registered Professional Engineer of record.
- (2) Federal agencies or other recognized and qualified government authorities may produce floodplain mapping work as a study proponent or on behalf of a study proponent.

**Rule 8. Standards for Regulatory Floodways:**

- A. Establishment of Floodway Criteria.** The CWCB recognizes that Designated Floodways are administrative limits and tools used by communities to regulate existing and future Floodplain developments within their jurisdictions. This Rule 8(A) does not require communities to automatically map ½ foot floodways within their jurisdictions. However, at such time when floodways are to be delineated through Physical Map Revisions involving local government participation, communities shall delineate floodways for the revised reaches based on ½-foot rise criteria. Letters of Map Revision to existing floodway delineations may continue to use the floodway criteria in place at the time of the existing floodway delineation. Until such time that floodways are revised and designated, communities may continue to regulate their mapped one-foot floodways. For reaches where a transition must be shown to connect new studies to existing studies with different floodway criteria, the transition length shall not exceed 2,000 feet.
- B. Designation of floodways.** Designation and approval of Floodplain information shall also include the designation and approval of corresponding Floodway Information. For waterways with Base Flood Elevations for which Floodways are not computed, the community shall apply a ½ foot floodway regulation according to its own determination, as outlined in FEMA Regulation 44 C.F.R. § 60.3(c)(10) (2010), incorporated herein by reference, for a 1-foot floodway. This reference is *available at* [http://www.access.gpo.gov/nara/cfr/waisidx\\_02/44cfr60\\_02.html](http://www.access.gpo.gov/nara/cfr/waisidx_02/44cfr60_02.html), and is hereby

incorporated by reference into this Rule and includes the material in existence at the time of the promulgation of these Rules, but does not include later amendments to or editions of this incorporated material

- C. **Incorporation of FEMA’s Floodway Regulations.** All regulations defined in the FEMA regulations “Criteria for Land Management and Use,” 44 C.F.R. § 60.3(c)(10), (d) (2010) *available at* [http://www.access.gpo.gov/nara/cfr/waisidx\\_02/44cfr60\\_02.html](http://www.access.gpo.gov/nara/cfr/waisidx_02/44cfr60_02.html), are hereby incorporated by reference into this Rule and includes the material in existence at the time of the promulgation of these Rules, but does not include later amendments to or editions of this incorporated material. All communities participating in the National Flood Insurance Program that have Base Flood Elevations defined for one or more of the waterways within their jurisdictions shall adopt and enforce these floodway regulations. Failure to enforce floodway regulations may impact the community’s standing in the National Flood Insurance Program and may eliminate or reduce eligibility for federal or state financial assistance for flood mitigation and disaster purposes.
- D. **Communities in Which This Rule Applies.** Communities with Regulatory Floodplains that have been Designated and Approved by the CWCB with Base Flood Elevations defined for one or more of the waterways within their jurisdictions shall be required to establish technical (quantified) surcharge criteria for floodway determination and regulation, which must meet or exceed the requirements set forth in this Rule. This Rule shall not apply in communities without Base Flood Elevations established, unless otherwise adopted by the community. This Rule shall not apply to approximate stream reaches for which Base Flood Elevations have not been defined.

**Rule 9. Criteria for Determining the Effects of Flood Control Structures on Regulatory Floodplains:**

- A. For the purposes of this Rule, local and regional hydraulic structures providing local or regional flood or stormwater detention, shall be considered to be “Flood Control Structures.” There are no separate criteria for these structures.
- B. **Flood Control Structures.** If a publicly operated and maintained structure is specifically designed and operated either in whole or in part for flood control purposes, then its effects shall be taken into consideration when delineating the floodplain below such structure. The effects of the structure shall be based upon the 100-Year Flood with full credit given to the diminution of peak flood discharges, which would result from normal Flood Control Structure operating procedures.

The hydrologic analysis pertaining to State Regulatory Floodplains shall consider the effects of on-site detention for rooftops, parking lots, highways, road fills, railroad embankments, diversion structures, refuse embankments (including, but not limited to, solid waste disposal facilities), mill tailings, impoundments, siltation ponds, livestock water tanks, erosion control structures, or other structures, only if they have been designed and constructed with the purpose of impounding water for flood detention and are publicly operated and maintained. For the purposes of this Rule, Public operation and maintenance may include direct responsibility or ultimate responsibility through written agreement. Detention structures that are privately operated or maintained shall not be included in the

hydrologic analysis unless it can be shown that they exacerbate downstream peak discharges.

- C. **Non-Flood Control Structures.** If a structure is not specifically designed and operated, either in whole or in part, for flood control purposes, then its effects, even if it provides inadvertent flood routing capabilities that reduce the 100-Year Flood downstream, shall not be taken into account, and the delineation of the Floodplain below such structure shall be based upon the 100-Year Flood that could occur absent the structure's influence. However, if adequate assurances have been obtained to preserve the flood routing capabilities of such structure, then the delineation of the Floodplain below the structure may, but need not, be based on the assumption that the reservoir formed by the structure will be filled to the elevation of the structure's emergency spillway and the 100-Year hydrology can be routed through the reservoir to account for any flood attenuation effects.
- D. **Adequate Assurances.** For the purposes of this Rule 9 "adequate assurances" shall, at a minimum, include appropriate recognition in the community's adopted master plan of: (1) the flood routing capability of the reservoir, as shown by comparison of the 100-Year Floodplain in plan and profile with and without the structure in place, in order that the public may be made aware of the potential change in level of Flood protection in the event that the reservoir flood routing capability is lost; (2) the need to preserve that flood routing capability by whatever means available in the event that the reservoir owners attempt to make changes that would decrease the flood routing capability; and (3) a complete operations and maintenance plan.
- E. **Irrigation Facilities.** The CWCB recommends that irrigation facilities (including, but not limited to, ditches and canals) not be used as stormwater or flood conveyance facilities, unless specifically approved and designated by local governing jurisdictions and approved by the irrigation facility owners. The flood conveyance capacity of irrigation facilities shall be acknowledged only by agreement between the facility owners and local governing jurisdictions, with review and concurrence from the Colorado Division of Water Resources to ensure that water rights administration needs are properly considered. A maintenance easement or agreement shall be in place allowing the local government maintenance access if needed.

Unless specified otherwise by aforementioned written agreement, flood hydrology for State Regulatory Floodplain mapping purposes shall consist of peak hydrologic flows that are identical immediately downstream and immediately upstream of a ditch or canal that is generally perpendicular to the stream or drainageway of interest. The irrigation facility shall be assumed as running full so that there are no computed flood reduction benefits downstream of the irrigation facility. Backwater behind irrigation facilities shall be mapped. The CWCB will designate and approve 100-Year Floodplain information for irrigation facilities if the above recommendations are met. This Rule is not intended in any way to interfere with Colorado water law.

