2017

Thornton, Federal Heights, and Northglenn

NATURAL HAZARD MITIGATION PLAN

Northglenn

City of Thornton

Federal Heights

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Acknowledgements

The success of the 2017 Hazard Mitigation Plan for the Cities of Thornton, Northglenn, and Federal Heights required contributions from a large number of people representing organizations of many kinds within the three cities, as well as input from many service providers which contribute to the ongoing stability, health, and resiliency of the people living and working within the study area.

First and foremost, thanks to our elected officials who provided the leadership and resources for this plan to take shape.

City of Thornton

Mayor	Heidi Williams
Ward 1	Jacque Phillips
	Mack Goodman
Ward 2	Eric Montoya, Mayor Pro Tem
	Val Vigil
Ward 3	Josh Zygielbaum
	Sam Nizam
Ward 4	Adam Matkowsky
	Janifer Kulmann

City of Northglenn

Mayor	Joyce Downing
Ward 1	Carol Dodge, Mayor Pro Tem
	Jordan Sauers
Ward 2	Joe Brown
	Becky Brown
Ward 3	Marci Whitman
	Kyle Mullica
Ward 4	Kim Snetzinger
	Antonio Esquibel

City of Federal Heights

Mayor	Daniel Dick
Ward 1	John Hamlin, Mayor Pro Tem
	Harold Thomas
Ward 2	Kevin Dougherty
	Carolyn Scharf
Ward 3	Ted May
	Elaine Sweeney

City of Thornton Northglenn Federal Heights

City Managers

Many thanks to the city managers of the three cities for the direction and guidance in conducting this plan for the benefit of the populations we serve:

Jack Ethredge, City of Thornton
Jim Hayes, City of Northglenn
Jacqueline Halburnt, City of Federal Heights

Project Management Team

It is only through the dedication of a committed group of staff members from all three cities that this plan could be implemented and completed.

Margaret Carew, GIS Analyst II, Thornton
Ryan Doyle, Emergency and Safety Administrator, Thornton
Sean Ellis, Fire Chief, Federal Heights, Federal Heights
Jim Kaiser, Senior Civil Engineer, Floodplain Manager, Thornton
JoAnn Koenig, Accounting Supervisor, Thornton
Glenda Lainis, Policy Planning Manager, Thornton
Dennis Laurita, Contract Administrator, Thornton
Martin Postma, Senior Policy Analyst, Project Manager, Thornton
Brook Svoboda, Director, Planning and Development, Northglenn

Consulting Team

If it were not for the dedication, expertise, and experience of the consulting team from Michael Baker International, this project would not have been the success that it is. In particular, thanks to the following people:

David Jula, Vice President
Mike Garner, Project Manager
Enessa Janes, Community Planner
Katie Villela, Community Planner
Jason Isherwood, GIS and HAZUS Specialist
Sloane Weidmann, Community Planner
Robert Lange, GIS Specialist

Community Participants

For this plan to truly serve our communities, including the businesses, nonprofit organizations, residents, and visitors, many people generously participated in the development of the plan by sharing their thoughts, concerns, and ideas about the ways that we can increase our resiliency to future natural hazards and enhance our ability to recover from them more quickly and completely when they do occur. For a complete list of participants, please see Table 3 of this document.

City of Thornton Northglenn Federal Heights

Adoption Pages

TABLE 1. CITY ADOPTION DATE

Participating Jurisdiction	2017 Adoption Date
City of Thornton	<Insert Date>
City of Federal Heights	<Insert Date>
City of Northglenn	<Insert Date>

<Include signed adoption pages from Thornton, Federal Heights, and Northglenn>

Table of Contents

Listing of Tables

Listing of Figures

1. Executive Summary

The City of Thornton is excited to be submitting this 2017 Thornton, Federal Heights and Northglenn Multi-Jurisdictional Hazard Mitigation Plan (HMP) for review by the State of Colorado, Division of Homeland Security and Emergency Management, and the Federal Emergency Management Agency. Stakeholders, partners and districts have worked together to complete a document that addresses hazards for all three cities and updates the 2010 Northern Colorado Regional Hazard Mitigation Plan. This Plan addresses natural hazards and mitigation measures, with the expressed purpose of saving lives and reducing future losses in anticipation of future events.

With the flooding events of 2013, the north Denver County region experienced significant damage to homes and infrastructure. The City of Thornton, Federal Heights, and Northglenn are working together to address hazard mitigation planning and are leading the efforts to improve each community's ability to withstand potential future hazard damages.

This HMP has been completed with a high degree of public participation. A broad range of public and private stakeholders, including agencies, local businesses, nonprofits, and other interested parties were invited to participate in the development of the 2017 Plan. Staff and planning team invitations to stakeholder and agencies encourage active participation in local planning meetings and to interaction with the planning materials and surveys posted on the project website. Public input was sought throughout the planning process by advertising open public meetings through local newspapers, email distribution lists, community bulletins, social media networks, and jurisdictional websites.

The Hazard Identification and Risk Assessment (HIRA) builds on available historical data from past hazard occurrences, establishes detailed profiles for each hazard, and culminates in a hazard risk ranking based on conclusions about the frequency of occurrence, spatial extent, and potential impact of each hazard. FEMA's Hazus loss estimation methodology was also utilized to estimate potential losses from future hazard events. In essence, the information generated through the risk assessment serves as a critical function as communities seek to determine the most appropriate mitigation actions to pursue and implement — enabling these communities to prioritize and focus their efforts on those hazards of greatest concern and those structures or planning areas facing the greatest risk(s). The hazards analyzed in detail in this plan include:

- Drought
- Earthquake
- Expansive Soils/Undermined Areas
- Extreme Temperatures
- Flood
- Severe Storms
- Public Health
- Tornado and Severe Wind
- Winter Storm
- Wildland Fire

The final, and arguably the most important step is creating a Mitigation Strategy with applicable Mitigation Actions. In preparing Mitigation Actions, each participating jurisdiction considered the 2017 planning goals, their individual hazard risks and priorities, and their capabilities to mitigate identified hazards. The mitigation actions represent the key outcome of the mitigation planning process.

2. The Planning Process

The Planning Process section of the Plan describes the mitigation planning process undertaken by the Cities of Thornton, Federal Heights, and Northglenn in the preparation of this Hazard Mitigation Plan. This chapter consists of the following subsections:

- Background
- Hazard Mitigation Planning
- Plan Update Process
- The Planning Team (multi-jurisdictional planning)
- Planning Meetings and Documentation
- Public Stakeholder Participation

2.1 Background

Emergency Management is the discipline of identifying, managing, and avoiding risks. It involves preparing for a disaster before it occurs, supporting those affected by disasters, and planning as well as rebuilding after a natural or human-caused hazard event. Emergency Management involves individuals, groups, and communities coming together to manage hazards in an effort to avoid or reduce the impact of disasters. This process is ever-changing and helps to reduce or eliminate long-term risks within the community. One method for proactively managing hazard risks is Hazard Mitigation Planning. Hazard Mitigation Planning includes the identification of policies, capabilities, activities, and tools necessary to implement successful and sustainable risk reduction actions.

Why are Thornton, Federal Heights, and Northglenn creating a multi-jurisdictional hazard mitigation plan? Mitigation planning offers many benefits, including;

- Saving lives and property
- Saving money
- Ensuring quick and effective recovery following disasters
- Reducing future vulnerability through wise development and post-disaster recovery and reconstruction
- Enhancing coordination within and across participating jurisdictions
- Expediting the receipt of pre-disaster and post-disaster grant funding, and
- Demonstrating a firm commitment to improving community health and safety

Mitigation planning has great potential to produce long-term and recurring benefits by breaking the repetitive cycle of disaster loss. A core assumption of hazard mitigation is that pre-disaster investments will significantly reduce the demand for post-disaster assistance by lessening the need for emergency response, repair, recovery, and reconstruction. Furthermore, mitigation practices enable local residents, businesses, and industries to re-establish themselves in the wake of a disaster, getting the community economy back on track sooner and with less interruption.

The benefits of mitigation planning go well beyond reducing hazard vulnerability. Measures such as the acquisition or regulation of land in known hazard areas can help achieve multiple community goals, such as preserving open space, improving water quality, maintaining environmental health, and enhancing

recreational opportunities. Thus, it is vitally important that any local mitigation planning process be integrated with existing local planning efforts. It's also important that any proposed mitigation strategies take into account broader community goals. Thornton, Federal Heights and Northglenn have embraced this approach by identifying multiple opportunities to link the Plan with pre-existing programs, policies, plans, and resilience-building initiatives.

During the last two decades, the emergency management cycle has evolved considerably. A renewed emphasis has been placed on planning for disasters before they occur as a complement to effective response and recovery. As a result, hazard mitigation has gained increasing prominence as a critical part of emergency management. By taking sustained mitigation actions to reduce or eliminate the long-term risk to human life and property, hazard risks can be proactively combated in a systematic manner. This approach to emergency management is much more effective than reacting to a hazard once it has occurred.

This Plan is the result of continuing work by the citizens and stakeholders of Thornton, Federal Heights, and Northglenn, to update a regional pre-disaster multi-hazard mitigation plan that will not only continue to guide these communities towards great disaster resistance, but also respect the character and needs of local jurisdictions and their residents.

Purpose

The Cities of Thornton, Federal Heights, and Northglenn have come together to produce an updated Hazard Mitigation Plan Update that will encompass hazard information and analysis for all three cities. The Cities of Thornton and the Federal Heights were previously included in the DRCOG Denver Regional Natural Hazard Mitigation Plan, which was approved by FEMA on November 24, 2010, but has since expired. Northglenn was not included in this regional plan, nor does it have an existing one, so this will be the first Hazard Mitigation Plan created for the City of Northglenn.

The intent of this project is to assist each community in progressing towards a more resilient future and to:

- Protect life and property by reducing the potential for future damages and economic losses that result from natural hazards;
- Qualify for additional grant funding, in both the pre-disaster and post-disaster environment;
- Provide quick recovery and redevelopment following future disasters;
- Integrate other existing and associated local planning documents;
- Demonstrate a firm local commitment to hazard mitigation principles; and
- Comply with state and federal legislative requirements tied to local hazard mitigation planning.

Scope

In order for Thornton, Federal Heights, and Northglenn to be eligible for funding and technical assistance from state and federal hazard mitigation programs, this plan has been prepared to meet requirements set forth by the Federal Emergency Management Agency (FEMA) and the Colorado Division of Homeland Security and Emergency Management (DHSEM). It will continue to be updated and maintained in order to address those natural hazards that have been determined to be of high and moderate risk as defined

by the updated results of the local hazard, risk, and vulnerability summary. Other natural hazards will continue to be evaluated during future updates of the Plan in order to determine if they warrant additional attention, including the development of specific mitigation measures intended to reduce their impact. This 2017 Plan will be updated and FEMA-approved within its five-year expiration date.

Authority

This Hazard Mitigation Plan has been adopted by the Cities of Thornton, Federal heights, and Northglenn in accordance with the authority granted to cities by the State of Colorado.

This Plan was developed in accordance with current state and federal rules and regulations governing local hazard mitigation plans. The Plan shall be monitored and updated on a routine basis to maintain compliance with the following legislation and guidance:

- Robert T. Stafford Disaster Relief and Emergency Assistance Act, 42 U.S.C., Section 322, Mitigation Planning, as enacted by Section 104 of the Disaster Mitigation Act of 2000 (P.L. 106-390) and by FEMA's Interim Final Rule published in the Federal Register on February 26, 2002, at 44 CFR Part 201

In addition, the following Federal Emergency Management Agency (FEMA) guides and reference documents were used to prepare this document:

- FEMA. 386-1: Getting Started. September 2002.
- FEMA. 386-2: Understanding Your Risks: Identifying Hazards and Estimating Losses. August 2001.
- FEMA. 386-3: Developing the Mitigation Plan. April 2003.
- FEMA. 386-4: Bringing the Plan to Life. August 2003.
- FEMA. 386-5: Using Benefit-Cost Review in Mitigation Planning. May 2007.
- FEMA. 386-6: Integrating Historic Property and Cultural Resource Considerations into Hazard Mitigation Planning. May 2005.
- FEMA. 386-7: Integrating Manmade Hazards into Mitigation Planning. September 2003.
- FEMA. 386-8: Multi-Municipality Mitigation Planning. August 2006.
- FEMA. Coordinators Manual, National Flood Insurance Program Community Rating System. 2007.
- FEMA. 386-9: Using the Hazard Mitigation Plan to Prepare Successful Mitigation Projects. August 2008.
- FEMA. Local Mitigation Plan Review Guide. October 1, 2011.
- FEMA. Mitigation Ideas. January 2013.
- FEMA. Local Mitigation Planning Handbook. March, 2013.
- FEMA. Integrating Hazard Mitigation into Local Planning. March, 2013.
- FEMA. Plan Integration: Linking Local Planning Efforts. July 2015.

2.2 Hazard Mitigation Planning

Local hazard mitigation planning is the process of organizing community resources, identifying and assessing hazard risks, and determining how to best minimize or manage those risks. This process results in a hazard mitigation plan, which identifies specific mitigation actions that are designed to achieve both short term planning objectives and long-term community vision. To ensure the functionality of each mitigation action, responsibility is assigned to a specific individual, department, or agency along with a schedule for its implementation. Plan maintenance procedures are then established to help implement,

evaluate, and enhance the Plan as necessary. Developing clear plan maintenance procedures ensures that this Hazard Mitigation Plan remains a current, dynamic, and effective planning document over time.

2.3 Plan Update Process

This 2017 Plan contains a narrative description of the process followed to prepare the hazard mitigation plan. The Cities of Thornton, Federal Heights, and Northglenn were all notified of the participation requirements related to the adoption of the plan and the formation of the Hazard Mitigation Planning Team. Throughout the planning process, the planning team reviewed and analyzed each section of the Plan. In preparing this plan, documentation indicates that the planning teams utilized a multi-jurisdictional planning process consistent with the one recommended by FEMA (see Publication Series 386).

The following local documents were reviewed and incorporated into the 2017 Thornton, Federal Heights, and Northglenn Hazard Mitigation Plan:

- 2010 Denver Regional Natural Hazard Mitigation Plan (HMP)
- 2015 City of Northglenn Emergency Operations Plan (EOP)
- 2015 City of Thornton Community Facilities Plan
- City of Thornton Continuity of Government (COG)
- 2014 City of Thornton Year End Housing & Population Report
- 2010 City of Thornton Housing Master Plan
- 2012 City of Thornton Community Demographic Profile
- 2009 City of Northglenn Comprehensive Plan
- 1997 City of Federal Heights Comprehensive Plan

The planning process used for this plan was based on Section 322 of the Disaster Mitigation Act of 2000 and supporting guidance developed by FEMA. The planning process followed these steps:

- Conduct kickoff meeting with the Thornton, Federal Heights, and Northglenn small planning team
- Conduct a 5-year Plan Review
- Conduct a Hazard Risk Factor exercise
- Establish a large planning team made up of local stakeholders and subject matter experts
- Review and update the local hazard, risk, and vulnerability summary
- Determine capability for the county and each municipality
- Update the mitigation strategy
- Update the plan maintenance procedures
- Complete a draft plan for review by planning teams
- Advertise opportunity for public and stakeholder comment on final draft
- Provide final draft for committee to review
- Provide final draft to CO DHSEM and FEMA for review and approval
- Present Plan to municipalities for adoption

Each of the planning steps described above resulted in key products and outcomes that collectively make up the Hazard Mitigation Plan. These work elements are discussed below in further detail.

Each community profile, located in Appendices A, B, and C, describes the general makeup of Thornton, Federal Heights, and Northglenn. This includes general geographic, demographic, economic, and housing characteristics. This baseline information provides a snapshot of the planning area and assists participating officials in recognizing the social, environmental, and economic factors that ultimately play a role in determining community vulnerability to natural hazards.

The Hazard Identification and Risk Assessment (HIRA), located in the main body of this plan and within each community profile section, focuses on three elements for each identified hazard: *Hazard Identification, Hazard Analysis, and a Potential Loss Assessment.* Together, these elements identify, assess, and profile each city's overall risk to natural and human-caused hazards. The HIRA builds on available historical data from previous hazard event occurrences, establishes hazard-by-hazard profiles, and culminates in a hazard risk priority or ranking based on conclusions about the frequency of occurrence, potential impact, spatial extent, warning time, and duration of each hazard. FEMA's Hazus loss estimation software was also used in evaluating known flood and earthquake risks according to their relative long-term cost, measured in expected damages. It should be noted that estimations do not take into account specific infrastructure or utility losses. The HIRA is designed to assist communities in seeking the most appropriate mitigation actions to implement by focusing their efforts on those hazards of greatest concern and those structures or planning areas facing the greatest risk(s).

The Community Profiles and HIRA collectively serve as the basis for establishing mitigation goals for this Plan, each contributing to the development, adoption, and implementation of a meaningful Mitigation Strategy that is based on accurate background information and community goals.

FIGURE 1. DAMAGES FROM 2013 FLOOD EVENT

The Mitigation Strategy in each community profile consists of broad goal statements as well as specific mitigation actions for each jurisdiction participating in the planning process. This updated strategy provides the foundation for detailed *Mitigated Actions Guides* (MAGs) that link jurisdictionally-specific mitigation actions to locally assigned implementation mechanisms. Together, these sections are designed to make the 2017 Thornton, Federal Heights, and Northglenn Hazard Mitigation Plan more strategic and functional through the identification of both long-term goals and near-term actions that will guide day-to-day decision-making and project implementation.

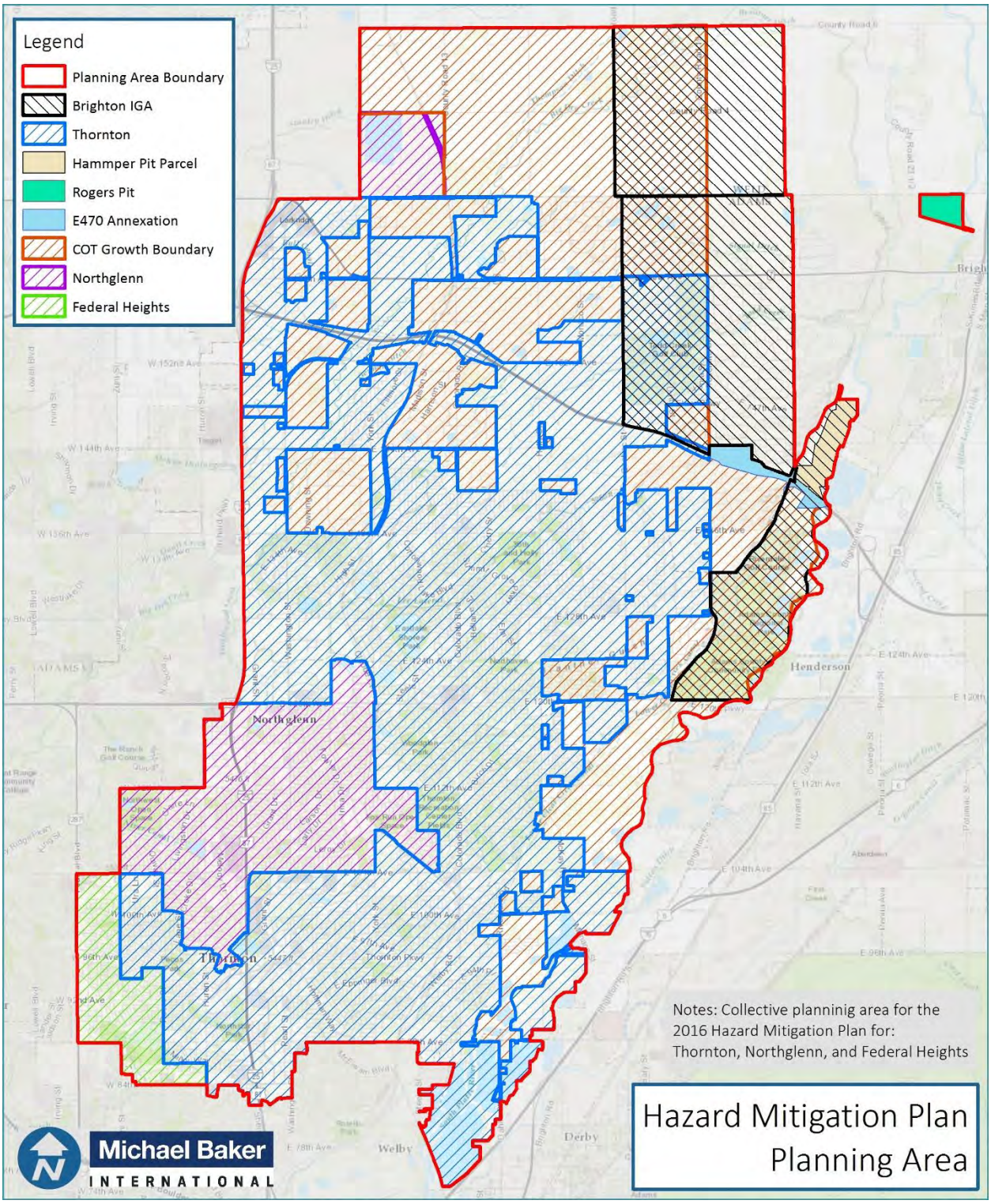
In addition to the identification and prioritization of possible mitigation projects, emphasis has been placed on the use of program and policy alternatives to help make Thornton, Federal Heights, and

Northglenn less vulnerable to the damaging forces of nature while improving the economic, social, and environmental health of the community. The concept of multi-objective planning is emphasized throughout this Plan, identifying ways to link hazard mitigation policies and programs with complimentary community goals that may be related to housing, economic development, community revitalization, recreational opportunities, transportation improvements, environmental quality, land development, and public health and safety. This Plan should be seen as a proactive document that represents a concerted effort to make these communities more livable and resilient to future hazards.

The Strategy Implementation and Maintenance procedures, also found in each of the community profiles, describe the measures each jurisdiction will take to ensure the Plan's continuous long-term implementation. The procedures also include the manner in which the Plan will regularly be monitored, reported upon, evaluated, and updated to remain a current and meaningful planning document. Local capabilities are outlined as well to highlight strengths and areas of improvement related to personnel, planning capacity, and ongoing risk-reduction efforts.

The following figure identifies the planning area for this project. In addition to the boundaries of the three jurisdictions, additionally identified potential future growth areas for the City of Thornton are included as well.

FIGURE 2 . HMP PLANNING AREA



City of Thornton Northglenn Federal Heights

2.4 The Planning Team (Multi-jurisdictional Planning)

A participatory, community-based planning approach contributed heavily to the development of this Plan. The Cities of Thornton, Federal Heights, and Northglenn engaged local government officials, public stakeholders, and community members in local meetings and planning workshops to discuss and complete tasks associated with preparing the Plan. Two planning teams were involved in the development of this Plan. A 'Small Team' was utilized throughout the planning process and included representatives from each of the three participating jurisdictions. This team helped to guide the planning process and were instrumental in making all decisions throughout the process. A 'Large Team', representing a diverse collection of local and regional stakeholders, was utilized to obtain feedback on particular sections of this Plan, most importantly the mitigation actions/projects. In addition to the planning teams, the Cities hired a consultant, Michael Baker International, to help guide them through the planning process and plan development.

The participants listed in the following table represent members of the 2017 Thornton, Federal Heights, and Northglenn Planning Small Team, who were responsible for leading in the updating of this plan:

TABLE 2. SMALL PLANNING TEAM MEMBERS

Name	Jurisdiction	Title
Martin Postma (HMP Project Lead)	Thornton	Senior Policy Analyst
Margaret Carew	Thornton	GIS Analyst II
Ryan Doyle	Thornton	Emergency and Safety Administrator
Sean Ellis	Federal Heights	Fire Chief
Jim Kaiser	Thornton	Senior Civil Engineer
Glenda Lainis	Thornton	Policy Planning Manager
Brook Svoboda	Northglenn	Director of Planning and Development

Stakeholders that participated as part of the Planning Large Team are identified below (listed in no particular order). Small Planning Team members listed above also participated as part of this group.

TABLE 3. LARGE PLANNING TEAM PARTICIPANTS

Name	Representing
Abel Montoya	Adams County
Adam Krueger	City of Thornton, Economic Development
Al Quintana	City of Thornton, Infrastructure
Alfonso Lopez	City of Thornton
Amber Oeltjenbruns	Pinnacle Charter School
Beth Tirrell	B&B Blending
Billy Burke	City of Thornton, Utilities Department
Brandon Young	Immaculate Heart

Name	Representing
Brook Svoboda	City of Northglenn, Planning & Development
Carolina VanHoorn	Adams County, Long Range Planning
Catherine Anderson	North Suburban Medical Center
Cassie Free	City of Thornton, Development Engineering
Cliff Brown	City of Thornton, Police
Cody Horn	Xcel Energy
Daniel Dick	City of Federal Heights, Mayor
Darrell Alston	City of Thornton, Infrastructure
David Sauer	School District 1
Dave Sayles	Tri-State Generation and Transmission Association, Inc.
Dave Willett	City of Northglenn, Public Works
Dennis Laurita	City of Thornton, Contracts
Don Stahurski	City of Federal Heights, Public Works
Elaine Hassinger	Tri-County Health Department
Emily Hunt	City of Thornton, Water Resources
Enessa Janes	Michael Baker International
Glenda Lainis	City of Thornton, Planning
Harlan Bryant	Hyland Hills Parks & Rec
Jeff Walker	Xcel Energy
Jennifer Pepper	The Senior Hub
Jim Kaiser	City of Thornton, Floodplain Manager
JoAnn Koenig	City of Thornton, Accounting
Joe Butler	City of Thornton, Building
John Ewy	Regional Transportation District
Jon Hardman	Quebec Run HOA, Lake Avery Estates HOA
Joshua Wood	Home Depot
Julia Ferguson	Adams County
Karl Wilmes	City of Federal Heights, Police
Kathy Huff	H&H Enterprises
Katie Villela	Michael Baker International

Name	Representing
Kent Moorman	City of Thornton, Community Development
Kevin Stewart	Urban Drainage and Flood Control District (UDFCD)
Krystle Codrey	City of Thornton, Arts & Culture
Lauren Broten	Tri-County Health
Lane Smyth	City of Thornton, City Development
Lisa Hollander	Metro Water Reclamation District
Lisa Nelson	Center for People with Disabilities
Lisa Oliveto	Tri-County Health Department
Lisa Ranalli	City of Thornton, Comm. Services
Lisa Wilson	City of Thornton, Communications
Liz Candelario	Walmart
Margaret Carew	City of Thornton, GIS
Martin Postma	City of Thornton, Planning
Matt Manning	Crossroads Church
Matt Stockton	City of Thornton
Matthew Eberly	City of Thornton
Michelle Gerbrant	Crossroads Church
Michele Martin	Weld County
Mike Garner	Michael Baker International
Nancy Ross	School District 27J
Pam Smith	Anythink Libraries
Patti Lowell	City of Federal Heights, City Clerk
Paul Burkholder	City of Thornton, Community Services
Rachel Bacon	Adams County
Ralph Mitchell	City of Thornton, Utility Ops
Rick Constance	Home Depot
Robb Kolstad	City of Thornton, City Manager's Office
Robin Brown	City of Thornton, Neighborhood Services
Ron Osgood	City of Northglenn, Police
Ryan Doyle	City of Thornton, Emergency and Safety
Scott Magerfleisch	City of Thornton, Technology Services

Name	Representing
Scott Myers	City of Federal Heights, Finance
Sean Ellis	City of Federal Heights, Fire
Steve Grace	City of Northglenn, Public Works
Steve Kelly	City of Thornton, Fire
Takami Peemoeller	City of Thornton, Development
Tim Williams	City of Federal Heights, Community Development
Todd Barnes	City of Thornton, Communications
Todd Rullo	City of Thornton, Streets
Tom Green	United Power
Yong Song	Regional Transportation District

2.5 Planning Meetings and Documentation

The preparation of this Plan required a series of meetings and workshops intended to facilitate discussion and initiate data collection efforts with local community officials. More importantly, the meetings and workshops prompted continuous input and feedback from local officials, public stakeholders, staff, and subject matter experts throughout the process.

Below is a summary of the key meetings and workshops conducted throughout the development of the 2017 Thornton, Federal Heights, and Northglenn Hazard Mitigation Plan. Agendas and sign-in sheets are provided in Appendix D.

Meeting #1: Hazard Mitigation Plan Kick-Off

The first meeting for the 2017 Thornton, Federal Heights, and Northglenn Hazard Mitigation Plan took place at Thornton City Hall on October 14, 2015. Attendees included representatives from all three jurisdictions. This was a largely logistics-oriented meeting, which focused on the following discussion topics:

- Communication, preparation, and leadership
- Senior Management and Council planning sessions
- Project timeline
- Determining the planning area
- Existing resources from each city
- 'Large' planning team development
- Outreach and public input

Meeting #2: Small Team

The second Hazard Mitigation Plan meeting was held on December 2, 2015 at Thornton's Development Office and included what would be identified as the Small Team.

This meeting was an opportunity for the Small Team to discuss action items following the Kick-off meeting. This working group gathered to discuss the following:

- Establishing critical facilities located within the planning area
- Reviewing the proposed Planning Area Map and making final changes to include for the plan
- Identifying hazards in the 2010 Denver Regional Natural Hazard Mitigation Plan and the 2013 Colorado Natural Hazards Mitigation Plan, then updating this list of hazards for the 2016 Thornton, Federal Heights, and Northglenn Hazard Mitigation Plan
- Project schedule
- Public surveys ideas
- An overview of the Mitigation Action Guides (MAGs)

This meeting was held in preparation for the community interviews that took place in the beginning of 2016. The Small Team discussed the goals of the community interviews so that participants could come to the interviews with relevant and resourceful information.

Meeting #3: Community Interviews

Individual community Interviews took place with various representatives from each city between January and February of 2016. These interviews were a great way for representatives to share their knowledge and background about the community and potential hazards affecting each jurisdiction. The purpose was to collect detailed information about each city's capabilities and assets including critical facilities, public engagement pathways, local planning efforts and infrastructure projects, special-needs populations, and more. The interviews were also designed to allow city staff to ask questions, share information, and become more familiar with the broader planning process.

During the interviews, the following topics were discussed:

- Goals and objectives from the 2010 Denver Metro Natural Hazard Mitigation Plan
    - How we can expand on these
    - Status of 2010 projects
- Critical Facilities
    - Determine the City's list of critical facilities and if/how they will be included in the planning document/risk assessment
- Local Capabilities
    - Available staff
    - Participation in the NFIP
    - Previous adoption of mitigation/hazard related plans, codes, ordinances
    - Experience applying for grants and other mitigation related funding mechanisms

- Public Engagement/Communication
    - Existing Social Media/Public Outreach pathways (including best practices in Thornton and any city-specific outreach goals for the project)
    - Content for local newsletter articles
- 5-Year Plan Review
    - Did Thornton or Federal Heights use the 2010 Denver Metro Natural Hazard Mitigation Plan in any way? Was it incorporated into other local planning mechanisms?
- Plan Implementation
    - What tools/processes can your community use to help facilitate the implementation of the plan?
- Keeping the plan current
    - What schedule and process will your city/department use to keep the plan current and updated over the next five years (ex. Annual/quarterly review, council review, etc.)?
- Integrating hazard mitigation and other city planning efforts
    - Moving forward, how will the new hazard mitigation plan be integrated with other planning mechanisms/efforts in your community?
- Major historical hazard/disaster events that have impacted Thornton and its residents
- Identification of special needs and vulnerable populations
    - Part of the hazard risk assessment includes a social vulnerability assessment of your community using census data and information about at-risk populations
- Risk Factor Analysis
    - This discussion will combine historical data, local knowledge, and consensus opinions to produce numerical values that allow several hazards to be ranked against one another.

Meeting #4: Risk Assessment

The third HMP meeting to discuss the results of the Hazard Identification and Risk Assessment was held on May 19, 2016 at the City of Thornton Recreation Center. Participants of both the Small and Large Planning Teams were invited to participate, which included a diverse collection of community stakeholders.

The initial presentation recapped the definition of hazard mitigation planning and what the requirements are for FEMA approval. The top hazards were identified per community and an overview of the worst case scenarios for each hazard were identified in terms of monetary loss and potential injury/damage to residents. The Risk Assessment web map tool, which displays all geospatial hazard information within the planning area, was presented to the group. Attendees were taught how to use the map and access important information, then directed them to where the link could be found on the project website. Following this was a short break so that participants could complete a survey on hazard risk rankings.

FIGURE 3. RISK ASSESSMENT MEETING

The hazard mitigation goals and implementation projects/actions were discussed next. Several example projects were highlighted to give the group an idea of what measures the community could take to protect themselves.

Meeting participants then took part in a 10-minute Mitigation Action Guide working session to brainstorm ideas. Each table was designated a specific hazard, and at the end, a representative presented on what the group had come up with actions for each mitigation category. This was a great way to get members active in thinking about hazard mitigation and what resources they could utilize. This exercise proved to be a beneficial segway to the next meeting so that people would come ready to finalize particular actions to be included in the plan.

Meeting #5: Mitigation Strategy Kick-Off

A webinar was held for the Small Team on June 30, 2016. This meeting was held so all participating jurisdictions could further discuss the development of mitigation actions/projects to include in their respective Mitigation Action Guides (MAGs). The following list highlights meeting topics:

- Benefits of identifying actions as part of this planning process
- Review of each city's updated mitigation strategy goals
- Review of each city's 'high' hazards to be mitigated against
- Types of mitigation projects and examples
- Potential resources to utilize when developing actions
- Review of potential project ideas that were noted during the City interviews
- Discussion of recent mitigation actions in neighboring jurisdictions

Meeting #6: Mitigation Actions Workshop

A Mitigation Actions Workshop was held on August 3, 2016. This meeting was opened up to all Large Team members across all three cities and focused on the review of draft MAGs currently identified. As part of this process, the Large Team was informed of a number of prioritization tools to help each jurisdiction evaluate each of their MAGs.

Following that review, the remainder of the workshop focused on brainstorming discussion for other potential mitigation actions. Participants were encouraged to continue working on additional mitigation project ideas and to submit them to their respective jurisdictions.

Meetings #7 & 8: Thornton Mitigation Actions Workshops

To finalize the planning process, a set of Thornton-specific Mitigation Actions Workshops were held on September 7 & 8, 2016. Participants represented a diverse mix of participants across all City departments. These workshops served as additional brainstorming sessions to try and identify additional mitigation actions to include in the Plan. The planning team was again educated on available prioritization tools that they could utilize. The results of both meetings were the addition of a number of additional City MAG's.

2.6 Public and Stakeholder Participation

An important component of the success of this mitigation planning process involved ongoing public, stakeholder, and jurisdiction participation. Individual citizen involvement provided the planning team with a greater understanding of local concerns and ensured a higher degree of mitigation success by developing community "buy-in" from those directly affected by the planning decisions of public officials.

A broad range of public and private stakeholders, including local public agencies, local businesses, nonprofits, and other interested parties were invited to participate in the development of this 2017 Thornton, Federal Heights, and Northglenn Hazard Mitigation Plan. Planning Team members sent out invitations to local stakeholders encouraging them to become active in project participation and to attend local planning meetings. The public was also directed to planning materials and a survey posted on the project website. Below are examples of a few of the planning announcements and public meeting invitations created and distributed by members of the Planning Team

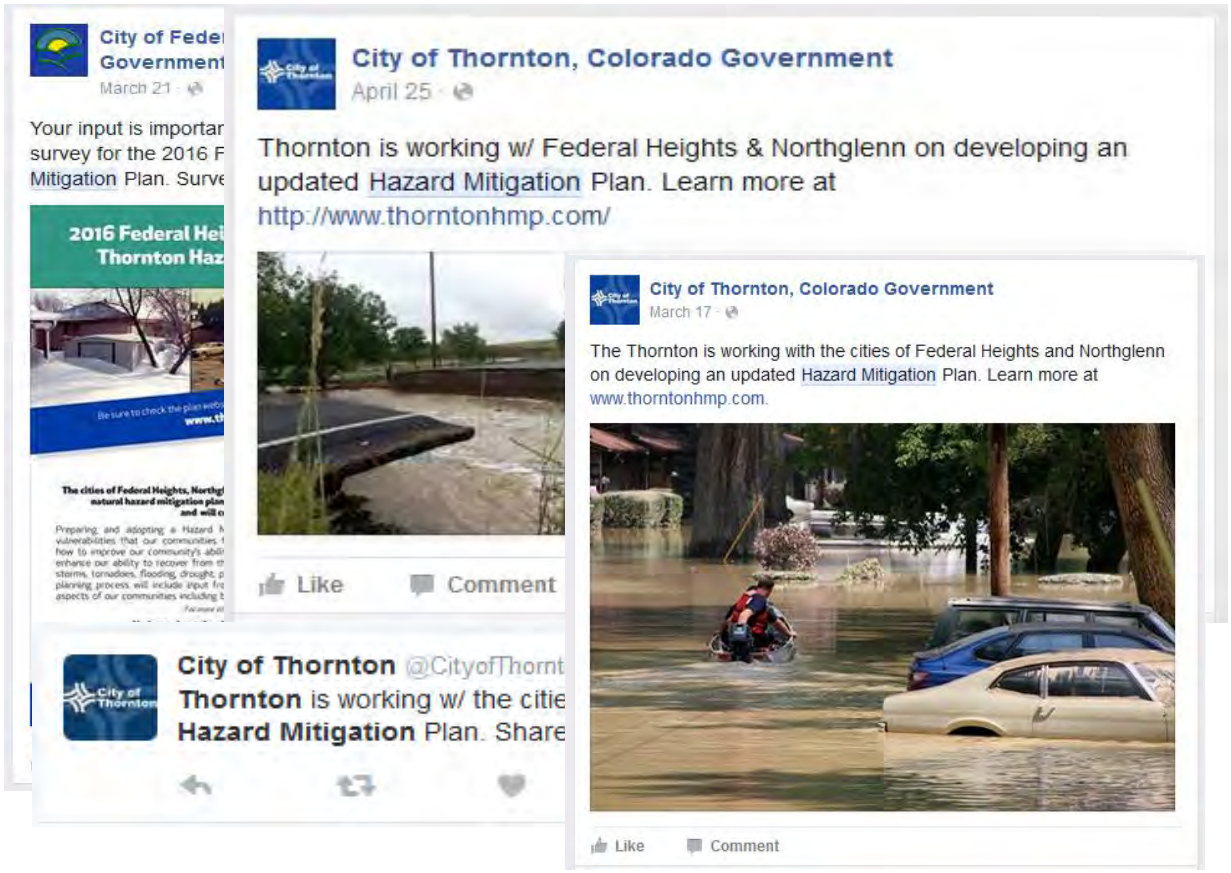
Public input was sought throughout the planning process by advertising public meetings through the following outlets (see the following figures for examples):

- Local newspaper bulletins and flyers distributed throughout the communities
- Social media networks (including agency and municipal Twitter and Facebook accounts)
- Online agency website: City of Thornton

- Utility bill inserts (April 2016)

Following are examples of a few of the planning announcements and public meeting invitations created and distributed by members of the HMPC.

FIGURE 4. SAMPLE SOCIAL MEDIA POSTINGS



City of Thornton Northglenn Federal Heights

FIGURE 5. THORNTON CITY VOICE ARTICLE (NOV-DEC 2015)

City Conducting Hazard Mitigation Plan

The city of Thornton, in conjunction with the cities of Federal Heights and Northglenn, will conduct a local natural hazard mitigation plan in late 2015 and 2016. It will assess the frequency, character, and extent that our communities experience and are affected by hazards.

Conditions that will be examined include high winds, ice storms, flooding, large hail, sink holes, and other natural events. "The plan will examine ways we can improve our ability to withstand future occurrences and enhance our ability to recover from them," says Thornton Senior Policy Analyst Martin Postma." The planning process will engage stakeholders representing many different aspects of our communities including businesses, nonprofits, neighborhoods, schools and others." For more information call 303-538-7295.

FIGURE 6. HAZARD MITIGATION PLANNING COMMUNITY OUTREACH FLYER

City of Thornton Northglenn Federal Heights

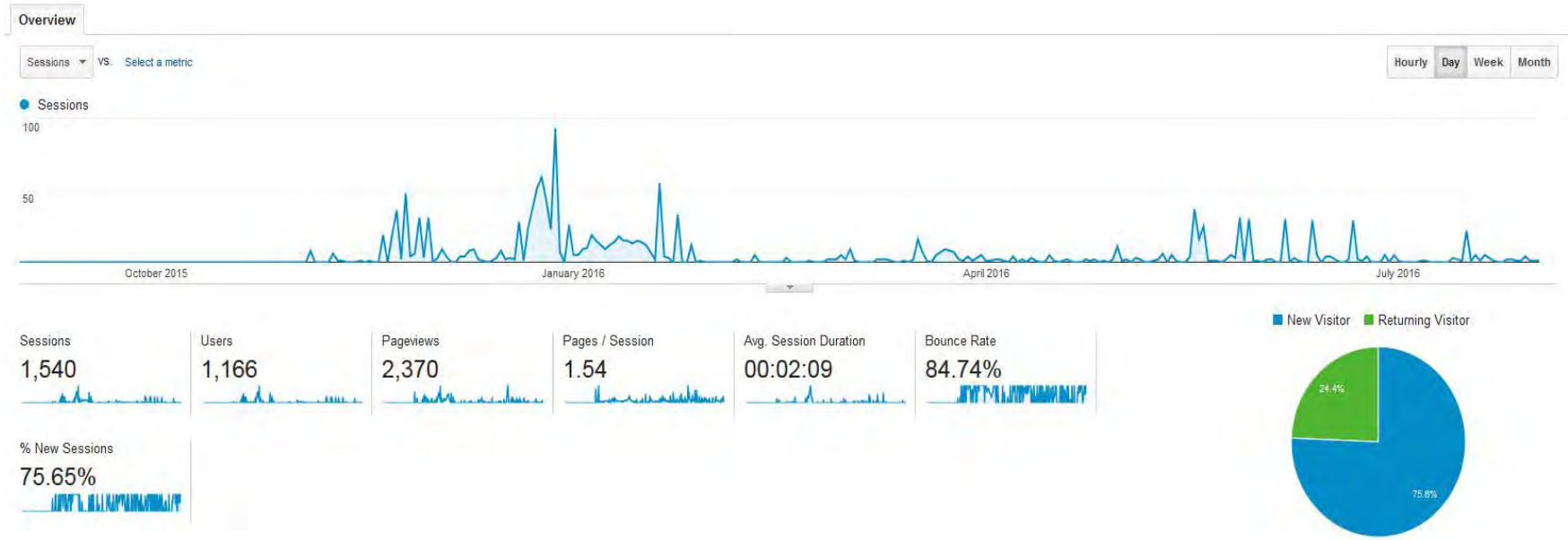
Additionally, a website was created to provide information to the public and stakeholders, and to obtain feedback on the 2017 Plan Update. It was utilized to provide hazard mitigation resources, contact information, survey links, project schedules, informative videos, meeting presentations, and announcements about community events, in addition to the risk assessment web map discussed later in this section. Community members were also encouraged to share their input, photos and experiences for use during the hazard mitigation planning process. The screen shot below provides a visual of the project website.

The draft Hazard Mitigation Plan was also posted on the website for public review and comment for a period of thirty days. Comments were accepted via an on-line survey and also through the project leads for each City. Only one comment was received and the Small Team then reviewed and incorporated as applicable.

FIGURE 7. SCREENSHOT OF THE HAZARD MITIGATION PLAN WEBSITE

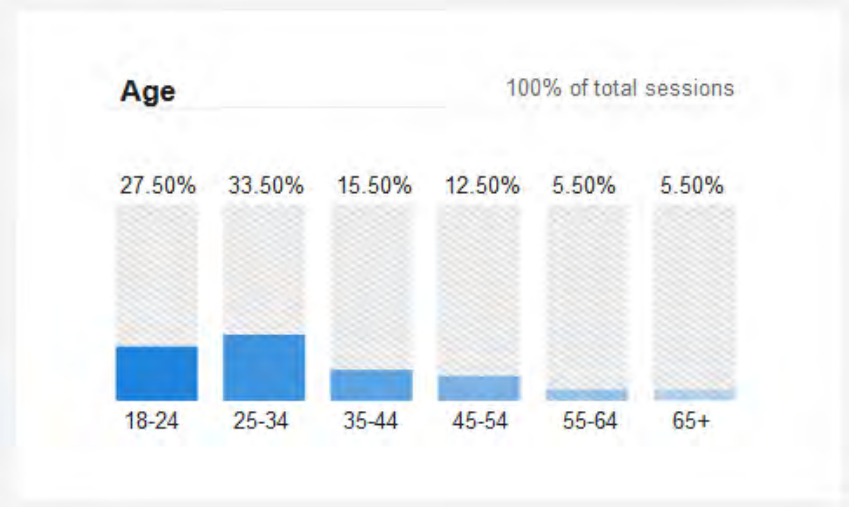
Based on website traffic diagnostics, the project website reached over 1,150 users throughout the course of the hazard mitigation planning process. The figure below summarizes website use between September 2015 and August 2016.

FIGURE 8. WEBSITE ANALYTICS



A third of visitors to the project website were between the ages of 25 and 34. Another 30% were in the 18-24 age group. Only a quarter of visitors fell in the three age groups (from 45 – 65+). The following figure shows this data.