**Rule 10. Criteria for Determining Effects of Levees on Regulatory Floodplains:**

**General.** The use of levees for property protection, flood control, and flood hazard mitigation is not encouraged by the CWCB, unless other mitigation alternatives are not

viable. The areas landward of an accredited levee and Provisionally Accredited Levee (PAL) system shall be mapped as Zone X (shaded). The DFIRMs for these areas will include an informational note that advises users of the flood risk in levee-impacted areas. In situations where levees are the only viable alternative for protection of existing development, “setback” levees should be designed and constructed to maintain the natural channel and reserve a portion of the natural floodplain capacity. Levees should not be used for flood protection along streams or watercourses where new development is planned. However, levees may be used to protect public utility plant facilities for wastewater treatment and pumping as well as electric power plants due to their close proximity to natural waterways. For existing levees that protect existing development, proper maintenance should be performed by levee owners/operators, or non-federal sponsors in the case of federal levees, according to an operations and maintenance plan.

Levees should not be constructed for the primary purpose of removing undeveloped lands from mapped floodplain areas for the purposes of developing those lands because of the potential impairment of the health, safety, welfare and property of the people. Design and construction of levees identified for this purpose will not be eligible for CWCB grants or loans.

When constructed, levees for which protection will be considered for designation and approval must meet the requirements set forth in “Mapping of Areas Protected by Levee Systems,” 44 C.F.R. § 65.10 (2010). Artificial embankments that either function as a Levee or a Flood Control Structure must meet the provisions of this Rule or “Office of the State Engineer Rules and Regulations for Dam Safety and Dam Construction,” 2 C.C.R. § 402-1 (2010), respectively, in order to be considered as providing protection. 44 C.F.R. § 65.10 (2010), *available at* [http://www.access.gpo.gov/nara/cfr/waisidx\\_02/44cfr65\\_02.html](http://www.access.gpo.gov/nara/cfr/waisidx_02/44cfr65_02.html), and 2 C.C.R. § 402-1 (2010), *available at* [http://water.state.co.us/pubs/rule\\_reg/ds\\_rules07.pdf](http://water.state.co.us/pubs/rule_reg/ds_rules07.pdf), are hereby incorporated by reference and include the incorporated material in each in existence at the time of the promulgation of these Rules, but do not include later amendments to or editions of either.

- A. **Maintenance.** An Operating and Maintenance manual that ensures continuing proper function of the structure shall be prepared and updated. The levee shall be structurally sound and adequately maintained. Sedimentation effects shall be considered for all levee projects. Certification from a federal agency, state agency, or a Colorado Registered Professional Engineer that the levee meets the minimum freeboard criteria, as stated above, and that it appears, on visual inspection, to be structurally sound and adequately maintained shall be required on a three-year basis and provided to the CWCB. Levees that have obvious structural defects or that are obviously lacking in proper maintenance shall not be considered in the hydraulic analysis.
- B. **Ownership.** Privately-operated or maintained levee systems will not be considered in the hydraulic analysis performed pursuant to Rule 7 unless a local ordinance mandates operation and maintenance of the levee system and the criteria set forth below are met. Levees for which the community, State, or Federal government has responsibility for operations and maintenance will be considered, provided that the criteria set forth below are met. Privately-owned levee systems shall only be considered in the hydraulic analysis if a fully executed agreement exists between the levee owner and a governmental entity

enabling unrestricted access to the governmental entity for the purposes of inspection and maintenance and gives the governmental entity responsibility for maintenance. A copy of the executed agreement shall be provided to the Board and the Board shall be notified in writing of any changes made to this agreement.

- C. **Freeboard.** A minimum levee freeboard of 3 feet shall be necessary, with an additional 1-foot of freeboard within 100 feet of either side of hydraulic structures within the levee or wherever the flow is constricted, such as at bridges. An additional 0.5-foot above this minimum is also required at the upstream end of the levee.
- D. **Interior Drainage.** In cases where levees are mapped as providing 100-year protection the adequacy of interior drainage systems, on the landward side of the levee, shall be evaluated. Areas subject to flooding from inadequate interior drainage behind levees will be mapped using standard procedures.
- E. **Human Intervention and Operation.** In general, evaluation of levees shall not consider human intervention (e.g., capping of levees by sandbagging, earth fill, or flashboards) for the purpose of increasing a levee's design level of protection during an imminent flood. Human intervention shall only be considered for the operation of closure structures (e.g., gates or stop logs) in a levee system designed to provide at least 100-year flood protection, including adequate freeboard as described above, provided that such human operation is specifically included in an emergency response plan adopted by the community.
- F. **Analysis.** For areas protected by a levee providing less than 100-year protection (e.g., 10-year protection), flood elevations shall be computed as if the levee did not exist. For the unprotected area between the levee and the source of flooding, the elevations to be shown shall be obtained from either the flood profile that would exist at the time levee overtopping begins or the profile computed as if the levee did not exist, whichever is higher. This procedure recognizes the increase in flood elevation in the unprotected area that is caused by the levee itself. This procedure may result in flood elevations being shown as several feet higher on one side of the levee than on the other. Both profiles shall be shown in the final report and labeled as "before levee overtopping" and "after levee overtopping" respectively.

**Rule 11. Floodplain Management Regulations:**

- A. **Compliance with Minimum Standards of the National Flood Insurance Program.** Each community in the State of Colorado shall comply with the minimum floodplain criteria set forth in the FEMA regulation "Criteria for Land Management and Use," 44 C.F.R. §§ 60.3–60.5 (2010), unless more restrictive standards have been adopted as set forth in Rules 1 through 20 of these Rules and Regulations for Regulatory Floodplains in Colorado or pursuant to regulations adopted by the local community. These Rules do not apply to local stormwater or local storm drainage studies where riverine flooding sources are not considered. 44 C.F.R. §§ 60.3–60.5 (2010) *available at* [http://www.access.gpo.gov/nara/cfr/waisidx\\_02/44cfr60\\_02.html](http://www.access.gpo.gov/nara/cfr/waisidx_02/44cfr60_02.html), are hereby incorporated by reference and include the material in existence at the time of the promulgation of these Rules, but do not include later amendments to or editions of the material.



- B. **Minimum Freeboard.** A minimum freeboard of one foot above the 100-year flood elevation (Base Flood Elevation) shall apply to structures in the floodplain as follows:
- (1) Residential Structures. New and Substantially Changed residential structures, and Additions to existing residential structures shall be constructed with the lowest floor placed with a minimum of one foot of freeboard above the Base Flood Elevation.
  - (2) Non-residential Structures. New and Substantially Changed ,non-residential structures, and Additions to existing non-residential structures shall be constructed with the lowest floor placed with a minimum of one foot of freeboard above the Base Flood Elevation, or be flood-proofed to an elevation at least one foot above the Base Flood Elevation. Agricultural structures shall be exempt from this requirement. Critical Facilities shall be regulated according to Rule 6.D. This rule does not affect the freeboard requirement for levees described in Rule 10.C.
- C. **Permit Restrictions for Properties Removed from the Floodplain by Fill.** No Community shall issue a permit for the construction of a new structure on a property removed from the floodplain by the issuance of a FEMA Letter of Map Revision Based on Fill (LOMR-F) with a floor elevation placed below the base flood elevation with one foot of freeboard that existed prior to the placement of fill. Issuance of any such permit shall constitute a violation of these Rules. Critical Facilities are exempted from this restriction if the facility is protected according to Rule 6.D herein.

**Rule 12. Effects of Flood Mitigation Measures and Stream Alteration Activities on Regulatory Floodplains:**

In order to assist the CWCB in carrying out its mission to protect the health, safety, welfare and property of the public, through the prevention of floods in Colorado, the CWCB requires the following:

- A. Detention/flood control storage and LID should be considered, when practicable, as part of a basinwide program for the watershed.
- B. Flood control channels shall include a low-flow channel with a capacity to convey the average annual flow rate, or other appropriate flow rate as determined through a hydrogeomorphological analysis, without excessive erosion or channel migration, with an adjacent overbank floodplain to convey the remainder of the 100-year flow. The channel improvement shall not cause increased velocities or erosive forces upstream or downstream of the improvement.
- C. Channelization and flow diversion projects shall appropriately consider issues of sediment transport, erosion, deposition, and channel migration and properly mitigate potential problems through the project as well as upstream and downstream of any improvement activity. A detailed geomorphological analysis should be considered, when appropriate, to assist in determining the most appropriate design.

Project proponents for a mitigation activity must evaluate the residual 100-year floodplain. Proponents are also encouraged to map the 500-year residual floodplain.

- D. All public and private Flood Control Structures shall be maintained to ensure that they retain their structural and hydraulic integrity. Annual inspections including, as appropriate, field surveys of stream cross-sections, shall demonstrate to the appropriate regulatory jurisdictions that the project features are in satisfactory structural condition, that adequate flow capacity remains available for conveying flood flows, and that no encroachment by vegetation, animals, geological processes such as erosion, deposition, or migration, or by human activity, endanger the proper function of the project. If any significant problems, as identified within annual inspection reports, , the facility or project owner shall notify the CWCB within 60 days of the inspection. The inspections shall be conducted by the local jurisdiction for all publicly owned or publicly maintained facilities, and shall be conducted by the property owner or facility owner for all privately owned and maintained facilities.
- E. Any stream alteration activity proposed by a project proponent must be evaluated for its impact on the regulatory floodplain and be in compliance with federal, state and local floodplain Rules, regulations and ordinances.
- F. Any stream alteration activity shall be designed and sealed by a Colorado Registered Professional Engineer or Certified Professional Hydrologist.
- G. All activities within the regulatory floodplain performed by federal agencies using local or state funds, or by private, local or state entities shall meet all state and federal floodplain requirements, and all applicable local floodplain requirements.
- H. Stream alteration activities shall not be constructed unless the project proponent demonstrates through a floodway analysis and report, sealed by a Colorado Registered Professional Engineer, that there are no adverse floodway impacts resulting from the project. This requirement only applies on stream reaches with base flood elevations established.
- I. No adverse floodway impact means that there is a 0.00-foot rise in the proposed conditions compared to existing conditions floodway.
- J. The Stream Alteration proponent shall provide Notification to the CWCB whenever the proposed Stream Alteration activity would result in proposed water surface profile increases to the regulatory 100-year flood profile in excess of 0.3 vertical feet (unless the local governing authority has adopted more stringent standards). Such Notification by the proponent shall be in writing, and meet the intent of notice procedures as described in 44 C.F.R. §§ 59, 60, 65, and 70 (2010), *available at* [http://www.access.gpo.gov/nara/cfr/waisidx\\_00/44cfrv1\\_00.html](http://www.access.gpo.gov/nara/cfr/waisidx_00/44cfrv1_00.html), which are hereby incorporated by reference and include the material in existence at the time of the promulgation of these Rules, but do not include later amendments to or editions of the material. In addition, whenever a proposed Stream Alteration activity in combination with all other previous floodplain alteration activities results in a cumulative increase of 1.0 vertical feet or greater, Notification shall also be provided by the Stream Alteration proponent. This section herein does not require a CLOMR to be applied for, unless mandated by the local government having land use authority.

- K. Whenever a Stream Alteration activity is known or suspected to increase or decrease the regulatory 100-year profile in excess of 0.3 vertical feet (or a more stringent standard adopted by the local government authority), a Letter of Map Revision showing such changes shall be obtained in order to accurately reflect the proposed changes on FEMA's regulatory floodplain map for the stream reach. The local community is responsible for ensuring that this process is pursued.

**Rule 13. Process for Designation and Approval of Regulatory Floodplains:**

- A. **Designation and Approval Requirements.** The Board will designate and approve regulatory floodplains and storm or floodwater runoff channels by the adoption of written resolutions based only upon such floodplain information as the Board determines meets the standards set forth in Rule 7, as applicable, with consideration of the effects of dams and levees being subject to the criteria or Rules 9 and 10, respectively and any mitigation activity in Rule 12.
- B. **Base Flood.** 100-year floodplain information shall generally be the basis for all designation and approval actions by the Board for regulatory purposes in Colorado. However, the CWCB will designate and approve 500-year floodplain information but only at the written request of a local authority having land use jurisdiction.
- C. **Provisional Designation.** The CWCB may designate and approve, on a provisional basis and for a maximum period of time not to exceed two years, floodplain information that does not meet the minimum requirements as set forth in Rule 7.
- D. **Process for Taking Designation and Approval Actions.** The Board shall consider the designation and approval of floodplain information either by request of a community or by acting on its own initiative.
- (1) **Consideration at a Community's Request.** The Board shall consider designation and approval of floodplain information upon written request from the governing body of any community having jurisdiction in the area where the floodplain information is applicable. The letter of request shall identify the report title, date, author or agency which prepared the report, stream name(s), upstream and downstream limits of the stream reach(es) to be designated, stream length(s) in miles, type of designation requested (detailed or approximate), and any other relevant information. The Board shall receive such a request at least 30 days prior to the Board meeting at which consideration of designation and approval is requested.
  - (2) **Consideration at the Board's initiative.** If designation and approval of a floodplain would be in the best interest of the health, safety, welfare and property of the citizens of the State of Colorado, then the Board may take action at its own initiative to consider the designation and approval of floodplain information. In such cases, the Board shall notify the affected communities in writing at least 45 days prior to the Board meeting at which it will consider the designation and approval of floodplain information within their jurisdiction.
  - (3) **Notification of Adopted Resolutions.** The CWCB shall send signed copies of each adopted resolution of designation and approval to the applicable local legislative

bodies of each community having jurisdiction over land-use decisions in the study area and to FEMA within 30 days of adoption.