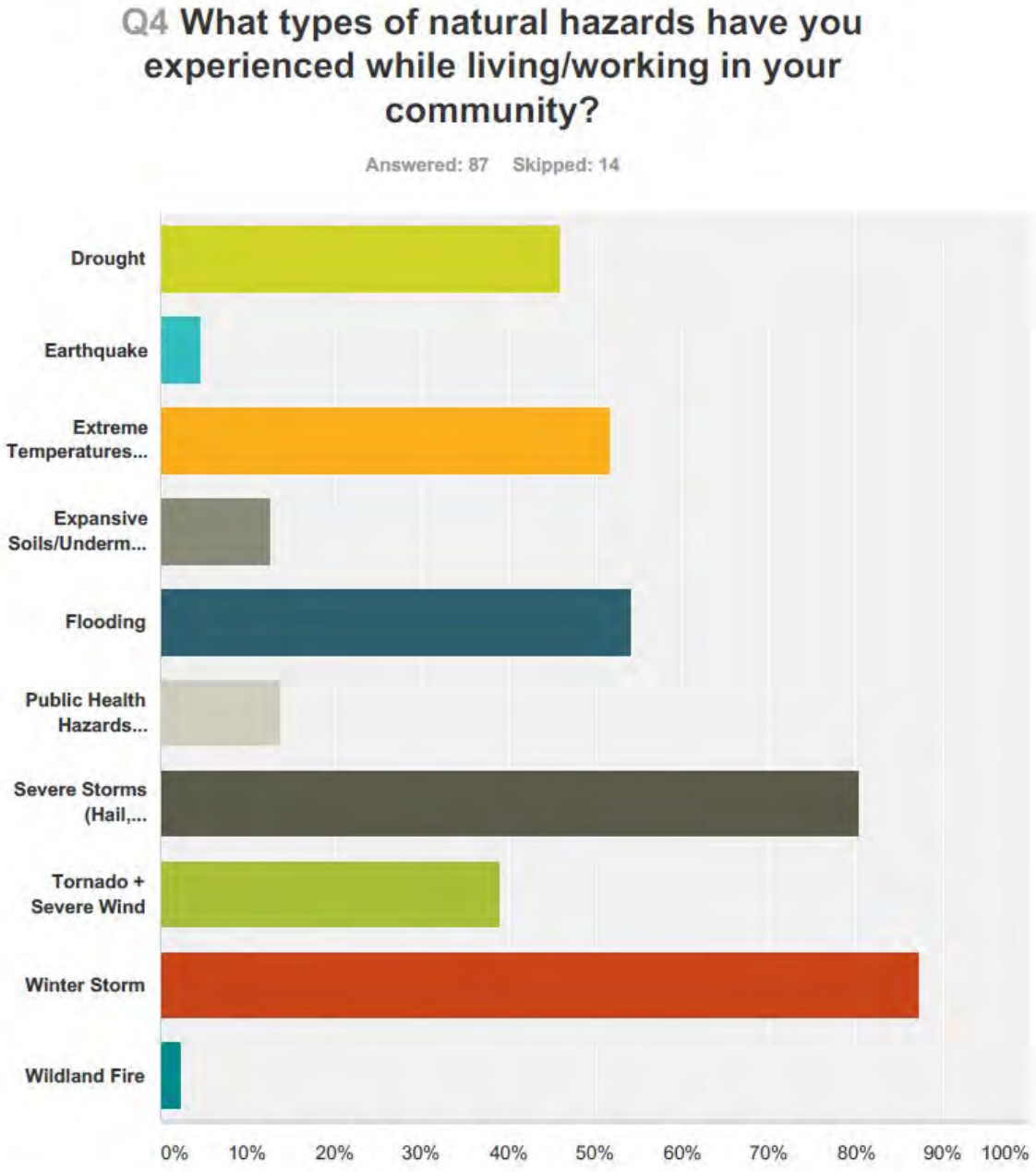
FIGURE 9. WEBSITE VISITOR AGE



The website, social media postings, and the project flyer included a link to a survey, which was designed to gather information about public hazard risk perceptions and visions for community resilience. This survey was utilized to engage and educate local residents throughout the planning process. Information and comments from the survey were shared with members of the planning team and used to guide the planning process. At the time of the final committee meeting, just over 100 Thornton, Federal Heights, and Northglenn residents had submitted responses for the "2017 Thornton, Federal Heights, and Northglenn Hazard Mitigation Plan" survey.

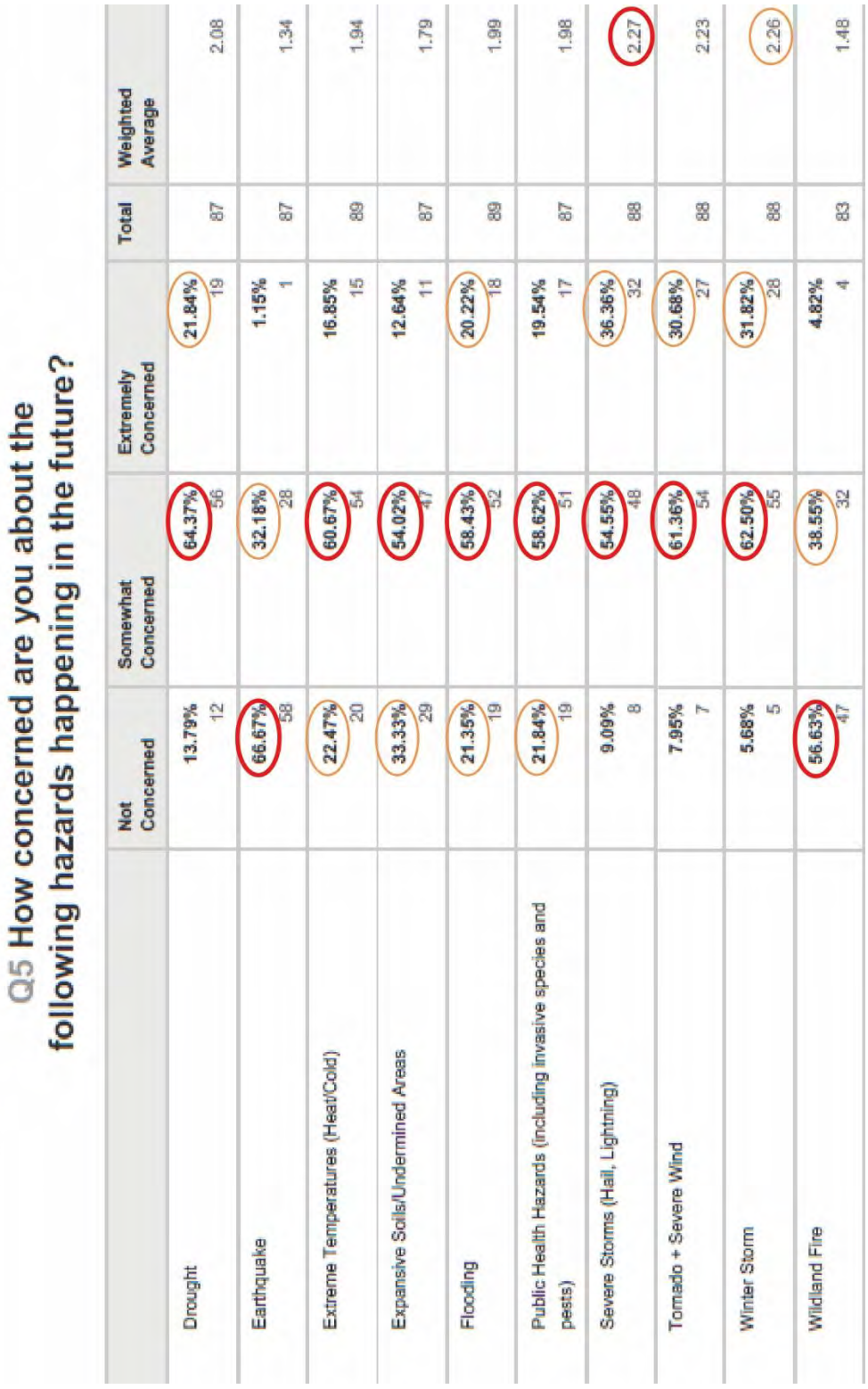
Sample results from the survey are included in the following figures. The results of the survey will also be utilized by the cities for ongoing planning projects related to hazard risk reduction and community planning.

FIGURE 10. SURVEY RESULTS Q4



City of Thornton Northglenn Federal Heights

FIGURE 11. SURVEY RESULTS Q5



Q5 How concerned are you about the following hazards happening in the future?

	Not Concerned	Somewhat Concerned	Extremely Concerned	Total	Weighted Average
Drought	13.79% 12	64.37% 56	21.84% 19	87	2.08
Earthquake	66.67% 58	32.18% 28	1.15% 1	87	1.34
Extreme Temperatures (Heat/Cold)	22.47% 20	60.67% 54	16.85% 15	89	1.94
Expansive Soils/Undermined Areas	33.33% 29	54.02% 47	12.64% 11	87	1.79
Flooding	21.35% 19	58.43% 52	20.22% 18	89	1.99
Public Health Hazards (including invasive species and pests)	21.84% 19	58.62% 51	19.54% 17	87	1.98
Severe Storms (Hail, Lightning)	9.09% 8	54.55% 48	36.36% 32	88	2.27
Tornado + Severe Wind	7.95% 7	61.36% 54	30.68% 27	88	2.23
Winter Storm	5.68% 5	62.50% 55	31.82% 28	88	2.26
Wildland Fire	56.63% 47	38.55% 32	4.82% 4	83	1.48

City of Thornton Northglenn Federal Heights

Q6 How concerned are you about the following possible effects of natural hazards?

	Not Concerned	Somewhat Concerned	Extremely Concerned	Total	Weighted Average
Not having enough food.	42.70% 38	41.57% 37	15.73% 14	89	1.73
Not having access to clean water.	15.73% 14	39.33% 35	44.94% 40	89	2.29
Not having access to required medicine.	35.96% 32	40.45% 36	23.60% 21	89	1.88
Not having access to medical services.	22.47% 20	51.69% 46	25.84% 23	89	2.03
Not having adequate shelter.	33.71% 30	49.44% 44	16.85% 15	89	1.83
Not having access to transportation in the event of evacuation.	44.94% 40	40.45% 36	14.61% 13	89	1.70
Not having electrical power for an extended period of time.	10.11% 9	48.31% 43	41.57% 37	89	2.31
Not having police or fire protection.	23.60% 21	47.19% 42	29.21% 26	89	2.06
Not having access to communication services.	12.36% 11	55.06% 49	32.58% 29	89	2.20
Not being able to get warning messages or other information pertaining to the natural hazard.	14.61% 13	44.94% 40	40.45% 36	89	2.26

FIGURE 12. SURVEY RESULTS Q6

FIGURE 13. SURVEY RESULTS Q7

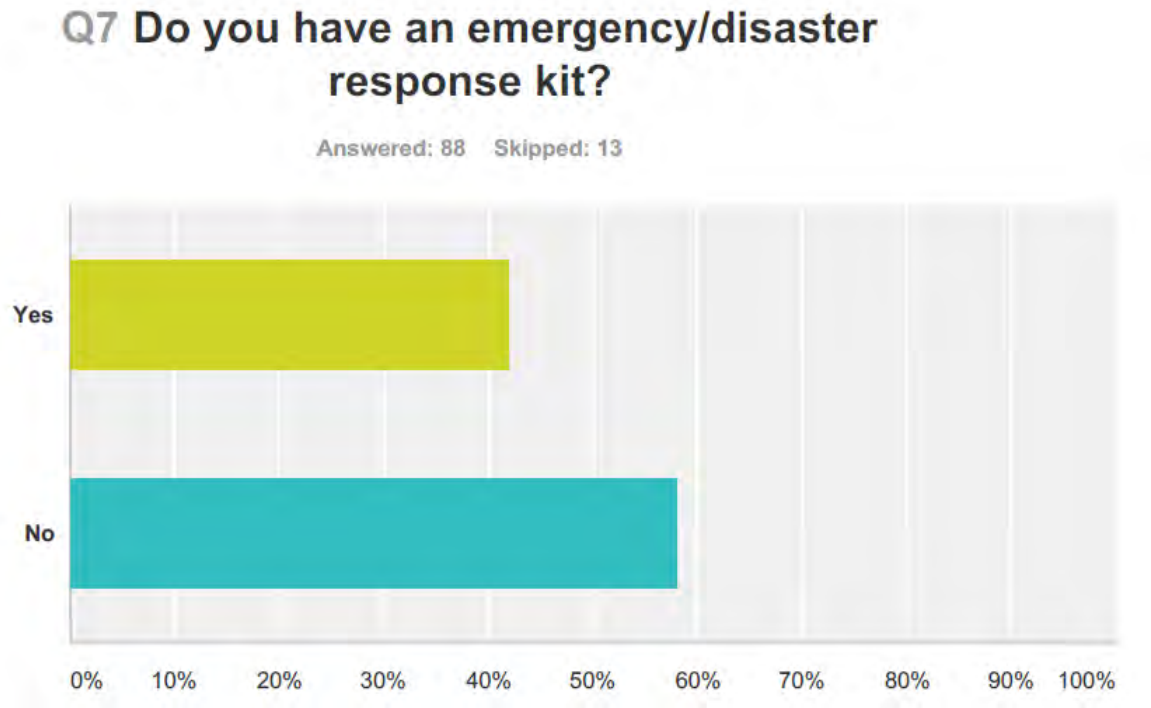


FIGURE 14. SURVEY RESULTS Q9

City of Thornton Northglenn Federal Heights

FIGURE 15. SURVEY RESULTS Q10

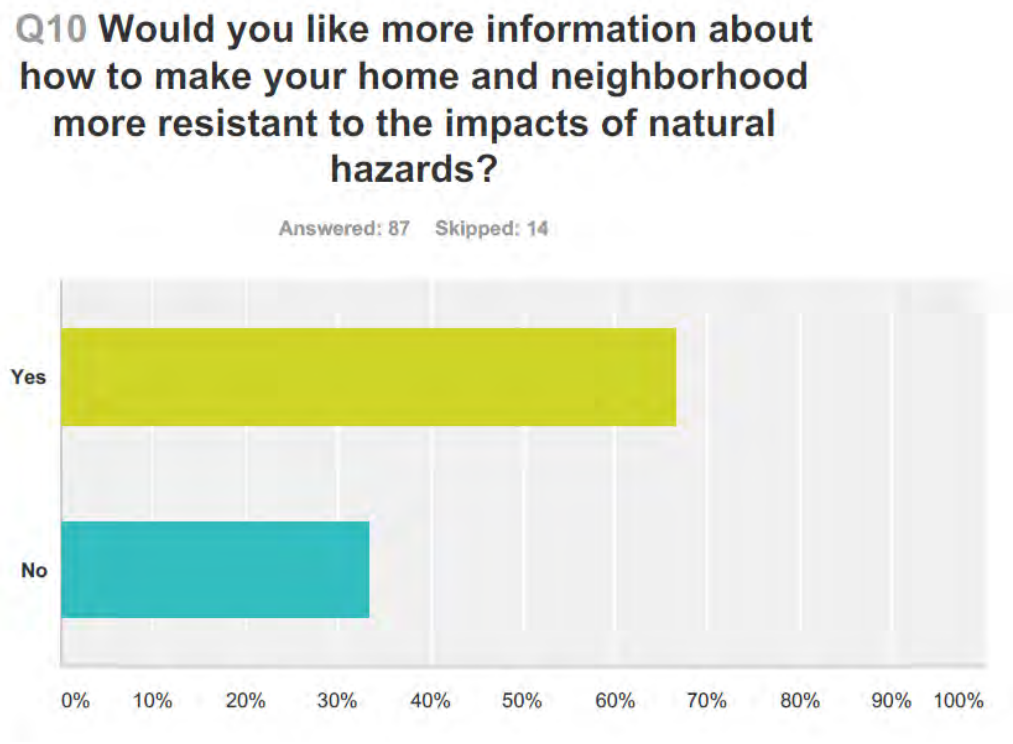
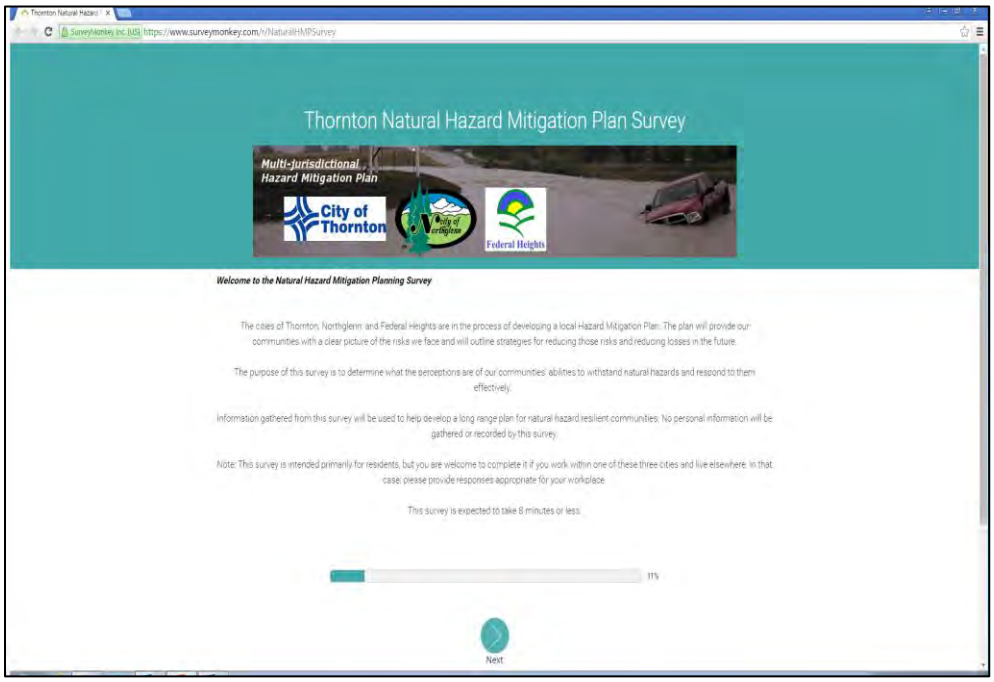


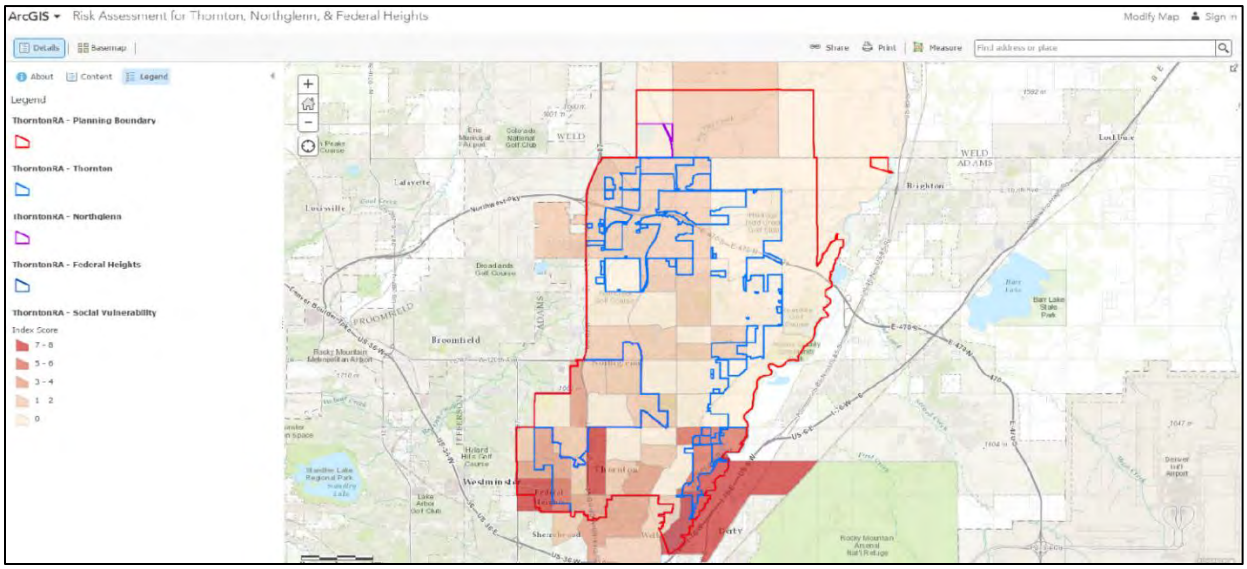
FIGURE 16. SCREENSHOT OF THE HAZARD MITIGATION PLAN SURVEY



The results of the risk assessment were utilized to create interactive online web maps. Available to the public on the project website, the maps served as a tool for analyzing hazards and patterns of risk at

various scales within the community. In addition to helping members of the Planning Team visualize and assess their risks to various hazards, the online maps were also designed as an outreach tool and were used to communicate risk to the public and to ground-truth quantitative risk assessment results at local public meetings throughout the planning process.

FIGURE 17. ARCGIS RISK ASSESSMENT TOOL



Planning Team representatives also manned a booth at Thorntonfest, a yearly community festival, which was held on May 21, 2016. This event receives a great turnout every year and many citizens from the three participating jurisdictions stopped by the booth to learn more about the hazard mitigation plan and planning process.

FIGURE 18. RESIDENTS AT THE THORNTONFEST BOOTH

The City of Federal Heights also presented information relating to the Plan during the Fire Department's annual pancake breakfast on Saturday, May 14, 2016. Approximately 340 people were in attendance.

FIGURE 19. FEDERAL HEIGHTS FIRE DEPT. ANNUAL BREAKFAST

Participating staff with the Cities of Thornton, Federal Heights, and Northglenn also sustained their own public outreach program throughout the planning process. Local representatives serve as a vital link between the local jurisdictions and its businesses and residents. The conversations held outside of the formal hazard mitigation planning meetings he lped to ensure a successful, open, and collaborative planning process.

The City of Thornton also decided to present the draft HMP document to its City Council during a session held on September 20, 2016. The City staff wanted to ensure City Council was informed of this planning process and how participation occurred across all City departments. The Council was also informed that this document would be submitted for formal Adoption following State and FEMA review and Approval Pending Adoption.

2.7 Existing Planning Mechanisms

There are numerous existing regulatory and planning mechanisms in place at the state, and city levels of government which support hazard mitigation planning efforts. These tools include the State of Colorado Hazard Mitigation Plan, the Denver Metro Natural Hazard Mitigation Plan, city subdivision regulations and road and bridge standards, and local zoning regulations. These planning mechanisms were discussed at mitigation planning meetings and the members of the Thornton, Federal Heights, and Northglenn Hazard Mitigation Planning team were encouraged to review all available technical information available for their city as they worked to develop the risk assessment and their mitigation actions. Moving forward, Thornton, Federal Heights, and Northglenn will utilize this Hazard Mitigation Plan to integrate the goals and actions of this Plan into their evolving local planning mechanisms, including comprehensive plans, capital improvement plans, and resource and land use regulations.

The State of Colorado mitigates natural hazards through a number of statutes and programs. Funded by the state and federal government, several agencies and programs within the state implement mitigation actions through assistance to local governments. State statues that are applicable to hazard mitigation are listed below:

- County Fire Planning Authority, Colorado Statute, Title 30, Article 11, Part 1:30-11-124
- Colorado Land Use Commission Authority, Colorado Revised Statute, 24-65-101 & 102
- Colorado Land Use Commission Directives & Duties, Colorado Revised Statutes, 25-65-105 & 24-65-104
- County Building Codes – Master Plan, Colorado Statute, Title 30, Article 28, Part 1:30-28-106
- Local Government Land Use Control Enabling Act, Colorado Revised Statute, 29-20-101, *et seq*
- Local Land Use Control and Regulation, Colorado Revised Statute, 29-20-104
- Colorado Wildfire Preparedness Plan and Fund, Colorado Revised Statute 24-30-310(2)(3)
- Fire Suppression Program Rules, Colorado Revised Statute, 24-33.5-1205(1) (a)
- State Fire Ban Authority, Colorado Revised Statute, 24-30-308
- Colorado Geological Survey (CGS), Colorado Statute, 34-1-1-1 & 103
- CGS Land Use Review Program (Subdivision Law), Colorado Revised Statute, 30-28-101, *et seq*
- Soils & Hazard Analyses of Residential Construction Act, Colorado Revised Statute, 6-6.5-101

- Drought Mitigation Planning, Colorado Revised Statute, 37-60-126.5
- Building Codes – Zoning – Planning, Colorado Revised Statute, 22-32-124(1)
- Colorado Floodplain Management Authority, Colorado Revised Statute, 24-65.1-403(1)
- Emergency Dam Repair Cash Fund, Colorado Revised Statute, 37-60-122.5
- Flood Response Fund, Colorado Revised Statute, 37-60-123.2
- Office of Smart Growth, Colorado Revised Statute, 24-32-3201 *et seq*
- State Engineer – High Hazard Dams Reports, Colorado Revised Statute, 37-87-123
- State Planning and Interest, Colorado Revised Statute, 24-65.1-203

Colorado Statute includes a number of measures that dictate the state's ability to influence land use decisions and subsequently impact local vulnerability to hazards. In most cases, these statutes allow county level and local governments to establish their own rules and regulations.

The Cities of Thornton, Federal Heights, and Northglenn risk and vulnerability reduction efforts are supported by additional planning efforts, including the following:

- Colorado Emergency Resource Mobilization Plan (2012)
- State of Colorado Emergency Operations Plan (2015)
- State of Colorado EOP Emergency Support Function Annexes (2015):
- State of Colorado EOP Supporting Annexes (2015):
    - Evacuation
    - Geographic Information Systems (GIS)
    - International Coordination
    - Public Affairs
    - Tribal Relations
    - Volunteer and Donations Management
- State of Colorado EOP Incident Annexes (2013):
    - Drought Incident
    - Tornado Incident
    - Mass Casualty Incident
    - Earthquake Incident
    - Landslide and Debris Flow Incident
    - Flood Incident
    - Winter Incident
    - Terrorism, Law Enforcement, and Investigation Incident
    - Cyber Incident
    - Biological Incident
    - Chemical Stockpile Emergency Preparedness Program Incident

In the future, this plan will serve as a source document for risk reduction, policy making, and land use planning. It will be incorporated into existing planning mechanisms as they are updated or developed.

These planning mechanisms will enhance the participating jurisdictions' ability to implement the actions outlined in the mitigation plan. During the hazard mitigation planning process, all three cities worked internally to identify ways in which identified mitigation actions/projects will be incorporated into their existing planning and regulatory mechanisms over time. Additional information can be found in the Community Profiles in Appendixes A, B, and C.

3. Hazard Identification

A key step in preventing disaster losses in our communities involves building a clear understanding of the hazards that pose risks to our residents, businesses, and visitors. For the purpose of this plan, the following terms facilitate comparisons between communities and can be found throughout the risk assessments and mitigation strategies.

TABLE 4. KEY HAZARD TERMS DEFINED

Term	Definition
Hazard:	Event or physical conditions that have the potential to cause fatalities, injuries, property damage, infrastructure damage, agricultural loss, damage to the environment, interruption of business, other types of harm or loss.
Risk:	A hazard's likelihood of occurrence and its consequences to society; the estimated impact that a hazard would have on people, services, facilities, and structures in a community.
Vulnerability:	The degree of susceptibility to physical injury, harm, damage, or economic loss; depends on an asset's construction, contents, and economic value of its functions.

Source: FEMA, 2001

The cities of Thornton, Federal Heights, and Northglenn are vulnerable to a wide range of natural hazards that threaten life, property, and environment. For the purpose of this plan, human-caused hazards such as terrorism, hazmat spills, civil unrest, etc., are not addressed. These hazards are addressed individually in local and regional emergency management plans. The hazards identified by the planning team for inclusion in the plan are those determined to be of potential threat to residents, businesses, visitors, and commuters and are consistent with the hazards identified by the State of Colorado and the Federal Emergency Management Agency (FEMA) for this part of the State and this region of the country. The hazards profiled for the 2017 Plan include:

- Drought
- Earthquake
- Expansive Soils / Undermined Areas
- Extreme Temperatures (Heat / Cold)
- Flood (including stream erosion and deposition, dam failure, and levee failure)
- Severe Storms (Hail, Lightning)
- Public Health Hazards (including invasive species and pests)
- Tornado and Severe Wind (including downbursts / microbursts)
- Winter Storm
- Wildland Fire

Clearly, many of these hazards are interconnected (for example, severe storms can cause flooding and prolonged drought can lead to wildland fire). Therefore, discussion of these hazards overlaps throughout the Risk Assessment.

The 2010 DRCOG Denver Regional Natural Hazard Mitigation Plan addressed hazards and mitigation strategies in the Denver region. Hazards were identified as part of a 2003 survey administered to emergency managers, which was reviewed for the 2010 Plan Update. There were 14 hazards identified in the natural hazards of local concern. Out of all the hazards listed, the top five hazards for the region were Avalanche, Drought, Earthquake, Flood, and Hail.

Of the 16 hazards profiled in the State of Colorado's 2013 Hazard Mitigation Plan, 10 are addressed in the 2017 Thornton, Federal Heights, and Northglenn Hazard Mitigation Plan. Hazards that were excluded were done so because no significant vulnerability was identified within the participating communities. The following Table summarizes this information.

TABLE 5. STATE/REGION/COUNTY PLAN HAZARDS MATRIX

Included in 2013 Colorado Natural Hazard Mitigation Plan	Included in 2010 DRCOG Hazard Mitigation Plan	Included in 2017 Thornton, Federal Heights, and Northglenn Mitigation Plan
Avalanche	Aircraft Accidents	Drought
Drought	Avalanche	Earthquake
Earthquake	Biological Hazards / Influenza	Expansive Soils / Undermined Areas
Erosion and Deposition	Civil Disturbance	Extreme Temperatures
Expansive Soil	Dam Failure	Flood – Flash and Riverine
Extreme Temperatures	Drought / Extreme Heat	Severe Storm (Hail, Lightning)
Flood	Earthquake	Public Health Hazards
Hail	Fire – Urban	Tornado and Severe Wind
Landslide, Mud/Debris Flow, Rockfall	Fire – Wildland	Wildland Fire
Lightning	Flood – Flash and Riverine	Winter Storm (Blizzard Conditions, Heavy Snow Accumulation)
Pest Infestation	Hail Storm	
Severe Wind	Hazmat – Fixed Facility	
Subsidence	Hazmat – Transportation	
Tornado	Landslide / Rockslide	
Wildfire	Lightning	
Winter Storm	Terrorism / WMD	
	Tornado	
	Utility Interruption	
	Wind Storm – Severe	
	Winter Storm - Severe	

To further understand the list of identified hazards for this hazard mitigation plan, the following table presents a list of all federal disaster and emergency declarations that have occurred in Adams and Weld Counties since 1965, according to the Federal Emergency Management Agency. This list presents the foundation for identifying which hazards pose the greatest risk to the cities of Thornton, Federal Heights, and Northglenn.

TABLE 6. PRESIDENTIAL DISASTER AND EMERGENCY DECLARATIONS IN ADAMS AND WELD COUNTIES

Declaration #	Date	Event Details
FEMA-4267-DR	01/22/2016	Severe Winter storm and Snowstorm
FEMA-4229-DR	05/04/2015	Severe Storm, Tornadoes, Flooding, Landslides, and Mudslides
FEMA-4145-DR	09/11/2013	Severe Storms, Flooding, Landslides, and Mudslides
FEMA-3365-EM	09/11/2013	Severe Storms, Flooding, Landslides, and Mudslides
FEMA-1762-DR	05/22/2008	Severe Storms and Tornadoes
FEMA-3270-EM	12/18/2006	Snow
FEMA-3224-EM	08/29/2005	Hurricane Katrina Evacuation
FEMA-3185-EM	03/17/2003	Snow
FEMA-1421-DR	04/23/2002	Wildfires
FEMA-1374-DR	04/11/2001	Severe Winter Storm
FEMA-1276-DR	04/29/1999	CO-Flooding 4/30/99
FEMA-1186-DR	07/28/1997	Severe Storms, Heavy Rains, Flash Floods, Mudslides
FEMA-517-DR	08/02/1976	Severe Storms & Flash Flooding
FEMA-385-DR	05/23/1973	Heavy Rains, Snowmelt and Flooding
FEMA-379-DR	08/08/1973	Dam Failure
FEMA-261-DR	05/19/1969	Severe Storms & Flooding

Declaration #	Date	Event Details
FEMA-200-DR	06/19/1965	Tornadoes, Severe Storms & Flooding

3.1 Hazard Ranking Results

The following table provides a summary of each city's self-identified vulnerability to the hazards identified in the plan. The results are a product of each city's review of previous hazard events, the results of the multi-hazard risk assessment, and each city's understanding of the probability, impact, spatial extent, warning time, and duration of each identified hazard. These have been re-evaluated and updated accordingly, as compared to the 2010 Plan, by Thornton and Federal Heights (Northglenn was not a participant in that Plan).

TABLE 7. HAZARD RISK SUMMARY

City	Drought	Earthquake	Expansive Soils / Undermined Areas	Extreme Temperatures	Flood	Severe Storms	Public Health Hazard	Tornado / Severe Wind	Winter Storm	Wildland Fire
City of Thornton	High	Low	Medium	Low	High	High	Medium	High	High	Low
City of Federal Heights	Medium	Low	Low	Medium	High	Medium	High	High	High	Low
City of Northglenn	High	Low	Low	Medium	High	High	Low	Medium	High	Medium

The proceeding table attempts to demonstrate, at a high level, the potential magnitudes of damages that could be realized in the planning area, specific to each hazard. This makes use of the best available data.

For some hazards, it was more accurate to look at the worst historical losses resulting from each hazard event. For other hazards, potential exposures or vulnerabilities were able to be assessed utilizing the best available GIS data sets and loss estimation tools. It should be noted that the planning area is not county-wide and some historical data sets used can only be evaluated and are only available at the county level. Therefore, throughout this plan it will be noticed that assessments were conducted utilizing both Adams and Weld County data.

TABLE 8. ESTIMATED POTENTIAL/HISTORICAL LOSSES

Hazard	Estimated Potential / Historical Losses	Source
Drought	n/a	-
Earthquake	49,764 structures - ~$250M estimated losses	Hazus: 6.5M Golden Fault Event / losses based on Improved Structure Valuations
Expansive Soils / Undermined Areas	n/a	-
Extreme Temperatures	n/a	-
Flood	100 structures - ~$9M estimated losses	Hazus: 100-Year Flood Scenario / losses based on Improved Structure Valuations
Severe Storms	Lightning: $215,000 property damage Hail: $127 million in property damage, $26 million in crop damage	NOAA: Countywide historical event data for Adams and Weld Co.
Public Health Hazards	7,975 days of estimated work loss due to Pandemic Flu	Colorado Reportable Disease Statistics (CDPHE), FluWorkLoss 1.0 modeled event
Tornado and Severe Wind	Strong Wind: $41,000 in property damage, $5,000 in crop damage Tornado: 56 injuries, $30,226,180 in property damage (Windsor - $125M, 1 death / 14 injured)	NOAA: Countywide historical event data for Adams and Weld Co.
Winter Storm	$102,000 in property damage	NOAA: Countywide historical event data for Adams and Weld Co.
Wildland Fire	n/a	-

The following hazard profiles include planning area risk assessments for each of the hazards identified by the planning team. The hazards are presented in alphabetical order rather than by their relative levels of risk.

3.2 Drought

Hazard Identification

Drought is a normal part of virtually all climates, including areas with high and low average rainfall. Drought events are caused by a deficiency of precipitation and can be aggravated by other factors such as high temperatures, high winds, and low relative humidity.

Droughts can be grouped as meteorological, hydrologic, agricultural, and socioeconomic. Representative definitions commonly used to describe the various types of drought are summarized below.

- **Meteorological drought** is defined solely on the degrees of dryness. It is expressed as a departure of actual precipitation from an expected average or normal amount based on monthly, seasonal, or annual time scales.
- **Hydrologic drought** is related to the effects of precipitation shortfalls on stream flows and reservoir, lake, and groundwater levels.
- **Agricultural drought** is defined principally in terms of soil moisture deficiencies relative to water demands of plant life, usually crops.
- **Socioeconomic drought** associates the supply and demand of economic goods or services with elements of meteorological, hydrologic, and agricultural drought. Socioeconomic drought occurs when the demand for water exceeds the supply as a result of a weather related supply shortfall. The incidence of this type of drought can increase because of a change in the amount of rainfall, a change in societal demands for water (or vulnerability to water shortages), or both.

The Palmer Drought Severity Index (PDSI) was developed by Wayne Palmer in the 1960s and uses temperature and rainfall information in a formula to determine dryness. Over time it has become the semi-official drought index for risk assessment and hazard analysis. The Palmer Index is most effective in determining long term drought—a matter of several months—and is not used for short-term forecasts (a matter of weeks). It uses a 0 as normal conditions, and drought is shown in terms of negative numbers; for example, -2 is moderate drought, -3 is severe drought, and -4 is extreme drought. The following table provides an overview of the Palmer Index compared to other drought classification systems. The return period is related to how often the type of drought typically occurs. For example a minor drought occurs every 3-4 years.

TABLE 9. DROUGHT SEVERITY CLASSIFICATION

Drought Severity	Return Period (yrs)	Description of Possible Impacts	Drought Monitoring Indices		
			Standardized Precipitation Index (SPI)	NDMC* Drought Category	Palmer Drought Index
Minor Drought	3 to 4	Going into drought; short-term dryness slowing growth of crops or pastures; fire risk above average. Coming out of drought; some lingering water deficits; pastures or crops not fully recovered.	-0.5 to -0.7	D0	-1.0 to -1.9
Moderate Drought	5 to 9	Some damage to crops or pastures; fire risk high; streams, reservoirs, or wells low, some water shortages developing or imminent, voluntary water use restrictions requested.	-0.8 to -1.2	D1	-2.0 to -2.9
Severe Drought	10 to 17	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed	-1.3 to -1.5	D2	-3.0 to -3.9
Extreme Drought	18 to 43	Major crop and pasture losses; extreme fire danger; widespread water shortages or restrictions	-1.6 to -1.9	D3	-4.0 to -4.9
Exceptional Drought	44 +	Exceptional and widespread crop and pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells creating water emergencies	Less than -2	D4	-5.0 or less

*Source: National Drought Mitigation Center

Previous Occurrences

With its semi-arid climate, drought is a natural part of the Colorado environment. Because of natural variations in regional climate and precipitation, it is rare for the entire state to be deficient in moisture at the same time. Single season droughts that cover specific portions of the state, however, are fairly common.

Drought impacts can cover large areas and may come in many forms. The most significant drought impacts in Colorado are related to water-intensive activities including agriculture, municipal use, wildfire protections, recreation, wildlife preservation, commerce, and tourism. Drought conditions can lead to the compaction of soil, increasing erosion potential and decreasing water quality. The impacts associated with drought magnify as the duration of the event increases, as supplemental supplies in reservoirs are depleted and water levels in groundwater aquifers decline.

The State of Colorado has experienced severe, widespread drought several times since the late 1800s. The 2013 State of Colorado Drought Mitigation and Response Plan included a comprehensive description of the major droughts that have occurred in Colorado, including the Dust Bowl of 1930s, the 1950s drought of the Great Plains, and the Colorado drought of 2002. The table below summarizes the duration of historical dry and wet periods in Colorado.

TABLE 10. HISTORICAL DRY AND WET PERIODS IN COLORADO

Date	Dry	Wet	Duration (years)
1893-1905	X		12
1905-1931		X	26
1931-1941	X		10
1941-1951		X	10
1951-1957	X		6
1957-1959		X	2
1963-1965	X		2
1965-1975		X	10
1975-1978	X		3
1978-1999		X	20
2000-2006	X		6
2007-2010		X	3
2010-2013	X		3

Source: 2013 Colorado Drought Mitigation and Response Plan

The previous table highlights seven multi-year drought episodes in Colorado since 1893. The most dramatic drought event occurred in the late 1930s and 1950s when a number of states in the region were affected by a several-year drought.

HAZARD IMPACTS

The Colorado drought of 2002 was the single most intensive year of drought in Colorado's history.[1] Statewide snowpack was at or near all-time lows, and the year is considered the driest single year recorded in Colorado history. What made the 2002 drought event so unusual was that all of the State was dry at the same time. Regional soil moisture was depleted and reservoirs dropped to extremely low levels. The dramatic drought conditions prompted widespread water restrictions that were heavily enforced and regulated. These restrictions included limits to watering lawns, washing cars, or the use of water for any other non-essential uses. Some municipalities offered incentives for property owners to remove their lawns and adopt xeriscaped landscape designs. Ultimately, it was the wet period of the late 1990s and the increased reservoir storage during that time that helped Colorado to survive the drought of 2002.

More recently, severe drought conditions have impacted the State of Colorado. Based on the U.S. Drought Monitor, approximately 50% of Colorado was already experiencing drought conditions by the start of

[1] Pielke and Doesken, 2003. The Drought of 2002 in Colorado.

2012. Minimal accumulations of snow worsened conditions further, as below average snowfall and above average temperatures occurred in February and March. In April and May of 2012, warm temperatures caused early runoff as the thin snowpack melted rapidly. The entire State of Colorado was under drought conditions by the end of May 2012 and stream flows measured only slightly better compared to the extreme drought years of 1934, 1954, 1977 and 2002.

Local agricultural production was heavily impacted by the 2011-2013 drought. Because soil moisture was low and temperatures high on the plains during the spring planting season, many crops struggled to take root and failed to survive the summer. Agricultural drought impacts were exacerbated by limited water availability for summer irrigation diversions due to less snowpack and runoff. In the eastern plains of Colorado, June temperatures were consistently over 100°F. As hay production decreased to 10% - 50% of average supply, prices increased dramatically. For example, corn prices increased 43% over two years as neighboring corn-producing regions in other states also struggled with drought. By early June 2013, many areas of the Eastern Plains normally covered by crops or cattle were barren. Many ranchers sold their herds as grasses had gone dormant and hay was expensive and in short supply.

Additional economic impacts seen during the 2011-2013 drought period included disruptions to the tourism industry. Colorado experienced decreased rafting numbers due to low stream flows and wildfire conditions that made some river reaches inaccessible. Colorado's ski industry, another important economic driver for the state, experienced an 11.9% decrease in visits for the 2011-2012 season as compared to the 5-year average. Many ski resorts closed early in 2012 because of high temperatures and minimal March snowfall.

In addition to having a devastating economic impact on Colorado agriculture and tourism, the 2011-2013 drought period contributed to elevated wildfire risk across the state. Two of the state's most destructive wildfires occurred during the 2012 drought period: the High Park Fire and the Waldo Canyon Fire. Dry conditions on the Eastern Plains contributed to an extended grass fire season that threatened homes and property.

During drought conditions, Secretarial Disaster Declarations are used to make low interest loans and other emergency assistance available to those who have been affected (largely farmers and ranchers). Under the process laid out by the Farm Services Agency (FSA), a U.S. Department of Agriculture (USDA) Disaster Declaration can be made if any portion of a County has experienced eight consecutive weeks of severe drought according to the U.S. Drought Monitor.[2]

Because drought is usually considered a regional hazard, all jurisdictions are assumed to have the same risk level across the 2017 local hazard mitigation planning area. Drought risk is based on a combination of the frequency, severity, and spatial extent (the physical nature of drought) and the degree to which a population or activity is vulnerable to the effects of drought. The degree of a single jurisdiction's vulnerability to drought depends on the environmental and social characteristics of the larger region and is measured by its ability to anticipate, cope with, resist, and recover from drought. City-specific drought

[2] The 2013 Colorado Drought Mitigation Response Plan

impact analyses and risk assessments are provided in the Community Profiles, Appendices A, B, and C, of this report.

The 2013 State of Colorado Drought Mitigation and Response Plan includes information about total drought impacts for all Colorado counties from 1935 (the earliest reported drought impact) to May 8, 2013 for the following impact categories:

Agriculture: Drought impacts associated with agriculture, farming, aquaculture, horticulture, forestry or ranching. Examples of drought-induced agricultural impacts include: damage to crop quality; income loss for farmers due to reduced crop yields; reduced productivity of cropland; insect infestation; plant disease; increased irrigation costs; cost of new or supplemental water resource development (wells, dams, pipelines) for agriculture; reduced productivity of rangeland; forced reduction of foundation stock; closure/limitation of public lands to grazing; high cost or unavailability of water for livestock, Christmas tree farms, forestry, raising domesticated horses, bees, fish, shellfish, or horticulture.

Business and Industry: Drought impacts affecting non-agriculture and non-tourism businesses, such as lawn care businesses, sales of recreational vehicles or other recreational gear, and plant nurseries. Examples of drought-induced business impacts could include: reduction or loss of employees, change in sales or volume of business, variation in number of calls for service, early closure or late opening for the season, bankruptcy, permanent store closure, economic impacts.

Energy: Drought impacts associated with power production, electricity rates, energy revenue, and purchase of alternate sources of energy. Examples include hydropower and non-hydropower production when affected by drought, electricity rates, revenue shortfalls and/or windfall profits, purchase of electricity when hydropower generation is down.

Fire: Drought impacts contributing to forest, range, rural, or urban fires, fire danger, and burning restrictions. Examples of fire impacts include: Enactment/easing of burning restrictions, fireworks ban, increased fire risk, occurrence of fire (number of acres burned, number of wildfires compared to average, people displaced, etc.), increase in firefighting personnel, state of emergency during periods of high fire danger, closure of roads land due to fire occurrence or risk.

Plants and Wildlife: Drought impacts associated with unmanaged plants and wildlife, fisheries, forests, and other fauna. Examples of drought-induced impacts on plants and wildlife include: loss of biodiversity of plants or wildlife; loss of trees from rural or urban landscapes, shelterbelts, or wooded conservation areas; reduction and degradation of fish and wildlife habitat; lack of feed and drinking water; greater mortality due to increased contact with agricultural producers, as animals seek food from farms and producers are less tolerant of the intrusion; disease; increased vulnerability to predation (from species concentrated near water); migration and concentration (loss of wildlife in some areas and too many wildlife in other areas); increased stress to endangered species; salinity levels affecting wildlife, wildlife encroaching into urban areas, loss of wetlands.

Relief, Response, and Restrictions: Drought effects associated with disaster declarations, aid programs, requests for disaster declaration or aid, water restrictions, fire restrictions. Impacts include: Disaster declarations, aid programs, USDA Secretarial disaster declarations, Small Business Association disaster declarations, government relief and response programs, state-level declarations, county-level

declarations, a declared "state of emergency," requests for declarations or aid, non-profit organization-based relief, water restrictions, fire restrictions, declaration of drought watches or warnings.

Society and Public Health: Drought effects associated with public and human health. Examples of drought-induced social impacts include: health-related problems related to reduced water quantity and/or quality, such as increased concentration of contaminants; loss of human life (e.g., from heat stress); increased respiratory ailments; increased disease caused by wildlife concentrations; population migration (rural to urban areas, migrants into the United States); loss of aesthetic values; change in daily activities (non-recreational, like putting a bucket in the shower to catch water), elevated stress levels, meetings to discuss drought, communities creating drought plans, lawmakers altering penalties for violation of water restrictions, demand for higher water rates, cultural/historical discoveries from low water levels, cancellation of fundraising events, cancellation/alteration of festivals or holiday traditions, stockpiling water, public service announcements and drought information websites, protests.

Tourism and Recreation: Drought effects associated with recreational activities and tourism. Examples of drought-induced tourism and recreation impacts include: water access or navigation problems for recreation; bans on recreational activities; reduced license, permit, or ticket sales (e.g. hunting, fishing, ski lifts, etc.); losses related to curtailed activities (e.g. bird watching, hunting and fishing, boating, etc.); reduced park visitation; delayed opening for ski resorts; increase in artificial snow generation; cancellation or postponement of sporting events.

Water Supply and Quality: Drought effects associated with water supply and water quality. Examples of drought-induced water supply and quality impacts include: Dry wells, water restrictions, changes in water rates, increase in requests for new well permits, changes in water use due to water restrictions, greater water demand, decrease in water allocation or allotments, installation or alteration of water pumps or water intakes, changes to allowable water contaminants, water line damage or repairs due to drought stress, drinking water turbidity, change in water color or odor, declaration of drought watches or warnings, mitigation activities.

CLIMATE CHANGE IMPACTS

The National Oceanic and Atmospheric Administration Paleoclimatology Program studies drought by analyzing records from tree rings, lake and dune sediments, archaeological remains, historical documents, and other environmental indicators to obtain a broader picture of the frequency of droughts in the United States. According to their research, “paleoclimatic data suggest that droughts as severe as the 1950’s drought have occurred in central North America several times a century over the past 300-400 years, and thus we should expect (and plan for) similar droughts in the future. The paleoclimatic record also indicates that droughts of a much greater duration than any in the 20th century have occurred in parts of North America as recently as 500 years ago.”