**Rule 14. Designation and Approval of Changes to Regulatory Floodplains:**

When changes are made to the characteristics of a floodplain that result in a revision of a community's Flood Insurance Rate Maps or Flood Hazard Boundary Maps (and a subsequent designation of the new map), the Board will designate and approve changes to the regulatory floodplain caused by development, new or better technical information, or other sources. The CWCB will designate the changed floodplains by adopting written resolutions based upon such floodplain information as the Board determines meets the standards set forth in Rules 6-12. In the event that a community is aware of and has access to better available information on a previously designated flooding source, then the CWCB allows for that undesigned information to be used for regulatory purposes.

- A. **Conditions.** All changes to designated floodplains shall meet the same conditions as those required for original approval and designation.
- B. **Process for Designation and Approval of Changes to a Regulatory Floodplain.** The Board may consider the designation and approval of floodplain information either by request of a community or by acting on its own initiative.
  - (1) **Consideration at a Community's Request.** The Board shall consider designation and approval of changes to a regulatory floodplain upon written request from the governing body of any community having jurisdiction in the area where the floodplain information is applicable. The Board staff shall receive such requests at least 30 calendar days prior to the Board meeting at which consideration of designation and approval is requested.
  - (2) **Consideration at the Board's Initiative.** If designation and approval of a floodplain would be in the best interest of the health, safety, welfare and property of the citizens of the State of Colorado, then the Board may take action at its own initiative to consider the designation and approval of floodplain information. In such cases, the Board shall notify the affected communities in writing at least 45 days prior to the Board meeting at which it will consider the designation and approval of floodplain information within their jurisdiction.
  - (3) **Notification of Adopted Resolution.** The CWCB shall send signed copies of each adopted resolution of designation and approval of changes to a regulatory floodplain to the applicable local legislative bodies of each community having jurisdiction over land-use decisions within the limits of the changed floodplain within 30 calendar days of designation and approval.
- C. **Identification of Designations of Changes to a Regulatory Floodplain.** The designation of the changes to the regulatory floodplain will be given a reference identification number that will differentiate the changed designation from the original. It is implied that designations to changes to a regulatory floodplain will only rescind the affected portions of the previously designated floodplain information. All other unaffected reaches will remain as originally designated.

- D. **Map Revisions to Flood Insurance Rate Maps or Flood Hazard Boundary Maps.** Floodplain map revisions (e.g., FEMA Letters of Map Revision) will be designated twice annually by the CWCB during a regularly scheduled Board meeting and will not be subject to a full technical review by the CWCB staff.

**Rule 15. Variances:**

- A. **Consideration by local jurisdiction.** Request for a variance to any of these Rules may be considered by the local jurisdiction having land use authority, provided the entity or individual requesting the variance has submitted a written request to the appropriate authority. A notice of the Request must be provided to any adjacent communities that would be affected by the variance.

- B. **Contents of a Request for Variance.** The request for a variance shall identify:

- (1) The Rule from which the variance is requested;
- (2) The communities that would be affected by the variance;
- (3) The reasons why the Rule cannot be complied with;
- (4) The estimated difference in water surface elevations, flood velocities and flood boundaries that would result if the requested variance were granted than if the calculations were made through strict compliance with the Rule;
- (5) The estimated number of people and structures that will be impacted by granting of the variance; and
- (6) Any other evidence submitted by the community, the CWCB staff, or other party of interest.

- C. **Factors to be considered.** Variances may be issued if it can be determined that:

- (1) There is a good and sufficient cause; and
- (2) The variance is the minimum necessary, considering the flood hazard, to afford relief; and
- (3) Failure to grant the variance would result in exceptional hardship to the community or the requestor and that the hardship is not the community's or requestor's own making; and
- (4) The granting of a variance will not result in increased vulnerability to flood losses, additional threats to public safety and welfare, extraordinary public expense, create nuisances, cause fraud or victimization of the public, hide information of significant interest to the public or conflict with existing local laws or regulations.
- (5) In lieu of items C(1) through C(4) above, a local jurisdiction having land use authority may, at its sole discretion, use an established variance procedure.

- D. **Variance Process.** Variance requests shall be processed as follows:

- (1) Local jurisdictions having land use authority shall render, confirm, modify, or reject all variance requests pertaining to these Rules.

- (2) The Board may review local variance decisions on a case-by-case basis to ensure that the overall intent and spirit of these Rules are properly considered at the local level.
- (3) Informal variance determination request may be presented to CWCB staff in order to guide community officials or project applicants as to whether a formal variance would be needed on a case by case basis.

**Rule 16. Enforcement of Floodplain Rules and Regulations:**

**A. Procedure to be followed regarding alleged violations**

- (1) **Notice of Non-Compliance.**
  - a. A Notice of Non-Compliance (NONC) may be prepared and transmitted by the CWCB or its Director. Information regarding potential violations may be discovered directly by CWCB staff or can be brought to the CWCB or its Director by a Complainant, such as the Federal Emergency Management Agency, other state agencies, the local government within whose boundaries the alleged violation took place, or by any other person who may be directly and adversely affected or aggrieved as a result of the alleged violation.
  - b. Oral complaints shall be confirmed in writing by the Complainant. Persons making a complaint are required to submit a formal letter of complaint to the CWCB Director.
  - c. NONC process.
    - i. An NONC issued by the CWCB shall be delivered to an alleged violator by personal delivery or by certified mail (return receipt requested). A copy of the NONC shall be transmitted to FEMA Region VIII and the local jurisdiction having land use authority.
    - ii. The NONC does not constitute final agency action.
    - iii. The NONC shall identify the statute, Rule, regulation, or policy subject to CWCB jurisdiction allegedly violated and the facts alleged to constitute the violation. The NONC may propose appropriate corrective action and suggested corrective action(s) if any, that the CWCB elects to require.
- (3) FEMA Region VIII shall support, through its National Flood Insurance Program activities, these Rules. This support will include the existing ability for FEMA to place sanctions upon a community for non-compliance.
- (4) Certain CWCB decisions to provide flood and watershed related grant funding to communities may be directly dependent upon a community's compliance with these Rules.