Based on this research, the 1950’s drought situation could be expected approximately once every 50 years or a 20% chance every 10 years. An extreme drought, worse than the 1930’s “Dust Bowl,” has an approximate probability of occurring once every 500 years or a 2% chance of occurring each decade.[3] A

[3] National Oceanic and Atmospheric Administration, 2003

500-year drought with a magnitude similar to that of the 1930's that destroys the agricultural economy and leads to wildfires is an example of a high magnitude event.

Inventory Exposed

Drought was identified as a high hazard for the Cities of Thornton and Northglenn. Additional information on inventory exposed can be found in the respective community profiles sections of this report (Appendices A and C).

Potential Losses

Drought was identified as a high hazard for the Cities of Thornton and Northglenn. Additional information on potential losses can be found in the respective community profiles sections of this report (Appendices A and C).

Probability of Future Occurrences

Drought was identified as a high hazard for the Cities of Thornton and Northglenn. Additional information on the probability of future occurrences can be found in the respective community profiles sections of this report (Appendices A and C).

Land Use and Development

Drought was identified as a high hazard for the Cities of Thornton and Northglenn. Additional information on land use and development can be found in the respective community profiles sections of this report (Appendices A and C).

3.3 Earthquake

Hazard Identification

An earthquake is defined as the motion or trembling of the ground produced by sudden displacement of rock usually within the upper 10 – 20 miles of the Earth's crust. Earthquakes can affect hundreds of thousands of square miles, cause damage to property measured in the tens of billions of dollars, result in loss of life and injury to hundreds of thousands of people, and disrupt the social and economic functioning of the affected area. Most property damage and earthquake-related deaths are caused by the failure and collapse of structures due to ground shaking which is dependent upon amplitude and duration of the earthquake (FEMA, 1997).

Earthquake Mechanics

Regardless of the source of the earthquake, the associated energy travels in waves radiating outward from the point of release. When these waves travel along the surface, the ground shakes and rolls, fractures form, and water waves may be generated. Earthquakes generally last a matter of seconds but the waves may travel for long distances and cause damage well after the initial shaking at the point of origin has subsided.

Breaks in the crust associated with seismic activity are known as "faults" and are classified as either active or inactive. Faults may be expressed on the surface by sharp cliffs or scarps or may be buried below surface deposits.

"Foreshocks," minor releases of pressure or slippage, may occur months or minutes before the actual onset of the earthquake. "Aftershocks," which range from minor to major, may occur for months after the main earthquake. In some cases, strong aftershocks may cause significant additional damage, especially if the initial earthquake impacted emergency management and response functions or weakened structures.

Factors Contributing to Damage

The damage associated with each earthquake is subject to four primary variables:

- The nature of the seismic activity
- The composition of the underlying geology and soils
- The level and quality of development of the area struck by the earthquake
- The time of day

Seismic Activity: The properties of earthquakes vary greatly from event to event. Some seismic activity is localized (a small point of energy release), while other activity is widespread (e.g., a major fault shifting or slipping all at once). Earthquakes can be very brief (only a few seconds) or last for a minute or more. The depth of release and type of seismic waves generated also play roles in the nature and location of damage; shallow quakes will hit the area close to the epicenter harder, but tend to be felt across a smaller region than deep earthquakes.

Geology and Soils: The surface geology and soils of an area influence the propagation (conduction) of seismic waves and how strongly the energy is felt. Generally, stable areas (e.g., solid bedrock) experience less destructive shaking than unstable areas (e.g., fill soils). The siting of a community or even individual buildings plays a strong role in the nature and extent of damage from an event**.**

Development: An earthquake in a densely populated area which results in many deaths and considerable damage may have the same magnitude as a shock in a remote area that has no direct impacts. Large magnitude earthquakes that occur beneath the oceans may not even be felt by humans.

Time of Day: The time of day of an event controls the distribution of the population of an affected area. On work days, the majority of the community will transition between work or school, home, and the commute between the two. The relative seismic vulnerability of each location can strongly influence the loss of life and injury resulting from an event.

Types of Damage

Often, the most dramatic evidence of an earthquake results from the vertical and/or horizontal displacement of the ground along a fault line. This displacement can sever transportation, energy, utility, and communications infrastructure potentially impacting numerous systems and persons. These ground displacements can also result in severe and complete damages to structures situated on top of the ground fault. However, most damage from earthquake events is the result of shaking. Shaking also produces a number of phenomena that can generate additional damage

- Additional ground displacement
- Landslides and avalanches
- Liquefaction and subsidence
- Seismic Seiches

Shaking: During minor earthquake events, objects often fall from shelves and dishes rattle. In major events, large structures may be torn apart by the forces of the seismic waves. Structural damage is generally limited to older structures that are poorly maintained, poorly constructed, or improperly (or not) designed for seismic events. Un-reinforced masonry buildings and wood frame homes not anchored to their foundations are typical victims of earthquake damage.

Loose or poorly secured objects also pose a significant hazard when they are loosened or dropped by shaking. These “non-structural falling hazard” objects include bookcases, heavy wall hangings, and building facades. Home water heaters pose a special risk due to their tendency to start fires when they topple over and rupture gas lines. Crumbling chimneys may also be responsible for injuries and property damage.

Dam and bridge failures are significant risks during stronger earthquake events, and due to the consequences of such failures, may result in considerable property damage and loss of life. In areas of severe seismic shaking hazard, shaking Intensity levels of VII or higher (see Table 25) can be experienced even on solid bedrock. In these areas, older buildings especially are at significant risk.

Ground Displacement: Ground displacement can also occur due to shaking, resulting in similar damages as mentioned previously.

Landslides and Avalanches: Even small earthquake events can cause landslides. Rock falls are common as unstable material on steep slopes is shaken loose, but significant landslides or even debris flows can be generated if conditions are ripe. Roads may be blocked by landslide activity, hampering response and recovery operations. Avalanches are possible when the snowpack is sufficient.

Liquefaction and Subsidence: Soils may liquefy and/or subside when impacted by the seismic waves. Fill and previously saturated soils are especially at risk. The failure of the soils has the potential to cause widespread structural damage. The oscillation and failure of the soils may result in increased water flow and/or failure of wells as the subsurface flows are disrupted and sometimes permanently altered. Increased flows may be dramatic, resulting in geyser-like water spouts and/or flash floods. Similarly, septic systems may be damaged creating both inconvenience and health concerns.

Seiches: Seismic waves may rock an enclosed body of water (e.g., lake or reservoir), creating an oscillating wave referred to as a "seiche." Although not a common cause of damage in past Colorado earthquakes, there is a potential for large, forceful waves similar to a tsunami ("tidal waves") to be generated on the large reservoirs within and neighboring Weld County. Such a wave would be a hazard to shoreline development and pose a significant risk on dam-created reservoirs. A seiche could either overtop or damage a dam leading to downstream flash flooding.

Environmental impacts of earthquakes can be numerous, widespread, and devastating, particularly if indirect impacts are considered. Some examples of impacts are listed below:

- Induced flooding and landslides
- Poor water quality
- Damage to vegetation
- Breakage in sewage or toxic material containments

HAZARD IMPACTS

The impact an earthquake event has on an area is typically measured in terms of earthquake intensity. Intensity is most commonly measured using the Modified Mercalli Intensity (MMI) Scale based on direct and indirect measurements of seismic effects.

Another way to express an earthquake's severity is to compare its acceleration to the normal acceleration due to gravity. Peak ground acceleration (PGA) measures the strength of ground movements in this manner and represents the rate in change of motion of the earth's surface during an earthquake as a percent. PGA can be partly determined by what soils and bedrock characteristics exist in the region. Unlike the Richter scale, PGA is not a measure of the total energy released by an earthquake, but rather of how hard the earth shakes at a given geographic area (the intensity). PGA is measured by using instruments including accelerographs and correlates well with the Mercalli scale. PGA is represented as %g in the report. A detailed description of the Modified Mercalli Intensity Scale is shown in the following table.

TABLE 11. MODIFIED MERCALLI INTENSITY SCALE

Intensity	Shaking	Description of effects	Richter Scale Magnitude
I	Not Felt	Not felt except by a very few under especially favorable conditions.	Up to 4.7
II	Weak	Felt only by a few persons at rest, especially on upper floors of buildings.	
III	Weak	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.	
IV	Light	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.	
V	Moderate	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.	4.8 – 5.3
VI	Strong	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.	5.4 – 6.0
VII	Very Strong	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.	6.1 – 6.8
VIII	Severe	Damage slight in specially designed structures; considerable	6.9 – 7.2

Intensity	Shaking	Description of effects	Richter Scale Magnitude
		damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.	
IX	**Violent**	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.	
X	**Extreme**	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.	7.3 – 8.0

TABLE 12. TABLE OF INTENSITY DESCRIPTIONS

Perceived Shaking	Not Felt	Weak	Light	Moderate	Strong	Very Strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC (%G)	< .17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL (CM/S)	< 0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

The Richter Scale is the most commonly used scale for measuring earthquake magnitudes and potential impacts. Because the public and policy makers are most familiar with the Richter Scale, this plan will use the Richter Scale coupled with PGA for the hazard risk assessment.

Studies indicate that there are roughly 100 potentially active fault lines in Colorado. Over 500 earthquake tremors of magnitude 2.5 or higher on the Richter Scale have been recorded across the state since 1870. It is likely that more earthquakes of similar magnitude occurred during that time, but were not recorded due to low population densities and limited coverage of sensors across most of the state. For comparison, over 20,500 similarly sized events have been recorded in the State of California since 1870.

Relative to other western states, Colorado's earthquake risk is higher than Kansas or Oklahoma, lower than Utah, and much lower than Nevada and California (Colorado OEM, 2003). Despite Colorado's lower earthquake risk, based on geologic observations and characteristics of faults located in the region, seismologists predict that Colorado will indeed experience a magnitude 6.5 earthquake at some point in the future.

Earthquakes are extremely difficult to predict and their occurrence rate is determined in one of two ways. If geologists can find evidence of distinct, datable earthquakes in the past, the number of these ruptures is used to define an occurrence rate. If evidence of ruptures is not available, geologists estimate fault slip rates from accumulated scarp heights and estimated date for the oldest movement on the scarp. Because a certain magnitude earthquake is likely to produce a displacement (slip) of a certain size, we can estimate the rate of occurrence of earthquakes of that magnitude.

Recurrence rates are different for different assumed magnitudes thought to be "characteristic" of that fault type. Generally, a smaller magnitude quake will produce a faster recurrence rate, and for moderate levels of ground motion, a higher hazard risk. Future earthquakes are assumed to be likely to occur where

earthquakes have produced faults in the geologically recent past. Quaternary faults are faults that have slipped in the last 1.8 million years and it is widely accepted that they are the most likely source of future large earthquakes. For this reason, quaternary faults are used to make fault sources for future earthquake models.

CLIMATE CHANGE IMPACTS TO EARTHQUAKE DAMAGE

Climate change is not expected at this time to have any impacts on the probability of geological hazards such as earthquakes. There is, however, potential for increased heat and reduced soil moisture that could contribute to the instability of regional soils. In theory, these subtle changes to the surface of the earth may affect the damage profile of local earthquake events in the future. However, it is unlikely that earthquake events within the planning area will be affected by climate change in a measurable way.

Previous Occurrences

Earthquakes are relatively infrequent in Colorado and records of historical earthquakes in and around Thornton, Northglenn and Federal Heights are limited. The following table provides a list of Colorado's larger earthquakes recorded since 1870.

TABLE 13. NOTABLE EARTHQUAKE EVENTS IN COLORADO (1870-2015)

Date	Location	Magnitude (Richter)	MMI Scale
1870	Pueblo/Ft. Reynolds	-	VI
1871	Lily Park, Moffat County	-	VI
1880	Aspen	-	VI
1882	North central Colorado	6.6*	VII
1891	Axial Basin (Maybell)	-	VI
1901	Buena Vista	-	VI
1913	Ridgeway Area	-	VI
1944	Montrose/Basalt	-	VI
1955	Lake City	-	VI
1960	Montrose/Ridgeway	5.5	V
1966	NE of Denver	5.0	V

Date	Location	Magnitude (Richter)	MMI Scale
1966	CO-NM border, near Dulce, NM	5.5	VII
1967	NE Denver	5.3	VII
1967	NE Denver	5.2	VI
2011	Southwest of Trinidad	5.3	VIII

*Estimated, based on historical felt reports
Source: Colorado Geological Survey

The most economically damaging earthquake in Colorado's history occurred on August 9th, 1967 in the Denver metro area. The 5.3 magnitude earthquake caused more than a million dollars of damage in Denver and the northern suburbs. The August 1967 earthquake was followed by an earthquake of magnitude 5.2 three months later in November 1967.

Although these two earthquake events cannot be classified as "major earthquakes" they are significant because of their location along the Front Range Urban Corridor, an area where nearly 75% of Colorado residents and many critical facilities are located. Historically, earthquake risk in Colorado has been rated lower than most subject matter experts consider justified and seismologists predict that Colorado will experience another 6.5 magnitude earthquake at some unknown point in the future. It is critically important that local emergency managers in Thornton, Federal Heights, and Northglenn become fully aware of the size and consequences of an earthquake that could occur.

Inventory Exposed

The most appropriate risk assessment methodology for seismic hazards involves scenario modeling using FEMA's Hazus loss estimation software. Hazus is a very useful planning tool because it provides an acceptable means of forecasting earthquake damage, loss of function of infrastructure, and casualties, among many other factors. There are two types of Hazus analyses, standard and enhanced. A standard Hazus analysis requires no specialized knowledge on the part of the user and leverages the default inventory, hazard, and engineering (damage function) data present in the program. This is also known as an "out of the box" or Level 1 analysis. An enhanced analysis requires the user to have localized knowledge and data in order to provide updated inventory, hazard and/or engineering (damage function) data that overwrites the default data present in the program. Historically, this has been known as a Level 2 (inventory or hazard updates) or Level 3 (engineering updates) Hazus analysis.

The earthquake analysis we conducted using the latest version of Hazus, 3.1. An Enhanced Hazus analysis was performed on the effects of earthquakes on all structures within the planning area. The risk assessment leveraged locally available parcel and assessor's data to complete a parcel centroid based analysis by incorporating these centroids as User Defined Structures (UDS points).

The Hazus earthquake scenario modeled a 6.5 event along the Golden Fault, located approximately 15 miles southwest of the planning area. This scenario was used because it represents the "worst case scenario" (i.e. - a large earthquake event along the closest quaternary fault to the planning area). Statewide soil type and landslide layers were incorporated into the model in order to further refine the results of the analysis.

Potential Losses

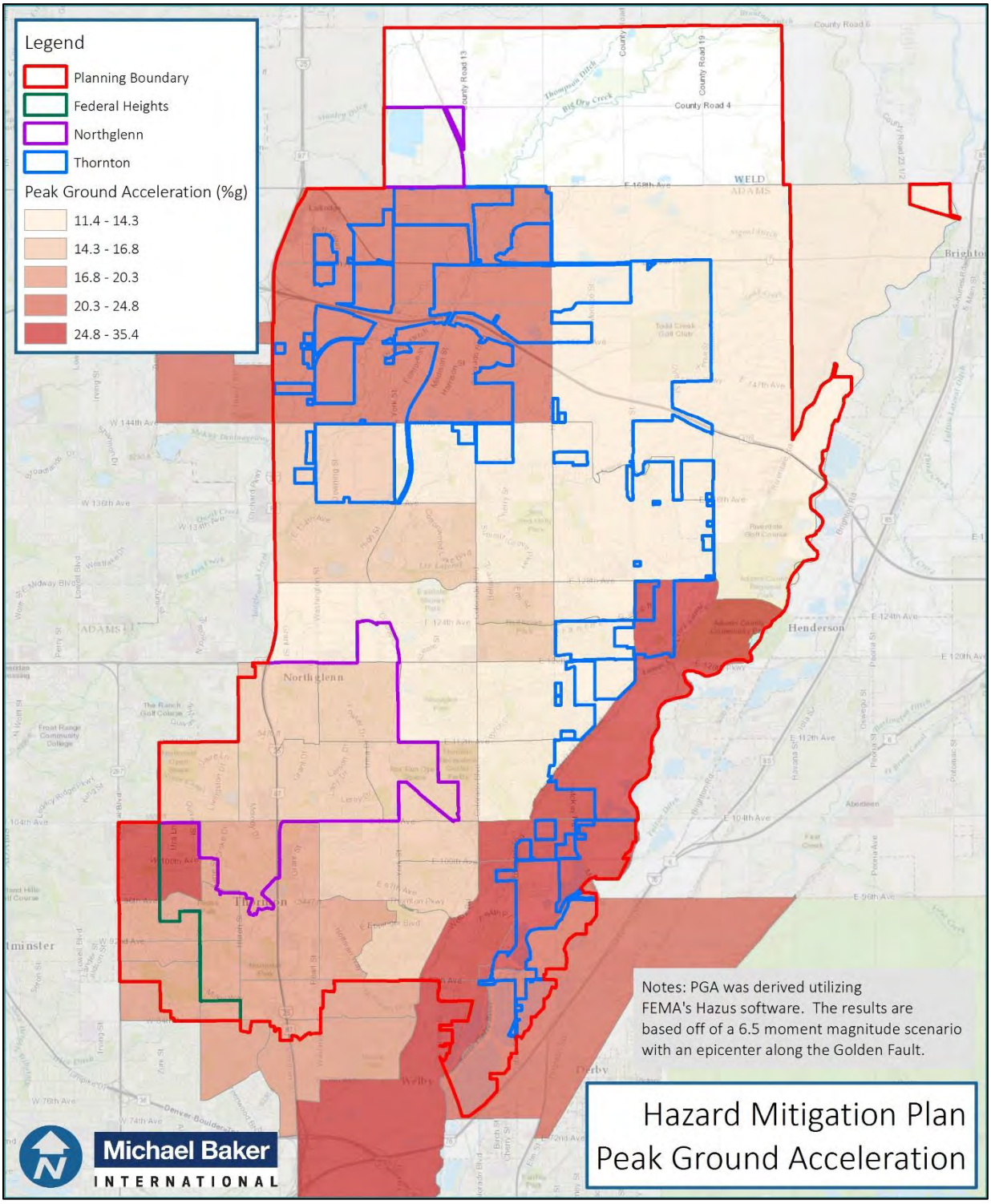
In Colorado, earthquakes are considered low probability, high-consequence events. Although earthquakes may occur infrequently they can have devastating impacts. Ground shaking can lead to the collapse of buildings and bridges, disrupt gas, electric, and phone service. Deaths, injuries, and extensive property damage are possible vulnerabilities from this hazard. Some secondary hazards caused by earthquakes may include fire, hazardous material release, landslides, flash flooding, avalanches, tsunamis, and dam failure. Moderate and even very large earthquakes are inevitable, although very infrequent, in areas of normally low seismic activity. Consequently, buildings in these regions are seldom designed to resist earthquakes; they are extremely vulnerable.

Most property damage and earthquake-related injuries and deaths are caused by the failure and collapse of structures due to ground shaking. The level of damage depends upon the amplitude and duration of the shaking, which are directly related to the earthquake size, distance from the fault, site, and regional geology. Other damaging earthquake effects include landslides, the down-slope movement of soil and rock (mountain regions and along hillsides), and liquefaction, in which ground soil loses shear strength and the ability to support foundation loads. In the case of liquefaction, anything relying on the substrata for support can shift, tilt, rupture, or collapse.

For the risk assessment conducted as part of the 2017 Plan, a 6.5-magnitude earthquake scenario with an epicenter on the Golden Fault was simulated in Hazus. Again, this scenario's event parameters and locations were chosen based on pre-existing scenarios outlined by the Colorado Geological Survey. The Front Range is defined by a 500- to 1,000-m-high, east-facing escarpment called the Golden Fault that is both a tectonic and erosional feature. The Golden Fault is a quaternary fault that bounds the eastern side of the Front Range near the town of Golden, adjacent to the Denver Metropolitan Area. The Golden Fault was selected as an epicenter because it is the closest proximity quaternary fault to the planning area.

In the following map, Peak Ground Acceleration (PGA) for the Golden Fault scenario is represented as %g. The Golden Fault model shows relatively medium-high PGA in the northwestern and south eastern parts of the planning area as the energy released from the Golden fault radiates away from the epicenter.

FIGURE 20. PEAK GROUND ACCELERATION PER CENSUS TRACT

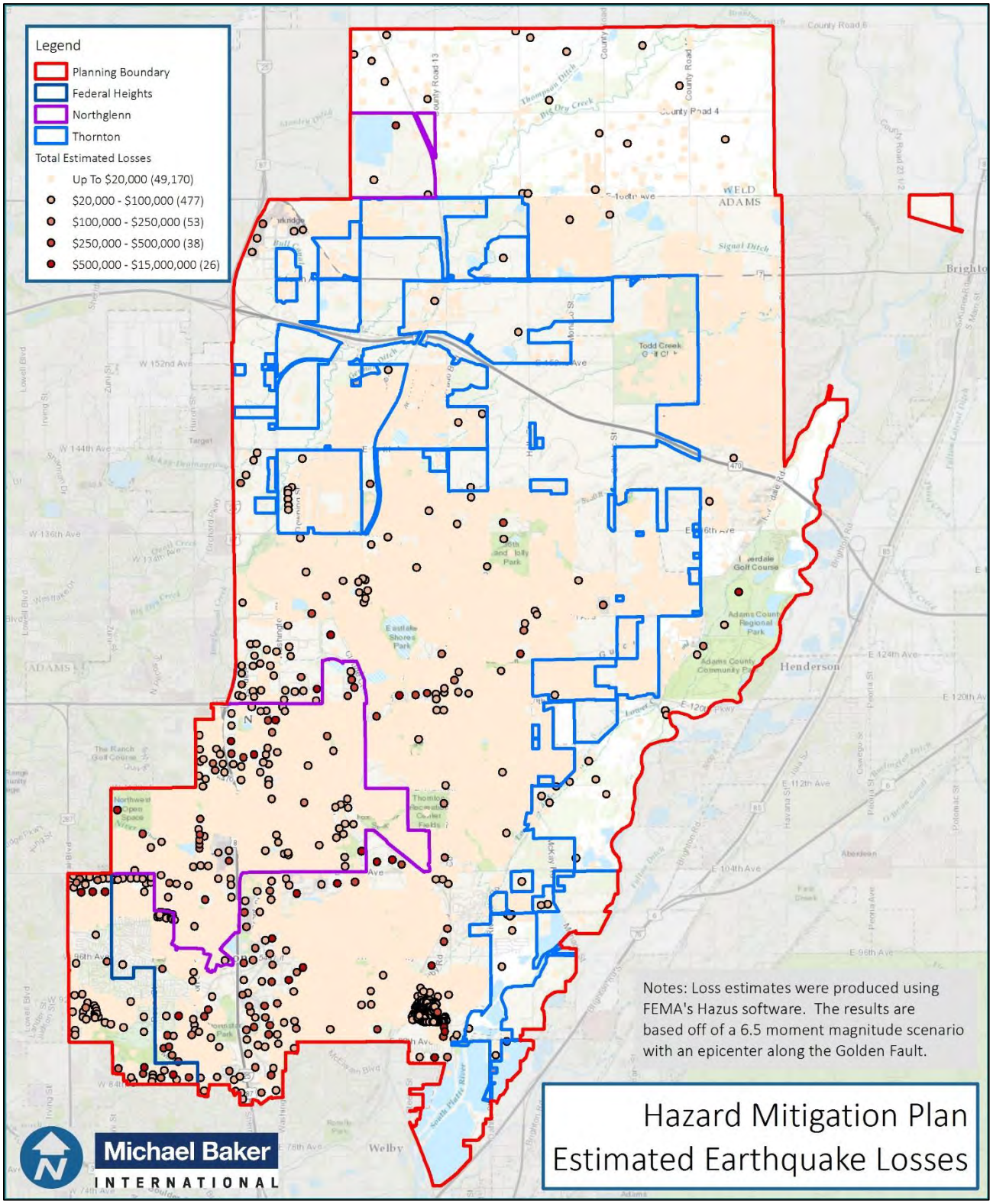


City of Thornton Northglenn Federal Heights

Estimated Losses and Building Damage

The following figure provides a map of total estimated economic losses in the planning area projected by the Golden Fault earthquake scenario. Total economic losses include losses from structural damage, relocation, and business interruption. For the Golden Fault earthquake scenario, the total losses were estimated to impact close to fifty-thousand structures with total modeled losses of over $250 million. Note that this analysis does not take into account any infrastructure damages that would be expected to be caused by this earthquake scenario.

FIGURE 21. EARTHQUAKE SCENARIO ESTIMATED LOSSES

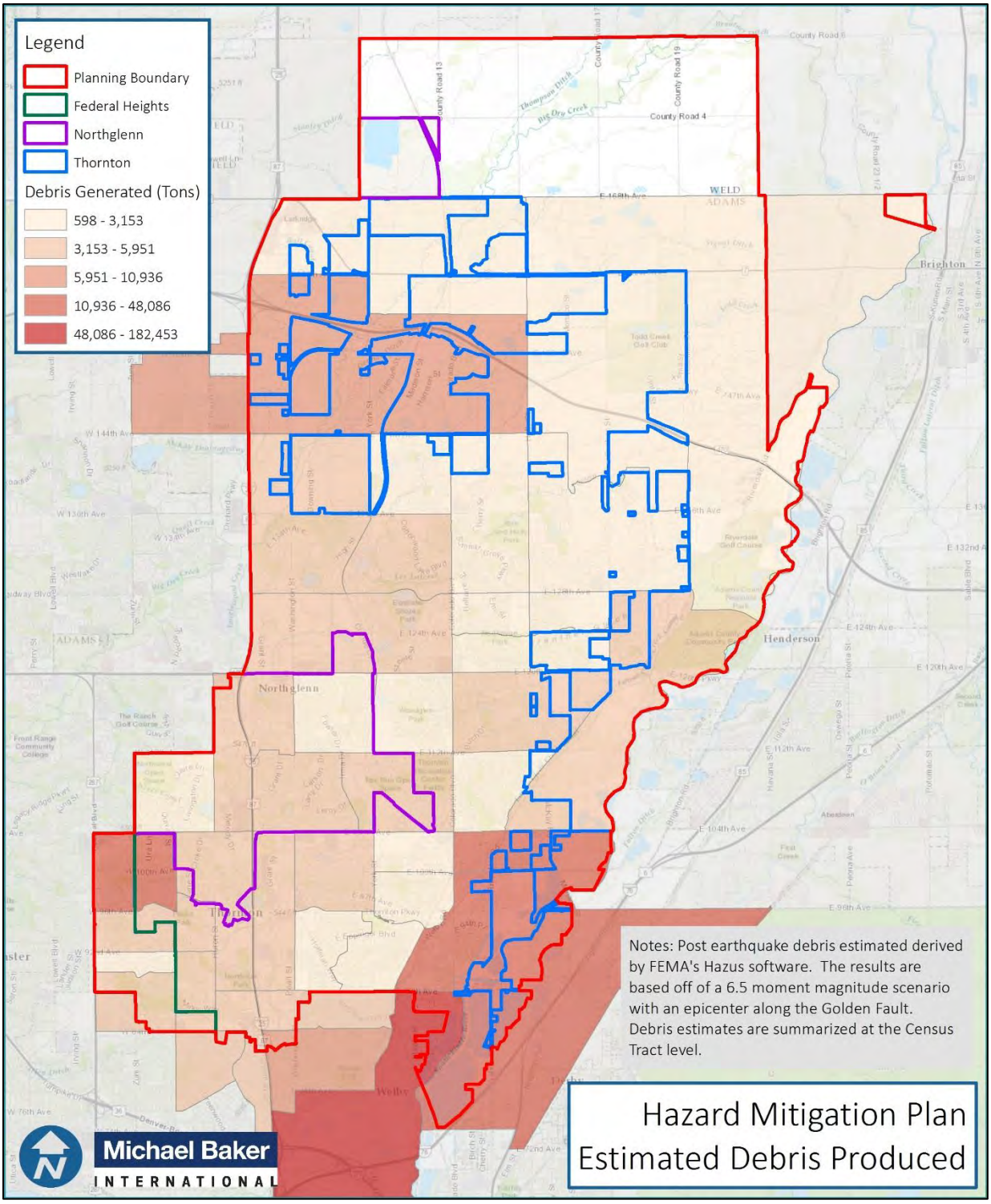


City of Thornton Northglenn Federal Heights

Debris Generation

Hazus models are able to estimate the amount of debris that will be generated by an earthquake of a specific magnitude. The Golden Fault earthquake scenario estimates that a total of 493 thousand tons of debris will be generated within the planning area from that 6.5 magnitude event. The figure below demonstrates where the debris (in tons) is generated within the planning area and to what extent that debris is produced at a census track level. The highest areas of debris are projected to be located in the south, south eastern, and northwestern portions of the planning area.

FIGURE 22. ESTIMATED DEBRIS PRODUCED PER CENSUS TRACT

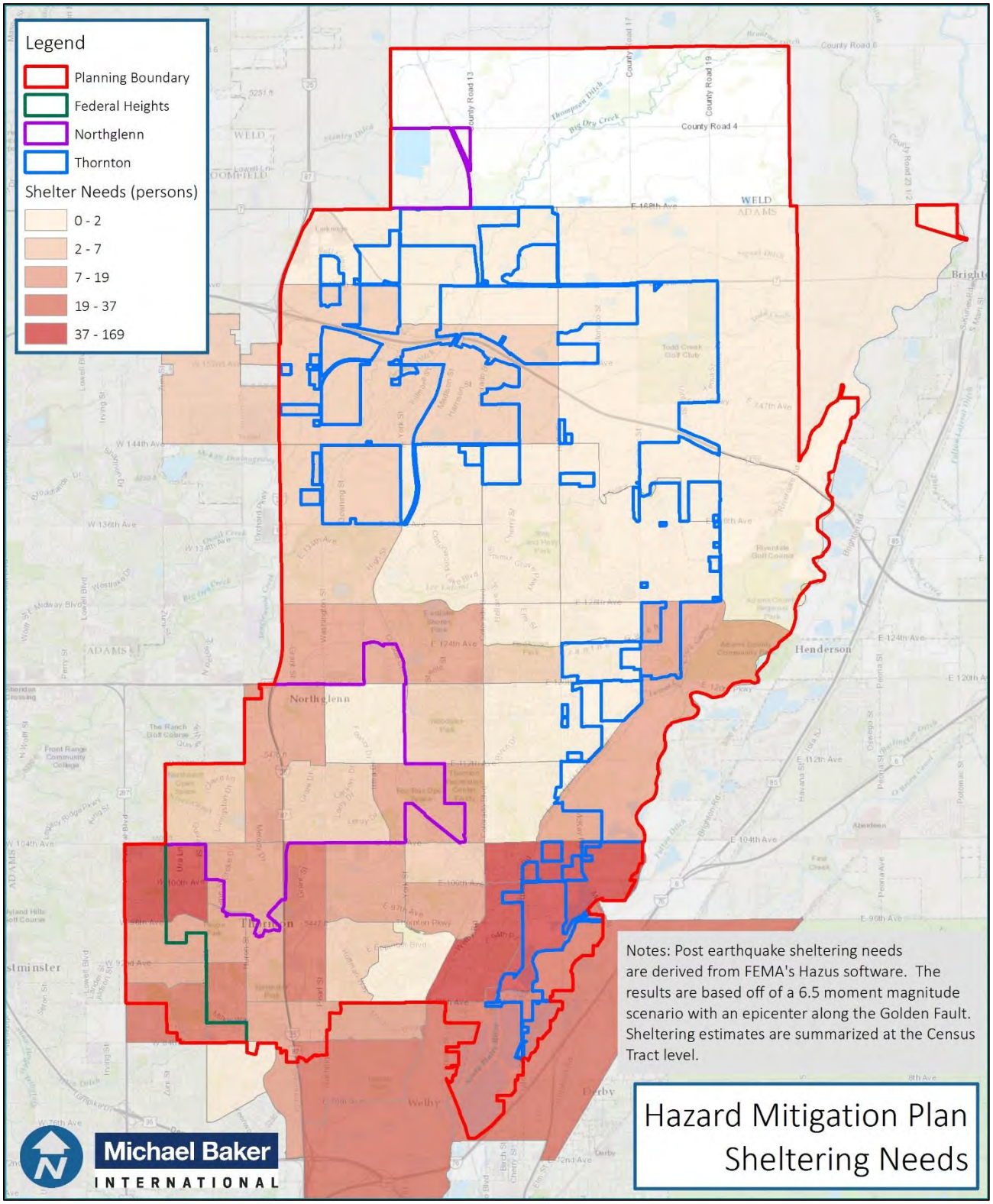


City of Thornton Northglenn Federal Heights

Shelter Requirements

In addition to providing loss estimation and debris models, Hazus estimates the number of households that are expected to be displaced from their homes due to an earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates that 1,131 households will be displaced in the planning area due to this earthquake scenario and 824 people will seek temporary shelter in public shelters. The following map shows shelter requirements at the Census Tract level for the Golden Fault earthquake scenario. Debris generation and shelter requirements appear to be positively correlated.

FIGURE 23. ESTIMATED SHELTERING NEEDS PER CENSUS TRACT



City of Thornton Northglenn Federal Heights

Probability of Future Occurrences

Even though the seismic hazard risk in the planning area is low to moderate, it is likely that earthquakes will occur in the planning area in the future. It is reasonable to expect future earthquakes as large as magnitude 6.5, the largest event on record in Colorado. Calculations based on the historical earthquake records and geological evidence of recent fault activity suggest that an earthquake of magnitude 6 or greater may be expected somewhere in Colorado every several centuries.

Earthquakes strike with little to no warning and they are capable of having multiple impacts on an area. After-effects from an earthquake can include impacted roadways, downed power and communication lines, fires, and damages to structures (especially poorly built, or those already in disrepair). Earthquakes are not a seasonal hazard, and thus can be experienced year round. This fact presents its own set of planning and preparedness concerns.

Ultimately, the probability of an earthquake occurring in the planning area is low. Additionally, if an earthquake were to occur in the near future it is likely to be of a low magnitude, with expected damages to property and people to be minimal. History has shown, however, that the planning area and Colorado are at risk to a larger magnitude seismic event. Should that type of event occur, major damages and losses should be expected. This fact makes these low probability, high impact hazards a challenge to deal with when planning a mitigation strategy to combat all hazards faced by a community.

Standard building codes have the opportunity to provide the planning area with reasonable guidance for development throughout unincorporated and incorporated areas. Contractors and builders should be aware of applicable codes and regulations designed to reduce losses sustained by new and existing construction due to seismic hazards.

For example, the light weight of wood frame buildings results in less force from inertia. Less force means less damage. Wood's natural flexibility also is an advantage when seismic forces are brought to bear and the nailed joints in wood frame buildings dissipate energy and motion. Wood's inherent earthquake resistance must be accompanied by design and construction techniques that take advantage of those characteristics.

Structural wood panels nailed to wall framing add rigid bracing, help resist lateral loads and help tie framing members together. Bolted connections at the sill plate/foundation joint help keep the structure in one spot. Securely connected wall, floor, and roof framing also help tie a structure together and make it a single, solid structural unit. Proper connections will do more to hold a house together during an earthquake than any other single seismic design element.

As development grows in the planning area, it will be important for citizens to consult with local building codes as modern building codes generally require seismic design elements for new construction.

Land Use and Development

With the unpredictable nature of earthquake epicenter locations, it is not feasible to identify specific areas where development may exacerbate the risk to an earthquake. It should be assumed that all development increases the risk to the planning area from the threat of earthquakes. As population and development continue to expand in the planning area, continued enforcement of the unified construction code has great potential to mitigate increasing vulnerability and development pressure.

Earthquakes are relatively uncommon in the planning area and the probability is low that they will occur regularly in the future. However, if an event was to occur within the planning area, there is potential for significant structural damage to occur near the epicenter. Due to the nature of earthquake hazards, neighborhoods within the planning area with high population densities and large numbers of structures and critical facilities are expected to experience greater damage and loss from an earthquake event.

3.4 Expansive Soils / Undermined Areas

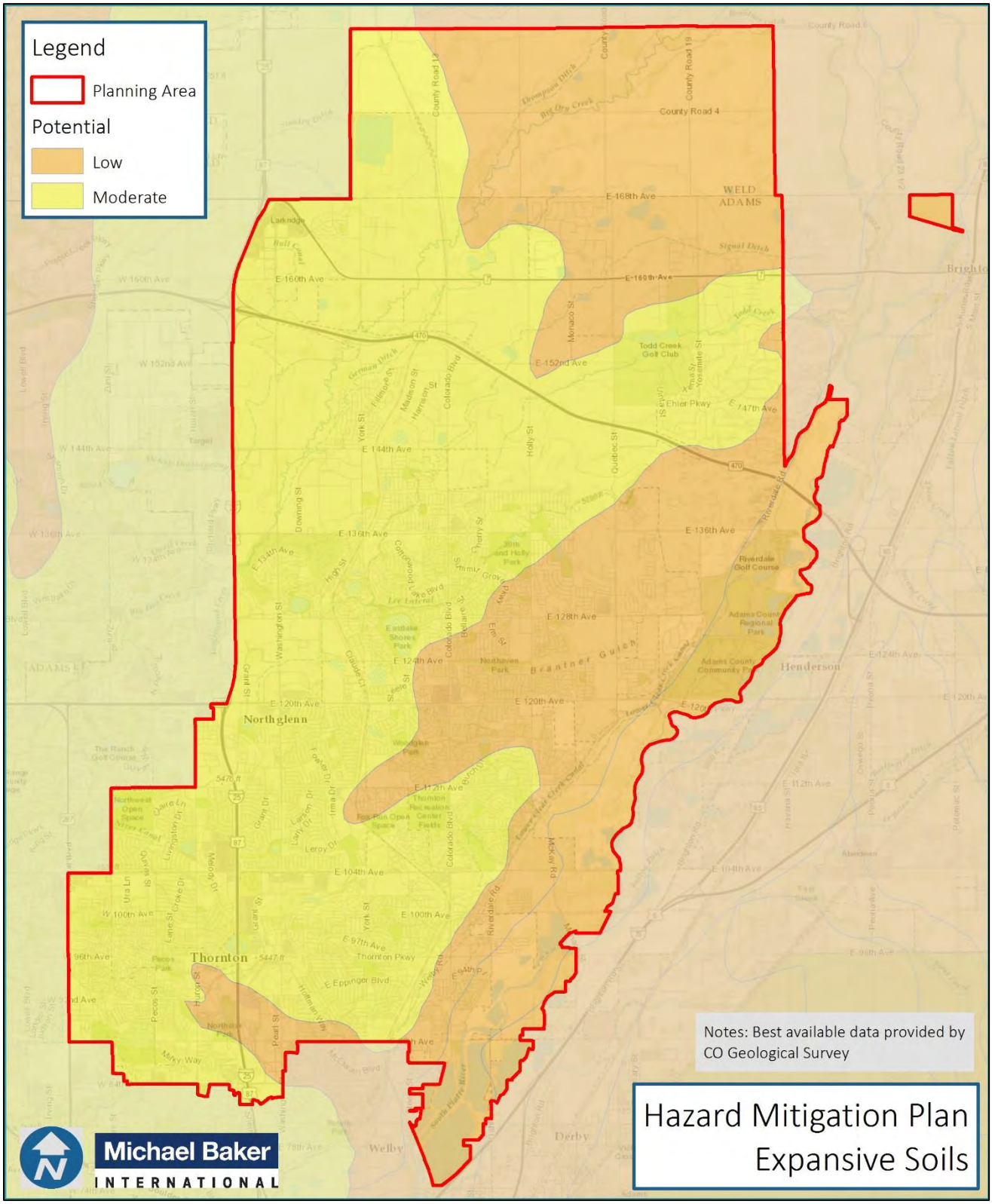
Hazard Identification

Expansive Soils

Damage caused by expansive soils/undermined areas may not occur within minutes, but can pose serious risks to infrastructure and public safety over time. Expansive soils describes soils that are capable of absorbing water and as the soil absorbs the water it can sometimes expand up to 10% in volume, creating pressure on existing infrastructure. As the soil begins to dry, shrinking can occur and deplete the soil's structural support. These changes in soil volume can cause significant damage to infrastructure foundations and have the potential to disrupt supply lines (i.e. roads, power lines, railways, and bridges). Damage due to expansive soils can be more than damage from floods, hurricanes, tornadoes, and earthquakes combined. Nationwide, annual losses due to expansive soils are estimated in the range of $2 billion.

The following map shows areas of expansive soil (and potential hazards) within the planning area provided by the Colorado Geological Survey (CGS). Based on CGS' best available data, there are no areas identified with Thornton, Federal Heights, or Northglenn that are at high risk of expansive soils-related hazards.

FIGURE 24. PLANNING AREA EXPANSIVE SOILS MAP



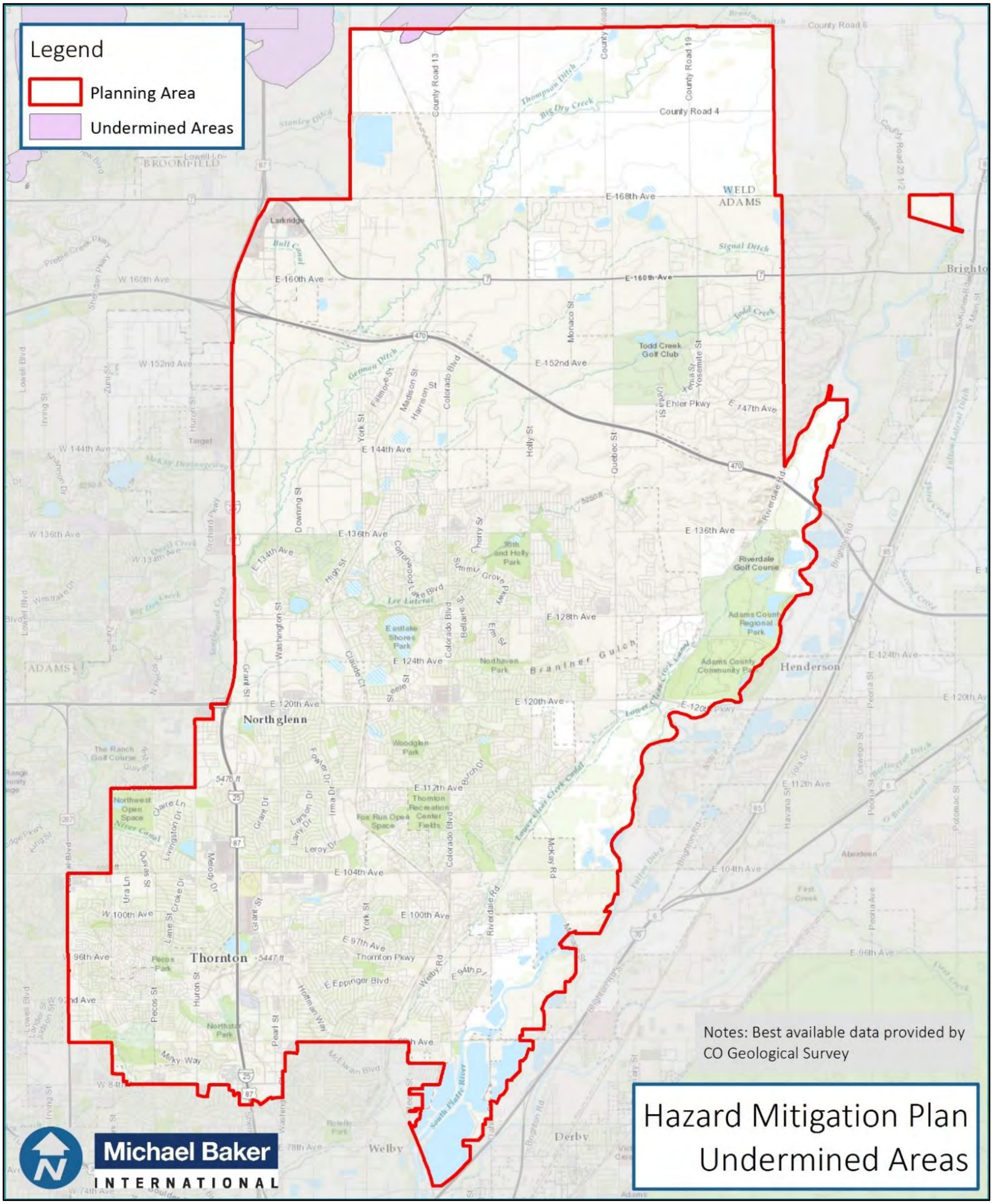
Undermined Areas and Erosion

Undermined areas subject to land subsidence or soil erosion have the potential to threaten health, safety, and local economies and can interrupt critical services. Land subsidence is defined as the gradual settling or sudden sinking of the Earth's surface. A subsidence event can occur rapidly due to a sinkhole or the collapse of an underground mine. It can also occur during a major earthquake.

Soil erosion and deposition involve the removal and transportation of earth materials occurring when soil is removed at a greater rate than it is formed. The natural geologic process of erosion has occurred since the Earth's formation and continues at a very slow and uniform rate. As with expansive soils, observing damage for subsidence or soil erosion in real-time can be difficult. It takes place slowly, becoming more evident over the time span of many years. The impacts of a soil erosion event depend on the inherent properties of the soil, topography, vegetative cover, soil disturbance and rainfall intensity but can also affect human and animal health and create public safety hazards.

The following map identifies the location of historically undermined area within the Thornton, Federal Heights, and Northglenn planning area. The data was provided by the Colorado Geological Survey (CGS) and illustrates that there is only one small area of at-risk soil located in the planning area (in the northwest portion of the map).

FIGURE 25. PLANNING AREA UNDERMINED AREAS MAP



Previous Occurrences

According to the Colorado Geological Survey (CGS), approximately 50% of Colorado's soil has a very high potential for shrinking and swelling. Expansive soil information was gathered for the Thornton, Federal Heights, and Northglenn planning boundary using best available CGS data. The level of risk within the planning area is determined to be low to moderate, with higher risk levels associated with the eastern half of the planning boundary and portions stretching near Heritage Todd Creek Golf Club. The remaining areas are classified as low risk and do not pose as severe a threat. However, as development and population are expected to increase within the planning area, more structures and people may become exposed to expansive soils and risks in the future.

Reliable, city-specific historical records of land subsidence or soil erosion events are sparse. Using the CGS GIS datasets, undermined area data was extracted for the cities of Thornton, Federal Heights, and Northglenn. Again, the risk here is low but as growth occurs in the north region of Thornton, the undermined area hazard risk level may increase.

Based on the community interviews, the perceptions of the cities of Thornton, Northglenn, and Federal Heights related to expansive soils/undermined area hazards is not of high concern. Thornton has described their risk as 'medium' and Federal Heights and Northglenn determined their risk to be 'low'. One area near the south side of the city (88th Street and Welby Commuter Station) has been determined to be of higher risk. This area contains bentonite soils, which has been affected due to recent flooding. Northglenn identified that soil within the community is considered 'sandy loam'. Although public concern is not high, hazard mitigation efforts should still be considered for expansive soils/undermined areas.

Inventory Exposed

A structure may be at risk to the impacts of soil expansion if it is located over or close to an undermined area. An important first step in determining exposure at a specific location is to determine if the area is undermined or near an area where underground mining took place. Data shows that there is one small undermined area near the northwestern portion in the Thornton future growth area boundary. Because the undermined area is so small, it does not pose a high hazard risk for the community. However, land use is a very important variable when it comes to exposure. As population growth brings new development into available land in the region, more inventory assets may become exposed to soil expansion, instability, and erosion-related hazards.

Potential Losses

Damages to property due to erosion and deposition are usually classified as cosmetic, functional, or structural. Cosmetic damages refer to slight problems where only the physical appearance of a structure is affected (e.g. cracking in plaster or drywall). Functional damages refers to situations where the use of a structure has been impacted due to subsidence. Structural damages include situations where entire foundations require replacement due to subsidence-caused cracking of supporting walls and footings.

Buildings and infrastructure across Thornton, Federal Heights, and Northglenn may be vulnerable to the impacts of soil expansion, instability, and erosion-related hazards. The effects of changing soils due to various hazard events (flooding, earthquake, etc.) are not known at this time, but are expected to increase the community's hazard level.

The risk analysis indicates that Thornton, Federal Heights, and Northglenn have low to moderate exposure to soil expansion/undermined area hazards. There are no structures at risk and no area within the study is considered to have high potential for expansive soils. This is due to the very small portion of undermined area and the low to moderate risk level of soil expansion is based on CGS information. Hazards related to expansive soil and undermined areas are typically localized events and the maps in this section show geographical areas that would be most vulnerable in the case of this hazard event.

Probability of Future Occurrences

Due to the uncertainty with existing data, it is challenging to accurately calculate probability for future events related to soil expansion/undermined area hazards. It can be assured, however, that these hazards will continue to alter the landscape of Thornton, Federal Heights, and Northglenn going forward.

In areas where climate change results in decreased precipitation in the summer months and reduced surface-water supplies, communities are often forced to pump more ground water to meet their needs. In Colorado, the major aquifers are composed primarily of compressed clay and silt, soil types that are prone to compact when ground-water is pumped. Based on analysis of CGS data and the existing moderate hazard ranking, it is probable that the eastern portions of the planning area will experience more frequent soil hazards over time as a result of local climate change. It is important that these communities consider future mitigation actions that will address this hazard, particularly in rapidly growing areas. Changing climate norms are expected to affect soil resources in many ways. During hot, dry years annual grasses that stabilize and protect topsoil often fail to germinate or do not grow well. This leaves soil surfaces highly vulnerable to erosion from wind and precipitation.

Land Use and Development

Rapid and sustained population growth across Colorado and the Front Range has contributed to increasing trends in geologic hazard risk, exposure, and vulnerability. As development and populations continue to grow, especially in the north Thornton region, more structures and residents will be exposed to soil expansion and the existing undermined area.

While soil expansion and undermined areas have been categorized as low to moderate risk hazards in Thornton, Federal Heights, and Northglenn, there has been property and infrastructure damage associated with these hazards within Colorado. In the semi-arid climate of Colorado, increases in seasonal precipitation, coupled with periods of prolonged drought, may accelerate processes of soil erosion and increase the potential for undermined areas.

Typically, the process of erosion does not limit land use, especially if efforts are made to minimize it. Erosion impacts can be reduced and controlled by surface drainage management, re-vegetation or disturbed lands, controlling stream-carried eroded materials in sediment catchment basins, and riprapping of erosion-prone stream banks (especially adjacent to structures). Ground modification and structural solutions can help mitigate the threats of localize erosion and deposition. Proper drainage and water management are also important to prevent increasing vulnerability to erosion and deposition hazards.

3.5 Extreme Temperatures

Hazard Identification

Cold temperatures are considered hazardous when they drop well below what is considered normal for an area during the winter months. Combined with increases in wind speed, such temperatures can be life threatening to those who are exposed for extended periods of time.

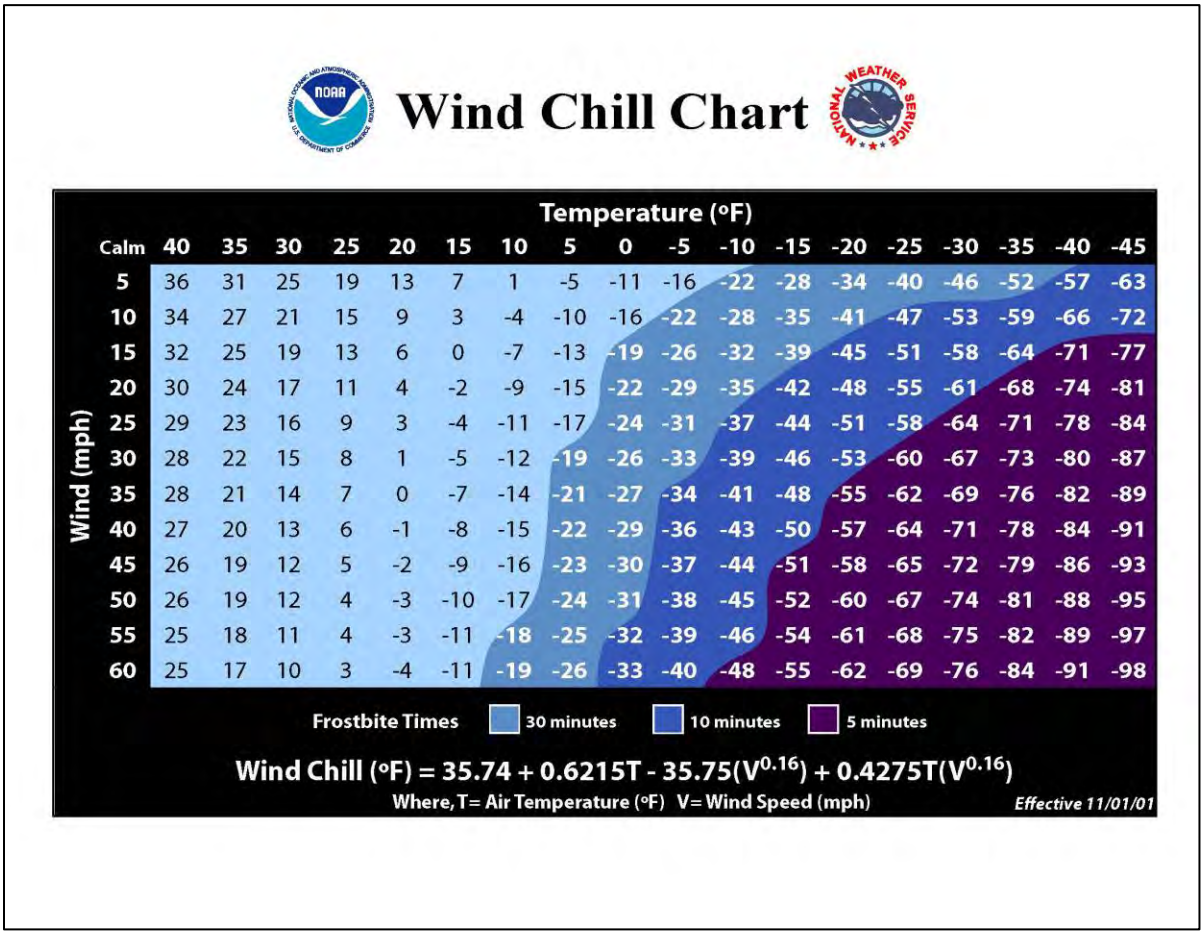
Extreme heat can be described as temperatures that hover 10°F or more above the average high temperature for a region at least for several weeks, most often occurring during the summer season. A heat wave is a period of excessive heat, which can lead to illness and other stress to vulnerable people and those who experience prolonged exposure to the heat. High humidity, which rarely accompanies heat waves in the tri-city planning area, can make the effects of heat even more harmful. While heat-related illness and death can occur from exposure to intense heat in just one afternoon, heat stress on the body has a cumulative effect. Consequently, the persistence of a heat wave increases the threat to public health.

Hazard Profile: Extreme Cold

Extended periods of extreme cold, although infrequent, can occur throughout the winter months within the planning area. When cold temperatures and wind combine, dangerous wind chills can develop. Wind chill is how cold it "feels" and is based on the rate of heat loss on exposed skin from wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature, and eventually, internal body temperature. This makes the environment feel much colder than the actual temperature.

As depicted in the following figure, the National Weather Service's Wind Chill Chart shows the difference between actual air temperature and perceived temperature, as well as the amount of time until frostbite occurs.

FIGURE 26. NOAA WIND CHILL CHART



The elderly, young children, the homeless, outdoor laborers, the infirm, and members of low-income communities are the most likely to suffer the negative effects of extreme cold. When conditions are appropriate, the National Weather Service issues wind chill warnings to provide advanced notification for preparedness and response purposes. The table below describes the criteria for these warnings.

TABLE 14. NATIONAL WEATHER SERVICE WIND CHILL WARNINGS

Warning	Description
Wind Chill Watch	Issued by the NWS when there is a chance that wind chill temperatures will decrease to at least 24°F below zero during the next 24 to 48 hours.
Wind Chill Advisory	Issued when the wind chill could be life threatening if action is not taken. The criteria for this advisory are expected wind chill readings from 15°F to 24°F below zero.
Wind Chill Warning	Issued when wind chill readings are life threatening. Wind chill readings of 25°F below zero or lower are expected.

Source: NWS

Hazard Profile: Extreme Heat

Extreme heat events are a considerable public health concern and are one of the leading weather-related killers in the United States. Although extreme heat events can occur in May or September, they are most common between June and August when above average temperatures are sustained for a prolonged period. During extended periods of very high temperatures, or high temperatures coupled with high humidity, individuals can suffer a variety of health problems, including heatstroke, heat exhaustion, and heat cramps. Rising temperatures and increased sunlight can also cause more occurrences of freshwater algae blooms. Algae blooms occurs when there is a rapid increase in algae, and can be harmful when humans or animals make contact with the affected water.

NOAA's National Centers for Environmental Information (NCEI – formerly known as National Climatic Data Center [NCDC]) documents the occurrence of storms and other significant weather phenomena having sufficient intensity to cause loss of life, injuries, significant property damage, and/or disruption to commerce. NCEI receives this information from The National Weather service, who obtains their information from a variety of sources, which include but are not limited to: county, state and federal emergency management officials, local law enforcement officials, skywarn spotters, NWS damage surveys, newspaper clipping services, the insurance industry and the general public, among others. This database represents the best available data source for a number of hazards profiled in this plan including tornados, hail, lightning, severe storms, and extreme temperature events.

NOAA's Heat Index measures the severity of hot weather by estimating how hot it feels to humans. By combining air temperature and relative humidity, the Heat Index is directly related to skin temperature. The ambient temperature is quantified by examining the relation between relative humidity versus skin temperature. If the relative humidity is higher (or lower) than the base value, the apparent temperature is higher (or lower) than the ambient temperature. The following table outlines the common heat disorders associated with apparent temperature values during extreme heat events.

TABLE 15. HEAT INDEX AND ASSOCIATED HEAT DISORDERS

Danger Category	Heat Disorders	Apparent Temperature (°F)
I Caution	Fatigue possible with prolonged exposure and physical activity	80-90
II Extreme Caution	Sunstroke, heat cramps, and heat exhaustion possible with prolonged exposure and physical activity	90-105
III Danger	Sunstroke, heat cramps, and heat exhaustion likely; heatstroke possible with prolonged exposure and physical activity	105-130
IV Extreme Danger	Heatstroke or sunstroke imminent	>130

Source: NOAA

Like extreme cold events, young children, the elderly, outdoor laborers, low-income families, the homeless, and the infirm are the most likely to suffer the negative effects of extreme heat. The National Weather Service initiates alerts based on the Heat Index as shown in the table below.

TABLE 16. EXTREME HEAT WARNINGS

Intensity	Detailed Description
Heat Advisory	Typically between 105°F to 110°F (41°C to 43°C) for 3 hours or more during the day and at or above 75°F (24°C) at night.
Excessive Heat Warning	Typically above 105°F (41°C) for 3 hours or more during the day and at or above 80°F (27°C) at night.

Source: National Weather Service

Previous Occurrences

The State of Colorado experiences cold events fairly frequently, although extended periods of sub-zero temperatures are rare. NOAA's NCEI storm database includes winter weather and cold/wind chill hazards, both of which represent periods of prolonged cold temperatures. The database defines "significant" extreme cold/wind chill events as periods of extremely low temperatures or wind chill temperatures reaching or exceeding locally/regionally defined warning criteria on a widespread or localized basis.

The following table lists the significant extreme cold and wind chill events reported to the NCEI for the planning area.

TABLE 17. EXTREME COLD EVENTS WITHIN THE PLANNING AREA (1950-2015)

Date	Event Type	Area	Injuries	Deaths	Property Damage	Crop Damage
December 16, 1996	Cold/Wind Chill	South Weld County	0	0	0	0
December 17, 1996	Cold/Wind Chill	South Weld County	0	0	0	0
December 18, 1996	Cold/Wind Chill	West Adams County	0	1	0	0
December 18, 1998	Cold/Wind Chill	West Adams County	15	3	0	0
February 1, 2001	Extreme Cold	West Adams County	0	0	0	0
		TOTAL:	**15**	**4**	**$0**	**0**

Source: NOAA, NCEI Storm Events Database

The first extreme cold/winter weather event reported in Adams and Weld Counties and listed in the NCEI database occurred in 1996. The NCEI database indicates that since then there have been 15 injuries and four deaths reported from extreme cold/winter weather events in Adams and Weld Counties. There are most likely additional extreme cold/winter weather events prior to 1996 that have not been captured by the database.

Understanding the historical frequency of extreme cold temperatures in Adams and Weld Counties assists in determining the likelihood of future occurrences within the planning area. The characteristics of past extreme cold and significant winter weather events provide a benchmark for projecting similar conditions into the future. The probability that Thornton, Federal Heights, and/or Northglenn will experience extreme cold temperatures in the future can be difficult to quantify, but based on historical record, it can reasonably be assumed that this type of event could occur each year.

Inventory Exposed

Unlike other natural hazards that affect the planning area, extreme temperatures have limited physical destructive force. However, damages to inventory assets exposed to extreme cold is dependent on the age of the building, type, construction material used, and condition of the structure. Heavy snow loads on roofs, particularly large span roofs, can cause roofs to leak or even collapse depending on their

construction. Extremely cold temperatures may cause pipes to freeze and subsequently burst, causing water damage. During the winter months, freezing temperatures and repeated freeze-thaw events can cause potholes, which may damage vehicles. Hazardous travel conditions may result if potholes are not tended to promptly. Frozen pipes, a common occurrence during extreme cold events, can cause service interruptions in water supply, gas supply, and drainage.

Most likely the greatest issue for critical facilities during significant extreme cold events is the inaccessibility of such facilities due to poor roadways, utility outages, or dangerous wind chills. During periods of heavy snow, ice, or blizzards, roads can quickly become impassable, stranding motorists and isolating communities. Long term road closures during an extended cold period may diminish and threaten propane and fuel supplies. Possible losses to critical infrastructure include:

- Electric power disruption
- Communication disruption
- Water and fuel shortages
- Road closures
- Damaged infrastructure components, such as sewer lift stations and treatment plants

Extended power outages during extreme cold events may make many homes and offices unbearably cold. Additionally, during extended winter-time power outages, people often make the mistake of bringing portable generators inside or not venting them properly, leading to carbon monoxide poisoning. With poor road conditions, sheltering residents may present significant logistical challenges with getting people to heated facilities, feeding, and providing medical care. These situations, accompanied by stranded motorists that need to be rescued, represent significant threats to the population of the planning area. Additional information on construction type and building codes enforced at time of construction would allow a more thorough assessment of the vulnerability of structures to extreme cold impacts.

Extreme heat can cause pavement of roads and bridges, or railroad tracks, to crack or buckle, resulting in service disruptions and potentially hazardous travel conditions. The most significant impact of extreme heat on general building stock and critical facilities within the planning area is the increased demand on air conditioning equipment. Surges in air conditioning demand can sometimes strain electrical systems and energy resources. Public utility infrastructure (including electrical generating and conveyance systems) may become damaged and break down causing localized and/or widespread power outages.

All assets located in the planning area can be considered for exposure to extreme temperatures. This includes 100% of the planning areas population and all buildings and critical infrastructure located within the planning area. Most structures, including the planning areas critical facilities, should be able to provide adequate protection in the event of an extreme temperature event. Facilities with back-up generators are better equipped to handle severe weather situations should the power go out. Additionally, public buildings with cooling systems are ideal shelters for at-risk individuals and families during heat waves.

Potential Losses

Although estimated property losses associated with extreme temperature hazards are anticipated to be minimal across the planning area, extreme heat and cold events do present a significant life and safety threat to the population of the planning area. Heat casualties are usually caused by lack of adequate air

conditioning and/or heat exhaustion. Extreme heat tends to affect the elderly, infirm, homeless, or low-income families the most, as these populations frequently live on low fixed incomes and cannot afford to run air conditioning on a regular basis. These socially vulnerable populations are often isolated, with no immediate family and/or limited mobility, which makes it more difficult for them to remove themselves from danger.

Casualties caused by extreme cold events can result from a lack of adequate heating, carbon monoxide poisoning from unsafe or unventilated heating systems, and frostbite from exposure to the elements. Again, the most vulnerable populations to extreme cold are the elderly, infirm, homeless, and low-income families. Often, these individuals do not have access to a heat source or are unable to afford to operate one on a regular basis.

Because there is no defined geographic boundary for extreme temperature hazards, all of the people and infrastructure within the planning area are exposed to extreme temperatures. Those with elevated risk and potential loss are the homeless, infirm, elderly, and low income families. Given the lack of historical data and limited likelihood of structural losses in the planning area resulting from extreme heat or cold, and that placing a dollar amount on the cost of a human life are beyond the scope of the Plan, annualized economic losses for the planning area due to extreme temperatures are currently considered unquantifiable.

However, due to the regional nature of extreme temperature hazards, jurisdictions with higher numbers of socially vulnerable residents are expected to experience magnified impacts of extreme temperatures. This includes places with high numbers of elderly residents, low income families, and homeless individuals/outdoor laborers.

The table below shows data related to population vulnerable to extreme temperatures by local jurisdiction. Based on Census information and knowledge of social vulnerability to hazards, jurisdictions with high numbers of elderly residents, a high poverty rate and/or large numbers of rental properties can plan accordingly to provide appropriate services and mitigation assistance during extreme temperature events.

TABLE 18. POPULATIONS VULNERABLE TO EXTREME TEMPERATURES

Jurisdiction	Age: 65 and Over (%)	Persons Below Poverty Level (%)	Renter-occupied housing units (%)
Colorado	10.9	12.9	34.5
City of Thornton	6.5	9.2	29.7
City of Federal Heights	11.1	18.7	48.0
City of Northglenn	11.3	13.6	41.5

Source: DOLA; Census 2010

The City of Thornton has a slightly lower percentage of elderly residents than does the state of Colorado. The City of Federal Heights has a slightly higher percentage of people over the age of 65, and the City of Northglenn has the highest percentage in the planning area. The percentage of people living below poverty level in the City of Thornton is lower than the state of Colorado. The City of Federal Heights has the highest percentage of people living below poverty level within the planning area. Northglenn also has a higher poverty level than the state. The City of Thornton percent of renter occupied homes is slightly lower than the State. The City of Federal Heights has the highest percent of the three cities and the City of Northglenn has a higher percent of renter occupied homes.

Based on these statistics, residents of Federal Heights (comparatively) appear to be more acutely vulnerable to the impacts of extreme temperatures compared to other communities within the planning area. That said, future mitigation efforts related to extreme temperature should focus on reaching those residents who are elderly, live in poverty or are homeless, or are renters.

Probability of Future Occurrences

Based on data provided by the NWS and NCEI, it is likely that the planning area will continue to experience hazardous extreme heat events in the future, and for more prolonged periods of time.

During extreme temperature events, inadequate protection from the elements is especially hazardous. A combination of more frequent heat waves and changing demographics (e.g. an increase in the elderly population) is likely to result in higher rates of temperature-related deaths in the planning area. In order to mitigate the impacts of extreme temperature hazards it is important that the planning area prioritize outreach and services to specific populations who are most vulnerable. High-vulnerability groups typically experience a disproportionate number of health impacts from extreme heat and cold, often due to physical, social, and economic limitations to adequate participation in mitigation and response activity. In the context of extreme temperature events, the most vulnerable the planning area residents are:

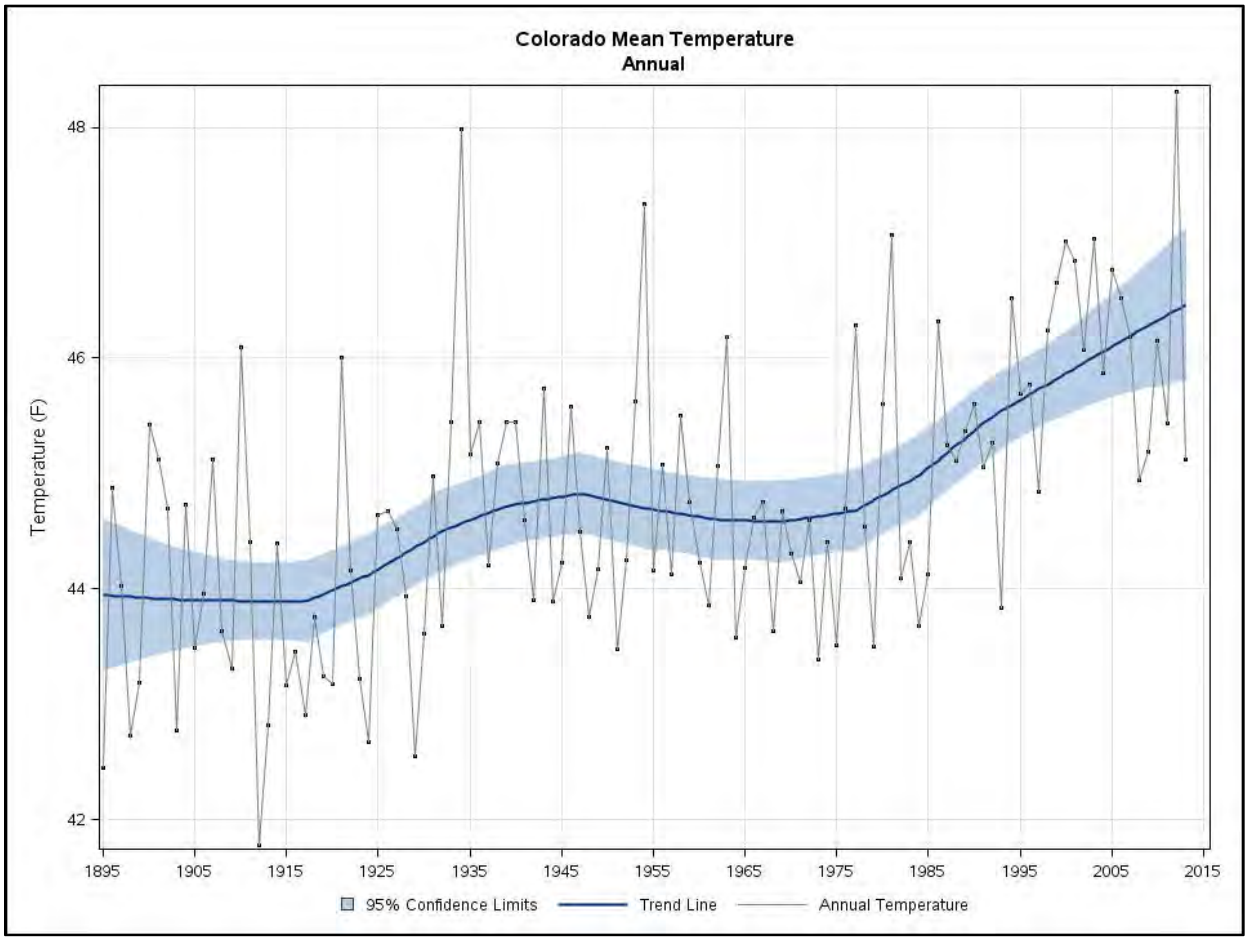
- The elderly (people over 65 years of age)
- Infants (under 1 year old)
- The homeless
- Low income families
- Socially isolated individuals
- People with mobility restrictions and/or mental impairments
- The infirm
- Outdoor laborers

Although stopping extreme temperature events is impossible, limiting their effect on people and property in the planning area is feasible. Ongoing mitigation activities should focus on protecting lives and preventing injuries during periods of extreme heat and cold. This includes, but is not limited to pre-season community outreach campaigns to educate the public about risks and available support, establishing cooling and heating centers, reaching out to vulnerable populations and care givers, and issuing advisories and warnings.

Extreme Heat and Climate Change

Data supports a shift towards a warmer climate with an increase in extreme high temperatures across the state of Colorado. The graph below depicts annual statewide mean temperature history for the state from 1895 to 2015. The probability of continued (and more frequent) extreme heat events across Colorado is supported by the clear upward trend in high temperatures since 1895.

FIGURE 27. MEAN COLORADO TEMPERATURE TRENDS (1895-2015)



Source: NOAA

Land Use and Development

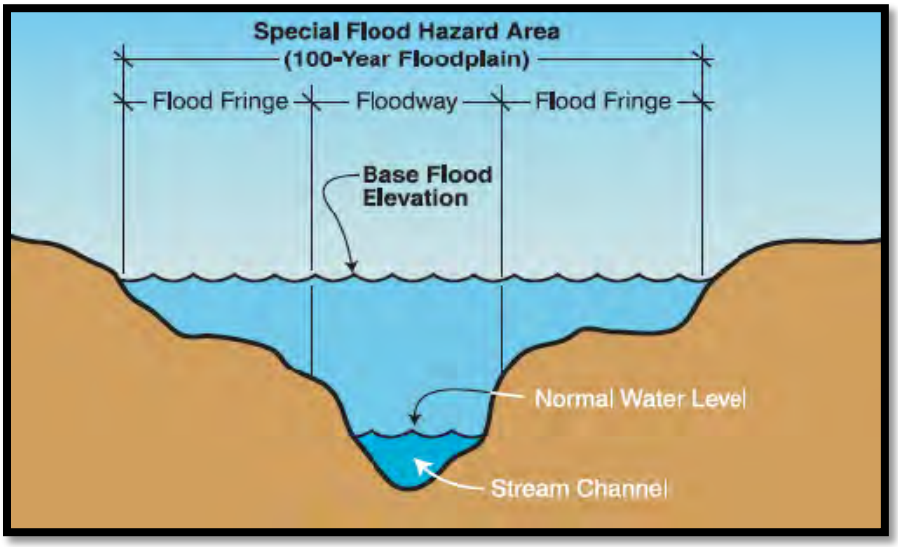
All future structures built in the planning area will likely be exposed to severe seasonal temperature extremes. As with other large extent hazards, increased development trends in and around the planning area will increase the vulnerability of growing areas to extreme heat and cold. The planning area and its jurisdictions must continue to adhere to building codes to facilitate new development that is built to current standards to account for future climate extremes. Additionally, as homes go up in more rural parts of the planning area, accessing those rural residents will present new emergency management and response challenges should sheltering or emergency services be needed in an extreme event.

3.6 Flood

Hazard Identification

A flood is a naturally occurring event for rivers and streams and occurs when a normally dry area is inundated with water. Excess water from snowmelt or rainfall accumulates and overflows onto the stream banks and adjacent floodplains. As illustrated in the figure below, floodplains are lowlands, adjacent to rivers, streams, and creeks that are subject to recurring floods. Flash floods, usually resulting from heavy rains or rapid snowmelt, can occur throughout the planning area. Additionally, extreme cold temperatures can cause streams and rivers to freeze, causing ice jams and creating flood conditions.

FIGURE 28. FLOODPLAIN TERMINOLOGY



Floods are considered hazards when people and property are affected. Nationwide, hundreds of floods occur each year, making it one of the most common hazards in all 50 states and U.S. territories. Most injuries and deaths from flooding happen when people are swept away by flood currents and most property damage results from inundation by sediment-filled water. Fast-moving water can wash buildings off of their foundations and sweep vehicles downstream. Pipelines, bridges, and other infrastructure can be damaged when high water combines with flood debris. Basement flooding can also cause extensive damage. Flooding can cause extensive damage to crop lands and bring about the loss of livestock. Several factors determine the severity of floods including rainfall intensity and duration, topography, and ground cover.

Riverine flooding originates from a body of water, typically a river, creek, or stream, as water levels rise onto normally dry land. Water from snowmelt, rainfall, freezing streams, ice flows, or a combination thereof, causes the river or stream to overflow its banks into adjacent floodplains. Winter flooding usually occurs when ice in the rivers creates dams or streams freeze from the bottom up during extreme cold spells. Spring flooding is usually the direct result of melting winter snow packs, heavy spring rains, or a combination of the two.

Flash floods can occur anywhere when a large volume of water flows or melts over a short time period, usually from slow moving storms or rapid snowmelt. Because of the localized nature of flash floods, clear definitions of hazard areas do not exist. These types of floods often occur rapidly with significant impacts. Rapidly moving water, only a few inches deep, can lift people off their feet, and only a depth of a foot or two, is needed to sweep cars away. Most flood deaths result from flash floods.

Previous flash flooding events have occurred within the planning area. Although data does not currently exist to perform robust assessments of flash flood risk within the tri-city area, local jurisdictions have expressed a desire and a need for data and information specifically related to flash flooding so that appropriate mitigation strategies can be identified and implemented.

Urban flooding is the result of development and the ground's decreased ability to absorb excess water without adequate drainage systems in place. Typically, this type of flooding occurs when land uses change from fields or woodlands to roads and parking lots. Urbanization can increase runoff two to six times more than natural terrain. The flooding of developed areas may occur when the amount of water generated from rainfall and runoff exceeds a storm water system's capability to remove it.

Stream Bank Erosion is measured as the rate of the change in the position or horizontal displacement of a stream bank over a period of time. It is generally associated with riverine flooding and discharge, and may be exacerbated by human activities such as bank hardening and dredging.

Ice Jams are stationary accumulations of ice that restrict flow through a waterway. Ice jams can cause considerable increases in upstream water levels, while at the same time, downstream water levels may drop. Types of ice jams include freeze up jams, breakup jams, or combinations of both. When an ice jam releases, the effects downstream can be similar to that of a flash flood or dam failure. Ice jam flooding generally occurs in the late winter or spring.

Dam Break Flooding

The 2010 Denver Metro NHMP has identified seven Class I and II dams in the planning area. Six of these dams have existing Emergency Preparedness Plans (EPP) in place. These plans provide details about each dam and include mapping of potential inundation areas should the structure fail. The following table lists Class I and II dams that directly affect the communities within the Thornton, Federal Heights, and Northglenn planning area.

TABLE 19. CLASS I AND II DAMS IN THE PLANNING AREA

Dam Name	Jurisdiction Affected	River/Stream Associated	Main Purpose of Dam	EPP Prepared	EPP Approved
Badding	Northglenn	South Platte River	Water Supply	Y	2/26/1993
Croke Lake	Thornton	Tributary of South Platte	Water Supply	Y	2/26/1993
East Lake #2	Thornton	Brantner Gulch	Flood control & stormwater management	Y	1/22/1998
Kalcevic	Thornton	Clear Creek	Water Supply	N	

Dam Name	Jurisdiction Affected	River/Stream Associated	Main Purpose of Dam	EPP Prepared	EPP Approved
Niver Creek Detention	Thornton	South Platte River	Flood control & stormwater management	Y	1/22/1998
Webster Lake East	Northglenn	Big Dry Creek	Irrigation/recreation/fish & wildlife	Y	6/16/1997

Source: 2010 Denver Metro NHMP, Division of Water Resources

Several flooding sources that flow through Thornton, Northglenn, and Federal Heights have numerous dams upstream of the planning area that could potentially cause hazardous impacts. For example Cherry Creek Reservoir Dam along Cherry Creek, Standley Lake along Clear Creek, and Chatfield Reservoir Dam along the South Platte River.

Flood Magnitude and Probability

Flooding events are typically measured in terms of magnitude and the statistical probability that they will occur. The 1% annual chance flood event is the standard national measurement for flood mitigation and insurance. A 1% annual chance flood, also known as the '100-year flood', has a 1 in 100 chance of being equaled or exceeded in any one year and has an average recurrence interval of 100 years. It is important to note that this recurrence interval is an average; it does not necessarily mean that a flood of such a magnitude will happen exactly every 100 years. Sometimes, only a few years may pass between one 1% annual chance flood and another while two other 1% annual chance floods may be separated by 150 years. The 0.2% annual chance flood event, or the '500-year flood', is another measurement which represents a 0.2% chance (or 1 in 500 chance) of occurring in a given year.

According to the NFIP's Community Information System (CIS) the cities of Thornton, Federal Heights, and Northglenn have been mapped for flood hazards and participate in the National Flood Insurance Program (NFIP). Details of local jurisdiction participation status are shown in the table below.

TABLE 20. COMMUNITIES PARTICIPATING IN THE FEMA NFIP

CID	COMMUNITY NAME	COUNTY	INITIAL FIRM IDENTIFIED	CURRENT EFFECTIVE MAP DATE
080007	City of Thornton	Adams	06/15/1978	01/20/2016
080240	City of Federal Heights	Adams	04/15/1986	03/05/2007
080257	City of Northglenn	Adams	09/15/1978	01/20/2016

*Participation status current as of February 9, 2016

The City of Thornton has a total of 84 NFIP policies. The City of Federal Heights has a total of seven NFIP policies. The City of Northglenn has a total of 39 NFIP policies. In addition to participating in the NFIP, the City of Thornton participates in the Community Rating System (CRS) program. CRS is a voluntary program for NFIP participating communities. The goals of the CRS are to reduce flood damages to insurable property, to strengthen and support the insurance aspects of the NFIP, and to encourage a comprehensive approach to floodplain management.

The CRS was developed to provide incentives in the form of insurance premium discounts to communities that go above and beyond the minimum floodplain management requirements and develop extra measures to reduce flood risk. There are 10 CRS classes and the classification determines the insurance premium discount for policy holders. The discounts range from 5% to a maximum of 45%.

TABLE 21. CRS PREMIUM DISCOUNTS

Class	Discount	Class	Discount
1	45%	6	20%
2	40%	7	15%
3	35%	8	10%
4	30%	9	5%
5	25%	10	--
SFHA (Zones A, AE, A1-A30, V, V1-V30, AO, and AH): Discount varies depending on class. SHFA (Zones A99, AR/A, AR/AE. AR/A1-A30, AR/AH, and AR/AO): 10% discount for Classes 1-6; 5% discount for Classes 7-9.* Non-SFHA (Zones B, C, X, D): 10% discount for Classes 1-6; 5% discount for Classes 7-9. *In determining CRS premium discount, all AR and A99 Zones are treated as non-SFHAs.			

All CRS participating communities start out with a Class 10 rating (which provides no premium discount). Class 1 requires the most credit points and offers the largest premium discount. Within the CRS program, there are 18 activities recognized as measures for eliminating local exposure to flooding. Credit points are assigned to each activity, which have been organized under four main categories:

- Public Information
- Mapping and Regulation
- Flood Damage Reduction
- Flood Preparedness

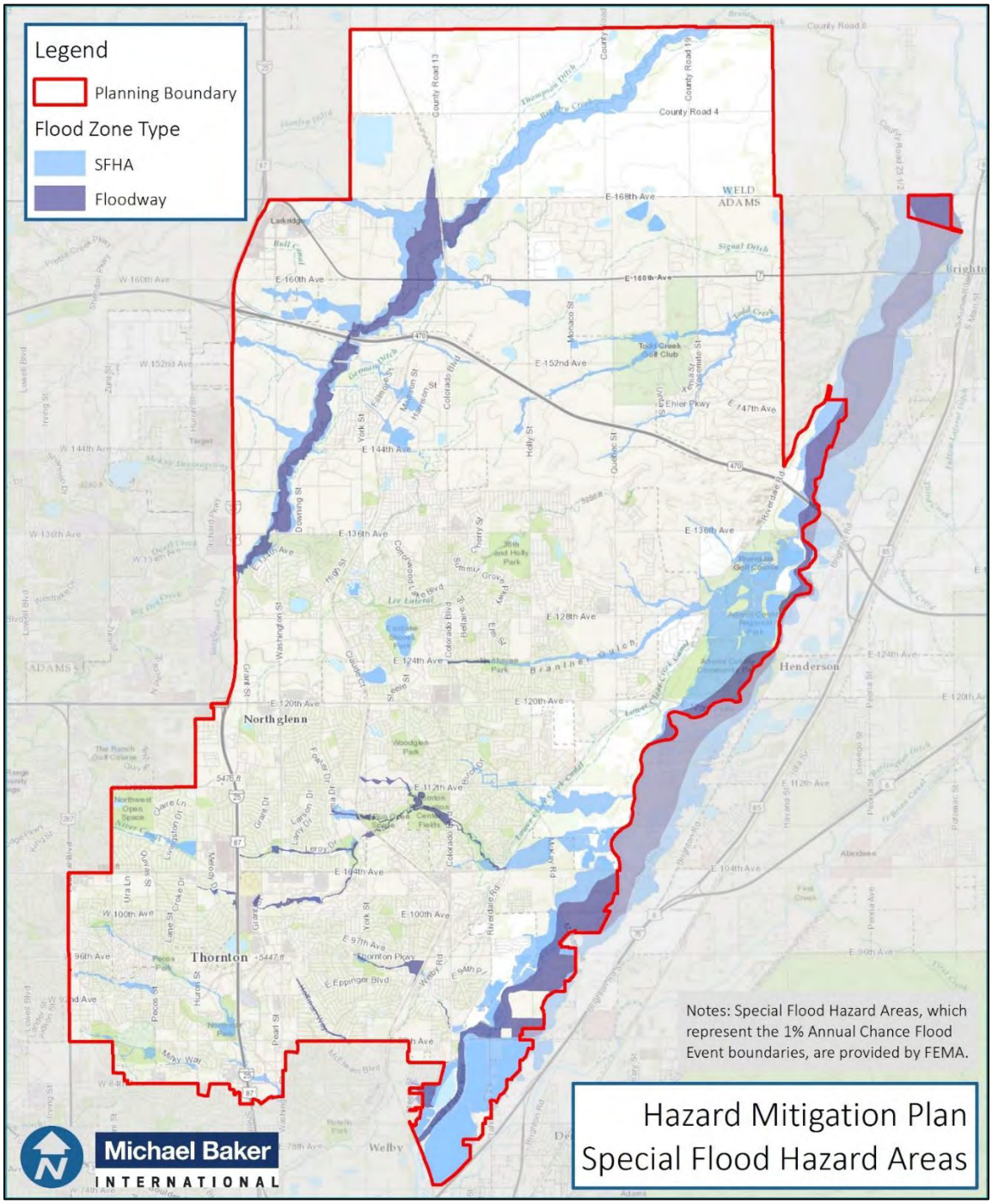
The City of Thornton entered CRS in October of 1994. Currently, the City of Thornton is a Class 6 CRS community. The Cities of Federal Heights and Northglenn do not currently participate in CRS.

Previous Occurrences

Seasonally, the cities of Thornton, Federal Heights, and Northglenn are confronted with the possibility of flooding and flood-related hazards. Floods have the potential to inflict tremendous damage with significant losses of life and property. They can also pose a threat to the health, safety, and welfare of citizens. Previous flooding events have caused the region extensive damage in a matter of just a few hours or days. Current development and population growth trends necessitate a heightened awareness that the impact of flooding may likely increase over time. The map below depicts the current Special Flood Hazard

Areas (SFHA) for the cities of Thornton, Federal Heights, and Northglenn. The SFHA areas span roads, infrastructure, property, and jurisdictions across the county.

Figure 29. Special Flood Hazard Areas (2017 Planning Area)



Documentation of flooding in Colorado collected by the National Centers for Environmental Information (NCEI) goes back to 1950.

The table below provides a history of major flood events that affected the cities of Thornton, Federal Heights, and Northglenn between 1950 and 2015.

TABLE 22. CITIES OF THORNTON, FEDERAL HEIGHTS, AND NORTHGLENN HISTORICAL FLOOD EVENTS (1950-2015)

Date	Location	Hazard Type	Injuries	Deaths	Property Damage	Crop Damage
6/3/1997	SOUTHERN WELD COUNTY	Flood	0	0	0	0
6/6/1997	ADAMS CO.	Flash Flood	0	0	0	0
5/1/1999	SOUTHERN WELD COUNTY	Flood	0	0	0	0
5/4/1999	SOUTHERN WELD COUNTY	Flood	0	0	0	0
8/4/1999	ADAMS CO.	Flash Flood	0	0	$500,000	0
7/16/2000	ADAMS CO.	Flood	0	0	0	0
8/17/2000	ADAMS CO.	Flash Flood	0	1	0	0
8/17/2000	WELD CO.	Flash Flood	0	0	0	0
7/23/2004	ADAMS CO.	Flash Flood	0	0	0	0
9/12/2013	ADAMS CO.	Flash Flood	0	0	0	0
		TOTAL:	0	1	$500,000	0

Source: NOAA (NCEI Storm Events Database)

Although damages within the planning area were minimal, the most significant flooding event to collectively impact the State of Colorado occurred during September 2013. During the week beginning on September 9th, a slow moving cold front circulated over the state, clashing with warm, humid monsoonal air from the south. This event sparked renewed commitment to resiliency planning and mitigation along the Front Range and across the state.

FIGURE 30. DAMAGES FROM 2013 FLOOD EVENT

On June 11, 2015, the Denver metro area saw a heavy amount of rainfall, and several streets were flooded, leaving parked cars damaged or inoperable. Parts of the area saw almost three inches of rain and flash flood warnings were directed throughout the day.

Repetitive Loss properties (RL) are structures covered by a contract for flood

insurance made available under the National Flood Insurance Program (NFIP) that: (a) have incurred flood-related damage on two occasions, in which the cost of repair, on the average, equaled or exceeded 25% of the market value of the structure at the time of each flood event; and (b) at the time of the second incidence of flood-related damage, the contract for flood insurance contains increased cost of compliance coverage. As of September 2016, there were no repetitive loss properties (RL) within the cities of Federal Heights and Northglenn. There is a single RL property in Thornton.[4]

A Severe Repetitive Loss property (SRL) is defined as a residential property that is covered under an NFIP flood insurance policy and: a) has at least four NFIP claim payments (including building and contents) over $5,000 each, and the cumulative amount of such claims payments exceeds $20,000; or, b) a property for which at least two separate claim payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building. For both a) and b) above, at least two of the referenced claims must have occurred within any ten-year period, and must be greater than ten days apart. As of September 2016, there were no severe repetitive loss (SRL) structures located within the cities of Thornton, Federal Heights, and Northglenn.[5]

City-specific flood loss estimates and risk assessment maps are provided in the Community Profiles, Appendices A, B, and C, of this report.

Flooding and Climate Change

In addition to increasing drought potential, climate change has the potential to intensify rain events and storms in the Colorado region. These events can lead to increased infrastructure damage, injury, illness, and death. Additionally, warmer temperatures in the winters may cause increased precipitation to fall as rain instead of snow in mountain regions of Colorado. This may lead to elevated stream flows and increased flood risk across the state. As climate science and data evolves it will be important for communities to address how our changing climate will affect how water moves through local streams and regional landscapes.

Inventory Exposed

Flood was identified as a high hazard for all three cities within the planning area. Additional information on inventory exposed can be found in the community profiles sections of this report (Appendices A, B, and C).

Potential Losses

Hazus is a regional multi-hazard loss estimation model developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Buildings Sciences (NIBS). The Hazus flood delineations developed for this Plan were generated using the fully-automated tools within the software, which use generalized regional regression equations to estimate flows and normal depth calculations to estimate flood depths.

The type of property damage caused by flood events depends on the depths and velocity of the floodwaters. Faster moving floodwaters can wash buildings off their foundations and sweep cars

[4] Source: Colorado DHSEM (FEMA FMA-RL-SRL-GSTF Document)
[5] Source: Colorado DHSEM (FEMA FMA-RL-SRL-GSTF Document)

downstream. Pipelines, bridges, and other infrastructure can be damaged when high waters combine with flood debris. Extensive damage can be caused by basement flooding and landslide damage related to soil saturation from flood events. Seepage into basements is common during flood events. Most flood damage is caused by water saturating materials susceptible to loss (e.g., wood, insulation, wallboard, fabric, furnishings, floor coverings, and appliances). Homes in flooded areas can also suffer damage to septic systems and drain fields. In many cases, flood damage to homes renders them uninhabitable.

Flood events impact businesses by damaging property and by interrupting business. Flood events can cut off customer access to a business as well as close a business for repairs or permanently. A quick response to the needs of businesses affected by flood events can help a community maintain economic vitality in the face of flood damage. Responses to business damages can include funding to assist owners in elevating or relocating flood-prone business structures.

FIGURE 31. DAMAGES FROM 2013 FLOOD EVENT

During flooding events, homes, businesses, and people face the threat of explosions and fires caused by leaking gas lines along with the possibility of being electrocuted. Domestic and wild animals forced out of their homes and brought into contact with humans by floodwaters can also pose a threat. In rural areas, property damage caused by flooding can be devastating to ranchers and farmers. When flooding occurs during the growing season, farmers can suffer widespread crop loss. Stock growers may lose livestock if they are unable to find safety from rising floodwaters. Flooding may also cause damage to pasture land, fences, barns, and out buildings.

Public buildings are of particular importance during flood events because they house critical assets for government response and recovery activities. Damage to public water and sewer systems, transportation networks, flood control facilities, emergency facilities, and offices can hinder the ability of the government to deliver services. Loss of power and communications can be expected. Drinking water and wastewater treatment facilities may be temporarily out of operation.

Mitigation against flood events is accomplished through sensible floodplain management and regulations as well as identifying flood prone areas, tributary watersheds that experience instability or sediment loading problems, and channel instability hazards. This involves strategies to modify flooding and to modify infrastructure to decrease the likelihood of damage. To modify the impact of flooding, measures must be taken to decrease susceptibility to flood damage and disruptions. Natural and cultural resources must also be protected and managed. Coordination with mitigation plans by Floodplain Managers will

increase effectiveness of flood mitigation projects. City and County Planners will be valuable resources to incorporate flood mitigation plans into their respective plans.

Flood was identified as a high hazard for all three cities within the planning area. Additional information on potential losses can be found in the community profiles sections of this report (Appendices A, B, and C).

Probability of Future Occurrences

Flash flooding has the potential to occur throughout the planning area, including the mapped Special Flood Hazard Area (SFHA). Flood was identified as a high hazard for all three cities within the planning area. Additional information on the probability of future occurrences can be found in the community profiles sections of this report (Appendices A, B, and C).

Land Use and Development

Flood was identified as a high hazard for all three cities within the planning area. Additional information on land use and development can be found in the community profiles sections of this report (Appendices A, B, and C).