**Rule 17. Incorporation by Reference:** FEMA Regulations 44 C.F.R. §§ 59, 60, 65, and 70 (2010), *available at* [http://www.access.gpo.gov/nara/cfr/waisidx\\_00/44cfrv1\\_00.html](http://www.access.gpo.gov/nara/cfr/waisidx_00/44cfrv1_00.html), EPA Regulations 40 CFR § 302 (2010), *available at* [http://www.access.gpo.gov/nara/cfr/waisidx\\_03/40cfr302\\_03.html](http://www.access.gpo.gov/nara/cfr/waisidx_03/40cfr302_03.html), and OSHA Regulations 29 CFR § 1910 (2010), *available at*

[http://www.access.gpo.gov/nara/cfr/waisidx\\_99/29cfr1910\\_99.html](http://www.access.gpo.gov/nara/cfr/waisidx_99/29cfr1910_99.html), are incorporated herein by reference. In addition, The Colorado “Office of the State Engineer Rules and Regulations for Dam Safety and Dam Construction Materials,” set forth in 2 C.C.R. § 402-1 (2010), *available at* [http://water.state.co.us/pubs/rule\\_reg/ds\\_rules07.pdf](http://water.state.co.us/pubs/rule_reg/ds_rules07.pdf), are incorporated herein by reference. The FEMA Guidelines and Specifications for Flood Mapping Partners (2009), *available at* [www.fema.gov/fhm/dl\\_cgs.shtm](http://www.fema.gov/fhm/dl_cgs.shtm), are also incorporated herein by reference. These regulations are hereby incorporated by reference by the Colorado Water Conservation Board and made a part of these Rules and Regulations for Regulatory Floodplains in Colorado. Materials in these Rules, including, but not limited to those mentioned here in Rule 17, which are incorporated by reference are those materials in existence as of the effective date of these Rules and do not include later amendments to or editions of these materials. The material incorporated by reference is available for public inspection during regular business hours at the Colorado Water Conservation Board, 1313 Sherman Street, Room 721, Denver, CO 80203 or may be examined at any state or federal publications depository library, or on the FEMA or CWCB website.

**Rule 18. Severability:** If any portion of these Rules is found to be invalid, the remaining portion of the Rules shall remain in force and in effect.

**Rule 19. Recommended Activities for Regulatory Floodplains:** The following list contains floodplain management activities and actions suggested by the CWCB to increase a community’s overall level of flood protection. Communities and other authorized government entities may:

- A. Adopt local standards above and beyond the FEMA and CWCB minimum requirements.
- B. Develop a Flood Response Plan that identifies responsibilities/actions before, during and after a flood event.
- C. Enroll in FEMA’s National Flood Insurance Program (NFIP) and possibly FEMA’s Community Rating System (CRS) Program.
- D. Develop an early warning flood detection system (flood warning system) using available technologies such as automated precipitation and stream flow gages linked to an appropriate notification system.
- E. Coordinate with lenders, insurance agents, real estate agents, and developers to prepare and discuss educational tools based on state and federal requirements.
- F. Promote wise floodplain development and support effective structural and non-structural flood mitigation projects.
- G. Conduct floodplain studies in areas of Foreseeable Development that do not currently have detailed floodplain studies.
- H. Maintain an electronic or paper library of local flood related data.

- I. Develop a flood risk outreach program and notify flood prone residents annually of flood hazards and the need for flood insurance.
- J. Encourage elevation of flood-prone structures and flood-proofing of structures in the floodplains.
- K. Utilize available state/federal mitigation and preparedness funds.
- L. Require certified floodplain managers to review proposed land developments.
- M. Advise the public at large that flooding does occur above and beyond the 100-year and 500-year floods. Floods greater than 500-year floods do occur, and loss of life and property is possible in areas mapped outside of both the 100-year and 500-year floodplains.
- N. Utilize the concept of “No Adverse Impact” floodplain management where the action of one property owner does not adversely impact the rights of other property owners, as measured by increased flood peaks, flood stage, flood velocity, and erosion and sedimentation. No Adverse Impact could be extended to entire watersheds as a means to promote the use of retention/detention or other techniques to mitigate increased runoff from urban areas.
- O. Prohibit the construction of new levees that are intended to remove land from a regulatory floodplain for the purpose of allowing new development activity to take place in areas that are otherwise flood prone.
- P. Require an appropriate level of freeboard at bridges between the 100-year water surface elevation and the lowest elevation of the lowest structural member to allow for passage of waterborne debris.
- Q. Identify areas prone to flooding outside of the 500-year floodplain where loss of life or substantial property damage may occur. Flooding greater than 500-year (0.2% chance) events can and do occur as well, and loss of life and property is possible in areas mapped outside of both the 100-year and 500-year regulatory floodplains. Communities are encouraged to map and regulate 500-year floodplains for Critical Facilities at their sole discretion.
- R. Maintain a flood hazard page on the community website with links to the CWCB, FEMA Flood Map Store, National Flood Insurance Program, National Weather Service, local building codes, and local permitting information.
- S. The CWCB discourages Compensatory Flood Storage because existing flood storage volume should be preserved. However, when necessary, structures and fill that displace floodplain storage volume shall be compensated for by excavation of equivalent volumes at equivalent elevations within a nearby vicinity of the displaced volume. The compensatory storage area shall be hydraulically connected to the source of flooding.
- T. Adopt Buffer Ordinances that limit development in and near natural protective features such as riparian stream corridors and wetlands. Natural protective features may extend



beyond 100 year flood elevations. Extra protections for these areas are beneficial because these areas attenuate runoff periods, improve water quality, stabilize streambanks, recharge groundwater aquifers, allow for lateral stream migration, and protect aquatic and terrestrial habitat. Riparian and wetland areas also enhance the general aesthetic value of a community.

- U. Buffer ordinances are often seen as part of land use or zoning code. They may also stand alone in other portions of the municipal code. Options for widths include fixed width, variable width, or multi-zoned buffers.
- V. Establish Residual Risk Mapping. Residual Risk is the threat to the areas behind levees that may still be at risk for flooding. FEMA has identified thousands of miles of levees nationwide, affecting millions of people. It is important for levee owners, communities, and homeowners to understand the risks associated with living in levee-impacted areas and the steps that can be taken to provide full protection from flooding. Even the best flood protection system or structure cannot completely eliminate the risk of every flood event, and when levee systems fail, the results may be catastrophic and the damage may be more significant than if the levee system had not been built.