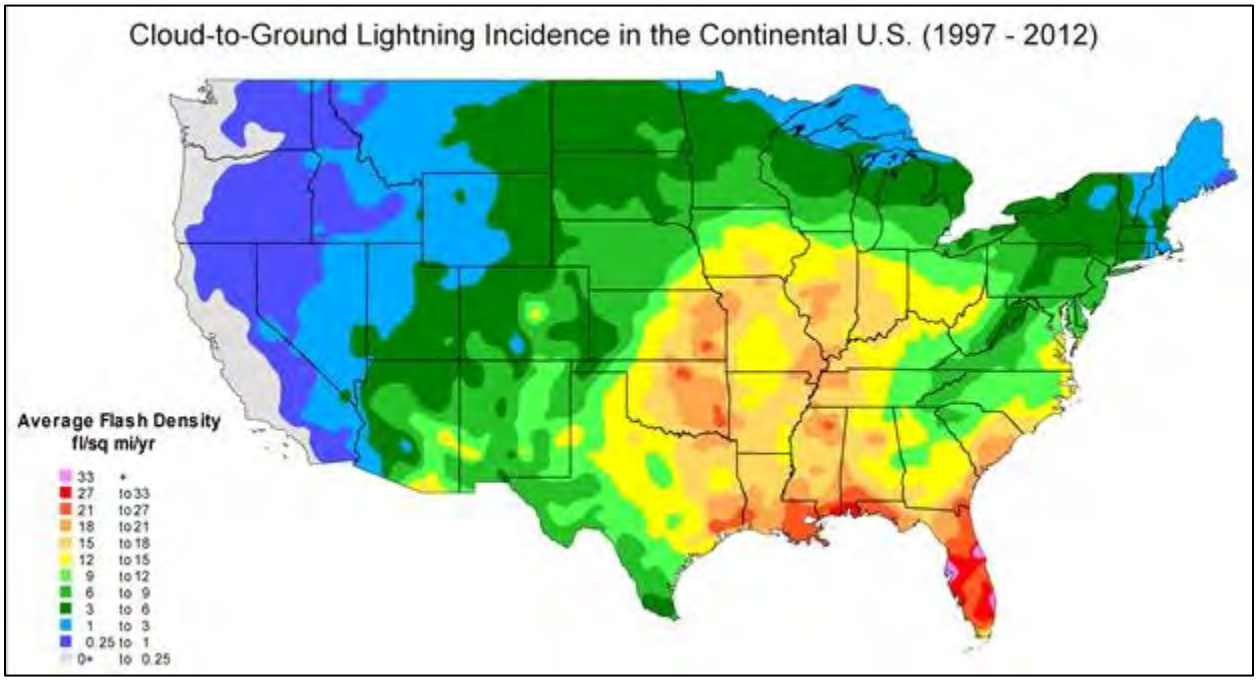
3.7 Severe Storms

Hazard Identification

Severe storms can occur during any season in the cities of Thornton, Federal Heights, and Northglenn. Lightning strikes can all be hazardous under the right conditions and locations. Large hail stones can damage crops, dent vehicles, break windows, and injure or kill livestock, pets, and people. Snow storms can take down trees and damage property and infrastructure.

The following figure depicts average cloud-to-ground lightning incidence in the US (or lightning flash densities) between 1997 and 2012.

FIGURE 32. AVERAGE LIGHTNING FLASH DENSITY IN THE U.S.[6]

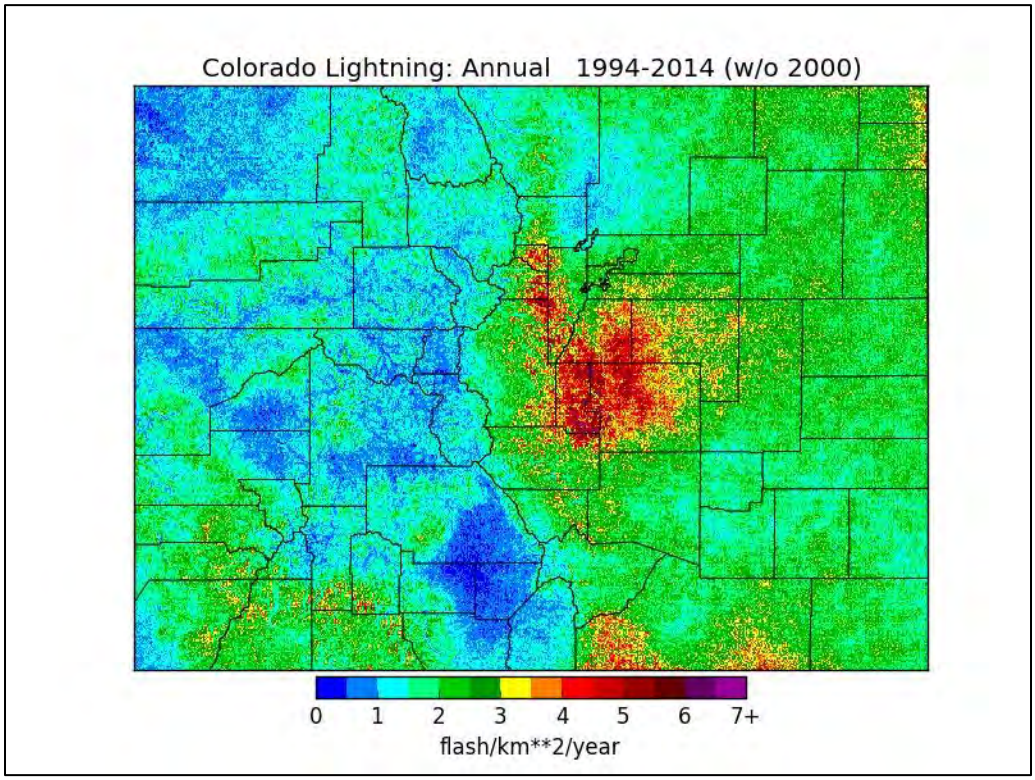


Although the state of Colorado ranks 32nd in terms of its cloud-to-ground lightning flash densities between 1997-2012, the state ranks 2nd in the country in terms of death rate from lightning per million people (between 2003 - 2012). Colorado's lightning death rate per million people from 2003-2012 is 0.51, second only to the state of Wyoming.

The following figure shows lightning flash densities for the State of Colorado for the years 1994 through 2014. Produced by National Weather Service, using data from Vaisala, the image is the result of contouring over eight million cloud-to-ground lightning flashes for the State of Colorado and averaging annually. The result of the analysis is a picture of average lightning flashes/km^2 per year from 1994 through 2014. The Colorado lightning map was calculated internally at the National Weather Service office in Pueblo.

[6] Source: http://www.lightningsafety.noaa.gov/statistics.htm

FIGURE 33. COLORADO LIGHTNING FLASH DENSITY MAP



In general, the flash density map shows a wide range of values across the State of Colorado, ranging from less than 0.5 flashes/year/km^2 over the south central portion of the state to over 6.5 flashes/year/km^2 over the east central part of the state. The higher density of lightning flashes located in the central area of the state is driven by the topography of the area. Where the higher terrain of the Plains intersects with the Rocky Mountains conditions are ripe for lightning events. Here, moist air from lower altitudes initiates and sustains convection systems as they move off of the mountain slopes, generating thunderstorms.

Thunderstorms affect relatively small areas when compared with the size of typical winter storms. Despite their small size, all thunderstorms are dangerous. The typical thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. Of the estimated 100,000 thunderstorms that occur each year in the United States, about 10% are classified as severe. The National Weather Service considers a thunderstorm severe if it produces hail at least 3/4 inch in diameter, winds of 58 MPH or stronger, or a tornado. Every thunderstorm needs three basic components: (1) moisture to form clouds and rain, (2) unstable air which is warm air that rises rapidly, and (3) lift, which is a cold or warm front capable of lifting air to help form thunderstorms.

Hail is precipitation that is formed when updrafts in severe storms carry raindrops upward into extremely cold areas of the atmosphere. The super cooled raindrops grow into balls of ice, which pose a hazard to property, people, livestock, and crops when they fall back to the earth.

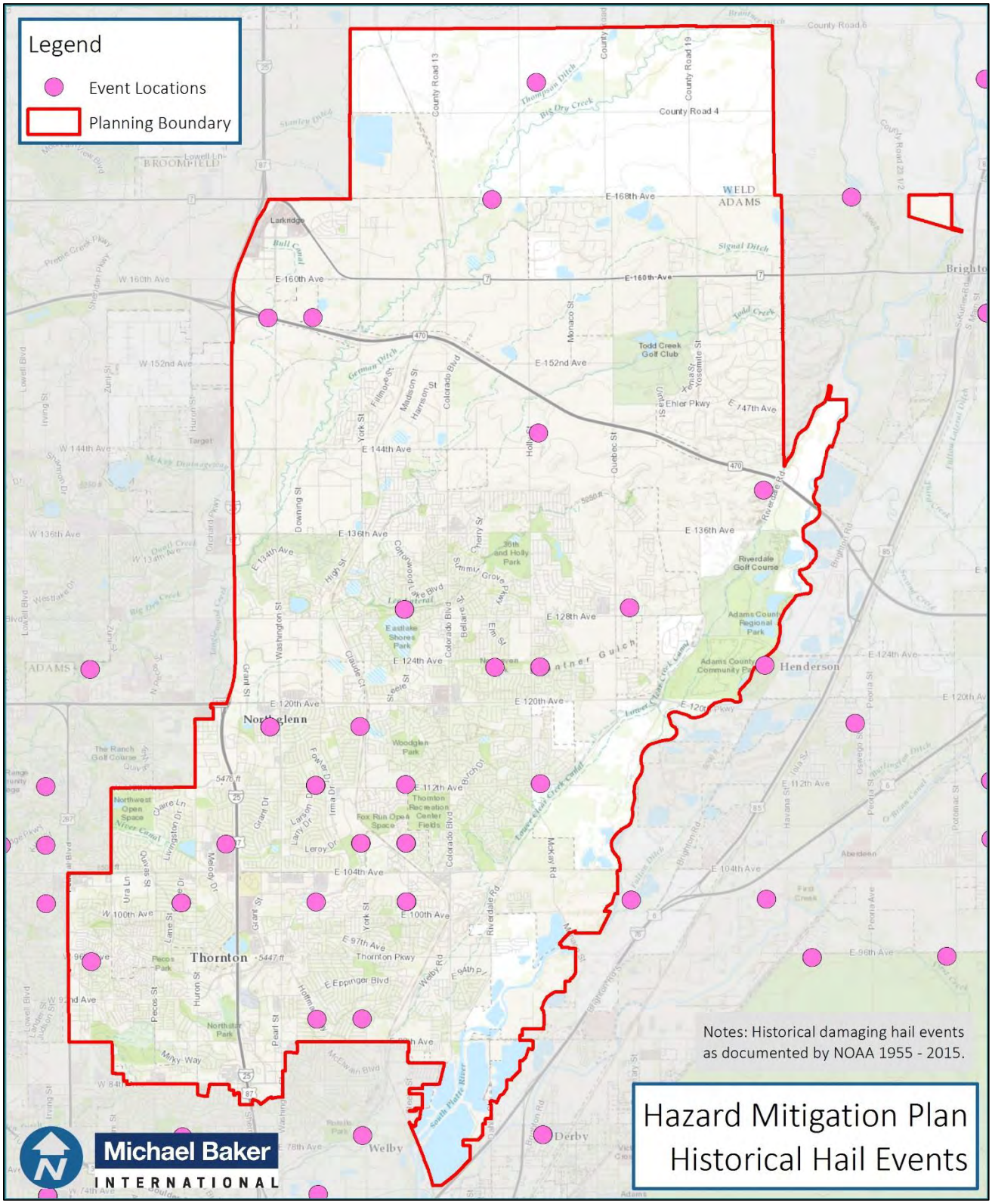
Lightning, although not considered severe by the National Weather Service definition, can accompany heavy rain during severe storms. Lightning develops when ice particles in a cloud collide with other particles. These collisions cause a separation of electrical charges. Positively charged ice particles rise to the top of the cloud and negatively charged ones fall to the middle and lower sections of the cloud. The negative charges at the base of the cloud attract positive charges at the surface of the Earth. Invisible to the human eye, the negatively charged area of the cloud sends a charge called a stepped leader toward the ground. Once it gets close enough, a channel develops between the cloud and the ground. Lightning is the electrical transfer through this channel. The channel rapidly heats to 50,000 degrees Fahrenheit and contains approximately 100 million electrical volts. The rapid expansion of the heated air causes thunder.

Previous Occurrences

Hail

According to NOAA there are no reported injuries, deaths, or crop damage in the Cities of Thornton, Federal Heights, and Northglenn due to hail between 1955 and 2015. There have been 24 hail events reported in the City of Thornton. Of the 24 incidents, one reported property loss of $120 million on May 22, 1996. There was one reported hail event in the City of Federal Heights, and 21 reported hail events in the City of Northglenn. Based on the historic data showing hazardous impacts on the cities, there is a great potential for hail events to occur at any given time.

FIGURE 34. HISTORICAL HAIL EVENTS



City of Thornton Northglenn Federal Heights

Lightning

Despite the fact that NCEI Storm Events Database includes no reported deaths, injuries, or crop damage in the Cities of Thornton, Federal Heights, or Northglenn due to lightning events between 1950 and 2015, lightning strikes occur frequently within the planning area and pose a very real threat to residents and visitors. According to the national NCEI database, On July 11, 2001 there was $215,000 reported in property damage in the City of Thornton due to lightning. The summary of lightning events included in the NCEI database for the planning area are included in the table below.

TABLE 23. HISTORIC LIGHTNING EVENTS REPORTED WITHIN THE PLANNING AREA

Date	Location	Hazard Type	Injuries	Deaths	Property Damage	Crop Damage
8/29/2000	THORNTON	Lightning	0	0	0	0
7/11/2001	THORNTON	Lightning	0	0	$200,000	0
7/11/2001	THORNTON	Lightning	0	0	$15,000	0
		TOTAL:	0	0	$215,000	0

*Source: NCEI Storm Events Database (most recent record is from 2001)

Despite the historical data showing limited hazardous impacts within the planning area, personal expertise of city staff and local stakeholders indicate that there is a great potential for hazardous lightning events to occur at any given time, especially during the spring and summer months when city residents are likely to be working and playing outdoors.

Inventory Exposed

Inventory assets exposed to severe weather is dependent on the age of the building, type, construction material used, and condition of the structure. Possible losses to critical infrastructure include:

- Electric power distribution
- Communication disruption
- Water and fuel shortages
- Road closures
- Damaged infrastructure components, such as sewer lift stations and treatment plants
- Damage to homes, structures, and shelters

Potential Losses

All assets located within the planning area can be considered at risk from spring and summer storms. This includes 166,028 people (or 100% of the tri-city planning area's population) and all buildings and infrastructure. Damages primarily occur as a result of lightning strikes, hail, and flooding. Most structures, should be able to provide adequate protection from hail but could suffer broken windows and dented exteriors. Those facilities with back-up generators are better equipped to handle a severe weather situation should the power go out.

Probability of Future Occurrences

Severe Storms can be predicted with a reasonable level of certainty. Through the identification of various indicators of weather systems, and by tracking these indicators, warning time for severe storms can be as much as a week in advance. Understanding the historical frequency, duration, and spatial extent of severe

storms assists in determining the likelihood and potential severity of future occurrences. The characteristics of past severe storm events provide benchmarks for projecting similar conditions into the future. The probability that the planning area will experience a severe storm event can be difficult to quantify. However, based on historical records and frequencies there is nearly a 100% chance that this type of event will occur somewhere in planning area at least once every year.

Land Use and Development

All future structures built in the planning area will likely be exposed to severe storm damage. Since the previous statement is assumed to be uniform throughout the planning area, the location of development does not increase or reduce the risk necessarily. The planning area and its jurisdictions must adhere to building codes, and therefore, new development can be built to current standards to account for adverse weather.

All future structures built in the planning area will likely be exposed to severe storm damage. As with other large extent hazards, increased development trends within Planning Reserve Areas and along the I-25 corridors will increase the vulnerability of these areas. The planning area and its jurisdictions must continue to adhere to building codes and to facilitate new development that is built to the highest design standards to account for severe storms.

Due to the nature of severe storm events, not all jurisdictions within the planning area are expected to be impacted equally. For example, older homes, which are often subject to less advanced building codes, suffer increased vulnerability to wind over time. Mobile homes, which are most often occupied by low-income, socially vulnerable residents, are the most dangerous places during a windstorm. As communities across the planning area continue to grow, it is important that local agencies monitor the inventory and locations of mobile homes, particularly in areas of high wind risk. Moreover, when discussing mitigation actions for straight-line winds, communities or geographic locations with large numbers of mobile homes deserve added attention.

3.8 Public Health Hazards

Hazard Identification

Public health hazards, including epidemics, pandemics, invasive species, and pests, have the potential to cause serious illness and death, especially among those who have compromised immune systems due to age or underlying medical conditions. There are several contagious and infectious diseases present in the Denver Metro Region that constitute a public health risk. Emergency Support Function 8 (ESF 8) of the State Emergency Operations Plan provides an organizational framework for public health and medical service preparedness, response, and recovery efforts for various emergency epidemics. During the 2017 planning process, pandemic flu was identified as the key public health hazard in the county. Public health data is analyzed by the Colorado Department of Public Health and Environment's (CDPHE) Colorado Reportable Disease Statistics database at the County level. Therefore, this hazard risk assessment includes an analysis of pandemic flu risk for Adams and Weld County, which are the applicable counties for the analysis of the planning area, and an analysis of the impacts of the hazards profiled in this plan on public health.

A pandemic can be defined as a disease that attacks a large population across great geographic distances. Pandemics are larger than epidemics in terms of geographic area and number of people affected. Epidemics tend to occur seasonally and affect much smaller areas. Pandemics, on the other hand, are most often caused by new subtypes of viruses or bacteria for which humans have little or no natural resistance. Consequently, pandemics typically result in more deaths, social disruption, and economic loss than epidemics.

According to data from the Colorado Reportable Disease Statistics (CDPHE) database, influenza viruses represent the most common cause of hospitalization due to disease in Adams and Weld County. Seasonal influenza (often referred to as the flu) is a common infection that affects large numbers of people in Colorado every year. Influenza is an acute respiratory disease caused by influenza type A or B viruses. The typical features of seasonal influenza include abrupt onset of fever and respiratory symptoms such as cough, sore throat, as well as headache, muscle ache, and fatigue. For seasonal influenza, the incubation period ranges from one to four days and the clinical severity of infection can range from asymptomatic infection to primary viral pneumonia and death. Most people experience influenza as a very uncomfortable but ultimately benign illness. However, the influenza virus can mutate, causing it to be much more dangerous to humans. Yearly seasonal influenza remains a significant disease in the U.S. and Colorado, and seasonal epidemics can result in high morbidity and mortality, as well as create strains on the health care system and communities.

Unlike influenza viruses that have achieved ongoing transmission in humans, the sporadic human infections with avian A (H5N1) viruses are far more severe with high mortality. Initial symptoms include high fever and other influenza-like symptoms. It also appears that the incubation period in humans may be longer for avian (H5N1) viruses, ranging from two to eight days, and possibly as long as 17 days. Diarrhea, vomiting, abdominal pain, chest pain, and bleeding from the nose and gums have also been reported. The disease often manifests as a rapid progression of pneumonia with respiratory failure ensuing over several days.

With the increase in global transport, as well as urbanization, epidemics due to new influenza viruses are likely to occur in and around the boundary of the planning area. A new flu virus, which eventually became known as H1N1, came to the world's attention in March 2009. The symptoms of pandemic H1N1 2009 influenza were similar to those of seasonal influenza. Illness in most cases was mild but there were cases of severe disease requiring hospitalization and a number of deaths. The initial experience with the emerging pandemic of H1N1 prompted the World Health Organization (WHO) to redefine their phase descriptions for an influenza pandemic.

The six-phase approach was designed for the easy incorporation of recommendations into existing national and local preparedness and response plans. Phases 1—3 correlate with preparedness in the pre-pandemic interval, including capacity development and response planning activities, while Phases 4—6 signal the need for response and mitigation efforts during the pandemic interval.

Pre-Pandemic Interval

Phase 1 is the natural state in which influenza viruses circulate continuously among animals but do not affect humans.

- In nature, influenza viruses circulate continuously among animals (primarily birds). Even though such viruses might develop into pandemic viruses, in Phase 1 no viruses circulating among animals have been reported to cause infections in humans.

Phase 2 involves cases of animal influenza that have circulated among domesticated or wild animals and have caused specific cases of infection among humans.

- In Phase 2 an animal influenza virus circulating among domesticated or wild animals is known to have caused infection in humans, and is thus considered a potential pandemic threat.

Phase 3 represents the mutation of the animal influenza virus in humans so that it can be transmitted to other humans under certain circumstances (usually very close contact between individuals). At this point, small clusters of infection have occurred.

- In Phase 3 an animal or human-animal influenza virus has caused sporadic cases or small clusters of disease in people, but has not resulted in human-to-human transmission sufficient to sustain community-level outbreaks. Limited human-to-human transmission may occur under some circumstances, for examples, when there is close contact between an infected person and an unprotected caregiver. Limited transmission under these circumstances does not indicate that the virus has gained the level of transmissibility among humans necessary to cause a pandemic.

Pandemic Interval

Phase 4 involves community-wide outbreaks as the virus continues to mutate and become more easily transmitted between people (for example, transmission through the air)

- Phase 4 is characterized by verified human to human transmission of the virus and is able to cause "community-level outbreaks." The ability to cause sustained disease outbreaks in a community marks a significant upward shift in the risk for a pandemic.

Phase 5 represents human-to-human transmission of the virus in at least two countries

- Phase 5 is characterized by verified human to human spread of the virus into at least two countries in one World Health Organization (WHO) region. While most countries will not be affected at this stage, the declaration of Phase 5 is a strong signal that a pandemic is imminent and that the time to finalize the organization, communication, and implementation of the planned mitigation measures is short.

Phase 6 is the pandemic phase, characterized by community-level influenza outbreaks.

- Phase 6, the pandemic phase, is characterized by community-level outbreaks in at least one other country in a different WHO region in addition to the criteria defined in Phase 5. Designation of this phase will indicate that a global pandemic is underway.

Previous Occurrences

Public health hazards can manifest as primary events by themselves, or they may be secondary to another disaster or emergency, such as a flood, a severe storm, or a hazardous materials incident. The common characteristic of most public health emergencies is that they adversely impact, or have the potential to adversely impact, a large number of people.

The Colorado Department of Public Health and Environment releases an annual reportable disease summary for each county. The events with the highest incidences in Adams and Weld County between 2009 and 2014 are summarized in the table below.

TABLE 24. COLORADO REPORTABLE DISEASE STATISTICS (CDPHE), ADAMS COUNTY

Disease	Number of Cases Per Year						
	2009	2010	2011	2012	2013	2014	Total
ANIMAL BITES	14	11	53	77	66	16	**237**
BRUCELLOSIS	-	-	-	-	-	1	**1**
CAMPYLOBACTER	55	54	50	40	42	57	**298**
CRYPTOSPORIDIOSIS	7	4	4	5	8	7	**35**
ENCEPHALITIS OTHER	2	-	-	-	2	3	**7**
GIARDIASIS	33	68	24	22	29	23	**199**

Disease	Number of Cases Per Year						
	2009	2010	2011	2012	2013	2014	Total
GROUP A STREP INVASIVE	23	30	29	22	19	34	**157**
GROUP B STREP INVASIVE	48	25	35	38	32	44	**222**
HAEMOPHILUS INFLUENZAE	4	9	5	8	14	10	**50**
HANTAVIRUS PULMONARY SYNDRM	-	-	-	1	-	1	**2**
HEMOLYTIC UREMIC SYNDRM	2	1	-	1	-	1	**5**
HEPATITIS A	2	4	1	4	1	-	**12**
HEPATITIS B, ACUTE	7	5	1	4	3	8	**28**
HEPATITIS B, CHRONIC	74	63	46	50	58	66	**357**
HEPATITIS B, PERINATAL INFECTION	-	-	-	-	1	-	**1**
HEPATITIS C, ACUTE	4	-	1	2	1	1	**9**
HEPATITIS C, CHRONIC	216	199	216	196	161	205	**1193**
INFLUENZA-hospitalized	343	22	97	86	174	299	**1021**
INFLUENZA-pediatric death	1	-	-	-	-	1	**2**
KAWASAKI SYNDROME	5	7	7	7	10	2	**38**
LEGIONELLOSIS	5	5	4	2	6	3	**25**
LEPROSY (HANSEN DIS)	-	1	-	-	-	-	**1**
LISTERIOSIS	1	1	3	1	1	2	**9**
MALARIA	1	2	-	5	3	5	**16**
MENINGITIS ASEPTIC/VIRAL	15	32	19	13	30	20	**129**

Disease	Number of Cases Per Year						
	2009	2010	2011	2012	2013	2014	Total
MENINGOCOCCAL DISEASE	2	-	2	1	-	2	**7**
MUMPS	-	2	1	-	1	1	**5**
PERTUSSIS	13	56	54	206	138	160	**627**
PLAGUE	-	-	-	-	-	4	**4**
SALMONELLOSIS	58	43	46	50	46	49	**292**
SHIGELLOSIS	10	11	8	13	32	7	**81**
STEC (shiga toxin producing E.coli)	9	28	14	20	11	18	**100**
STREP PNEUMO INVASIVE	81	56	48	40	57	43	**325**
TOXIC SHOCK-OTHER	1	1	-	-	-	-	**2**
TOXIC SHOCK-STREP	-	1	-	-	-	-	**1**
TULAREMIA	-	-	-	-	-	1	**1**
TYPHOID FEVER	-	-	-	3	-	2	**5**
VARICELLA(CHICKEN POX)	51	47	42	37	27	28	**232**
WEST NILE VIRUS	-	3	-	-	-	-	**3**
YERSINIOSIS	2	-	3	-	5	1	**11**
Total:	**1089**	**791**	**813**	**954**	**978**	**1125**	**5750**

Source: Division of Disease Control and Environmental Epidemiology, CDPHE

TABLE 25. COLORADO REPORTABLE DISEASE STATISTICS (CDPHE), WELD COUNTY

Disease	Number of Cases Per Year						
	2009	2010	2011	2012	2013	2014	Total
ANIMAL BITES	39	49	36	40	86	38	**288**
CAMPYLOBACTER	68	81	86	51	80	56	**422**
CRYPTOSPORIDIOSIS	12	26	12	4	9	5	**68**
ENCEPHALITIS OTHER	1	2	-	-	2	2	**7**
GIARDIASIS	22	26	13	6	10	11	**88**
HAEMOPHILUS INFLUENZAE	5	5	4	2	6	2	**24**
HEMOLYTIC PULMONARY SYNDRM	-	2	2	-	-		**4**
HEMOLYTIC UREMIC SYNDRM	-	-	2	-	2	1	**5**
HEPATITIS A	7	-	1	1	1	2	**12**
HEPATITIS B, ACUTE	-	1	1				**2**
HEPATITIS B, CHRONIC	20	27	26	23	18	7	**121**
HEPATITIS C, ACUTE	-	2	-	2	3	-	**7**
HEPATITIS C, CHRONIC	106	107	111	87	89	100	**600**
INFLUENZA-hospitalized	155	5	77	57	145	200	**639**
KAWASAKI SYNDROME	1	6	2	5	5	-	**19**
LEGIONELLOSIS	1	1	1	1	-	1	**5**
LISTERIOSIS	-	-	2	-	2	1	**5**
MALARIA	-	-	-	-	2	1	**3**
MENINGITIS ASEPTIC/VIRAL	41	18	10	42	38	13	**162**

Disease	Number of Cases Per Year						
	2009	2010	2011	2012	2013	2014	Total
MENINGOCOCCAL DISEASE	-	3	-	-	-	-	**3**
MUMPS	-	-		1	-	1	**2**
PERTUSSIS	4	10	5	83	94	183	**379**
RELAPSING FEVER	-	-	-	-	1		**1**
ROCKY MTN SPOTTED FVR	-	1	-	1			**2**
SALMONELLOSIS	44	28	25	43	45	33	**218**
SHIGELLOSIS	7	10	8	41	6	3	**75**
STEC (shiga toxin producing E.coli)	9	10	10	6	14	8	**57**
STREP PNEUMO INVASIVE	35	29	32	17	22	24	**159**
TETANUS	-	-	-	1	-	-	**1**
TULAREMIA	1	1	1	-		1	**4**
VARICELLA(CHICKEN POX)	37	14	12	11	14	12	**100**
WEST NILE VIRUS	-	18	-	-	-	-	**18**
Total:	**615**	**482**	**479**	**525**	**694**	**705**	**3500**

Chronic Hepatitis C and hospitalizations from influenza represent the largest disease incidence in both Weld and Adams County between 2009 and 2014.

Inventory Exposed

The information in the table below is from the Impact Analysis of Potential for Detrimental Impacts of Hazards for the Emergency Management Accreditation Program (EMAP). The table explains possible impacts to various subjects due to public health emergencies.

TABLE 26. IMPACTS TO SUBJECTS IMPACTED BY PUBLIC HEALTH EMERGENCIES

Subject	Detrimental Impacts
Health and Safety of Persons in the Area as the Time of Incident	Adverse impacts are expected to be severe for unprotected personnel and moderate to light for protected personnel.
Health and Safety of Persons Responding to the Incident	Adverse impacts are expected to be severe for unprotected personnel and uncertain for trained and protected personnel, depending on the nature of the incident.
Continuity of Operations	Danger to personnel in the area of the incident may require relocation of operations and lines of succession execution.
Property, Facilities, and Infrastructure	Access to facilities and infrastructure in the area of the incident may be denied until decontamination is complete.
Delivery of Services	Stress on resources and facilities due to increased volume and demand may overwhelm and/or extensively postpone delivery of services.
The Environment	Incident may cause denial or delays in the use of some areas.
Economic and Financial Condition	Local economy and finances may be adversely affected, possibly for an extended period of time.
Regulatory and Contractual Obligations	Regulatory waivers may be needed. Fulfillment of contracts may be difficult. Demands may exceed the ability to deliver.
Reputation of, or Confidence in, Management and Response Authorities	Ability to respond and recover may be questioned and challenged if planning, response, and recovery are not timely and effective.

Public Health Hazards were identified as a high hazard for the City of Federal Heights. Additional information on inventory exposed can be found in their community profile section within this report (Appendix B).

Potential Losses

Public Health Hazards were identified as a high hazard for the City of Federal Heights. Additional information on potential losses can be found in their community profile section within this report (Appendix B).

Probability of Future Occurrences

Public Health Hazards were identified as a high hazard for the City of Federal Heights. Additional information on the probability of future occurrences can be found in their community profile section within this report (Appendix B).

Land Use and Development

Public Health Hazards were identified as a high hazard for the City of Federal Heights. Additional information on land use and development can be found in their community profile section within this report (Appendix B).

3.9 Tornado and Severe Wind

Hazard Identification

Tornadoes

Tornados in Colorado are most often generated by severe storm activity when cool, dry air intersects and overrides a layer of warm, moist air forcing the warm air to rise rapidly. The damage caused by a tornado is a result of high wind velocities and wind-blown debris. According to the National Weather Service, tornado wind speeds can range between 30 to more than 300 miles per hour. They are more likely to occur during the spring and early summer months of March through June and are most likely to form in the late afternoon and early evening. Most tornadoes are a few dozen yards wide and touch down briefly, but even small, short-lived tornadoes can inflict tremendous damage. Destruction ranges from minor to catastrophic depending on the intensity, size, and duration of the storm. Structures made of light materials such as mobile homes are most susceptible to damage. An average of 1,253 tornadoes occur nationwide, resulting in an average of 60 deaths and 1,500 injuries (NOAA, 2010). The majority of Colorado tornadoes occur in the eastern plains.

Tornadoes were previously classified by their intensity using the Fujita (F) Scale, with FO being the least intense and F6 being the most intense. The Fujita Scale was used to rate the intensity of a tornado by examining the damage caused by the tornado after it has passed over a man-made structure.

On February 1, 2007, the Fujita scale was decommissioned in favor of the more accurate Enhanced Fujita Scale (aka the EF Scale). The EF-Scale measures tornado strength and associated damages and classifies tornadoes into six intensity categories, as shown in the following table. The scale was revised to reflect better examinations of tornado damage surveys, so as to align wind speeds more closely with associated storm damage. The new scale takes into account how most structures are designed, and is thought to be a much more accurate representation of the surface wind speeds in the most violent tornadoes.

TABLE 27. ENHANCED FUJITA (EF) SCALE[7]

Enhanced Fujita (EF) Scale		
Enhanced Fujita Category	**Wind Speed (mph)**	**Potential Damage**
EF0	65-85	**Light damage**: Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
EF1	86-110	**Moderate damage**: Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	**Considerable damage**: Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	136-165	**Severe damage**: Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166-200	**Devastating damage**: Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF5	>200	**Incredible damage**: Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 m (109 yds.); high-rise buildings have significant structural deformation; incredible phenomena will occur.

The Storm Prediction Center has developed damage indicators to be used with the Enhanced Fujita Scale for different types of buildings. These indicators can be also be used to classify any high wind event. Indicators for different building types are shown in the following tables.

[7] Source: http://www.spc.noaa.gov/faq/tornado/ef-scale.html

TABLE 28. INSTITUTIONAL BUILDINGS

DAMAGE DESCRIPTION	WIND SPEED RANGE (Expected in Parentheses)
Threshold of visible damage	59-88 MPH (72 MPH)
Loss of roof covering (<20%)	72-109 MPH (86 MPH)
Damage to penthouse roof & walls, loss of rooftop HVAC equipment	75-111 MPH (92 MPH)
Broken glass in windows or doors	78-115 MPH (95 MPH)
Uplift of lightweight roof deck & insulation, significant loss of roofing material (>20%)	95-136 MPH (114 MPH)
Façade components torn from structure	97-140 MPH (118 MPH)
Damage to curtain walls or other wall cladding	110-152 MPH (131 MPH)
Uplift of pre-cast concrete roof slabs	119-163 MPH (142 MPH)
Uplift of metal deck with concrete fill slab	118-170 MPH (146 MPH)
Collapse of some top building envelope	127-172 MPH (148 MPH)
Significant damage to building envelope	178-268 MPH (210 MPH)

Source: Storm Prediction Center, 2009

TABLE 29. EDUCATIONAL INSTITUTIONS (ELEMENTARY/HIGH SCHOOLS)

DAMAGE DESCRIPTION	WIND SPEED RANGE (Expected in Parentheses)
Threshold of visible damage	55-83 MPH (68 MPH)
Loss of roof covering (<20%)	66-99 MPH (79 MPH)
Broken windows	71-106 MPH (87 MPH)
Exterior door failures	83-121 MPH (101 MPH)
Uplift of metal roof decking; significant loss of roofing material (>20%); loss of rooftop HVAC	85-119 MPH (101 MPH)
Damage to or loss of wall cladding	92-127 MPH (108 MPH)
Collapse of tall masonry walls at gym, cafeteria, or auditorium	94-136 MPH (114 MPH)
Uplift or collapse of light steel roof structure	108-148 MPH (125 MPH)
Collapse of exterior walls in top floor	121-153 MPH (139 MPH)
Most interior walls of top floor collapsed	133-186 MPH (158 MPH)

DAMAGE DESCRIPTION	WIND SPEED RANGE (Expected in Parentheses)
Total destruction of a large section of building envelope	163-224 MPH (192 MPH)

Source: Storm Prediction Center, 2009

TABLE 30. METAL BUILDING SYSTEMS

Damage Description	Wind Speed Range (Expected in Parentheses)
Threshold of visible damage	54-83 MPH (67 MPH)
Inward or outward collapsed of overhead doors	75-108 MPH (89 MPH)
Metal roof or wall panels pulled from the building	78-120 MPH (95 MPH)
Column anchorage failed	96-135 MPH (117 MPH)
Buckling of roof purlins	95-138 MPH (118 MPH)
Failure of X-braces in the lateral load resisting system	118-158 MPH (138 MPH)
Progressive collapse of rigid frames	120-168 MPH (143 MPH)
Total destruction of building	132-178 MPH (155 MPH)

Source: Storm Prediction Center, 2009

TABLE 31. ELECTRIC TRANSMISSION LINES

Damage Description	Wind Speed Range (Expected in Parentheses)
Threshold of visible damage	70-98 MPH (83 MPH)
Broken wood cross member	80-114 MPH (99 MPH)
Wood poles leaning	85-130 MPH (108 MPH)
Broken wood poles	98-142 MPH (118 MPH)

Source: Storm Prediction Center, 2009

Severe wind

Severe Wind can also occur outside of tornadoes, severe storms, and winter storms. These winds typically develop with strong pressure gradients and gusty frontal passages. The closer and stronger two systems (one high pressure, one low pressure) are, the stronger the pressure gradient, and therefore, the stronger the winds are.

Although severe wind events often garner less attention in the local media than tornadoes do, damaging straight line winds (or downbursts) can injure and kill animals and humans. Straight-line winds, which can cause more widespread damage than a tornado, occur when air is carried into a storm's updraft, cools rapidly, and comes rushing to the ground. Cold air is denser than warm air, and therefore, wants to fall to the surface. On warm summer days, when the cold air can no longer be supported up by the storm's updraft, or when an exceptional downdraft develops, the air crashes to the ground in the form of strong winds. These winds are forced horizontally when they reach the ground and can cause significant damage. These types of strong winds can also be referred to as straight-line winds. Downbursts with a diameter of less than 2.5 miles are called microbursts and those with a diameter of 2.5 miles or greater are called macrobursts. A "derecho" is a series of downbursts associated with a line of severe storms.

Previous Occurrences

Colorado, lying just west of "tornado alley," is fortunate to experience less frequent and intense tornadoes than its neighboring states to the east. However, tornadoes remain a significant hazard in the region. Tornadoes are the most intense storm on earth having been recorded at velocities exceeding 315 mph. The phenomena results in a destructive rotating column of air ranging in diameter from a few yards to greater than a mile, usually associated with a downward extension of cumulonimbus clouds.

All portions of the cities of Thornton, Federal Heights and Northglenn have the potential to be hit by tornadoes. Historically, tornadoes have been relatively small on the EF Scale but F1 tornadoes can still produce dangerous winds up to 112mph. High winds can cause damage to buildings (tearing shingles from roofs, tearing awnings, collapsing structures, etc.).

FIGURE 35. JUNE 3, 1981 TORNADO DAMAGE ALONG WASHINGTON STREET (SOURCE: CITY OF THORNTON)

The following table summarizes tornado history and damage data for the cities of Thornton and Northglenn from 1954 – 2015 collected by the NOAA Storm Prediction Center. There are no historical tornado touchdowns recorded for the City of Federal Heights.

TABLE 32. TORNADO HISTORY IN THE CITIES OF THORNTON AND NORTHGLENN (1954-2015)

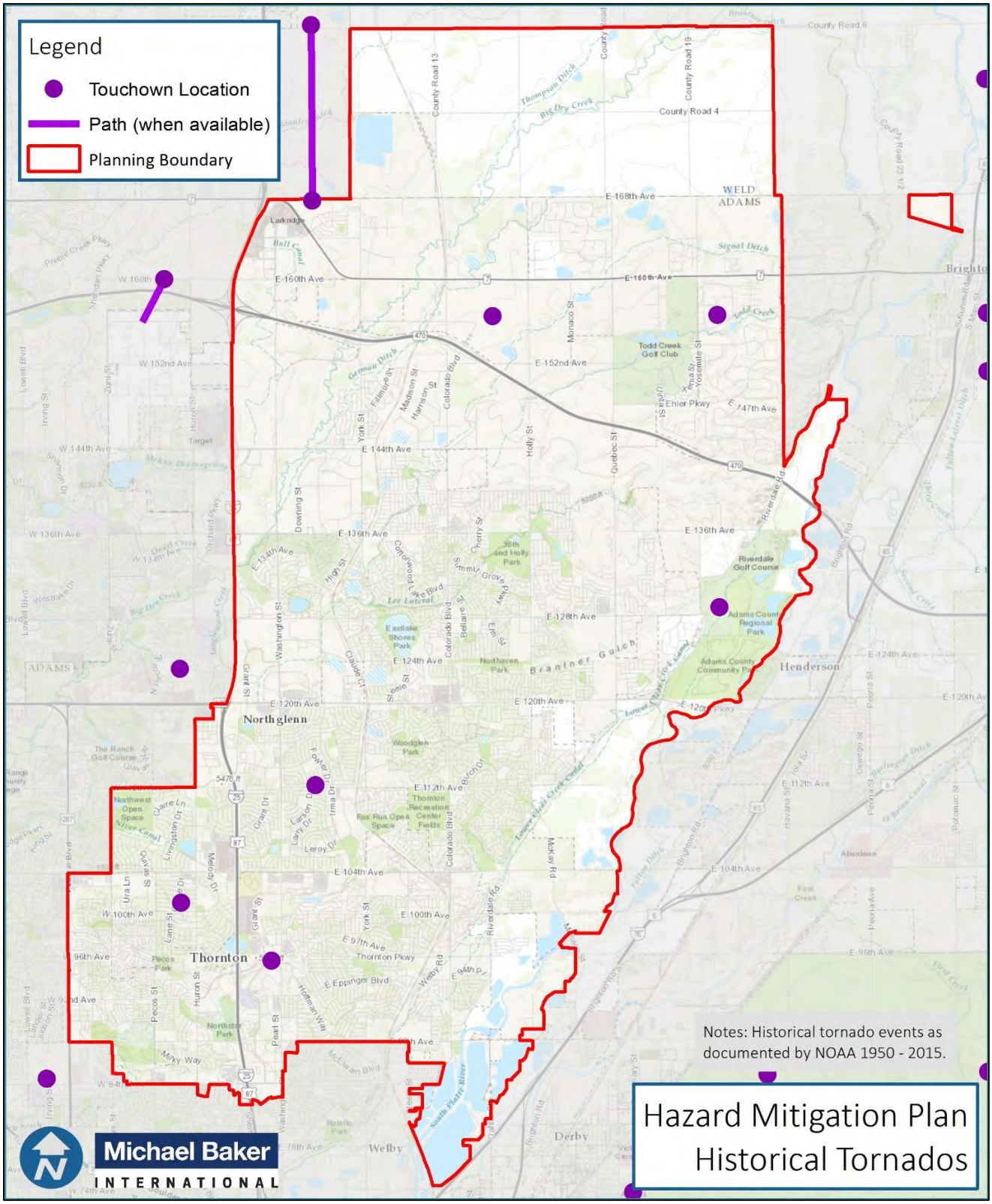
Date	Location	EF scale	Injuries	Deaths	Estimated Property Damage	Estimated Crop Damage
06/30/1965	Northglenn	0	0	0	0	0
06/03/1981	Thornton	2	42	0	7,000*	0
06/05/1988	Thornton	2	0	0	5,000	0
05/29/1990	Northglenn	1	0	0	5,000	0
06/01/1990	Thornton	0	0	0	0	0
06/22/1996	Thornton	0	0	0	0	0
06/22/1997	Thornton	1	0	0	0	0
		TOTALS:	**42**	**0**	**$17,000**	**0**

Source: NOAA; NCEI Storm Events Database

**Media sources have reported over $50 million in damage due to this tornado event.*

NCEI's Storm Events Database estimates that seven tornadoes have touched down in, or moved through, the Cities of Thornton, Federal Heights and Northglenn between 1954 and 2015. The following figure depicts historical tornado tracks and events in and around the cities of Thornton, Federal Heights and Northglenn. The map illustrates where tornadoes have touched down (and where they traveled) between 1954 and 2015.

FIGURE 36. HISTORICAL TORNADO EVENTS IN THE PLANNING AREA



City of Thornton Northglenn Federal Heights

Data from NOAA's NCEI Storm Events Database was used to complete the risk assessment for straight-line wind events in the Cities of Thornton, Federal Heights, and Northglenn. Currently, the Storm Events Database only includes wind events that are classified as "Severe Storm Winds" (including downbursts). These events are defined as winds with speeds of at least fifty knots (58 mph), or winds of any speed (non-severe winds under fifty knots) that result in a fatality, injury and/or damage. The following table summarizes severe wind history and damage totals in the Cities of Thornton, Federal Heights, and Northglenn from 1980 to 2014.

TABLE 33. SEVERE WIND EVENT HISTORY IN THE PLANNING AREA (1980-2014)

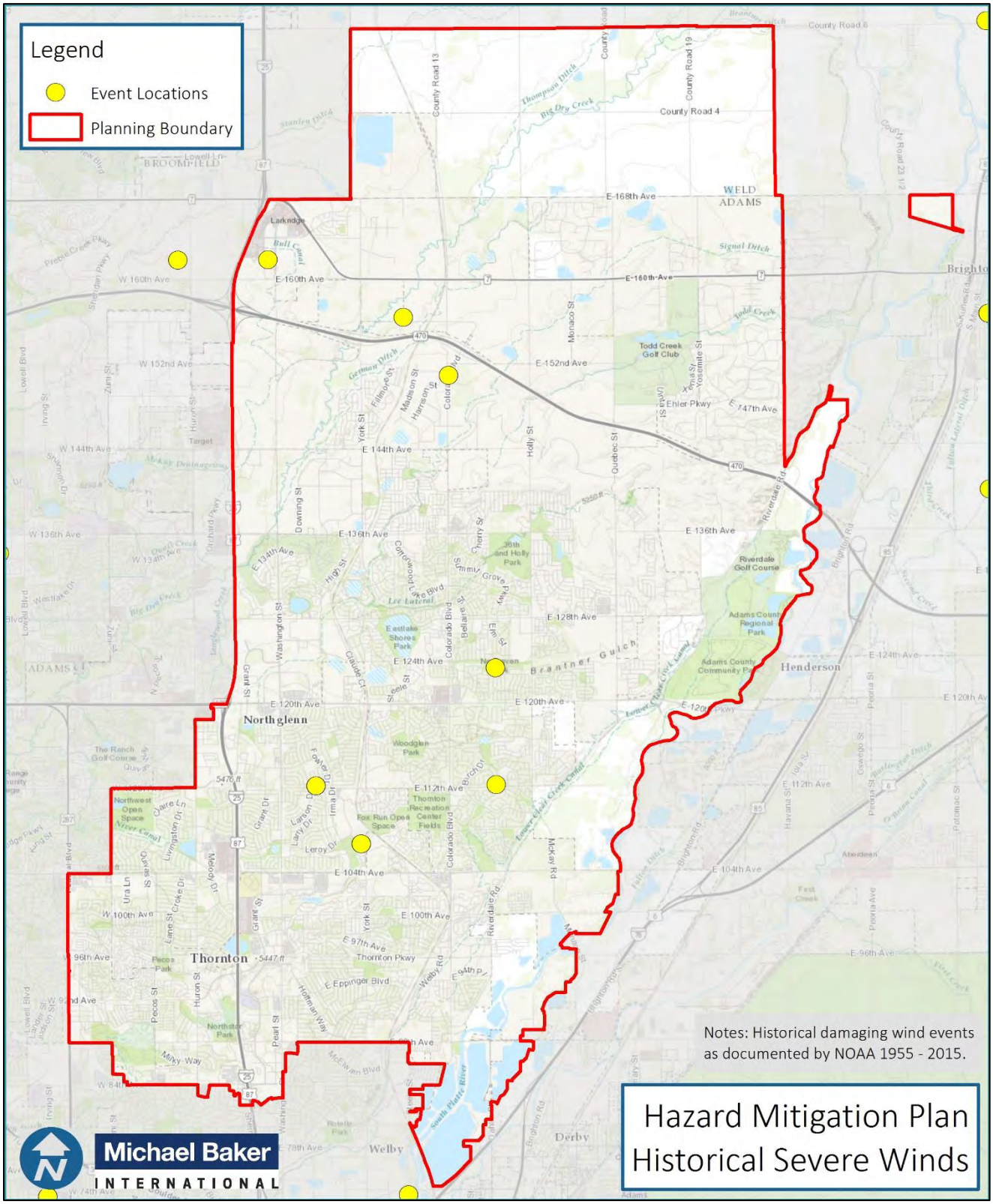
Date	Magnitude (knots)[8]	Injuries	Deaths	Property Damage	Crop Damage
07/23/1997	52	0	0	0	0
07/19/2011	52	0	0	0	0
08/03/2013	52	0	0	0	0
04/30/2014	51	0	0	0	0
TOTAL		**0**	**0**	**$0**	**$0**

Source: NOAA, NCEI Storm Events Database

Based on data provided by NCEI's Storm Events Database, seven severe wind events have occurred in the Cities of Thornton, Federal Heights, and Northglenn between 1980 and 2014. The following figure provides a geospatial view of these historical severe wind events in the Cities of Thornton, Federal Heights, and Northglenn between 1980 and 2014. As with tornadoes, it should be noted that severe winds affect all portions of the three cities. City-specific loss estimates and tornado/severe wind risk assessments are provided for Thornton and Federal Heights in the Community Profiles, Appendices A and B, of this report.

[8] 1 knot = 1.15 mph

FIGURE 37. HISTORICAL SEVERE WIND EVENTS IN THE PLANNING AREA



City of Thornton
Northglenn
Federal Heights

Inventory Exposed

Tornado and severe wind events were identified as a high hazard for the Cities of Thornton and Federal Heights. Additional information on inventory exposed can be found in the respective community profile sections of this report (Appendices A and B).

Potential Losses

Tornado and severe wind events were identified as a high hazard for the Cities of Thornton and Federal Heights. Additional information on potential losses can be found in the respective community profile sections of this report (Appendices A and B).

Probability of Future Occurrences

Tornado and severe wind events were identified as a high hazard for the Cities of Thornton and Federal Heights. Additional information on the probability of future occurrences can be found in the respective community profile sections of this report (Appendices A and B).

Land Use and Development

Tornado and severe wind events were identified as a high hazard for the Cities of Thornton and Federal Heights. Additional information on land use and development can be found in the respective community profile sections of this report (Appendices A and B).

3.10 Winter Storm

Hazard Identification

Severe winter weather can cause hazardous driving conditions, communications and electrical power failure, community isolation, and can adversely affect business continuity. This type of snow-related weather may include one or more of the following winter factors:

Winter storms can include blizzards, heavy snow, ice storms, and extreme cold.

Blizzards as defined by the National Weather Service, are a combination of sustained winds or frequent gusts of 35 mph or greater and visibilities of less than a quarter mile from falling or blowing snow for three hours or more. A blizzard, by definition, does not indicate heavy amounts of snow, although they can happen together. The falling or blowing snow usually creates large drifts from the strong winds. The reduced visibilities make travel, even on foot, particularly treacherous. The strong winds may also support dangerous wind chills. Ground blizzards can develop when strong winds lift snow off the ground and severely reduce visibilities.

Heavy snow, in large quantities, may fall during winter storms. Six inches or more in 12 hours or eight inches or more in 24 hours constitutes conditions that may significantly hamper travel or create hazardous conditions. The National Weather Service issues warnings for such events. Smaller amounts can also make travel hazardous, but in most cases, only results in minor inconveniences. Heavy wet snow before the leaves fall from the trees in the fall or after the trees have leafed out in the spring may cause problems with broken tree branches and power outages.

Ice storms develop when a layer of warm (above freezing), moist air aloft coincides with a shallow cold (below freezing) pool of air at the surface. As snow falls into the warm layer of air, it melts to rain, and then freezes on contact when hitting the frozen ground or cold objects at the surface, creating a smooth layer of ice. This phenomenon is called freezing rain. Similarly, sleet occurs when the rain in the warm layer subsequently freezes into pellets while falling through a cold layer of air at or near the Earth's surface. Extended periods of freezing rain can lead to accumulations of ice on roadways, walkways, power lines, trees, and buildings. Almost any accumulation can make driving and walking hazardous. Thick accumulations can bring down trees and power lines.

Extreme cold, in extended periods, although infrequent, could occur throughout the winter months across the planning area. Heating systems compensate for the cold outside. Most people limit their time outside during extreme cold conditions, but common complaints usually include pipes freezing and cars refusing to start. When cold temperatures and wind combine, dangerous wind chills can develop. Additional information pertaining to extreme cold can be found in the Extreme Temperatures section of the Plan.

Previous Occurrences

According to the NCEI Storm Events Database there have been no reported injuries, no reported deaths, $102,000 worth of property damage, and no reported crop damage in the cities of Thornton, Federal Heights, and Northglenn due to winter storm events between 1996 and 2014. The table below shows the history of "significant" winter storms and blizzards in the cities of Thornton, Federal Heights, and Northglenn since 1996. "Significant" winter storm, winter weather, and blizzard events are included in the NCEI Storm Events Database if the event has more than one significant hazard (i.e., heavy snow and

blowing snow; snow and ice; snow and sleet; sleet and ice; or snow, sleet, and ice) and meets or exceeds locally/regionally defined twelve or twenty-four hour warning criteria for at least one of the precipitation elements on a widespread or localized basis.

According to best available data there have been at least two to three significant winter storm events recorded in the cities of Thornton, Federal Heights, and Northglenn each year. The following table shows winter storm data from the storm events database at a county-wide level. Only those events located in county areas in close proximity to the planning area have been included.

TABLE 34. HISTORIC WINTER STORMS IN THE CITIES OF THORNTON, FEDERAL HEIGHTS, AND NORTHGLENN

Date	Location	Injuries	Deaths	Damage to Property	Damage to Crops
1/17/1996	C & S WELD COUNTY (ZONE)	0	0	0	0
4/13/1996	C & S WELD COUNTY (ZONE)	0	0	0	0
12/16/1996	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
12/16/1996	C & E ADAMS & ARAPAHOE COUNTIES (ZONE)	0	0	0	0
12/16/1996	C & S WELD COUNTY (ZONE)	0	0	0	0
4/4/1997	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
4/23/1997	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
11/28/1997	DENVER METROPOLITAN AREA (ZONE)	0	0	0	0
12/8/1997	DENVER METROPOLITAN AREA (ZONE)	0	0	0	0
12/8/1997	EASTERN ADAMS AND EASTERN ARAPAHOE COUNTIES (ZONE)	0	0	0	0
3/18/1998	DENVER METROPOLITAN AREA (ZONE)	0	0	0	0
4/2/1998	DENVER METROPOLITAN AREA (ZONE)	0	0	0	0
4/18/1998	DENVER METROPOLITAN AREA / E JEFFERSON / W ADAMS / DENVER / W ARAPAHOE / N DOUGLAS (ZONE)	0	0	0	0
2/10/1999	DENVER METROPOLITAN AREA (ZONE)	0	0	0	0
2/10/1999	SOUTHERN WELD COUNTY/GREELEY AND VICINITY (ZONE)	0	0	0	0
11/21/1999	DENVER METROPOLITAN AREA / E JEFFERSON / W ADAMS / DENVER / W ARAPAHOE / N DOUGLAS (ZONE)	0	0	0	0

Date	Location	Injuries	Deaths	Damage to Property	Damage to Crops
4/10/2001	DENVER METROPOLITAN AREA / E JEFFERSON / W ADAMS / DENVER / W ARAPAHOE / N DOUGLAS (ZONE)	0	0	0	0
4/10/2001	SOUTHERN WELD COUNTY/GREELEY AND VICINITY (ZONE)	0	0	0	0
4/22/2001	DENVER METROPOLITAN AREA / E JEFFERSON / W ADAMS / DENVER / W ARAPAHOE / N DOUGLAS (ZONE)	0	0	0	0
4/22/2001	EASTERN ADAMS AND EASTERN ARAPAHOE COUNTIES (ZONE)	0	0	0	0
4/22/2001	SOUTHERN WELD COUNTY/GREELEY AND VICINITY (ZONE)	0	0	0	0
3/1/2002	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES (ZONE)	0	0	0	0
3/1/2002	C & S WELD COUNTY (ZONE)	0	0	0	0
11/1/2002	C & S WELD COUNTY (ZONE)	0	0	0	0
1/3/2004	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
1/3/2004	C & S WELD COUNTY (ZONE)	0	0	0	0
1/25/2004	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
1/25/2004	C & S WELD COUNTY (ZONE)	0	0	0	0
4/9/2004	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
4/22/2004	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
3/13/2005	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
3/13/2005	C & S WELD COUNTY (ZONE)	0	0	0	0
3/30/2005	C & E ADAMS & ARAPAHOE COUNTIES (ZONE)	0	0	0	0

Date	Location	Injuries	Deaths	Damage to Property	Damage to Crops
4/10/2005	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
4/10/2005	C & S WELD COUNTY (ZONE)	0	0	0	0
10/10/2005	C & E ADAMS & ARAPAHOE COUNTIES (ZONE)	0	0	0	0
10/10/2005	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
10/25/2006	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
12/28/2006	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
12/28/2006	C & S WELD COUNTY (ZONE)	0	0	$102,000	0
12/25/2007	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
12/27/2007	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
12/27/2007	C & E ADAMS & ARAPAHOE COUNTIES (ZONE)	0	0	0	0
12/27/2007	C & S WELD COUNTY (ZONE)	0	0	0	0
4/9/2008	C & E ADAMS & ARAPAHOE COUNTIES (ZONE)	0	0	0	0
3/26/2009	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
3/26/2009	C & E ADAMS & ARAPAHOE COUNTIES (ZONE)	0	0	0	0
3/26/2009	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0

Date	Location	Injuries	Deaths	Damage to Property	Damage to Crops
3/26/2009	C & S WELD COUNTY (ZONE)	0	0	0	0
4/16/2009	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
10/20/2009	C & E ADAMS & ARAPAHOE COUNTIES (ZONE)	0	0	0	0
10/27/2009	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
10/27/2009	C & S WELD COUNTY (ZONE)	0	0	0	0
10/28/2009	C & E ADAMS & ARAPAHOE COUNTIES (ZONE)	0	0	0	0
11/14/2009	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
11/14/2009	C & E ADAMS & ARAPAHOE COUNTIES (ZONE)	0	0	0	0
11/14/2009	C & S WELD COUNTY (ZONE)	0	0	0	0
12/22/2009	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
3/19/2010	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
3/23/2010	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
3/23/2010	C & E ADAMS & ARAPAHOE COUNTIES (ZONE)	0	0	0	0
3/23/2010	C & S WELD COUNTY (ZONE)	0	0	0	0
10/25/2011	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
10/25/2011	C & E ADAMS & ARAPAHOE COUNTIES (ZONE)	0	0	0	0
10/25/2011	C & S WELD COUNTY (ZONE)	0	0	0	0

Date	Location	Injuries	Deaths	Damage to Property	Damage to Crops
11/1/2011	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
11/1/2011	C & E ADAMS & ARAPAHOE COUNTIES (ZONE)	0	0	0	0
11/1/2011	C & S WELD COUNTY (ZONE)	0	0	0	0
12/21/2011	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
2/2/2012	C & E ADAMS & ARAPAHOE COUNTIES (ZONE)	0	0	0	0
2/2/2012	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
2/2/2012	C & S WELD COUNTY (ZONE)	0	0	0	0
2/24/2013	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
3/9/2013	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
3/22/2013	C & E ADAMS & ARAPAHOE COUNTIES (ZONE)	0	0	0	0
3/22/2013	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
3/22/2013	C & S WELD COUNTY (ZONE)	0	0	0	0
4/8/2013	C & S WELD COUNTY (ZONE)	0	0	0	0
4/15/2013	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
4/15/2013	C & S WELD COUNTY (ZONE)	0	0	0	0
1/30/2014	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0

Date	Location	Injuries	Deaths	Damage to Property	Damage to Crops
1/30/2014	C & S WELD COUNTY (ZONE)	0	0	0	0
5/11/2014	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
2/1/2015	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
5/9/2015	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
5/9/2015	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
5/9/2015	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
5/9/2015	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
5/9/2015	N DOUGLAS COUNTY BELOW 6000 FEET / DENVER / W ADAMS & ARAPAHOE COUNTIES / E BROOMFIELD COUNTY (ZONE)	0	0	0	0
	Total:	0	0	$102,000	$0

Source: NOAA; NCEI Storm Events Database

Inventory Exposed

All assets located within the planning area can be considered at risk from winter storms. This includes 166,028 people, or 100% of the planning area population, and all buildings and infrastructure within the planning area. Damages primarily occur as a result of high winds, lightning strikes, hail, snow-loading, and flooding. Most structures, including critical facilities, should be able to provide adequate protection from hail but the structures could suffer broken windows and dented exteriors. Those facilities with back-up generators are better equipped to handle a severe weather situation should the power go out.

Potential Losses

Winter storms affect the entire planning area including all above-ground structures and infrastructure. Although losses to structures are typically minimal, there can be secondary impacts associated with lost

time, maintenance costs, and damaged building contents. A timely forecast may not be able to mitigate property loss, but could reduce storm-related casualties and injuries.

Probability of Future Occurrences

Severe winter storms can be predicted with a reasonable level of certainty. Through the identification of various indicators of weather systems, and by tracking these indicators, warning time for snow storms can be as much as a week in advance. However, subtle shifts in the track of the low pressure center can radically change storm totals from predictions as little as 12-hours earlier from "little to no snow" to 18-inches. Understanding the historical frequency, duration, and spatial extent of severe winter weather assists in determining the likelihood and potential severity of future occurrences. The characteristics of past severe winter events provide benchmarks for projecting similar conditions into the future. The probability that Thornton, Federal Heights, and Northglenn will experience a severe winter storm event can be difficult to quantify. However, based on historical records and frequencies there is nearly a 100% chance of this type of event will occur somewhere within the planning area at least once every year.

Winter Storms and Climate Change

As a result of global climate change, the United States is already experiencing more intense rain and snowstorms. The amount of snow falling in the heaviest one percent of storms has risen nearly 74%, averaged nationally, between 1958 and 2011.[9] As the planning area prepares for regional changes in climate, it will be important to consider scenarios in which larger amounts of snow will fall over shorter periods of time. The impacts have the potential to affect infrastructure, public safety, and the local economy in a diversity of (potentially) negative ways including higher levels of precipitation per storm event as well as soil instability due to drought.

Land Use and Development

All future structures built in in the planning area will be exposed to severe weather. As development pressures increase and new construction speeds up in the area over time Thornton, Northglenn, and Federal Heights must continue to adhere the best available building code standards to account for the impacts of adverse weather.

[9] T*hird U.S. National Climate Assessment*, 2014. U.S. Global Change Research Program.

3.11 Wildland Fire

Hazard Identification

Wildfires are defined as unwanted or unplanned wildland fires. They include unauthorized human caused fires, escaped prescribed burn projects, and all other wildland fires where the objective is to put the fire out.

Wildfires are fueled by natural ground cover, including native and non-native species of trees, brush and grasses, and crops along with weather conditions and topography. While available fuel, topography, and weather provide the conditions that allow wildfires to spread, most wildfires are caused by people through criminal or accidental misuse of fire.

Wildfires pose serious threats to human safety and property in the cities of Thornton, Federal Heights and Northglenn. They can destroy crops, timber resources, recreation areas, and critical wildlife habitat, as well as increase air pollution. Wildfires are commonly perceived as hazards in the western part of the state; however, wildfires are a growing problem in the wildland-urban interfaces of eastern Colorado, including communities within the cities of Thornton, Federal Heights and Northglenn.

Wildfire behavior is dictated in part by the quantity and quality of available fuels. Fuel quantity is the mass of material per unit area. Fuel quality is determined by a number of factors, including fuel density, chemistry, and arrangement. Arrangement influences the availability of oxygen surrounding the fuel source. Another important aspect of fuel quality is the total surface area of the material that is exposed to heat and air. Fuels with large area-to-volume ratios, such as grasses, leaves, bark and twigs, are easily ignited when dry.

Climatic and meteorological conditions that influence wildfires include solar insulation, atmospheric humidity, and precipitation, all of which determine the moisture content of wood and leaf litter. Dry spells, heat, low humidity, and wind increase the susceptibility of vegetation to fire. Additional natural agents can be responsible for igniting wildfires, including lightning, sparks generated by rocks rolling down a slope, friction produced by branches rubbing together in the wind, and spontaneous combustion.

Arson and accidents, including sparks from equipment and vehicles, can also cause wildfires. Human-caused wildfires are typically worse than those caused by natural agents. Arson and accidental fires usually start along roads, trails, streams, or at dwellings that are generally on lower slopes or bottoms of hills and valleys. Nurtured by updrafts, these fires can spread quickly uphill. Arson fires are often set deliberately at times when factors such as wind, temperature, and dryness contribute to the spread of flames.

Hazard Impacts

Local impacts from wildfire events include the following:

- Loss of life (human, livestock, wildlife)
- Damage to municipal watersheds
- Loss of property
- Evacuations
- Transportation interruption (closing highways)

- Reductions in air quality and human health
- Injuries – burns, smoke inhalation, etc.
- Coal seam or other energy facility ignitions
- Loss of vegetation (erosion, loss of forage and habitat for livestock and wildlife)
- Expense of responding (equipment, personnel, supplies, etc.)
- Loss of revenue from destroyed recreation and tourism areas

Predicting the intensity of a wildfire, its rate of spread, and its duration are important for wildfire mitigation activity, response, and firefighter safety. Three key factors affect wildfire behavior in the WUI:

1. *Fuels:* The type, density, and continuity of surrounding vegetation and, sometimes, flammable structures, that provide fuel to keep a wildfire burning. Fuels consist of combustible materials and vegetation (including grasses, leaves, ground litter, plants, shrubs, and trees) that feed a fire.

2. *Weather:* Relative humidity, wind, and temperatures all affect wildfire threat and behavior.

3. *Topography:* The steepness and aspect (direction) of slopes, as well as building-site locations, are features that affect fire behavior.

Very often the only factor that a community can have direct influence over is fuel.

Wildfires are often rated based on their ability of their fuels to ignite. Descriptions for the commonly used "Fire Danger Rating" system are listed below:

- **Low:** Fuels do not ignite readily from small firebrands. However, an intense heat source, such as lightning, may start fires in duff or rotted wood. Fires in open grasslands may burn freely for a few hours after rain, but wood fires spread slowly by creeping or smoldering, and burn in irregular fingers. There is little danger of spotting.
- **Moderate:** Fires can start from most accidental causes, with the exception of lightning. Fires in open grasslands will burn briskly and rapidly on windy days. Timber fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel may burn hot. Short-distance spotting may occur. Fires are not likely to become serious and control is relatively easy.
- **High:** All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short-distance spotting is common. High-intensity burning may develop on slopes or in concentrations of fine fuels. Fires may become serious and their control difficult unless they are attacked successfully while small.
- **Extreme/Very High:** Fires start easily from all causes and immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop intensity characteristics such as long-distance spotting and fire whirlwinds when they burn into heavier fuels.

Long-term weather patterns in the cities of Thornton, Federal Heights and Northglenn have followed a cyclical pattern of wet years (characterized by average to high precipitation levels for the region), followed by a series of drought years (characterized by below average precipitation levels). During wet years, the typical fire season is from March through November. During drought years, the fire season in Colorado has been as long as a full year.

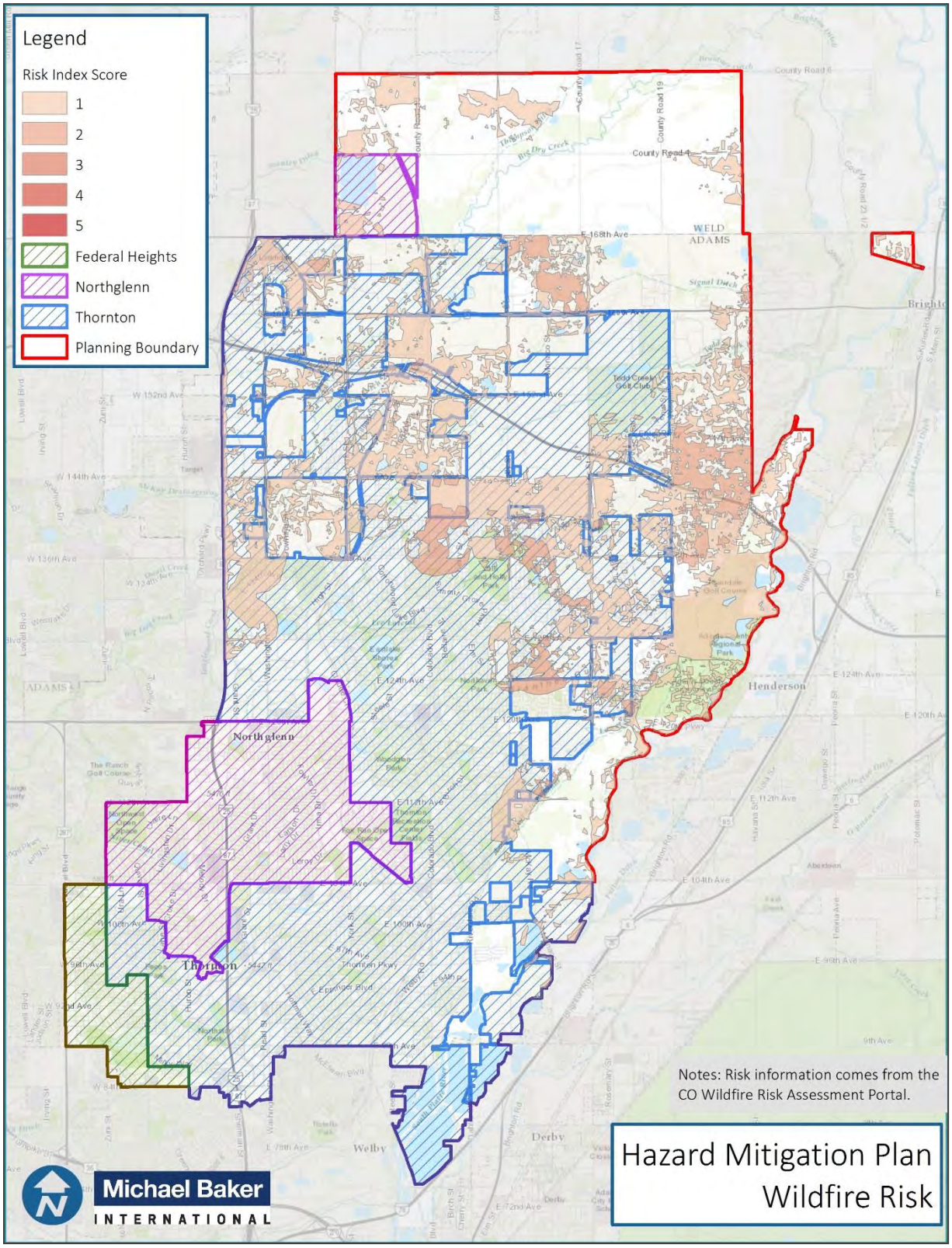
Previous Occurrences

According to the NCEI Storm Events Database there have been no historic wildfire events recorded in the Cities of Thornton, Federal Heights, and Northglenn. However, wildland fires have the potential to threaten people and property on the outskirts of the planning area. As continued population growth pushes community assets into wildland-urban interface areas new challenges will be presented to Front Range communities.

The Colorado Wildfire Risk Assessment Portal (aka COWRAP) is the primary mechanism for the Colorado State Forest Service to collect, analyze, and deploy risk information about wildfire issues across the state. Not only is the purpose of COWRAP to create awareness about wildfire risk, it is also designed to provide baseline data needed to support mitigation activity and wildfire prevention in diverse communities across Colorado. COWRAP was the primary source of information used for the 2017 Thornton, Federal Heights, and Northglenn wildland fire risk assessment.

“Wildfire Risk” represents the possibility of loss or harm occurring from a wildfire. For the purpose of this Plan, risk has been derived by combining “Wildfire Threat” and “Fire Effects.” Fire Effects is comprised of several inputs that identify damaged assets. These inputs include the following: information on where people live (derived from 2012 LandScan data from Colorado), Colorado forest assets, riparian assets, and drinking water assets. The following Wildfire Risk map identifies areas with the greatest potential impacts from a wildfire, in other words, those areas most at risk.

FIGURE 38. WILDFIRE RISK MAP



City of Thornton Northglenn Federal Heights

The Wildfire Risk Map displays the levels of wildfire risk within the Thornton, Federal Heights, and Northglenn planning area based on best available COWRAP data, which was taken at the statewide level. Risk levels have been broken out by scores of 1-5. As seen in the map, Thornton is the only community that is determined to be at risk for wildfire (with risk scores that range from 1-2). The planning areas' risk level is fairly low compared to other parts of the state.

Inventory Exposed

Fires can extensively impact the economy of an affected area, including the agricultural, recreation and tourism industries, water resources, and the critical facilities upon which the planning area depends.

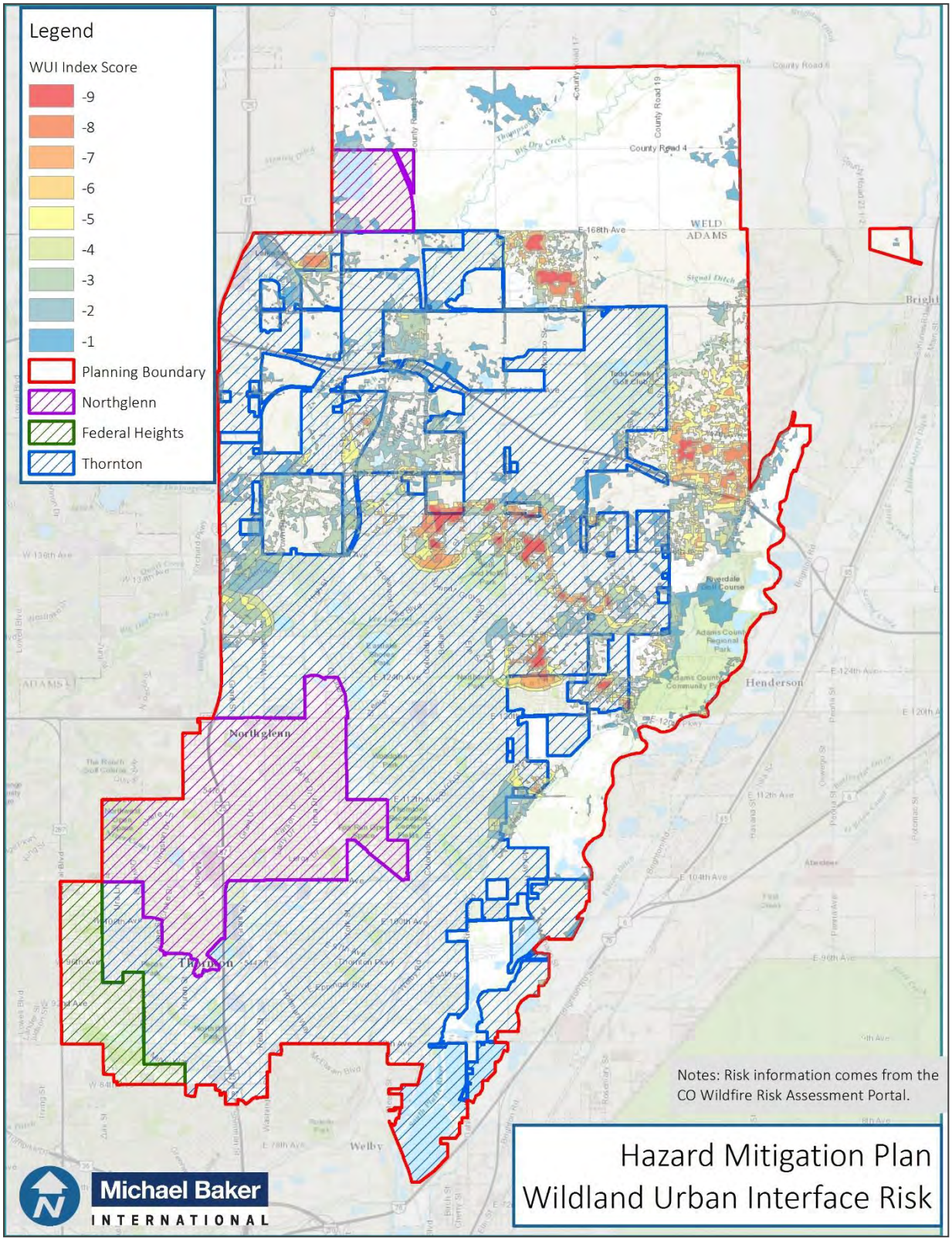
The term ''wildland-urban interface", or WUI, is widely used within the wildland fire management community to describe any area where manmade buildings are constructed close to or within a boundary of natural terrain and fuel, where high potential for wildland fires exist. Communities are able to establish the definition and boundary of their local WUI, and the boundaries often help in meeting local management needs. WUIs can include both public and private land, and can help improve local access to funding sources.

As was discussed previously, understanding the location of people living in the wildland-urban interface is essential for defining potential wildfire impacts to people and homes. The WUI Risk analysis provides a rating of the potential impact of a wildfire on people and their homes. The key input, the wildland-urban interface, reflects housing density (houses per acre).

To calculate WUI risk, COWRAP combined WUI housing density data with response function data. Response functions are a method of assigning a net change in the value of a resource or asset based on its susceptibility to fire at various intensity levels (such as flame length). The response functions were defined by a team of experts led by Colorado State Forest Service mitigation planning staff. By combining these data sets it is possible to determine where the greatest potential impact to homes and people are likely to occur in the planning area.

The following map shows the various levels of WUI Risk within the Cities of Thornton, Federal Heights, and Northglenn relative to a statewide assessment of WUI risk. The state-wide scale ranges from a value of -1 to -9, with -1 representing the least negative impacts and -9 representing the most negative impact. For example, areas with high housing density and high flame lengths are rated -9, while areas with low housing density and low flame lengths are rated -1. Understandably so, the map of WUI Risk shows a number of high risk areas concentrated around densely populated parts of the planning area. The 2017 Wildland-Urban Interface Risk map was developed for using the same methodology as the one included in the 2013 Colorado State Hazard Mitigation Plan. This allows for comparison and ordination to be made across the state.

FIGURE 39. PLANNING AREA WILDLAND URBAN INTERFACE RISK



City of Thornton Northglenn Federal Heights

The WUI Index Score can be summarized into three risk levels; low (-1 to -3), medium (-4 to -6), and high (-7 to -9). Based on the planning area wildfire risk analysis, there are over 2,100 identified parcels that overlap with the highest one third of the WUI Index (aka high risk areas). The appraised structural value of buildings on those parcels is collectively close to $775 million.

Potential Losses

Currently, there is no method for estimating future wildfire losses. In most cases, the emergency management community equates potential losses to assets exposed to wildfire as a method of quantifying and comparing potential losses across communities.

Probability of Future Occurrences

Wildfires can occur at any time of day and during any month of the year. Moreover, the length of a wildfire season and/or peak months may vary appreciably from year to year. Recent wildfires and brush fires across Colorado have forced school closures, disrupted telephone services by burning fiber optic cables, damaged railroads and other infrastructure, and adversely affected tourism, outdoor recreation, and hunting. The likelihood of one of those fires attaining significant size and intensity within the planning area is highly unlikely. That said, weather conditions, particularly drought events, increase the likelihood of wildfires occurring.

It is important to note that 98% of wildfires are human-caused. Ultimately, the occurrence of future wildfire events will strongly depend on patterns of human activity and events are more likely to occur in wildfire-prone areas experiencing new or additional development.

Wildland Fire and Climate Change

Land use, vegetation, available fuels, and weather conditions (including wind, low humidity, and lack of precipitation) are chief factors in determining the number of fires and acreage burned in Colorado each year. Generally, fires are more likely when vegetation is dry from a winter with little snow and/or a spring and summer with sparse rainfall. For these reasons, climate change in Colorado (specifically, a pattern of extended drought conditions) had contributed to increased concern about wildfire in the Cities of Thornton, Federal Heights, and Northglenn.

The frequency, intensity, and duration of wildfires have increased across the Western United States since the 1980s. A 2012 federal report released by the U.S. Department of Agriculture found that the Colorado region, among others, will face an even greater fire risk over time. The report expects Colorado to experience up to a five-fold increase in acres burned by 2050.[10] The report's findings are consistent with previous studies on the relationship between climate change and fire risk. Colorado landscapes, including those that characterize the Cities of Thornton, Federal Heights, and Northglenn, are expected to become hotter and drier as the planet warms, which will in turn increase regional wildfire risk.

Land Use and Development

Future development is an important factor to consider in the context of wildfire mitigation because development and population growth can contribute to increased exposure of people and property to

[10] US Department of Agriculture. Effects of Climate Variability and Change on Forest Ecosystems. General Technical Report, December 2012

wildfire. Although Northglenn and Federal Heights are not expected to expand a great deal in the future, during the past few decades' population growth in the planning area WUI has increased greatly. Subdivisions and other high-density developments have created a situation where wildland fires can involve more buildings and people. By identifying areas with significant potential for population growth and/or future development in high-risk areas, communities can identify areas of mitigation interest and reduce hazard risks associated with increased exposure.

4. Social Vulnerability

The local vulnerability to disasters depends on more than the relationship between a place and its exposure to hazards. Social and economic factors – including race, age, income, renter status, or institutionalized living – directly affect a community's ability to prepare for, respond to, and recover from hazards and disasters. The concept of social vulnerability helps explain why communities often experience a hazard event differently, even when they experience the same amount of physical impacts or property loss.

Social vulnerability to disasters refers to *"the characteristics and situation of a person or group that influence their capacity to anticipate, cope with, resist, or recover from the impact of a hazard"*[11]. It is determined by a number of pre-existing social and economic characteristics. Very often, the impacts of hazards fall disproportionately on the most disadvantaged or marginalized people in a community – the poor, children, the elderly, the disabled, and minorities. During emergencies, for example, self-evacuation can be nearly impossible for disabled or institutionalized individuals. Additionally, the willingness of an individual/family to invest in residential mitigation actions is often limited if their home is a rental and they are adverse to investing money in long-term mitigation activity. Not only do conditions like these limit the ability of some communities to get out of harm's way, they also decrease the ability of communities to recover from and thrive in the aftermath of a disaster event.

The 2017 Plan integrates social vulnerability into the hazard risk analysis in order to more effectively identify hazard risk experienced by the most vulnerable residents and communities within the county. The social vulnerability assessment is designed to improve local decision making, hazard prioritization, and emergency management activities. By incorporating social vulnerability into the risk assessments of individual hazards, local communities are able to identify more vulnerable areas and tailor their mitigation actions to accommodate all members of their community, including the most sensitive groups.

The pre-existing social conditions that contribute to disaster losses can be identified using social vulnerability indicators. Using methods identified in the Social Vulnerability Index (SoVI) developed by Cutter et. al. (2003)[12], a county-wide social vulnerability analysis was carried out at the census tract level. Local socioeconomic and demographic data were used to identify spatial patterns in social vulnerability across the county and have been applied to the hazards in the 2017 Thornton, Federal Heights, and Northglenn Multi-Jurisdictional Hazard Mitigation Plan.

The table below outlines the social vulnerability indicators that were used in the Thornton, Federal Heights, and Northglenn social vulnerability analysis. Indicators with plus signs (+) are positively related to social vulnerability levels. For example, communities with higher percentages of people 65 years or older have higher levels of social vulnerability to disasters. Indicators with minus signs (-) are negatively related to social vulnerability levels. For the purpose of the Thornton, Federal Heights, and Northglenn

[11] Wisner, B., Blaikie, P., Cannon, T., Davis, I. (2004). At Risk: Natural Hazards, People's Vulnerability and Disasters. London: Routledge.

[12] Cutter, S.L., Boruff, B.J., and Shirley, W.L. (2003). Social Vulnerability to Environmental Hazards. *Social Science Quarterly*, 84:242-261.

Multi-Jurisdictional Hazard Mitigation Plan, each social vulnerability factor was weighted equally in the Social Vulnerability Index.

TABLE 35. SOCIAL VULNERABILITY INDICATORS – LARIMER COUNTY, CO

Social Vulnerability Factors	Indicators
Age/Elderly	• Children (Age 18 and under) (+) • Elderly (Age 65 and over) (+) • Social Security Recipients, % Population (+) • Renter Occupied, % HH (+) • Median Age
Special Needs	• Group Quarters, % Population (+) • Mobile Homes, % OCHH (+) • 5 years old, % Population (+) • Age 18 and under (+)
Ethnicity	• Hispanic, % Population (+) • Native American, % Population (+) • Other Races, % Population (+) • Pacific Islander, % Population (+) • Linguistically Isolated, % Population (+)
Race, Class, Poverty	• African American Population, % Population(+) • Female Headed Households, % HH (+) • No Vehicles, % HH (+) • No High School Diploma, % Over 25 years old (+) • Poverty, % Population • Unemployment Rate (+)
Wealth	• Asian, % Population (-) • Household earnings greater than $200K, % HH (-) • Housing Density (+) • Per-Capita Income (-) • Population Density (+) • White, % Population

Social vulnerability is represented as the social, economic, demographic, and housing characteristics that influence a community's ability to respond to, cope with, recover from, and adapt to hazard events. The pre-existing social conditions that contribute to disaster losses can be identified using social vulnerability indicators. Using methods identified in the Social Vulnerability Index (SVI) Documentation (2014), this layer shows the social vulnerability index scores for the State of Colorado at the census tract level. Additional information social vulnerability can be found in the community profiles sections of this report (Appendices A, B, and C). As seen in the maps, there are five classes of vulnerability: Low (0), Medium-Low (1-2), Medium (3-4), Medium-High (5-6), and High (7-8).

5. Mitigation Strategy

The intent of the Mitigation Strategy is to provide the participating jurisdictions with the goals that will guide future mitigation policy and project administration. The Mitigation Strategy includes a list of proposed actions deemed necessary to meet those goals and reduce the impact of natural hazards. The development of the strategy included a thorough review of natural hazards and identified policies and projects intended to not only reduce the future impacts of hazards, but also to help each community balance and achieve their economic, environmental, and social goals. The development of the Mitigation Strategy was strategic, in that all goals and resulting mitigation projects/actions have been linked to establish priorities. Moreover, when possible, projects have been assigned to specific departments or individuals responsible for their implementation. Potential funding sources are identified when possible and identified projects were assumed to be realistically achievable over the next five years.

- Mitigation Goals are general guidelines that explain what the cities want to achieve. Goals are usually expressed as broad policy statements representing desired long-term results.
- Mitigation Projects/Actions provide more detailed descriptions of specific work tasks to help the participating communities achieve prescribed goals.

Based on participation from the small team, the mitigation strategy from the 2010 Denver Metro Natural Hazard Mitigation Plan has been modified and updated individually for each of the jurisdictions. Previously identified project statuses were updated and new ones have been added to address particular hazards facing participating communities in 2016. These strategies, reporting on past projects, and newly identified projects are contained in each cities individual community profile located in Appendixes A, B, and C of this document.

In order to prioritize the mitigation actions in this plan, each participating jurisdiction was provided an overview of FEMA's STAPLEE methodology as a guide. The STAPLEE approach allows for a careful review of the feasibility of mitigation actions by using seven criteria. The criteria are described below:

- *S – Social*
- *T – Technical*
- *A – Administrative*
- *P – Political*
- *L – Legal*
- *E – Economic*
- *E – Environmental*

FEMA mitigation planning requirements indicate that any prioritization system used shall include a special emphasis on the extent to which benefits are maximized according to a cost-benefit review of the proposed projects. To do this in an efficient manner that is consistent with FEMA's guidance on using cost-benefit review in mitigation planning, each jurisdiction ranked its mitigation projects/actions with these factors in mind.

In order to ensure that a broad range of mitigation projects were considered for the Mitigation Strategy, the planning team analyzed a comprehensive range of specific mitigation projects for each hazard after the risk assessment was complete. This helped to ensure that there was sufficient span and creativity in the mitigation actions considered.

There are six categories of mitigation actions which each community considered in developing its Mitigation Strategy. Those categories include:

- **Prevention**: Government administrative or regulatory actions or processes that influence the way land and buildings are developed and built. These actions also include public activities to reduce hazard losses. Examples include planning, zoning, building codes, subdivision regulations, hazard specific regulations (such as floodplain regulations), capital improvement programs, and open-space preservation and stormwater regulations.
- **Property Protection**: Actions that involve modifying or removing existing buildings or infrastructure to protect them from a hazard. Examples include the acquisition, elevation and relocation of structures, structural retrofits, flood-proofing, storm shutters, and shatter resistant glass. This category also includes insurance.
- **Public Education and Awareness:** Actions to inform and educate citizens, elected officials, and property owners about potential risks from hazards and potential ways to mitigate them. Such actions include hazard mapping, outreach projects, library materials dissemination, real estate disclosures, the creation of hazard information centers, and school age / adult education programs.
- **Natural Resource Protection**: Actions that in addition to minimizing hazard losses also preserve or restore the functions of natural systems. These actions include sediment and erosion control, stream corridor restoration, forest and vegetation management, wetlands restoration or preservation, slope stabilization, and historic property and archeological site preservation.
- **Structural Project Implementation**: Mitigation projects intended to lessen the impact of a hazard by using structures to modify the environment. Structures include stormwater controls (culverts); dams, dikes, and levees; and safe rooms.
- **Emergency Services**: Actions that typically are not considered mitigation techniques but reduce the impacts of a hazard event on people and property. These actions are often taken prior to, during, or in response to an emergency or disaster. Examples include warning systems, evacuation planning and management, emergency response training and exercises, and emergency flood protection procedures.

Summary of Goals

Mitigation Goals are general guidelines that explain what a community wants to achieve with their local hazard mitigation plan. Goals are overarching targets and describe the ideal long-term outcomes envisioned by the community.

A set list of unique goals were established by each of the three jurisdictions after reviewing the Colorado State HMP, the Denver Regional Natural Hazard Mitigation Plan, and neighboring jurisdictional HMP goals. These can be found within the respective community profiles located in Appendixes A, B, and C.

2010 Hazard Mitigation Plan Actions

The HMP small team was tasked with reviewing mitigation projects included in the 2010 Denver Metro NHMP. Although the City of Northglenn was not included in the 2010 NHMP plan, the Cities of Thornton and Federal Heights had specific mitigation projects created for their communities. These can be found within the respective community profiles located in Appendixes A, B, and C.

2017 Mitigation Actions

As part of the 2017 planning process, the Cities identified a number of mitigation projects/actions that align with their newly identified Mitigation Goals. Focus was paid to ensure that each jurisdiction's highest risk hazards were mitigated against. To attempt to highlight these project and actions, Mitigation Action Guides (MAGs) were developed. These one-page documents were designed to be able to capture a breadth of project-related background information, when available, to assist with project implementation as staffing and funding allow. An example MAG template is included on this page.

The following pages document those MAGs that are not focused on any single jurisdiction, instead relating to the entire planning area or projects that are being led by non-jurisdictional entities. Jurisdictional-specific MAGs are included in the following community profiles found in Appendixes A, B, and C.

FIGURE 40. MITIGATION ACTION GUIDE (MAG)

Mitigation Action Guide

Mitigation Action Guides (MAGs) provide an in-depth explanation of priority mitigation projects that have been identified during the local hazard mitigation planning process. MAGs link jurisdiction- or organization-specific mitigation projects or initiatives to locally assigned implementation strategies. MAGs facilitate project implementation and plan maintenance over time.

City or Organization: **Project Name:**	
PRIORITY: (High, Med, Low)	**HAZARDS ADDRESSED:** Please list the hazards that are intended to be mitigated by the proposed project. Drought, Earthquake, Extreme Temperatures, Flood, Expansive Soils / Undermined Areas, Severe Storms, Public Health Hazards, Tornado / Severe Wind, Winter Storm, Wildland Fire
LOCATION: Project location	**PLANNING GOALS ADDRESSED:** Which 2016 LHMP goals does this project address?
RECOMMENDATION DATE: xx/xx/2016	
TARGET COMPLETION DATE: xx/xx/20xx	
OBJECTIVES ADDRESSED: Include a brief description of the issue/concern that this proposed project is focused on resolving/mitigating	
ACTION: Describe exactly 'what' this project involves.	
LEAD AGENCY: Who will be in charge of making sure this project moves forward and is tracked over time (be specific)?	**EXPECTED COST:** Provide a best estimate of cost at this time (dollars and/or staffing time).
SUPPORT AGENCIES: Who will support the Lead Agency in making sure this project moves forward and is tracked over time (be specific)?	**POTENTIAL FUNDING SOURCES:** List all potential funding sources, be as specific as possible.
PROGRESS MILESTONES: List any major anticipated project milestones and/or reports about current project status.	

Mitigation Action Guide

City or Organization: Adams County **Project Name: (AdCo1) Regional Park Sheltering**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** Thunderstorms, Tornados, Flooding
LOCATION: Adams County Regional Park	**PLANNING GOALS ADDRESSED:** • Protect people, property, and natural resources • Improve capability to reduce disaster losses
RECOMMENDATION DATE: 09/30/2012	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: There is no safe room at the Adams County Regional Park. The park is the largest event center in unincorporated Adams County as well as the secondary location for the Alternative Care Facility. Rapid egress of citizens from the park is not possible due to roadway issues.	
ACTION: Review funding options as well as storm shelter alternatives (retrofitting or new construction) to provide Safe Rooms at the Adams County Regional Park. Provide adequate sheltering for severe storms and tornados. Currently, the park does not have adequate structures or facilities to shelter citizens during a significant weather event requiring immediate sheltering for life safety.	
LEAD AGENCY: Adams County Parks	**EXPECTED COST:** TBD
SUPPORT AGENCIES: None	**POTENTIAL FUNDING SOURCES:** General Fund, Grants
PROGRESS MILESTONES: Identification of potential funding and evaluation of options available for retrofit or additions of storm water facilities.	