**Rule 20. Effective Date:** These Rules shall apply to the designation and approval of all floodplain information made by the Board and all other floodplain activities on or after January 14, 2011 and are, therefore, not retroactive to any floodplain information designated and approved by the Board or other floodplain activities prior to the effective date. These Rules contain provisions that will require many local ordinances to be updated to be consistent with these rules. A transition period of three years beginning from the effective date of these rules will be in effect during which all local governments may follow current local ordinances but must undertake activities to come into compliance with these Rules. Following this transition period, all floodplain activities shall be in conformance with these Rules. In addition, communities may, at their sole discretion, allow un-built projects that were previously permitted by the local government, prior to the adoption date of the local ordinance for which these Rules are incorporated, to be built and therefore considered to be in compliance with these Rules. Communities may also, at their sole discretion, permit and allow projects for which a valid CLOMR was issued prior to the adoption date of the local ordinance for which these Rules are incorporated.

## **APPENDIX D**

### **ASFPM WHITEPAPER: HIGHER REGULATORY STANDARDS**



# **A Guide for Higher Standards in Floodplain Management**

Prepared by:

**Floodplain Regulations Committee**

Association of State Floodplain Managers

May 10, 2010

## Table of Contents

### INTRODUCTION

|  |    |
|--|----|
| I. A ZONE FREEBOARD .....  | 3  |
| II. ACCESS (INGRESS-EGRESS) .....                                | 3  |
| III. COMPENSATORY STORAGE.....                                   | 4  |
| IV. CRITICAL DEVELOPMENT PROTECTION .....                        | 4  |
| V. CUMULATIVE SUBSTANTIAL DAMAGE / SUBSTANTIAL IMPROVEMENT ..... | 5  |
| VI. FILL STANDARDS .....   | 5  |
| VII. FLOODWAY RISE .....   | 6  |
| VIII. FOUNDATION DESIGN .....                                    | 6  |
| IX. FREEBOARD .....  | 7  |
| X. FUTURE CONDITIONS HYDROLOGIC MAPPING.....                     | 7  |
| XI. MATERIALS STORAGE .....                                      | 8  |
| XII. SETBACKS.....   | 8  |
| XIII. STORMWATER MANAGEMENT .....                                | 8  |
| XIV. SUBDIVISION STANDARDS.....                                  | 9  |
| XV. USE RESTRICTIONS.....  | 9  |
| XVI. REGULATING AREAS NOT MAPPED ON FIRM.....                    | 10 |
| XVII. ELEVATION OF ALL ADDITIONS .....                           | 11 |
| XVIII. COASTAL SITING .....                                      | 11 |
| XIX. DUNE PROTECTION .....                                       | 11 |
| XX. COASTAL CONSTRUCTION .....                                   | 11 |
| XXI. COASTAL A ZONE .....  | 12 |

## Introduction

The purpose of the Guide for Higher Regulatory Standards in Floodplain Management is to provide option for communities that want to implement floodplain regulations which reduce flood damage and the overall impacts of floods. These impacts include human risk, environmental damage, property damage, flood insurance claims, displacement of residents, and burden on community infrastructure and services.

The Guide is not a substitute for a set of community floodplain regulations, rather it is a guide to enhancing existing regulations with higher standards that will greatly reduce risk.



The higher standards options in this guide are described in detail because they are recommended for safer development and natural benefit protection. Please note that the model language presented in this document was developed to promote effective floodplain management, and mesh with the FEMA minimum flood damage reduction standards described in 44CFR§60.3. Each community can tailor the model language to meet its own specific needs.

A note about enforcement:

Higher regulatory standards are only as good as the enforcement process supports them. Many of the higher regulatory standards suggested in this guide require increased documentation requirements and enforcement effort than the minimum NFIP standards

ASFPM strongly believes minimum NFIP floodplain regulations do not provide adequate flood protection for most communities and that the benefits of flood risk reduction achieved by higher regulatory standards far outweighs the burden of administering them.

## ASFPM RECOMMENDED HIGHER REGULATORY STANDARDS

---

### I. A ZONE FREEBOARD

#### OBJECTIVE:

To at least minimally protect structures against damage from floods in areas where no 1%-annual-chance flood elevations are available.

#### MODEL LANGUAGE:

Add the following sentence (bolded) to specific requirements for Residential Structures and Non-Residential structures:

***New Construction and substantial improvement of any residential structure, including manufactured homes, shall have the lowest floor, including basement, elevated to or above the flood protection elevation. Where flood protection elevation data are not available the structure shall have the lowest floor, including basement, elevated at least two feet above the highest adjacent natural grade.***

### II. ACCESS (INGRESS-EGRESS)

#### OBJECTIVE:

To promote development design which will reduce flood damage and facilitate emergency vehicular access and/or pedestrian access during flood events.

#### MODEL LANGUAGE:

(1) Add to specific requirements for Residential Structures:

***New development proposals will be designed, to the maximum extent practicable, so residential building sites, walkways, driveways, and roadways are located on land with a natural grade with elevation not less than the flood protection elevation and with evacuation routes leading directly out of the floodplain area.***

(2) Add to specific requirements for Nonresidential Structures:

***New development proposals will be designed, to the maximum extent practicable, so non-residential building sites, walkways, driveways, and roadways are located on land with a natural grade with elevation not less than the flood protection elevation and with evacuation routes leading directly out of the floodplain area.***

### III. COMPENSATORY STORAGE

#### OBJECTIVE:

To compensate for the loss of floodplain storage caused by filling in the floodplain.

#### MODEL LANGUAGE:

There are a number of versions of compensatory storage language. The following sample language is provided as developed from a review of existing regulations:

(1) Add to language for the Assurance of Flood Carrying Capacity:

#### *Compensatory Storage Required for Fill*

*Fill within the area of special flood hazard shall result in no net loss of natural floodplain storage. The volume of the loss of floodwater storage due to filling in the special flood hazard area shall be offset by providing an equal volume of flood storage by excavation or other compensatory measures at or adjacent to the development site.*

(2) If your regulations explain the minimum application items necessary to seek a permit, add to the Application Requirements section:

#### *Volumetric calculations demonstrating compensatory storage.*

---

### IV. CRITICAL DEVELOPMENT PROTECTION

#### OBJECTIVE:

To protect critical development against damage and minimize the potential loss of life from flooding.

#### MODEL LANGUAGE:

The standard used in Executive Order 11988 is the 500-year flood event, or the historically highest flood (if records are available), whichever is greater. Two alternatives are presented below, the first being less restrictive, the second being more restrictive:

(1) Add to Definitions:

#### *Critical Development*

*Critical development is that which is critical to the community's public health and safety, are essential to the orderly functioning of a community, store or produce highly volatile, toxic or water-reactive materials, or house occupants that may be insufficiently mobile to avoid loss of life or injury. Examples of critical development include jails, hospitals, schools, daycare facilities, public electric utilities, fire stations, emergency operation centers, police facilities, nursing homes, wastewater treatment facilities, water plants, and gas/oil/ propane storage facilities, and other public equipment storage facilities.*

(2) Add to Use Regulations (Prohibited Uses):

*[option I]*

*Critical developments in all special flood hazard areas. Where critical developments are located adjacent to special flood hazard areas, the flood protection elevation shall be two feet above the 0.2% flood elevation and that elevation shall be used as the basis for the ACCESS (INGRESS-EGRESS) provisions in section II.*

*[option II] Critical developments in all special flood hazard areas, and in all 0.2% annual (500-year) floodplains.*

---

## V. CUMULATIVE SUBSTANTIAL DAMAGE / SUBSTANTIAL IMPROVEMENT

### OBJECTIVE:

To track cumulative improvements or damages to structures in special flood hazard areas to ensure that flood protection measures are incorporated.