Mitigation Action Guide

City or Organization: Adams County **Project Name: (AdCo2) Communications Plan for Critical Facilities within Adams County**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** Thunderstorms, Tornados, Flooding, Earthquakes, Severe Winter Storms, Earthquakes, Wildland Fire.
LOCATION: Countywide	**PLANNING GOALS ADDRESSED:** • Protect people, property, and natural resources • Improve capability to reduce disaster losses • Ensure that functionality of local critical facilities are maintained in the event of a disaster • Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens • Integrate hazard mitigation into other planning mechanisms
RECOMMENDATION DATE: 09/30/2012	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: **The ability to communicate with all critical facilities within the County during and after an emergency event is critical to the response and recovery of the community as well as overall safety of the community.**	
ACTION: Investigate the options and develop a communication plan for critical facilities with input and assistance from County personnel including, but not limited to, County Emergency Management, Emergency Medical Services (EMS), Tri-County Health Department, care facilities, hospitals, Adams County schools, and others. Investigate and develop a communications plan with the at-risk population facilities. More specifically, facilities with large numbers of residents currently are not effectively connected to receive notification, warning, and information from the County Emergency Operations Center (EOC). In order to provide proper situational information and resources for public health needs, a communication plan any system are required. Investigate improved emergency communications systems with Adams County schools. County schools own their own communication systems to connect internally within their district. School districts within Adams County sit within multiple different municipal jurisdictions and are not effectively connected to receive notification, warning, and information from the County EOC. In order to provide proper situation information and resources to the schools and the communities they serve, a communication plan and system are required. Emergency Medical Services (EMS) lead is needed for proper Public Health/Hospital Coordination. EMS agencies are a part of the Public Health Plan, but due to statutory provisions, there is no lead EMS agency at the state or local level. While legislation is needed to rectify on a state scale, Adams County requires a communication plan to effectively coordinate EMS agencies during any event where multiple EMS agencies are involved.	
LEAD AGENCY: Adams County Office of Emergency Management and the Adams County Information Technology Department	**EXPECTED COST:** TBD

SUPPORT AGENCIES:	**POTENTIAL FUNDING SOURCES:**
Tri-County Health Department	Adams County General Fund, Tri-County Health Department, Grants
PROGRESS MILESTONES:	
Develop and maintain a current accurate critical facilities database to use in emergency planning efforts as related to at-risk facilities and schools. Identify processes and procedures. Investigate current resources and capabilities.	

Mitigation Action Guide

City or Organization: Adams County **Project Name: (AdCo3) Develop Recovery Plan Integrate Emergency Plan and Comprehensive Plan**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Flooding, Severe Storms, Drought, Tornado, Wildland Fire, Subsidence, Earthquake
LOCATION: Countywide	**PLANNING GOALS ADDRESSED:** • Protect people, property, and natural resources • Improve capability to reduce disaster losses • Ensure that functionality of local critical facilities are maintained in the event of a disaster • Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens • Increase public awareness of natural hazards and mitigation options • Integrate hazard mitigation into other planning mechanisms
RECOMMENDATION DATE: 09/30/2012	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED:	
ACTION: Assess the update cycle of the County Emergency Operations Plan and associated annexes as they support the County Comprehensive Plan. Determine activities to ensure that all plans are current and coordinated with the hazard mitigation and hazard identification and risk assessment process and the Comprehensive Plan.	
LEAD AGENCY: Adams County Office of Emergency Management	**EXPECTED COST:** TBD
SUPPORT AGENCIES: None	**POTENTIAL FUNDING SOURCES:** Adams County general fund and Emergency Management grants.
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: Adams County **Project Name: (AdCo4) Dispatch Coordination**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Flooding, Severe Storms, Drought, Tornado, Wildland Fire, Subsidence, Earthquake
LOCATION: Countywide	**PLANNING GOALS ADDRESSED:** • Protect people, property, and natural resources • Improve capability to reduce disaster losses • Ensure that functionality of local critical facilities are maintained in the event of a disaster • Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens
RECOMMENDATION DATE: 09/30/2012	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED:	
ACTION: Integrate NetCAD capabilities into Emergency Operations Center (EOC) operations for incident dispatch and coordination between dispatching agencies. Adams County has five different dispatching agencies that operate off the CAD system. Emergency managers operate off the WebEOC. These systems need coordination so as to better manage situational information and resource ordering between jurisdictions within the County.	
LEAD AGENCY: Adams County Office of Emergency Management	**EXPECTED COST:** $200,000
SUPPORT AGENCIES: None	**POTENTIAL FUNDING SOURCES:** Adams County general fund and Emergency Management grants.
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: Adams County **Project Name: (AdCo5) Early Warning Systems**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** Thunderstorms, Tornados, Flooding, Wildland Fire
LOCATION: Countywide	**PLANNING GOALS ADDRESSED:** • Protect people, property, and natural resources • Improve capability to reduce disaster losses • T4 - Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens • Increase public awareness of natural hazards and mitigation options
RECOMMENDATION DATE: 09/30/2012	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Adams County does not have an effective and well-advertised means of providing citizens and businesses with information during natural disasters or recovery operations. While some systems exist, they are not effectively practiced and integrated in a way that provides effective notification.	
ACTION: Investigate warning systems for unincorporated Adams County. Examine First Call, Notify Me, and others which would provide effective notification to citizens and businesses.	
LEAD AGENCY: Adams County Office of Emergency Management, Management and Administration, Communications Group	**EXPECTED COST:** $200,000 (Estimated)
SUPPORT AGENCIES: None	**POTENTIAL FUNDING SOURCES:** General Fund, Grants
PROGRESS MILESTONES: Identifying options, securing grant funding, developing a marketing strategy.	

Mitigation Action Guide

City or Organization: Adams County **Project Name: (AdCo6) Ensure Uninterrupted Communications between County Departments During Emergencies**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Flooding, Severe Storms, Drought, Tornado, Wildland Fire, Subsidence, Earthquake
LOCATION: Countywide	**PLANNING GOALS ADDRESSED:** • Protect people, property, and natural resources • Improve capability to reduce disaster losses • Ensure that functionality of local critical facilities are maintained in the event of a disaster • Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens
RECOMMENDATION DATE: 09/30/2012	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED:	
ACTION: Determine which County facilities currently have radios, assess the appropriateness and feasibility of hardwiring, and investigate other options to ensure constant and uninterrupted communications is maintained during critical events. Address the internal department communications to integrate Public Works, Assessors, and First Responders.	
LEAD AGENCY: Adams County Human Resources (Risk Management) and Adams County Office of Emergency Management	**EXPECTED COST:** TBD
SUPPORT AGENCIES: None	**POTENTIAL FUNDING SOURCES:** Adams County general fund and Emergency Management grants.
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: Adams County **Project Name: (AdCo7) Hazard Mitigation Steering Committee**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Flooding, Severe Storms, Drought, Tornado, Wildland Fire, Subsidence, Earthquake
LOCATION: Countywide	**PLANNING GOALS ADDRESSED:** • Protect people, property, and natural resources • Improve capability to reduce disaster losses • Integrate hazard mitigation into other planning mechanisms
RECOMMENDATION DATE: 09/30/2012	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED:	
ACTION: Broaden and formalize the participation of the Hazard Mitigation Steering Committee to include City representatives and partner organizations. Educate them on the importance of their participation in the plan development process, updates, and other periphery endeavors.	
LEAD AGENCY: Adams County Office of Emergency Management	**EXPECTED COST:** TBD
SUPPORT AGENCIES: None	**POTENTIAL FUNDING SOURCES:** Adams County general fund and Emergency Management grants.
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: Adams County **Project Name: (AdCo8) Hazardous Materials Facilities Planning and Regulation**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** Flooding, Severe Storms, Tornados, Drought, Earthquake, Subsidence, Wildland Fire
LOCATION: Countywide	**PLANNING GOALS ADDRESSED:** • Protect people, property, and natural resources • Improve capability to reduce disaster losses • Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens
RECOMMENDATION DATE: 09/30/2012	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: **There are fewer than 200 facilities in Adams County that store or manufacture hazardous materials. Many of these facilities are currently located proximate to residential and institutional land uses as well as critical facilities.**	
ACTION: Investigate the various methods of regulating incompatible land uses. 1. Review of existing zoning regulations. 2. Investigate a new zoning classification, performance standards, buffering requirements for critical facilities from schools, special needs facilities, and critical infrastructure. 3. Develop policies for a coordinated review process internal to the County for all Tier II facilities. 4. Develop integration opportunities between the Local Emergency Planning Committee (LEPC) and the Adams County Planning Commission.	
LEAD AGENCY: Adams County Planning and Development	**EXPECTED COST:** Staff time.
SUPPORT AGENCIES: None	**POTENTIAL FUNDING SOURCES:** Adams County General Fund, Grant Funds
PROGRESS MILESTONES: Establish a project team including representatives from various impacted and impacting County departments as well as community representatives and analyze the existing situation and potential situations. Make an informed recommendation to the Planning Commission of next steps.	

Mitigation Action Guide

City or Organization: Adams County **Project Name: (AdCo9) Hoffman Drainage Way Improvements**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Flooding
LOCATION: Countywide	**PLANNING GOALS ADDRESSED:** • Protect people, property, and natural resources • Improve capability to reduce disaster losses
RECOMMENDATION DATE: 09/30/2012	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED:	
ACTION: Enlarge undersized creek watercourse in order to remove the more than 20 structures form the 100 year floodplain.	
LEAD AGENCY: Adams County	**EXPECTED COST:** $8,500,000 (approx.)
SUPPORT AGENCIES: Urban Drainage and Flood Control District City of Thornton	**POTENTIAL FUNDING SOURCES:** Adams County general fund, Urban Drainage and Flood Control District, FEMA Hazard Mitigation Funds
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: Adams County **Project Name: (AdCo10) Little Dry Creek Flood Mitigation**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Flooding
LOCATION: Countywide	**PLANNING GOALS ADDRESSED:** • Protect people, property, and natural resources • Improve capability to reduce disaster losses
RECOMMENDATION DATE: 09/30/2012	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED:	
ACTION: Since the Little Dry Creek is close to residential areas that are within the floodplain, property improvements include reconstruction and elevation of 68th Avenue and creating a park that will incorporate a regional detention pond which will help mitigate potential flooding of existing residences and provide recreational opportunities for Adams County citizens.	
LEAD AGENCY: Adams County	**EXPECTED COST:** $17.7 million (approx.)
SUPPORT AGENCIES: Urban Drainage and Flood Control District City of Westminster	**POTENTIAL FUNDING SOURCES:** Adams County general fund, Urban Drainage and Flood Control District, City of Westminster
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: Adams County **Project Name: (AdCo11) Municipal Intergovernmental Agreements (IGAs) for Preparedness Partnerships**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** Thunderstorms, Tornados, Flooding, Earthquakes, Severe Winter Storms, Earthquakes, Wildland Fire.
LOCATION: Countywide	**PLANNING GOALS ADDRESSED:** • Protect people, property, and natural resources • Improve capability to reduce disaster losses • Ensure that functionality of local critical facilities are maintained in the event of a disaster • Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens • Increase public awareness of natural hazards and mitigation options • Integrate hazard mitigation into other planning mechanisms
RECOMMENDATION DATE: 09/30/2012	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: **Currently, other than what is provided in the State Mutual Aid Agreements, there are no formalized IGAs related to preparedness actions and response costs.**	
ACTION: Develop formal agreements. The development of a countywide IGA to integrate preparedness actions and response costs were not otherwise provided in state mutual aid agreements. Such IGA would provide for staffing of EOC recourses, damage assessment teams, public works trucks, and other equipment and labor pools.	
LEAD AGENCY: Adams County Office of Emergency Management	**EXPECTED COST:** $25,000
SUPPORT AGENCIES: None	**POTENTIAL FUNDING SOURCES:** Adams County General Fund
PROGRESS MILESTONES: Active participation from each municipality within Adams County.	

Mitigation Action Guide

City or Organization: Adams County **Project Name: (AdCo12) Public Education and Awareness Campaign**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** Flooding, Severe Storms, Tornados, Drought, Earthquake, Subsidence, Wildland Fire
LOCATION: Countywide	**PLANNING GOALS ADDRESSED:** • Protect people, property, and natural resources • Improve capability to reduce disaster losses • Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens • Increase public awareness of natural hazards and mitigation options
RECOMMENDATION DATE: 09/30/2012	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: **A collaborative effort between Adams County and the communities within it is needed to better prepare and protect the citizens of Adams County from future hazard events.**	
ACTION: Initiate with municipalities and businesses a collaborative emergency management public education and information program. Investigate effective marketing strategies needed to provide education and information. 1. Design a program to encourage residents and businesses to take preparedness actions on their own behalf. The program should utilize and build upon communication platforms such as Youtube and webinars to educate the public on hazards at most risk to the community. 2. Work with county businesses to develop disaster-resistant business programs. 3. Develop public education and outreach to address ADA requirements for those who have access and functional needs. 4. Develop multi-lingual disaster education for fundamental needs preparedness into the community.	
LEAD AGENCY: Adams County Office of Emergency Management	**EXPECTED COST:** Staff time.
SUPPORT AGENCIES: None	**POTENTIAL FUNDING SOURCES:** Adams County General Fund, FEMA Grant Funds
PROGRESS MILESTONES: Develop a partnership team with representatives from the County, incorporated communities, county businesses, etc. with the purpose of reaching all segments of the County with emergency preparedness information and outreach.	

Mitigation Action Guide

City or Organization: Adams County **Project Name: (AdCo13) Redundant Emergency Operations Center (EOC) Communication System**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** Thunderstorms, Tornados, Flooding, Earthquakes, Severe Storms, Wildland Fire.
LOCATION: Countywide	**PLANNING GOALS ADDRESSED:** • Protect people, property, and natural resources • Improve capability to reduce disaster losses • Ensure that functionality of local critical facilities are maintained in the event of a disaster • Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens
RECOMMENDATION DATE: 09/30/2012	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: **Develop an internal county team to identify current and potential fail points in the current system as well as to access and develop recommendations to implement a secondary communications system to assure redundancy.**	
ACTION: Investigate the implementation of a redundant communication system in the Adams County EOC and the County Government Center where the EOC is located. The telephone system currently used is VOIP. Cell phone coverage is limited or non-existent in some areas and land lines into the government center do not currently exist. While ARES capabilities are present in the EOC, they are not sufficient to manager the volume that may be necessary to support a Type I or Type II incident.	
LEAD AGENCY: Adams County Office of Emergency Management and the Adams County Information Technology Department	**EXPECTED COST:** TBD
SUPPORT AGENCIES: None	**POTENTIAL FUNDING SOURCES:** General Fund, Grants
PROGRESS MILESTONES: Investigate current fail points and solutions. Develop and internal team for development implementation. Team should identify feasibility of backup power system, backup land lines, and capabilities of increasing cell phone coverage within the EOC.	

Mitigation Action Guide

City or Organization: Adams County **Project Name: (AdCo14) Regional Park Access**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** Thunderstorms, Tornados, Flooding, Severe Storms, Wildland Fire.
LOCATION: Adams County Regional Park Facilities	**PLANNING GOALS ADDRESSED:** • Protect people, property, and natural resources • Improve capability to reduce disaster losses
RECOMMENDATION DATE: 09/30/2012	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: **Current ingress and egress of the Adams County Regional Park facility is via a single point/route. Currently, the Regional Park is identified as the secondary location for and Alternative Care Facility and Local Transfer Point for a public health event. Additionally, the park is the largest event center in unincorporated Adams County and frequently hosts events with thousands of people in attendance.**	
ACTION: Develop, at minimum, at least one alternative point of ingress and egress to the Regional Park to ensure safe movement of personnel, visitors, and vehicles during an emergency event. Provide additional access to the Adams County Regional Park to improve emergency access.	
LEAD AGENCY: Adams County Parks	**EXPECTED COST:** TBD
SUPPORT AGENCIES: None	**POTENTIAL FUNDING SOURCES:** General Fund, Grants
PROGRESS MILESTONES: Develop opportunities and constraints analysis identifying alternative points of ingress and egress, right-of-way issues, ownership, etc.	

Mitigation Action Guide

City or Organization: Adams County **Project Name: (AdCo15) Regional Park Secondary Power**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Flooding, Severe Storms, Tornado, Wildland Fire, Earthquake
LOCATION: Countywide	**PLANNING GOALS ADDRESSED:** • Protect people, property, and natural resources • Improve capability to reduce disaster losses
RECOMMENDATION DATE: 09/30/2012	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED:	
ACTION: Investigate the implementation of a backup generator to help power the pump to the water supply.	
LEAD AGENCY: Adams County Parks	**EXPECTED COST:** TBD
SUPPORT AGENCIES: None	**POTENTIAL FUNDING SOURCES:** Adams County Parks
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: Adams County **Project Name: (AdCo17) Storm Water and Flood Control Master Planning**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** Flooding
LOCATION: Countywide	**PLANNING GOALS ADDRESSED:** • Protect people, property, and natural resources • Improve capability to reduce disaster losses • Ensure that functionality of local critical facilities are maintained in the event of a disaster
RECOMMENDATION DATE: 09/30/2012	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: **Initiate master planning efforts where necessary, implement storm drainage improvements and storm warning systems.**	
ACTION: Adequate drainage control is necessary to protect neighborhoods throughout the County. Berkley Outfalls – Provide adequate storm drainage to the Berkeley neighborhood. Kalcevik Gulch Storm Sewer – Provide adequate storm drainage to the Perl-Mack neighborhood in order to eliminate frequent flooding of Scott Carpenter Middle School. Western Hills – Provide adequate storm drainage to the Sherrlelwood and Welby neighborhoods; provide additional overflow capacity and warning system for Kalcevik Detention Pond in case of dam failure to protect at-risk residential properties.	
LEAD AGENCY: Adams County	**EXPECTED COST:** 1. $600,000 (approx.) 2. TBD 3. TBD
SUPPORT AGENCIES: Urban Drainage and Flood Control District	**POTENTIAL FUNDING SOURCES:** Adams County
PROGRESS MILESTONES: Master planning completed	

Mitigation Action Guide

City or Organization: Adams County **Project Name: (AdCo18) Uninterrupted Communications between County Departments During Emergencies**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Flooding, Severe Storms, Drought, Tornado, Wildland Fire, Subsidence, Earthquake
LOCATION: Countywide	**PLANNING GOALS ADDRESSED:** • Protect people, property, and natural resources • Improve capability to reduce disaster losses • Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens
RECOMMENDATION DATE: 09/30/2012	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: **Multiple areas within the County along rivers and creeks flood. Development of these areas will likely only exacerbate the flooding.**	
ACTION: Determine which County facilities currently have radios, assess the appropriateness and feasibility of hardwiring, and investigate other options to ensure constant and uninterrupted communications is maintained during critical events. Address the internal department communications to integrate Public Works, Assessors, and First Responders.	
LEAD AGENCY: Adams County Human Resources (Risk Management) and Adams County Office of Emergency Management	**EXPECTED COST:** TBD
SUPPORT AGENCIES: None	**POTENTIAL FUNDING SOURCES:** Adams County general fund and Emergency Management grants.
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: Adams 12 Five Star Schools **Project Name: Emergency Food Provider**	
PRIORITY: (High, Med, Low) Medium to High	**HAZARDS ADDRESSED:** Public Health Hazards Low level famine
LOCATION: Adams 12 Five Star Schools	**PLANNING GOALS ADDRESSED:** • Protect people, property, and natural resources • Improve capability to reduce disaster losses
RECOMMENDATION DATE: 06/20/2016	
TARGET COMPLETION DATE: 06/20/2017 The timeline can be discussed with options.	
OBJECTIVES ADDRESSED: Adams 12 Five Star schools has a responsibility to provide food to kids under a "free and reduced cost" to families that qualify in a "declaration of emergency" situation. If we are unable to provide those services to our students. We become an annex to the Thornton OEM, the Northglenn OEM, and the Adams County OEM. The Adams 12 school district does branch out into three other cities.	
ACTION: 1. Identify the costs and impact of interruption of services to the students for an extended timeline. 2. Investigate all options to support the school district during a "disaster". 3. Draw up an emergency plan with "trigger" points to help guide action.	
LEAD AGENCY: Unsure who will take the lead? Adams 12 School District	**EXPECTED COST:** TBD
SUPPORT AGENCIES:	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES: Scheduling of meetings.	

Mitigation Action Guide

City or Organization: City of Thornton, City of Northglenn, City of Federal Heights
Project Name: (TCHD1) Address Risks Associated with Climate Change

PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** Drought, Extreme Temperatures, Flood, Severe Storms, Public Health Hazards, Winter Storm, Wildland Fire
LOCATION: Throughout the Study Area	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster • N1 - Protect people, property, and natural resources • N2 - Improve capability to reduce disaster losses • N6 - Increase the city's resilience to hazards during all phases of the Emergency Management Cycle • N7 - Increase individual resilience to hazards • F1 - Improve capability to reduce disaster losses • F5 - Increase the city's resilience to hazards during all phases of the Emergency Management Cycle. • F6 - Increase individual resilience to hazards
RECOMMENDATION DATE: January 2015 – Colorado Climate Change Vulnerability Study	
TARGET COMPLETION DATE: TBD	

OBJECTIVES ADDRESSED:

Address risks associated with climate change, including heat-related illness due to frequency of number and severity of extreme heat days, negative air quality due to earlier spring pollen production, increased ozone due to higher temperatures, increased air particulates, loss of life and property, and water quality contaminants from more frequent wildfires, increase in infectious diseases due to extended seasons and expanded range for disease vectors, potential of loss of life and property and contamination of water supplies from flooding, increased competition for water supplies and reduced water quality including increase in pathogens that thrive in water due to drought, and higher food prices and increasing food insecurity for low-income families due to changing weather patterns.

ACTION:

The Colorado Climate Change Vulnerability Study produced by the University of Colorado and Colorado State University provides 35 recommendations divided into four categories: assessing, planning and managing for resilience; developing and sharing information; public engagement; and building capacity.

LEAD AGENCY: Cities of Thornton, Northglenn, and Federal Heights.	**EXPECTED COST:** Not determined at this time
SUPPORT AGENCIES: Tri-County Health Department	**POTENTIAL FUNDING SOURCES:** Undetermined

PROGRESS MILESTONES:

- Assess, plan, and manage for resilience
- Developing and sharing information
- Public engagement
- Build capacity

City of Thornton Northglenn Federal Heights

Mitigation Action Guide

City or Organization: Tri-County Health Department **Project Name: (TCHD2)** Maintain public health monitoring, surveillance, and emergency response capabilities through the Public Health Emergency Operations Plan (PHEOP)	
PRIORITY: High	**HAZARDS ADDRESSED:** Public Health Hazards
LOCATION: Adams, Arapahoe, and Douglas Counties	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T6 - Integrate hazard mitigation into other planning mechanisms • N1 - Protect people, property, and natural resources • N2 - Improve capability to reduce disaster losses • F1 - Improve capability to reduce disaster losses • F5 - Increase the city's resilience to hazards during all phases of the Emergency Management Cycle. • F6 - Increase individual resilience to hazards
RECOMMENDATION DATE: NA	
TARGET COMPLETION DATE: Ongoing	
OBJECTIVES ADDRESSED: The Tri-County Health Department PHEOP is an all-hazards plan that establishes a comprehensive framework for the management of the public health response to incidents within Adams, Arapahoe, and Douglas Counties.	
ACTION: PHEOP assigns roles and responsibilities to Tri-County Health Department and its divisions. It requires planning, training, and exercising prior to a real-world incident in order for TCHD to respond effectively.	
LEAD AGENCY: Tri-County Health Department	**EXPECTED COST:** Unknown
SUPPORT AGENCIES: Partner agencies and organizations identified in the PHEOP	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES: • Plan is in place	

Mitigation Action Guide

City or Organization: Xcel Energy **Project Name: (Xcel1) Thornton Substation**	
PRIORITY: High (Note: Project has been in development for over three years)	**HAZARDS ADDRESSED:** Power supply
LOCATION: East-central Thornton	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster
RECOMMENDATION DATE: 07/26/2016	
TARGET COMPLETION DATE: 2020	
OBJECTIVES ADDRESSED: - Local plans and regulations - Structure and infrastructure projects	
ACTION: Submit application for new substation if location is not zoned appropriately or if new parcel needs to be created.	
LEAD AGENCY: Xcel Energy	**EXPECTED COST:** No public funds.
SUPPORT AGENCIES: Colorado Department of Transportation	**POTENTIAL FUNDING SOURCES:** Xcel Energy
PROGRESS MILESTONES: Approval by Thornton city council.	

Mitigation Action Guide

City or Organization: School District 27J **Project Name: Building Schools to Serve as Shelters**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Severe Storms, Tornado, Earthquake
LOCATION: School District Wide	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster • T5 - Increase public awareness of natural hazards and mitigation options • T6 - Integrate hazard mitigation into other planning mechanisms
RECOMMENDATION DATE: August 1, 2016	
TARGET COMPLETION DATE: Ongoing	
OBJECTIVES ADDRESSED: **To the extent feasible, design and build schools** to take into consideration severe weather and tornados and ensure better spaces for taking refuge in the schools.	
ACTION: Limit the number and size of interior corridor windows, increase classroom space on the first floors of multi-floor facilities to enable more space for people to take refuge, eliminate sidelight windows, assess older structures to determine the best places for people to take refuge, never use broad-beamed roofed areas such as gyms and auditoriums as places of refuge. Bring people in from modular units to permanent structures when taking refuge.	
LEAD AGENCY: School District 27J	**EXPECTED COST:** TBD
SUPPORT AGENCIES: None	**POTENTIAL FUNDING SOURCES:** School District 27J general fund, grants.
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: UNITED POWER & TRI-STATE GENERATION
Project Name: On Going hazard recognition and rectification

PRIORITY:
(High, Med, Low) LOW- only because WE address any task identified as high priority quickly

HAZARDS ADDRESSED:
Expansive Soils / Undermined Areas, preparation for Severe Storms, hardships of power loss

LOCATION:
Several submissions

RECOMMENDATION DATE:
(we do ASAP)

TARGET COMPLETION DATE:
ONGOING

PLANNING GOALS ADDRESSED:

- T1 - Protect people, property, and natural resources
- T2 - Improve capability to reduce disaster losses
- T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster
- N1 - Protect people, property, and natural resources
- N2 - Improve capability to reduce disaster losses
- N7 - Increase individual resilience to hazards
- F1 - Improve capability to reduce disaster losses
- F2 - Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens
- F6 - Increase individual resilience to hazards

OBJECTIVES ADDRESSED:

United power and tri-State's on-going mission is to provide reliable electric service. To ensure that reliability, we annually identify capital improvements and major projects in our service areas that will enhance reliability, improve service, and maintain our safe operations. These projects and their completion timelines are identified in our annual report to our franchise cities (including Thornton and Northglenn).

The ongoing mitigation actions taken by United Power and Tri-State make transmission electrical infrastructure more resistant to natural hazards through:

- Vegetation management
- Looped communication
- Pole replacement – as needed during annual inspections
- Telecom facility backup generation
- Hardened communications
- Remote facility control
- Improved guys/anchors
- Cross-arm enhancement
- Hot spot identification
- N-1 planning that allows for redirection of electricity during an outage
- Verifying or moving lines to ensure they are not in a flood zone
- Perform maintenance according to NERC Reliability Standards

ACTION:

Various are performed every year as outlined in our Capital Plans including relocation/undergrounding of lines to provide more direct and safer routes, increasing capacity of existing infrastructure to improve power quality, and updating outdated equipment

LEAD AGENCY: United Power and Tri-State produce annual reports on the progress and serve as leads	**EXPECTED COST:** United Power and Tri-State spend in excess of $10 million annually to upgrade, improve and invest in capital projects identified as needing attention by our regular inspections.
SUPPORT AGENCIES: TBD	**POTENTIAL FUNDING SOURCES:** United Power and Tri-State.
PROGRESS MILESTONES: UP completed distribution automation and smart meters throughout our entire system (completed in 2015) this year we focused on load balancing to reduce losses and unnecessary voltage spikes, sectionalizing our services to allow for faster outage restoration, replacing older fuse cabinets and conducting annual equipment testing to identify areas of repair.	

Mitigation Action Guide

City or Organization: Urban Drainage and Flood Control District - Federal Heights, Northglenn & Thornton **Project Name: Flood Threat Assessment & Flood Risk Communication (Website development)**	
PRIORITY: High	**HAZARDS ADDRESSED:** Flooding
LOCATION: Federal Heights, Northglenn, Thornton, and nearby surrounding areas that are periodically threatened by floodwaters	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster • T5 - Increase public awareness of natural hazards and mitigation options • T6 - Integrate hazard mitigation into other planning mechanisms • N1 - Protect people, property, and natural resources • N2 - Improve capability to reduce disaster losses • N4 - Increase public awareness of natural hazards and mitigation options • N5 - Integrate hazard mitigation into other planning mechanisms • N7 - Increase individual resilience to hazards • F1 - Improve capability to reduce disaster losses • F3 - Increase public awareness of natural hazards and mitigation options • F4 - Integrate hazard mitigation into other planning mechanisms • F6 - Increase individual resilience to hazards
RECOMMENDATION DATE: 07/15/2016	
TARGET COMPLETION DATE: 12/31/2017	
OBJECTIVES ADDRESSED: Educating the general public about various flooding risks in their communities; the steps they can take before, during and after a flood to protect their property and businesses; and ways to stay informed and safe when floods threaten.	
ACTION: Inventory public assets at risk from flooding and categorize the corresponding risk. Develop an interactive public website tailored to each jurisdiction to educate people about flood risks and specific actions they can take to keep safe during dangerous conditions and minimize flood-related losses.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** $ 50,000
SUPPORT AGENCIES: Urban Drainage and Flood Control District	**POTENTIAL FUNDING SOURCES:** City of Thornton, City of Northglenn, City of Federal Heights, Urban Drainage and Flood Control District, Colorado Water Conservation Board, FEMA
PROGRESS MILESTONES: Inventory known trouble spots and problem areas; develop and promote E-notification capabilities for potential and imminent flood threats; prepare web-based multi-flood extent mapping; organize available resources concerning flood insurance, self-help guidance on flood safety and minimizing losses; public website.	

Appendix A - Community Profile - The City of Thornton

The City of Thornton is located just northeast of Denver, and is the sixth largest city in Colorado. It's located within Adams County where its city border mostly lies parallel and just east of the I-25. Broomfield is located northwest of Thornton, with Northglenn to the north and Westminster to the west. Much like other areas in the Denver metropolitan region, Thornton experienced rapid growth beginning in 2000. Growth had leveled out during the housing market crash, but has since began increasing again.

Demographics

The City of Thornton had a total population of 118,772 in 2010[13]. The median age of the population is 32 and the median household income is $66,176. Thornton has 9% of its population below the poverty level, compared to 13% in the State[14]. In 2013, the City was made up of approximately 60% Caucasian and 32% Hispanic. As seen in Table 1 below, the City has seen a steady increase of Hispanic populations as well as a slight change in other race/ethnicity categories[15]. In comparison to the Denver metro region, Thornton has a higher percentage of Hispanic populations and a lower percentage of Caucasian and African-American populations. Although Thornton has mostly been a community of families, there is a subtle trend that demonstrates an aging population[16].

TABLE 36. THORNTON DEMOGRAPHICS - ETHNICITY

Race Alone	Colorado	% of Colorado	Adams County	% of Adams County	Thornton	% of Thornton
Hispanic or Latino	1,047,700	20.7%	169,287	38.2%	34,563	29.0%
White	3,528,477	69.9%	235,974	53.2%	73,692	61.7%
Asian	131,852	2.6%	15,280	3.4%	5,510	4.6%
Black/African American	189,658	3.8%	12,993	2.9%	3,061	2.6%
Am. Indian/AK Native	26,890	0.5%	2,659	0.6%	477	0.4%
Pacific Islander	4,313	0.1%	567	0.1%	223	0.2%
Some Other Race	6,092	0.1%	175	0.0%	42	0.0%
Two or More Races	114,089	2.3%	6,780	1.6%	1,756	1.5%
Total Population	**5,049,071**	**100%**	**443,715**	**100%**	**119,324**	**100%**

Source: City of Thornton, Community Demographic Profile Report (2012)

Social Vulnerability

Like most other communities in the North Denver Metro region, Thornton has an aging population and a growing number of non-English speaking residents. Both sets of population groups require an extra

[13] DRCOG Community Profile: Thornton (2015)
[14] Community Facilities Plan (2015)
[15] 2014 Year End Housing & Population Report
[16] Community Facilities Plan (2015)

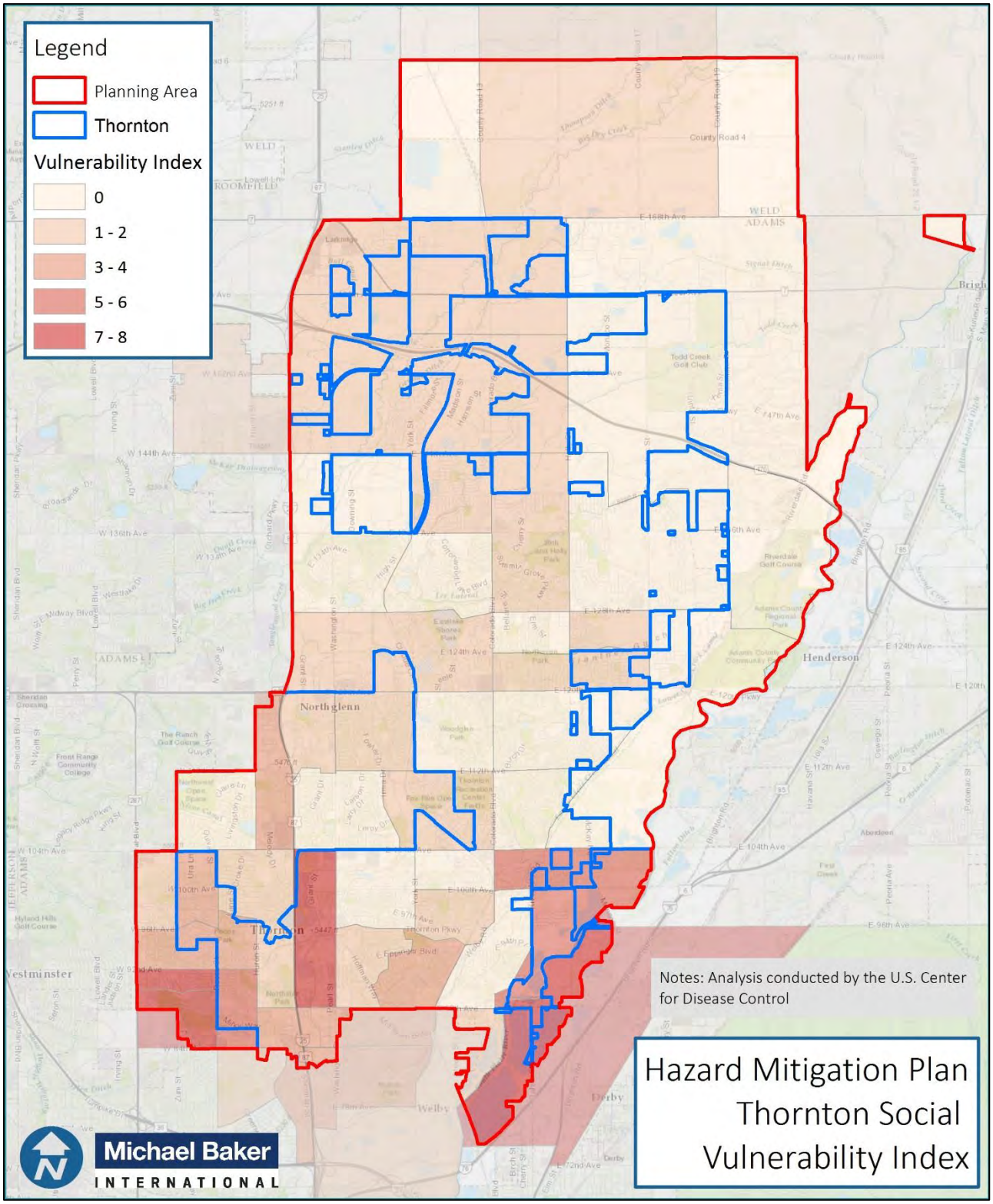
amount of outreach and assistance when preparing for a hazard within the community. Having several senior living facilities in the community helps when reaching out to the elderly community and having a gathering place for education. The City should also consider creating multilingual information to inform the non-English speaking community about hazards.

As the population and housing growth rates are expected to rise in Thornton in the coming years, a need for expanded city services will ultimately increase and the City should continue to update their services.

The results of the social vulnerability assessment are displayed on the following map. On the map, social vulnerability is represented at the census tract level by five classes of vulnerability: Low (bottom 20% of the county), Medium-Low(20%-40%), Medium(40%-60%), Medium-High(60%-80%), and High (top 20% of the county).

Thornton is characterized by a mix of low to medium-high levels of social vulnerability. The south western area of the city has higher levels of social vulnerability than the rest of the community. The southeast corner of the community shows high social vulnerability; however, this area has very little if any residents as it is comprised mostly of gravel pits. A closer look at the individual social vulnerability indicators within Thornton will give local emergency managers, planners, and stakeholders an even clearer picture of where resources should be prioritized in order to reduce vulnerability in the community. Over time, Thornton should continue to monitor their social vulnerability as demographic, economic, and housing related conditions change.

FIGURE 41. THORNTON SOCIAL VULNERABILITY MAP



City of Thornton Northglenn Federal Heights

Housing

Thornton is made up of mostly single-family detached homes. The average household size is 2.9 people; families make up 72% of households and nonfamilies make up 28% of households within the city. In 2014, Thornton had approximately 45,000 housing units with a 70% home ownership rate[17]. Approximately 4% of those were vacant[18]. Of all those units, 72% were single-unit structures, 22% were multi-unit structures, and 6% were mobile homes. Fifty-four percent of all existing housing units were built in 1990[19]. The median home price in 2012 was $203,000[20]. But much like the rest of the country, Thornton's housing market bottomed out in 2010 and 2011 and new construction stalled.

The average family size in Thornton has increased from 3.41 people in 2009 to 3.47 people in 2013. Statistically, families are younger in Thornton when compared to the Denver metropolitan region. While median household income has decreased in the past five years, it still remains higher than the Denver metropolitan region at $63,000 per family compared to $58,000 regionally[21].

As predicted in the Thornton 2014 Year End Population Housing Report, single-family detached homes will likely see the highest number of new units in the near future. In the medium to long term, Thornton could see more multi-family and single-family attached development along the future North Metro Rail Line[22].

Critical Facilities

For the purpose of this Multi-Jurisdictional Hazard Mitigation Plan, 'critical facilities' are defined as local assets vital to the health, safety, and well-being of residents and visitors during time of natural disaster. These facilities include community centers, churches, hospitals, libraries, non-profits, post offices, water treatment centers, police & fire stations, and city administration buildings. Critical facilities are essential to a community's long-term disaster resilience as they are important delivery pathways for diverse crisis management services and resources. As part of the HMP planning process, Thornton identified those facilities being termed as critical by utilizing the best available data from Thornton GIS and the Adams County assessor's office. There are currently 219 parcels within the City that are considered as containing critical facilities, with those structures being assessed at over $280 million.

As Thornton's population and land area has increased, so have the number of critical facilities within city limits. There are a number of emergency shelters throughout the city. They are listed in the following table.

[17] Community Facilities Plan (2015)
[18] DRCOG Community Profile: Thornton (2015)
[19] Denver Regional Natural Hazard Mitigation Plan (2010 Update)
[20] Community Demographic Profile (2012)
[21] 2014 Year End Housing & Population Report
[22] 2014 Year End Housing & Population Report

Table 37. Thornton's Emergency Shelters

Facility	Address
Margaret W. Carpenter Recreation Center	11151 Colorado Blvd.
Thornton Community Center	2211 Eppinger Blvd.
Thornton Senior Center	9471 Dorothy Blvd.
Thornton High School	9351 Washington St.
Crossroads Church	53 E. 128th Ave.

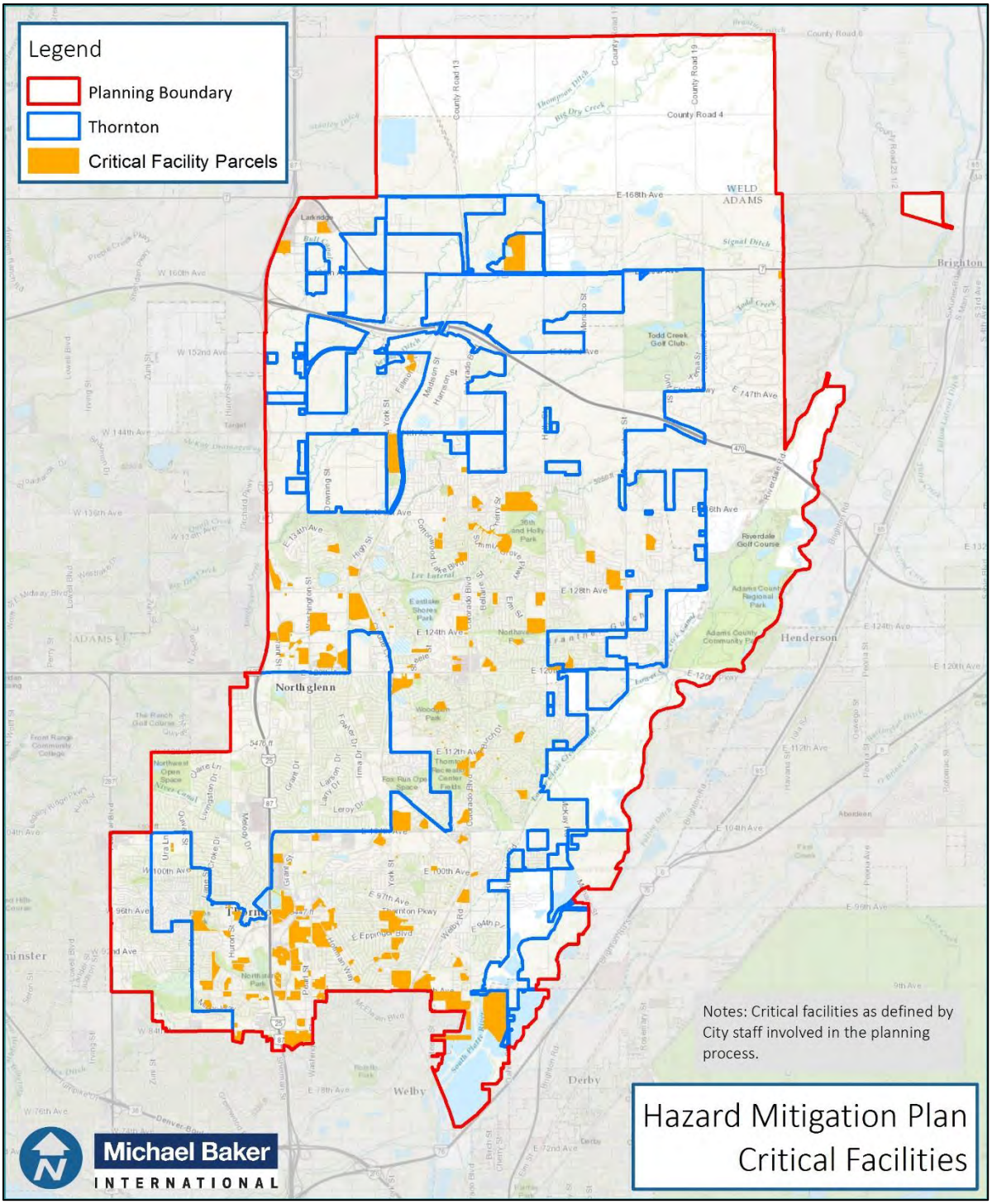
RTD has approved construction of Phase 1 of the FasTracks North Metro Rail. This will include three stations in Thornton, which are scheduled to open in late 2018. The new commuter rail should be considered as a critical facility and mitigation efforts should be seen in order to keep residents and infrastructure safe.

There are 12 primary schools located within city limits, three libraries, one fire rescue training facility, and several local governmental buildings. There are multiple capital improvement plans, totaling more than $37.9 million, which will affect Thornton residents in the coming years[23]. There are also plans to incorporate more fiber connectivity throughout the region, which the city welcomes.

Thornton has several vulnerable mobile home communities and Section 8 housing, which are mostly located south of 104th Avenue. These residential areas are at higher risk in the case of a disaster and should be considered for further outreach and mitigation projects. The following figure shows critical facilities located in Thornton.

[23] Community Facilities Plan (2015)

FIGURE 42. THORNTON CRITICAL FACILITIES



City of Thornton Northglenn Federal Heights

Future Development

Thornton saw major growth between 2000 and 2006. A 35.2% increase in population at this time period welcomed mostly new residential growth in the Northeast portion of the City. Thornton's urban extent is projected to grow by 17.5 square miles between 2016 and 2035, a 1.9% annual percent increase over that time period[24]. The southern area of Thornton is projected to see growth in both single and multi-family development along the North Metro Rail Line[25]. Although Thornton's population continues to grow, it is still growing at a slower rate compared to the Denver Metropolitan Area[26].

Hazard Identification

Introduction and Update Summary

Although the City of Thornton was included in the DRCOG Hazard Mitigation Plan, it was primarily a general plan for the Denver metropolitan area and did not provide a great deal of guidance for Thornton in particular. It has, however, been used as reference for writing this HMP, but more importantly in obtaining information from the community to address community-specific needs and goals.

Thornton has several staff members that have knowledge about emergency operations. There is a Floodplain Administrator, an Emergency and Safety Administrator, City Planners, and GIS Analyst who are full-time. City Council approved the position of Emergency and Safety Administrator for coordinating emergency operations during an incident. The City is exceptionally prepared with plans and codes that discuss hazards and are an important part of the research and reference portion of hazard mitigation planning.

Climate Change and Hazards

In the Thornton community interview, several hazards were identified as being of significant importance. They were as follows: tornadoes, drought, flooding (southern area of city), hail storms, expansive soils (southern area of city), severe storms, pests/invasives, winter storms, and downed trees. Thornton saw most flood damage in 2013 to South Platte water storage reservoir infrastructure, but minimal residential damage within city limits.

As part of the Community Interview, interviewees were asked to categorize the profiled hazards in terms of high, medium, or low risk. As a result of those discussions, hazards were ranked as follows:

<u>High</u>

- Drought
- Flood
- Severe Storms
- Tornado and Severe Wind
- Winter Storm

[24] Denver Regional Natural Hazard Mitigation Plan (2010 Update)
[25] City of Thornton Community Facilities Plan (2015)
[26] 2015 Year End Housing & Population Report

Medium

- Expansive Soils / Undermined Areas
- Public Health

Low

- Earthquake
- Extreme Temps
- Wildland Fire

Hazard Profiles

This section provides a refined risk and vulnerability assessment, specific for the City of Thornton, for those hazards that were identified as being rated high in the preceding section. This analysis was conducted separately from that of the planning area-wide vulnerability assessment to specifically focus on the population, structures, infrastructure, and other assets unique to the City.

Drought

Drought is often hard to predict and not easily identifiable, but its impacts can be severe and put a community at risk for catastrophic economic, social, and environmental impacts.

Previous Occurrences

According to NOAA's NCEI Storm Events Database, there have been three drought events in Adams County and Weld County, which have occurred between 2002 and 2011. There were no injuries, deaths, or crop damages recorded within the City of Thornton due to drought but there is potential for a future drought event to occur at any given time.