### MODEL LANGUAGE:

(1) Add the following sentence at the end of the “substantial damage” definition:

**Substantial Damage**

*Substantial damage also means flood related damage sustained by a structure on two (2) separate occasions during a 10-year period for which the cost of repairs at the time of each such flood event, on the average, equals or exceeds 25 percent of the market value of the structure before the damage occurred.*

(2) Add the following sentence (bolded) to the “substantial improvement” definition:

**Substantial Improvement**

*Any reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds 50 percent of the market value of the structure before the "start of construction" of the improvement. When the combined total of all improvements or repairs made after the adoption of this regulation equals or exceeds 50 percent of a structure's market value, that structure is considered to be substantially improved.*

---

## VI. FILL STANDARDS

### OBJECTIVE 1:

To provide guidelines for the placement of fill in special flood hazard areas.

### MODEL LANGUAGE:

There are many variations and combinations of standards that can be used for fill. The model language below incorporates standards for quality, stability, and compaction.



Add to Use and Development Standards for Flood Hazard Reduction:

***Fill***

***The following standards apply to all fill activities in special flood hazard areas:***

- A. Fill sites, upon which structures will be constructed or placed, must be compacted to 95 percent of the maximum density obtainable with the Standard Proctor Test method or an acceptable equivalent method,***
- B. Fill slopes shall not be steeper than one foot vertical to two feet horizontal,***
- C. Adequate protection against erosion and scour is provided for fill slopes. When expected velocities during the occurrence of the base flood of five feet per second armoring with stone or rock protection shall be provided. When expected velocities during the base flood are five feet per second or less protection shall be provided by covering them with vegetative cover.***
- D. Fill shall be composed of clean granular or earthen material.***

**OBJECTIVE 2:**

To ensure structures built in areas removed from the floodplain via Letters of Map Revision Based on Fill (LOMR-F) are built “reasonably safe from flooding.”

**MODEL LANGUAGE:**

Add the following provisions to the residential and non-residential development requirements for new construction or substantial improvement

***In any area that has been removed from the floodplain via a Letter of Map Revision Based on Fill, any existing or new structure, addition, or substantial improvement must meet the required elevation freeboard requirements.***

---

**VII. FLOODWAY RISE**

**OBJECTIVE:**

To delineate a larger area within the 1%-annual-chance floodplain for flood flow conveyance and to restrict future encroachments that could increase flood levels.

**MODEL LANGUAGE:**

***The allowable floodway rise is that level in the community flood study. For new studies, floodway encroachment analyses shall be performed using a \_\_\_ foot surcharge to be determined by the community where practicable. The ASFPM generally recommends an allowable floodway rise of no more than 0.5 foot and as little as 0.1 foot where vulnerable or critical development exists.***

---

**VIII. FOUNDATION DESIGN**

**OBJECTIVE:**

To ensure proper design and construction of building foundations to protect building structural integrity against the effects of buoyancy, uplift, debris impacts, and other flood forces.

MODEL LANGUAGE:

Add the following sentence (bolded) to the Residential Construction section:

***New construction and substantial improvement of any residential structure, including manufactured homes, shall have the lowest floor, including basement, elevated to or above the flood protection elevation. Support structures and other foundation members shall be certified by a registered professional engineer or architect as designed in accordance with ASCE 24, Flood Resistant Design and Construction, or shall be constructed with designs meeting this standard.***

---

**IX. FREEBOARD**

OBJECTIVE:

To protect structures against damage from floods heights greater than the base flood (1%-annual-chance frequency flood).

MODEL LANGUAGE:

Add “flood protection elevation” to the Definitions with the desired freeboard (bolded):

**Flood Protection Elevation**

**The Flood Protection Elevation, or FPE, is the base flood elevation plus XX feet of freeboard.**

---

**X. FUTURE CONDITIONS HYDROLOGIC MAPPING**

OBJECTIVE:

To protect property against impacts of increased flood heights due to anticipated future development in rapidly developing areas.

MODEL LANGUAGE:

Communities that are experiencing rapid urban and suburban growth and development should require that all new construction and substantial improvement have the lowest floor elevated to or above the future conditions 1%-annual-chance flood level.

(1) Add the following definition:

***Future Conditions Flood Hazard Area – Also known as area of future conditions flood hazard, the land area that would be inundated by the one-percent-annual-chance flood based on future conditions hydrology.***

(2) Add the following sentence to the “special flood hazard area” definition:

*Any area outside the one-percent-annual-chance flood hazard area identified by FEMA AND designated as Future Conditions Flood Hazard Area on FEMA's Flood Insurance Rate Map shall also be considered special flood hazard areas.*

---

## XI. MATERIALS STORAGE

### OBJECTIVE:

To protect the community against flood damage from materials that may block flood flows or which become buoyant, flammable, explosive, or cause other environmental health issues in floods.

### MODEL LANGUAGE:

(1) Add the following to the Prohibited Uses section:

- A. Storage or processing of materials that are hazardous, flammable, or explosive in the identified special flood hazard area.*
- B. Storage of material or equipment that, in time of flooding, could become buoyant and pose an obstruction to flow in identified floodway areas.*

(2) Add the following to the Storage of Materials section:

*Storage of material or equipment not otherwise prohibited shall be firmly anchored to prevent flotation.*

---

## XII. SETBACKS

### OBJECTIVE:

To provide a limited use/development set aside area along a stream for flood damage prevention, resource protection, floodwater storage, water quality, pollutant/sediment removal, and natural stream function.

### MODEL LANGUAGE:

Specific model language has not been developed due to the technical and planning information needed to establish a setback for a given watercourse. The Center for Watershed Protection ([www.cwp.org](http://www.cwp.org)) has developed some excellent materials about setbacks and has sample ordinances that can be downloaded from the internet.

---

## XIII. STORMWATER MANAGEMENT

### OBJECTIVE:

To prevent increased flood flows and limit increased runoff from a proposed development to pre-development conditions, and to maintain floodplains and stream channels by reducing erosion and sedimentation from construction activities in flood hazard areas.

MODEL LANGUAGE:

Specific model language has not been developed due to the diverse options available to communities in the management of stormwater. Your NFIP State Coordinator may have language specific to your state that you may want to consider.

---

**XIV. SUBDIVISION STANDARDS**

OBJECTIVE:

To ensure subdivisions, including infrastructure and lots are created and designed to minimize risk of damage to property and potential loss of life from flooding, and to minimize the disturbance of floodplain riparian zones.

MODEL LANGUAGE:

The following higher standards language should be adopted into the community's subdivision regulations (if applicable) and/or flood damage reduction regulations:

- (1) Modify the section on subdivisions and large scale development to incorporate the bolded text:

***In all areas of special flood hazard where base flood elevation data are not available, the applicant shall provide a hydrologic and hydraulic engineering analysis that generates base flood elevations for all subdivision proposals, and other proposed developments at least 5 acres or 5 lots in size. These studies shall be submitted to FEMA with a request for map revision.***

- (2) Add the following to the section for Subdivisions and Large Scale Development:

***A. All preliminary plans for platted subdivisions shall identify the flood hazard area and the elevation of the base flood.***

***B. All final subdivision plats will provide the boundary of the special flood hazard area, the floodway boundary, and base flood elevations.***

***C. In platted subdivisions, all proposed lots or parcels that will be future building sites shall have a minimum buildable area outside the natural (non-filled) 1% chance annual floodplain. The buildable area shall be large enough to accommodate any primary structure and associated structures such as sheds, barns, swimming pools, detached garages, on-site sewage disposal systems, and water supply wells, if applicable.***

***D. Approval shall not be given for streets within a subdivision, which would be subject to flooding. All street surfaces must be located at or above the base flood elevation***

---

**XV. USE RESTRICTIONS**

OBJECTIVE:

To restrict or prohibit uses of the floodplain which are dangerous to health, safety or property in times of flood, or which cause excessive increases in flood stages or velocities.

MODEL LANGUAGE:

Add the following to the Prohibited Uses section:

- A. New construction of any residential or nonresidential structures in floodway areas.*
- B. Storage or processing of hazardous, flammable, or explosive materials in special flood hazard areas.*
- C. Critical development in special flood hazard areas. (Note: Must also adopt the critical development definition – see critical development higher standard).*
- D. The use of nonconforming structures shall not be changed from a non-residential structure to a residential structure or a mixed-use structure, or increase the residential use area of a mixed-use structure.*
- E. The use of any structure shall not be changed to a critical facility, where such a change in use will render the new critical facility in violation of Section IV - Critical Development Protection.*

---

**XVI. REGULATING AREAS NOT MAPPED ON FIRM**

OBJECTIVE:

To provide a means for a community to regulate development in areas at risk to flooding that have not been mapped on FEMA's FIRMs.

MODEL LANGUAGE:

(1) Add the following sentence to the "special flood hazard area" definition:

*Any area outside the FEMA studied areas lying along blue line streams as shown on the United States Department of the Interior Geological Survey (hereafter referred to as "USGS") quadrants of which [community name] is contained and/or areas with flood prone soils which are contiguous to blue line streams as shown on the [community name] Flood Prone Soils Map shall also be considered special flood hazard areas.*

*[Note – in determining the extent of land "contiguous" to blue line streams, communities may elect to establish a buffer defined by width, land elevation, historical flooding, or other data].*

(2) Add the following references to the flood hazard data adopted in Basis for Establishing the Areas of Special Flood Hazard:

- A. USGS quadrants in which [community name] is contained;*

*B. [community name] Flood Prone Soils Map.*

---

**XVII. ELEVATION OF ALL ADDITIONS**

OBJECTIVE:

To protect new horizontal additions (increase in building footprint) from flood damage.

MODEL LANGUAGE:

Add the following provisions to the residential and non-residential development requirements:

*All new horizontal additions must have the lowest floor and all HVAC elevated to the regulatory flood protection elevation.*

---

**XVIII. COASTAL SITING**

OBJECTIVE:

To provide greater protection to coastal resources and structures that would be at risk of experiencing damage from wave action (V Zones).

MODEL LANGUAGE:

Add the following provisions to the general requirements for development in V Zones:

*All new structures shall be located on the lot so as to minimize exposure to coastal hazards and shoreline erosion. Structures should be located outside of the V-Zone, to the greatest extent possible. Building setback requirements should consider predicted future erosion rates, or historical erosion rates.*

---

**XIX. DUNE PROTECTION**

OBJECTIVE:

To provide greater protection to sand dunes and their flood mitigation qualities.

MODEL LANGUAGE:

Add the following provisions to the general requirements for development in V Zones:

*Retaining walls, landscaping, dune crossovers and other non-essential accessory structures shall be designed and located to minimize impacts to sand dunes. Primary frontal dunes shall not be altered unless a qualified engineer demonstrates and certifies that flood risk will not be increased to the subject, or other, properties. Activities which reduce the volume of sand on the dunes or beach can generally be presumed to increase flood risk to landward locations. Adding sand volume to the dune or beach can generally be presumed to not increase flood risk.*

---

**XX. COASTAL CONSTRUCTION**

OBJECTIVE:

To provide a greater factor of protection to structures built in V Zones.

MODEL LANGUAGE:

Add the following provisions to the residential and non-residential development requirements for V Zone construction:

- A. New and substantially improved structures shall have the bottom of the lowest horizontal structural member elevated two or more feet above the flood protection elevation.*
  - B. Enclosures below the lowest floor of elevated buildings shall be usable solely for parking, access, and limited storage. These enclosures shall be less than 300 square feet in area, and shall be designed and constructed with breakaway walls which minimize the amount and impact of debris and adverse effects on adjacent properties.*
  - C. Breakaway walls for enclosures below the lowest floor shall be designed to meet building code wind requirements. Such enclosures may be used only for limited storage, parking and access and shall be designed to minimize adverse debris impacts to adjacent properties. Where enclosures are used as access ways to elevated buildings, a secure door located at the lowest floor level must separate the enclosed area from the elevated building.*
  - D. Detached accessory structures such as sheds or garages shall be prohibited in V-Zones.*
- 

**XXI. COASTAL A ZONE**

OBJECTIVE:

To better protect structures in coastal areas where storm-induced velocity wave actions are unknown.

MODEL LANGUAGE:

Add the following provisions to the residential and non-residential development requirements for Coastal A Zone construction:

*In areas which have been identified as subject to limited wave action (between 1.5 and 3 feet) and designated as a Coastal A-Zone, new and substantially improved structures shall comply with all of the V-Zone provisions of this ordinance. Elevation requirements should refer to the lowest horizontal structural member of the lowest floor.*