TABLE 38. HISTORY OF DROUGHT, ADAMS AND WELD COUNTY

Beginning Date	Location	Injuries	Death	Damage
4/1/2002	Adams and Weld County	0	0	0
6/9/2002	West Adams County	0	0	0
3/1/2011	Weld and Adams County	0	0	0

Source: NOAA, NCEI Storm Events Database

Starting in 2002, Colorado's Front Range cities began to experience one of the worst droughts in over 300 years and Thornton felt the impacts significantly. In 2002 the driest year on record for the region and the state was recorded. Reports showed that snowpack was about 50% of what it would have typically been in the early months of the year, indicating that water supplies would be low.

City staff addressed growing concerns by initiating mandatory water use restrictions and banning lawn watering. Also, the 2002 Drought Management Plan was adopted in order to respond to diminishing water supply. Residents were receptive to this issue, proving that the community takes drought seriously and will appreciate new mitigation efforts to build resiliency.

FIGURE 43. PAST DROUGHT EVENT ARTICLE

FEATURES

thornton quarterly

Water restrictions expected through spring

The Drought Picture Worsens

There is no doubt that we are experiencing the worst drought to hit Colorado since the 1880's, when records began to be kept on snow pack and stream flows. It may be the worst in over 300 years, according to some tree ring studies. Will it end by next spring or summer? No one knows.

city manager's message

The drought forecast may be uncertain, but we do know that we won't be getting much in the way of additional water supplies until next year's snow pack, whatever it may be, melts. This won't occur until sometime in late spring to early summer 2003. Even if we see plenty of snow this winter, building up our water supply will take time. It's important to realize that the effects of the drought may last quite a while after the actual drought comes to an end.

With our water storage at only about one third capacity, we need to make sure that you, our water customer, have sufficient water for your inside home usage. So, the City of Thornton, like most cities in the metro area, has determined that it is in your best interest to go to the next phase of our drought management plan as described in detail on the next page.

Effective November 1, 2002, and until further notice, no turf or lawn watering is allowed except on publicly owned athletic fields, other publicly owned high-use areas, and golf course greens and tees. These uses will be exempted by permit only.

As needed, you may water your trees, shrubs and perennial plants using a hose with shut-off valve or a drip system. If you don't already have one, you may want to get a soaker hose or soil needle (also known as a root probe or a deep root feeder) to help preserve the life of your trees and shrubs. More than likely, unless the situation changes dramatically, it will be necessary to extend this restriction well into next spring. Please note: if you have received a prior exemption to our watering restrictions by obtaining a permit, these permits will be rescinded on November 1.

We encourage you to take whatever steps you can to prepare your lawn and landscaping should mandatory water restrictions continue to be necessary next summer. Helpful information can be found in this issue of the Thornton Quarterly, on our website at www.cityofthornton.net, from the Colorado State University extension office, or your local lawn and garden store.

I greatly appreciate your cooperation during this unusually difficult time, and hope you'll join me in following the water conservation tips you'll find here in the Thornton Quarterly to save as much water as possible. If you have any questions or concerns about Thornton's water restrictions, please contact our Water Resources Division at 303-538-7360.

Jack Ethredge
Thornton City Manager

Standing beside one of the largest gravel lakes used for the City's water storage, Water Resources Manager Mark Koleber indicates the former water level markings on the wall of a water pump station. The City's water storage is currently at about 1/3 of capacity.

4 Thornton Quarterly Winter 2002-2003

The 2002-2003 Thornton Winter Quarterly addressed the worsening drought, stating that, "the City's water storage is currently at about 1/3 of capacity."

Inventory Exposed

Drought typically does not have a direct impact on critical facilities or structures. Drought conditions evolve slowly over time and communities typically have ample time to prepare for the effects. Should a drought affect the water available for public water systems or individual wells, the availability of clean drinking water could be compromised. This situation would require emergency actions and could possibly overwhelm the local government and financial resources.

City of Thornton Northglenn Federal Heights

Impacts from drought can include the following:

- Economic losses to agricultural producers (crops and livestock)
- Physical and mental health issues
- Water supply interruption for business and industry
- Water quality problems
- Reduced soil and vegetation moisture
- Vegetation mortality, insect infestations
- Impacts to fish and wildlife populations
- Increase in wildland fires and associated losses

Potential Losses

Possible losses/impacts to critical facilities include the loss of critical function due to low water supplies. Severe droughts can negatively affect drinking water supplies. Should a public water system be affected, the losses could total into the millions of dollars if outside water is shipped in. Private springs/wells could also dry up. Possible losses to infrastructure include the loss of potable water.

Although drought events rarely pose immediate risks to public health, they can impact local public health in numerous ways. Examples of drought-induced public health impacts include: increased respiratory ailments due to increased particulate matter in the air; sickness due to decreased availability of clean water; increased disease caused by wildlife concentrations; population migrations (rural to urban areas); loss of human life (e.g. from heat stress, suicides); and impacts on behavioral health (due to unemployment in the agricultural sector, stress on the tourism and other businesses related to the natural environment and/or water).

The impacts of drought on local vegetation and wildlife can include death from dehydration and spread of invasive species or disease because of stressed conditions. In general, environmental impacts from drought are more likely at the interface of the human and natural world. The loss of crops or livestock due to drought can have far-reaching economic effects on communities, wind and water erosion can alter the visual landscape, and dust can damage property. Water-based recreational resources are also heavily affected by drought conditions. Indirect impacts from drought arise from wildfire, which may have additional effects on the landscape and sensitive resources such as historic or archeological sites.

Probability of Future Occurrences

Due to the nature of drought, it is an extremely difficult hazard to predict. However, identifying various indicators of drought, and tracking these indicators, provides us with a crucial means of monitoring drought. Additionally, understanding the historical frequency, duration, and spatial extent of drought assists in determining the likelihood and potential severity of future droughts. The characteristics of past droughts provide benchmarks for projecting similar conditions into the future.

Historic frequency suggests that there is a 50% chance of this type of event occurring each year. The Colorado Climate Report, published in 2015 by the Colorado Water Conservation Board (CWCB), include climate models that project Colorado will warm by 2.5°F by 2025 and 4°F by 2050, relative to the 1950-

1999 baseline. If these projections are accurate, changes in the quantity and quality of water are likely to occur due to increased temperatures, even in the absence of precipitation changes.

Although it is unlikely that drought conditions will affect existing buildings, infrastructure, and critical infrastructure, economic livelihoods in the City of Thornton could be negatively impacted due to crop loss, water shortages, and wildfires as a result of drought. Possible losses/impacts to critical facilities include the loss of critical function due to low water supplies.

Land Use and Development

Society's vulnerability to drought is affected largely by population growth, urbanization, demographic characteristics, technology, water use trends, government policy, social behavior, and environmental awareness. These factors are continually changing, and society's vulnerability to drought may rise or fall in response to these changes. For example, increasing and shifting populations puts increasing pressure on water and other natural resources—more people need more water.

Future development greatly impacts drought hazards by stressing both surface and ground water resources. Agricultural and industrial water users consume large amounts of water. Expansion of water-intensive enterprises is limited in a time when water resources are strained. In rapidly growing communities, new water and sewer systems or significant well and septic sites could use up more of the water available, particularly during periods of drought. Public water systems are monitored, but individual wells and septic systems are not as strictly regulated. Therefore, future development could have a profound impact on the vulnerability of the City of Thornton to drought.

In relation to both current land use and future development trends, the use of turf grass affects the available water supplies. Maintaining lush, green lawns in the semi-arid climate of the Front Range requires large amounts of water. Urban lawn watering is the single largest water demand on most municipal supplies. Outdoor water use accounts for about 55% of the residential water use in the Front Range urban area, most of which is used on turf. [27] Residential and commercial landscaping can greatly impact future drought events and future water use regulations may be able to mitigate this trend.

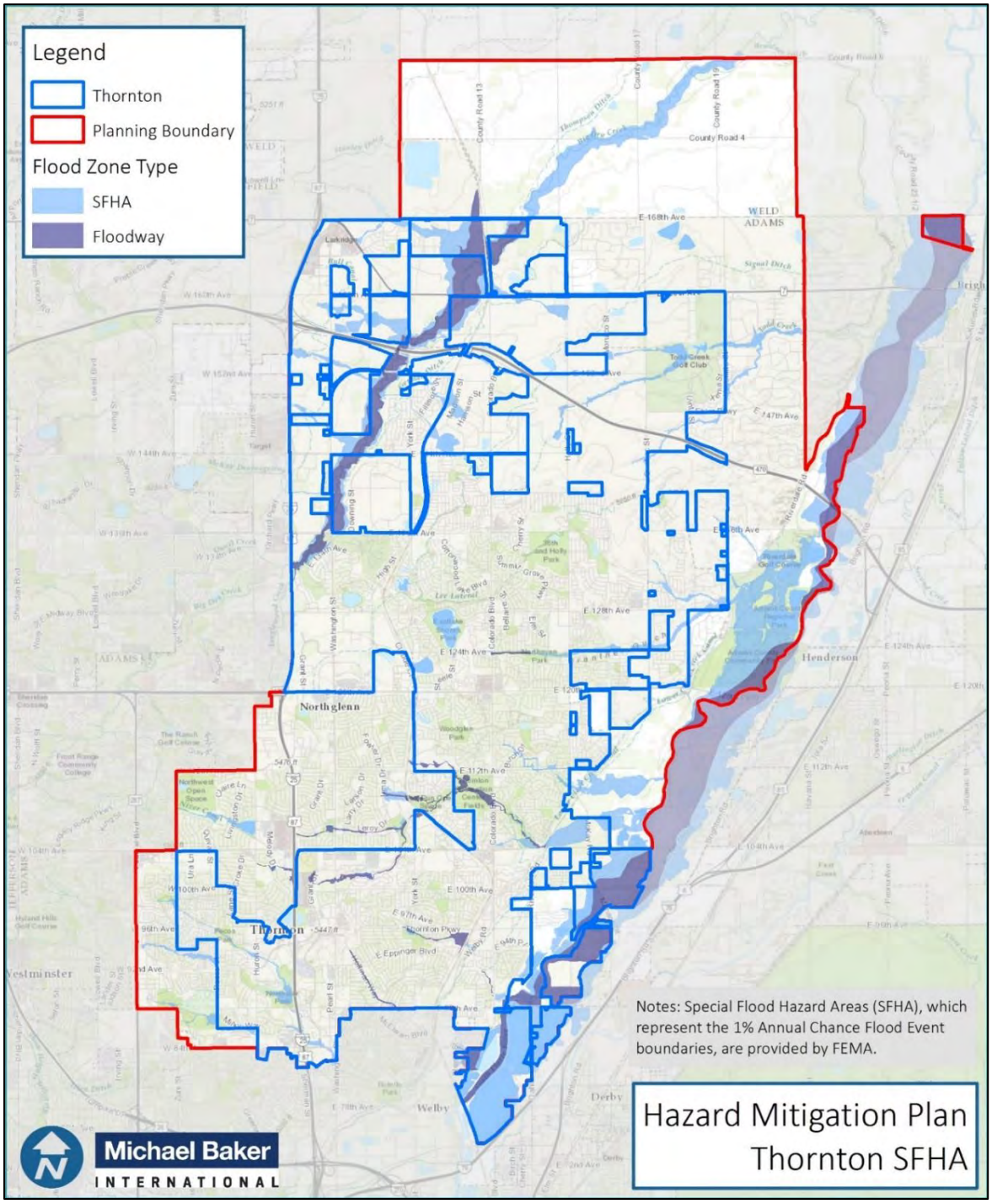
As the City of Thornton continues to grow, it should consider practical guidelines for determining the impacts of drought such as measuring the economic value of water in alternative uses and objective methods for quantifying non-market impacts of drought on those uses. Additionally, the City of Thornton should continue to follow guidance found within the State of Colorado's Multi-Hazard Mitigation Plan as well as the Colorado Drought Mitigation and Response Plan.

Flood

Major flooding has occurred within the State of Colorado in recent years. As climate has rapidly changed in recent years, communities along the Front Range have seen devastating effects and the City of Thornton has been directly impacted. The figure below presents flood risk areas in Thornton, where the 1% annual-chance flood event could occur in any given year.

[27] http://www.ext.colostate.edu/pubs/consumer/09952.html

FIGURE 44. THORNTON SPECIAL FLOOD HAZARD AREA



City of Thornton Northglenn Federal Heights

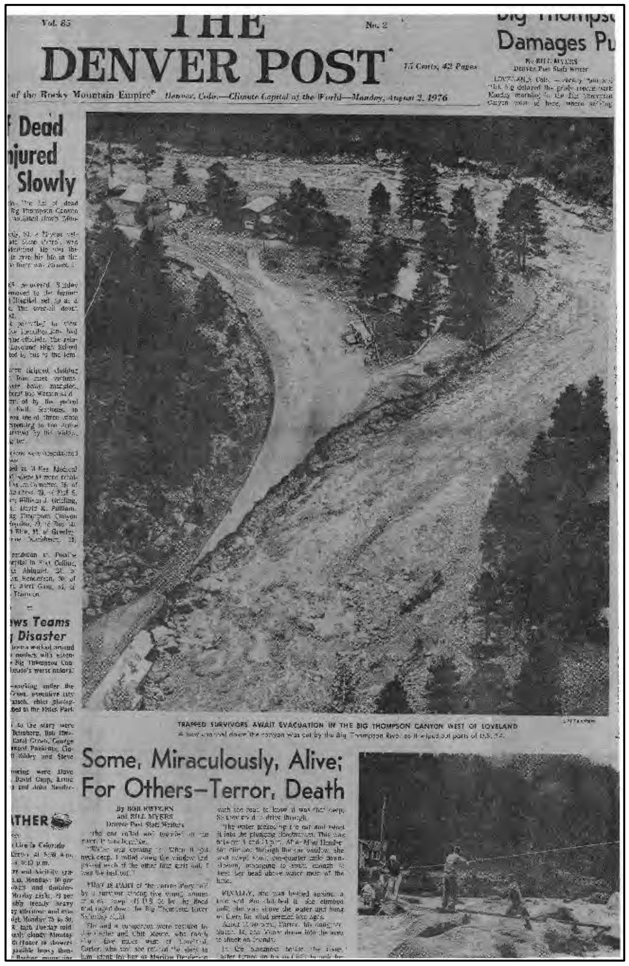
Previous Occurrences

According to NOAA's NCEI Storm Events Database there have been no reported injuries in the City of Thornton caused by flooding. Thornton experienced significant, multi-million dollar losses in 2013 and 2015 from South Platte flooding. Based on the Adams County Flood Insurance Study, Thornton mainly sees flooding due to cloudbursts during May through August. Although historic documentation is sparse, the southeast areas of Thornton have been known to experience shallow sheet flow flooding from the South Platte River.

On August 17, 2000 there was one reported death caused by flooding in the west central portion of Adams County. In May of 1973, the Denver metro region was hit by some of the worst flood the area had seen in 8 years. Many local creeks were inundated with high water and advisory warnings and evacuation were ordered for communities near the creek. In August of 1976, Denver metro experienced another intrusive flooding event. Local streets were flooded several feet deep and extensive property damage (especially to residential basements) was seen. Another historic flood event took place from September 12-16, 2013, when 6-18 inches of rain fell across Colorado's Front Range and I-25 corridor. Historic flooding on the South Platte River has caused breakout flow into the gravel lakes storage areas that resulted in damage to the facilities, which in turn cost a large amount of money to repair.

FIGURE 45. PLATTE RIVER BREACH AT ARVADA CELL (2013 FLOOD)

Figure 46. The Region has Seen Substantial Flooding for Years


THE DENVER POST

Damages

Dead

Slowly

Some, Miraculously, Alive; For Others—Terror, Death

Thornton's close proximity to bodies of water have made the community susceptible to flood hazards. Population and development increases have heightened the communities' risk for flood damage as urbanization increases runoff two to six times over what would occur on natural terrain. Based on the historic data showing hazardous impacts on the district and the community's expected growth, there is great potential for future flooding events to occur at any given time.

Thornton has taken great steps in making the community aware by engaging residents in discussions about potential flood and making them aware of flood insurance. In the Winter 2003 Thornton Quarterly, the Cities identified flooding sources. Areas affected include;

- South Platte River
- Quail Creek
- McKay Lake
- Tanglewood Creek
- Preble Creek
- Sack Creek
- Mustang Run
- Shay Ditch
- Morris Creek
- Elms Run
- Short Run
- Wadley North

- Wadley South
- Niver Creek
- Grange Hall Creek
- Branter Gulch
- Big Dry Creek
- Hoffman Drainage

In addition to the previous mentioned flooding sources, the gravel pit storage areas located in the south eastern portion of the planning area are prone to breakout flooding from the South Platte River.

The City of Thornton does have a single Repetitive Loss (RL) property and is working at identifying ways to mitigate this particular structure to avoid future losses.

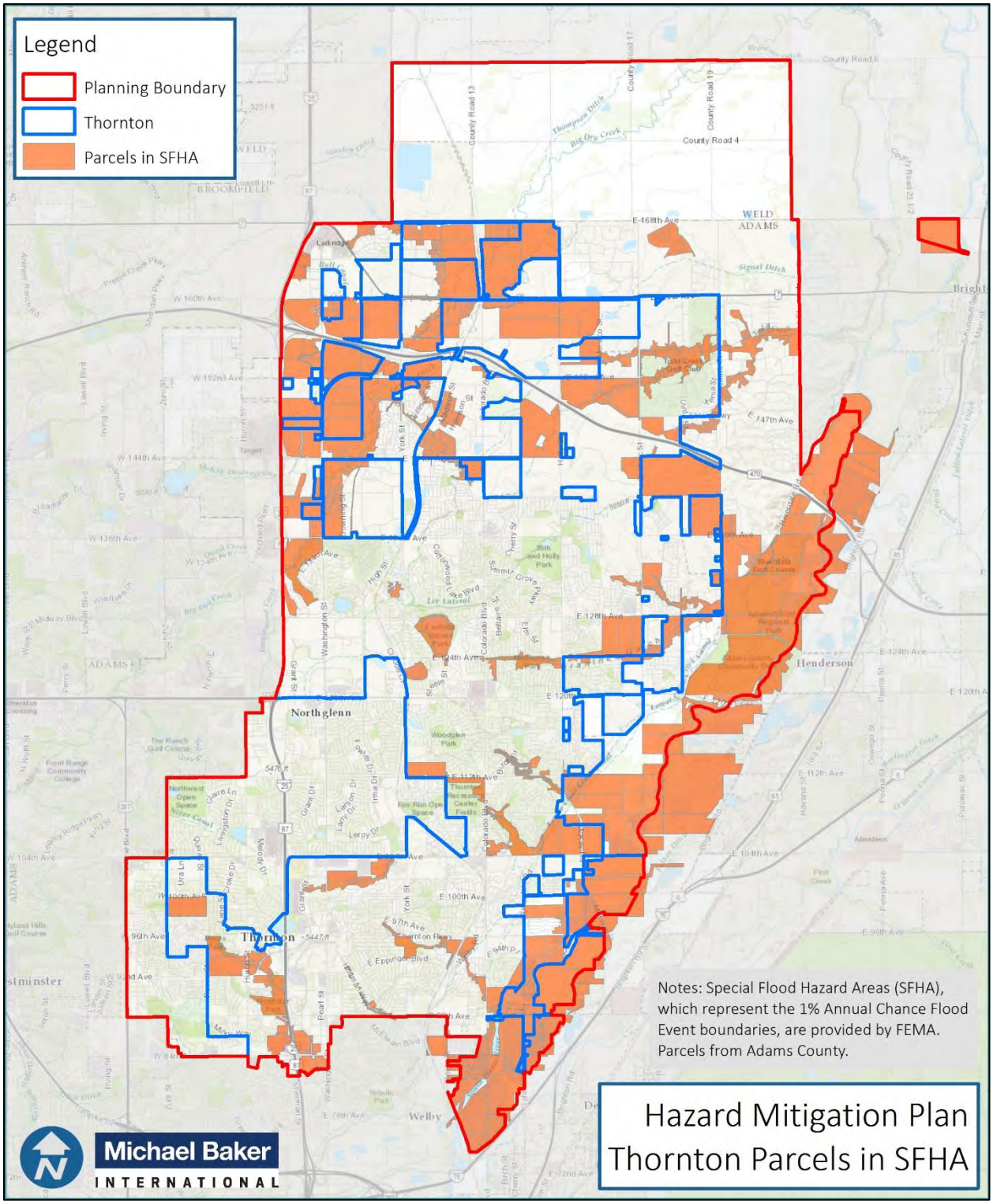
Inventory Exposed

The exposure data included provides the clearest picture of potential losses to flood in the City of Thornton. There are 1,067 parcels, which contain 1,467 structures/units, located within or near the SFHA and their improved value is estimated at over $95 million. This analysis was performed utilizing the most recent DFIRM data combined with Adams County parcel information. The following figure shows parcels located in the SFHA.

Critical facilities are essential to the health and welfare of the whole population and are especially important both during and after hazard events. Critical structures or areas that overlap or touch the Special Flood Hazard Area (SFHA) are considered “flood prone”.

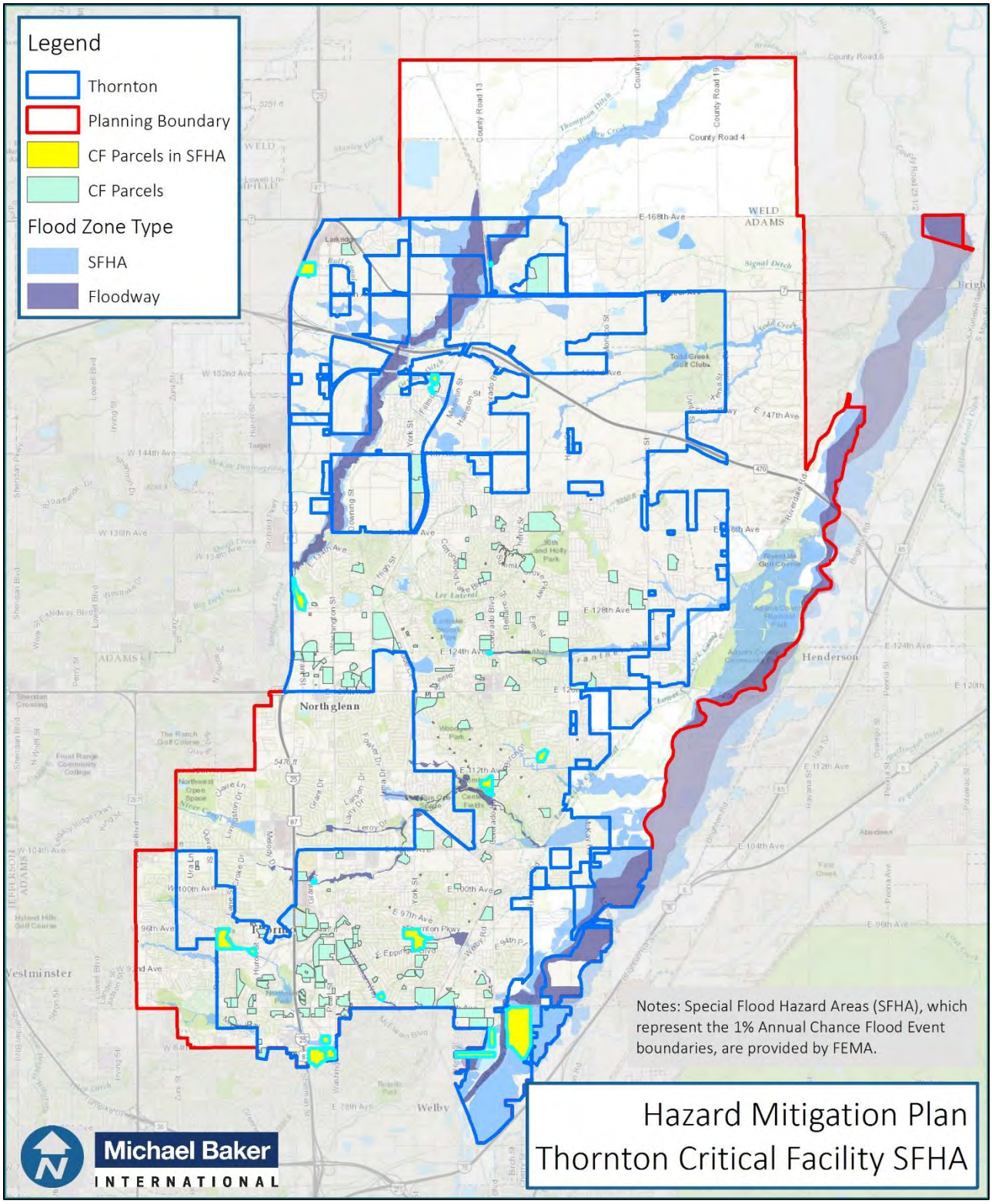
The critical facility and structure exposure analysis estimates that there are 19 critical facility parcels, which include 29 total structures/units, in the City of Thornton that are flood prone (not including the total miles of flood prone infrastructure). The appraised value of these exposed structures is over $27 million. The second following figure represents the critical facilities located in or within close proximity to the SFHA and floodway planning area.

FIGURE 47. THORNTON PARCELS IN SPECIAL FLOOD HAZARD AREA (SFHA)



City of Thornton Northglenn Federal Heights

FIGURE 48. THORNTON CRITICAL FACILITIES IN THE SPECIAL FLOOD HAZARD AREA



City of Thornton Northglenn Federal Heights

Potential Losses

The methodology used to determine potential losses to flooding was conducted using FEMA's Hazus loss estimation software. For this Plan, a 100-year flood scenario was modeled for the City to demonstrate a worst case scenario for estimated losses. The results are presented below.

Hazus 100-Year Flood Scenario

In addition to the SFHA boundaries, the flood risk analysis for this Plan integrates DFIRM depth grids, a digital dataset that shows flood depths at various locations within the floodplain. This enhanced data input allows Hazus to more accurately approximate floodplain boundaries and their associated flood depths for a 100-year flood event.

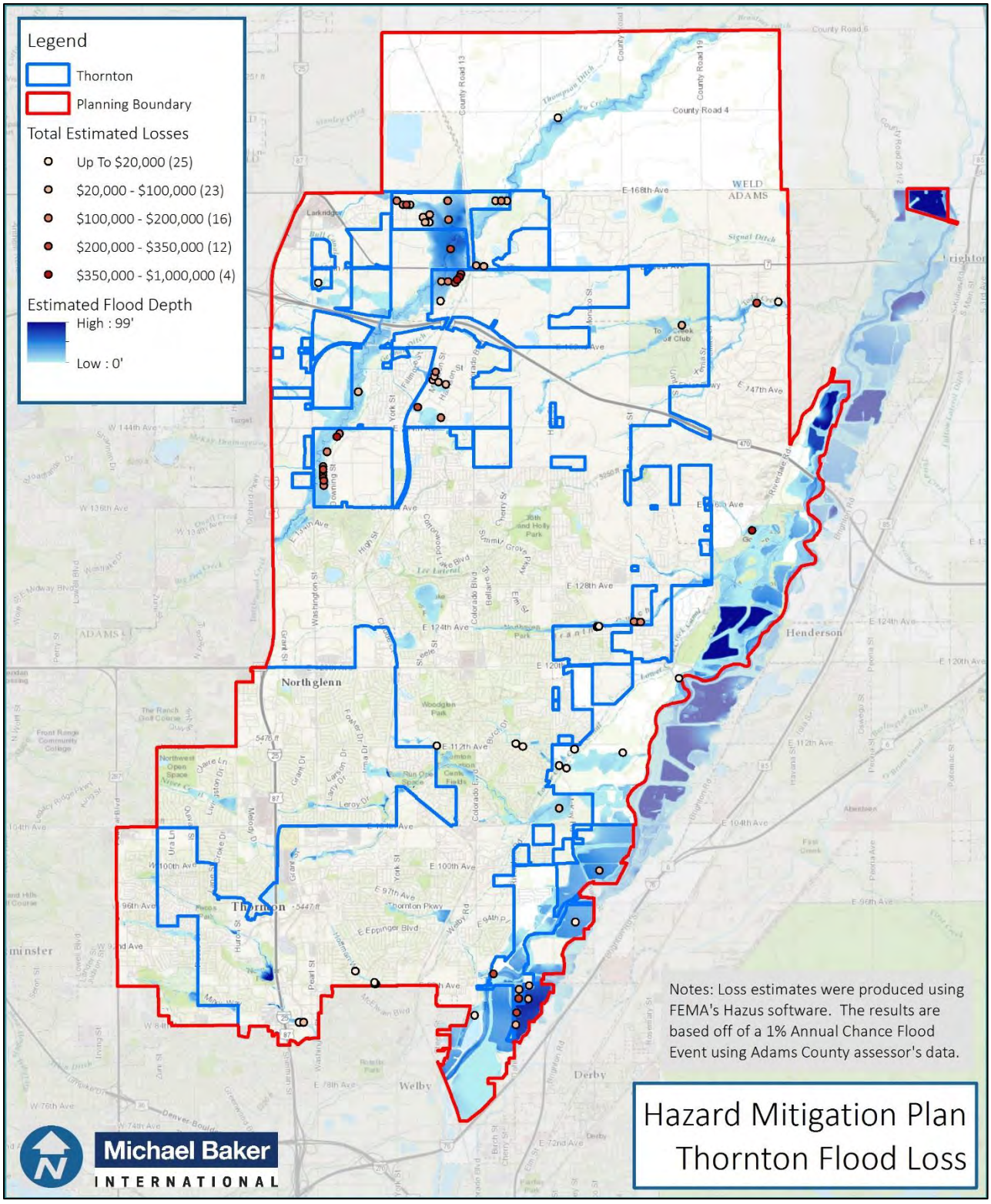
Hazus is a national loss estimation model developed by FEMA and the National Institute of Building Science. The primary purpose of Hazus is to provide a methodology and software application to develop flood and earthquake loss at a regional scale. There are two types of Hazus analyses, standard and enhanced. A standard Hazus analysis requires no specialized knowledge on the part of the user and leverages the default inventory, hazard, and engineering (damage function) data present in the program. This is also known as an "out of the box" or Level 1 analysis. An enhanced analysis requires the user to have localized knowledge and data in order to provide updated inventory, hazard and/or engineering (damage function) data that overwrites the default data present in the program. Historically, this has been known as a Level 2 (inventory or hazard updates) or Level 3 (engineering updates) Hazus analysis.

Utilizing Hazus 3.0, FEMA's loss estimation and hazard modeling software, a detailed flood analysis was conducted for structures within the planning area, specifically around the City of Thornton. The risk assessment leveraged a parcel inventory as well as Light Imaging, Detection, And Ranging (LiDAR) terrain data. A project area Digital Elevation Model was created using this terrain data, also used in the flood analysis was a 100 year flood Depth Grid derived from FEMA's National Flood Hazard Layer (NFHL) data. In addition to these custom datasets, User Defined Structures (UDS points) were also created for all parcels that were impacted by the FEMA effective floodplains. The Hazus analysis was then performed at every one these locations to estimate the flood damages associated with the impacted structures.

When calculating structural losses, Hazus breaks loss values into two categories: direct economic losses and indirect economic losses. Direct economic losses are the estimated costs to repair or replace the damage caused to a building and its contents. These values are organized in terms of Building Losses and Building Content Losses. Indirect economic losses include Inventory Losses and other losses associated with business interruption and the inability to operate a business because of the damage sustained during the flood.

A 100-year flood scenario was defined in Hazus and potential losses were calculated for each point that intersected the depth grid based on the Hazus depth damage curves for specific structure attributes (such as foundation type, building type, and first flood height). The map below shows the results of the Hazus 100-year flood scenario estimated structural loss analysis for the City of Thornton.

FIGURE 49. THORNTON FLOOD LOSS MAP



City of Thornton Northglenn Federal Heights

The map of total building losses illustrates a clear loss pattern in which damages are clustered around the most populated areas of the city. These places represent areas where resources and people are concentrated, making those areas of high potential loss and clear priority areas for focused mitigation action.

Hazus estimates that for a 100-year flood event, approximately 81 buildings will be damaged. The total economic losses for these structures is estimated to be almost $8.7 million for that 100-year event. It should be noted that these losses do not take into account public or private infrastructure. A number of variables are included in Hazus analyses in order to arrive at the estimated values of loss due to flooding. For this reason, it is important to note that the Hazus loss estimates should not be used as a precise measure, but rather viewed from the perspective of the potential magnitudes of expected losses.

Probability of Future Occurrences

Frequency of previously reported flood events in the City of Thornton provide an acceptable framework for determining the probability of future flood occurrence in the area. The probability that the city will experience a flood event can be difficult to predict or quantify, but it is expected that localized flooding will be experienced yearly. Recently, larger flooding events have occurred more regularly, so the City should be prepared for future increases to the number of large events occurring.

Severe flooding has the potential to inflict significant damage to people and property in the district. Mitigating flood damage requires that communities remain diligent and notify local officials of potential flood (and flash flood) prone areas near infrastructure such as roads, bridges, and buildings.

Land Use and Development

The City of Thornton floodplain development code regulates building within the identified Special Flood Hazard Area (SFHA). It is essential that future development plans take into account not only the dollar amount of damage that buildings near waterways could incur, but also the added risk of development activity that could alter the natural floodplain of the area.

Existing floodplain management ordinances are intended to address methods and practices to minimize flood damage to new and substantial home improvement projects as well as to address zoning and subdivision ordinances and state regulations. Currently, the City of Thornton is a National Flood Insurance Program (NFIP) participant and continues to support floodplain management activity at the local scale.

The greatest protection against flooding is afforded by quality construction and compliance with local ordinances which exceed NFIP requirements. Code adoption by local jurisdictions, compliance by builders, and local government inspection of new homes can greatly reduce the risk of flooding. Moving forward, Thornton will continue to support monitoring, analysis, modeling, and the development of decision-support systems and geographic information applications for floodplain management activities.

In addition to land-use planning, zoning, and codes applicable to new development, flood mitigation measures include structural and non-structural measures to address susceptibility of existing structures. Flood mitigation measures such as acquisition, relocation, elevation-in-place, wet/dry flood proofing, and enhanced storm drainage systems all have the potential to effectively reduce the impact of flood in Thornton.

Severe Storms

Spring and summer weather can often be unpredictable in the Denver metro region; sometimes producing significant hail and lightning events. Damage due to these events has risen over the years and can be expected to steadily increase and further put communities at risk.

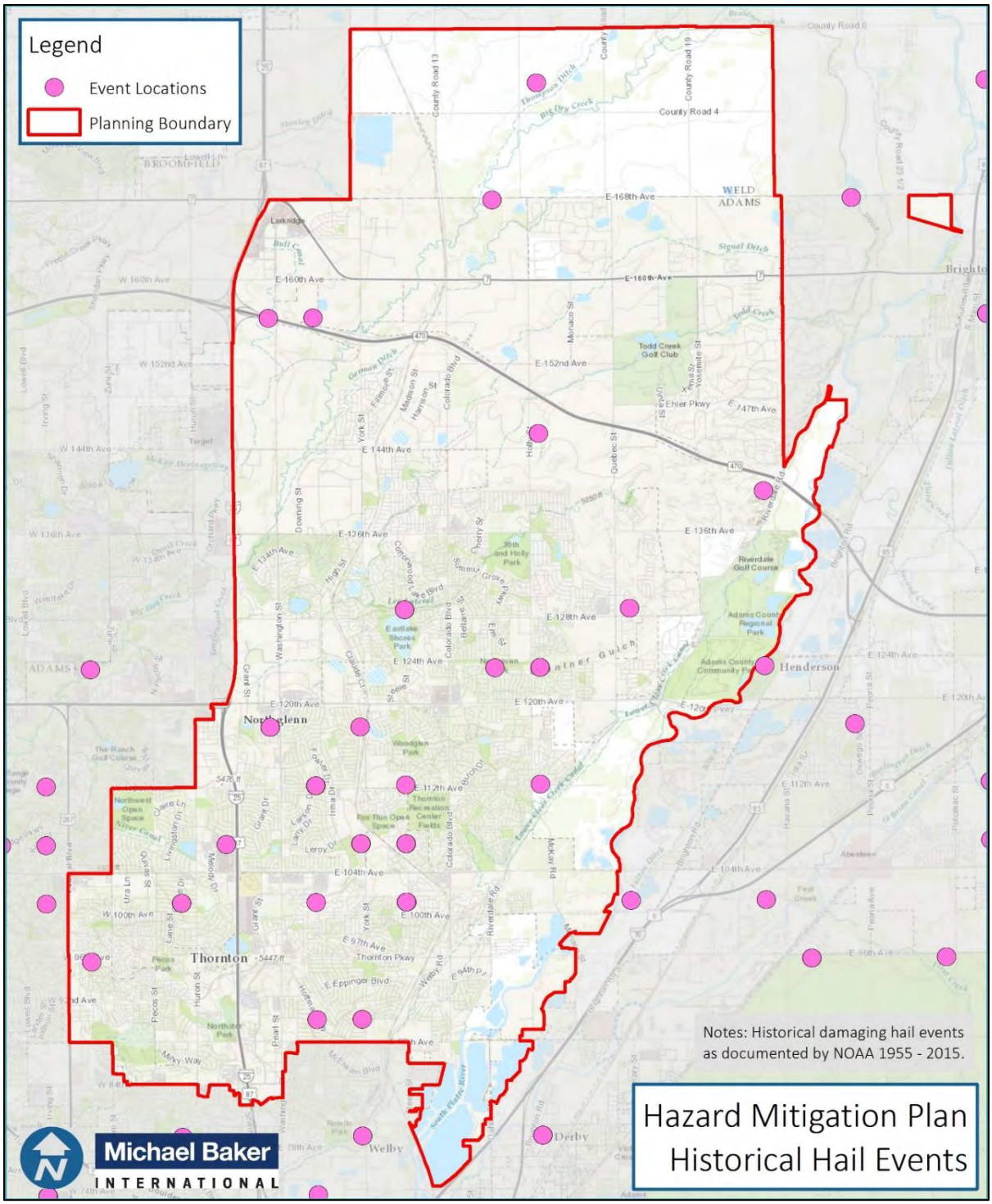
Previous Occurrences

Hail

According to the 2010 Denver Metro Natural Hazard Mitigation Plan, Thornton has seen 18 major hail events from 1955-2007 with no injuries or fatalities[28]. Additional data detailed that between 1955 and 2014, there were 125 hail events within Adams County. One of those events caused property damage of approximately $120 million, although there were no reported injuries or deaths during this time period. Weld County had 737 hail events with no deaths or injuries. Over $10 million in property damage and over $30 million in crop damage was seen because of these numerous hail storms. Within the Denver region, there has been extensive hail damage to crops, roofs and automobiles. On July 11, 1990, the Front Range experienced three hours of hailstones the size of marbles to tennis balls. The damage from this totaled more than $600 million, which mostly affected roofs and automobiles[29]. Historic data shows that hail hazards occur in areas that are within close proximity to the tri-city planning area. Therefore, these planning area communities should be prepared for future hail events.

[28] 2010 Denver Natural Hazard Mitigation Plan (pg. 52)
[29] 2010 Denver Natural Hazard Mitigation Plan (pg. 50)

Figure 50. Historical Hail Events within the Planning Area



City of Thornton Northglenn Federal Heights

Lightning

Lightning is a leading hazard in Colorado, which ranks 11th in the U.S. in both injuries and deaths[30]. No historic data shows hazardous impacts on Thornton specifically, but there is great potential for lightning to occur at any given time. While lightning losses are often quantified, the best available data sources included the following information for Adams County between 1950 and 2015 (Weld County data was not available).

TABLE 39. LIGHTNING EVENTS FOR ADAMS CO. 1950-2015

County	Number of Recorded Events	Injuries	Fatalities	Property Damage
Adams	19	3	2	$391,000

Source: NOAA, NCEI Storm Events Database

Inventory Exposed

All assets located in the City of Thornton can be considered at risk from severe storms. This includes 118,772 people, or 100% of the city's population and all buildings and infrastructure within the city. Damages primarily occur as a result of high winds, lightning strikes, hail, snow-loading, and flooding. Most structures, including the city's critical facilities, should be able to provide adequate protection from hail but the structures could suffer broken windows and dented exteriors. Those facilities with back-up generators are better equipped to handle severe weather situations should the power go out.

Inventory assets exposed to severe wind are dependent on the age of the building, type, construction material used, and condition of the structure. Possible losses to critical infrastructure include:

- Electric power disruption
- Communication disruption
- Water and fuel shortages
- Road closures
- Damaged infrastructure components, such as sewer lift stations and treatment plants
- Damage to homes, structures, and shelters

Potential Losses

Severe storms affect the entire planning area of the City of Thornton including all above-ground structures and infrastructure. Although losses to structures are typically minimal and covered by insurance, there can be impacts with lost time, maintenance costs, and contents within structures. A timely forecast may not be able to mitigate the property loss, but could reduce the casualties and associated injuries.

It appears possible to forecast these extreme events with some skill, but further research needs to be done to test the existing hypothesis about the interaction between the convective storm and its environment that produces the extensive swath of high winds. Severe storms will remain a highly likely

[30] 2010 DRCOG Denver Natural Hazard Mitigation Plan

occurrence for the City of Thornton and it is likely that lightning and hail will also be experienced in the area due to such storms.

Probability of Future Occurrences

Severe storms can be predicted with a reasonable level of certainty. Through the identification of various indicators of weather systems, and by tracking these indicators, warning time for severe storms can be as much as a week in advance. Understanding the historical frequency, duration, and spatial extent of severe weather assists in determining the likelihood and potential severity of future occurrences. The characteristics of past severe events provide benchmarks for projecting similar conditions into the future. The probability that the City of Thornton will experience a severe storm event can be difficult to quantify. However, based on historical records and frequencies there is nearly a 100% chance this type of event will occur somewhere in the City of Thornton at least once every year.

Land Use and Development

All future structures built in the City of Thornton will likely be exposed to severe weather extremes and damage. Since the previous statement is assumed to be uniform to the tri-city planning area, the location of development does not increase or reduce the risk necessarily. Although, with Thornton's expected population and development growth, the chances of community members and structures being at risk to severe weather storms will increase. Thornton must continue to adhere to building codes and development should be built to current standards in case of adverse weather

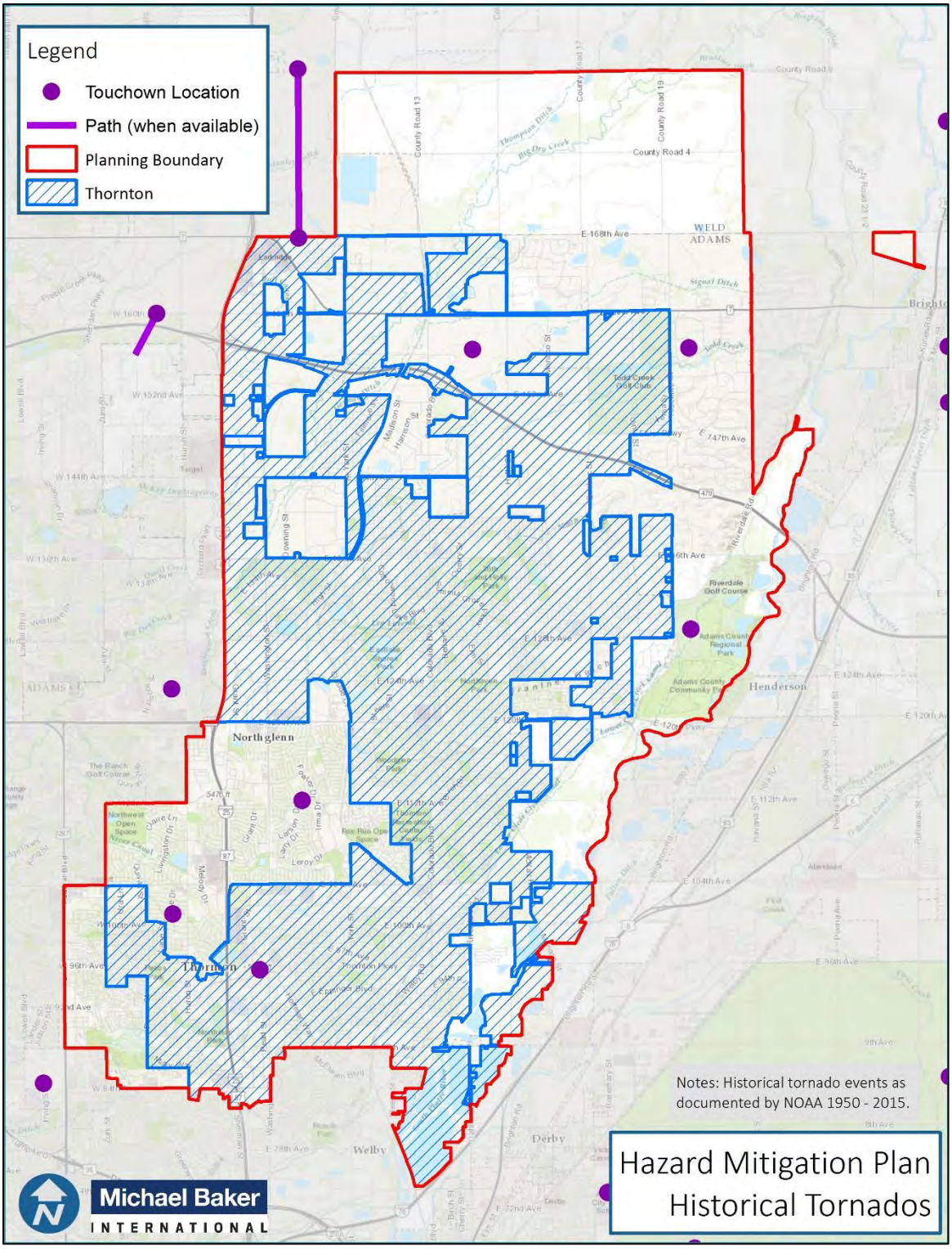
Tornado and Severe Wind

Although large tornadoes are a rare event along the Front Range of Colorado, this hazard, along with severe winds, are a concern for representatives and residents of communities in the planning area.

Previous Occurrences

NCEI's Storm Events Database estimates that 237 tornadoes have touched down in, or moved through, Adams and Weld Counties between 1950 and 2015. There have been no reported deaths but there have been 56 total injuries and over $30 million in property damage. It is important to note that this data is for the entire county limits and not specific to the City of Thornton. The following figure depicts historical tornado tracks and events within the planning area. The map illustrates where tornadoes have touched down (and traveled) between 1950 and 2015.

FIGURE 51. HISTORICAL TORNADO EVENT MAP



City of Thornton Northglenn Federal Heights

NCEI's Storm Events Database estimates that no injuries or deaths have occurred within Thornton from severe wind events. There have been five recorded strong wind events in west Adams and Weld County between 2009 and 2014 causing approximately $41,000 in damages.

Although tornadoes are a rare event, on June 3, 1981, a severe storm produced five tornadoes over the Denver Metro Area, one of which touched down in Thornton. The Thornton tornado tore through what was then the heart of the city and at a rating of F2 on the Fujita Scale. This tornado damaged approximately 600 homes, 87 of which were completely destroyed. The tornado hit shopping centers, restaurants, and other buildings, causing extensive damage. There were 42 reported injuries, seven of which were considered serious. Property damage was estimated up to $50 million. The Thornton Quarterly has addressed tornado hazards in the past and has identified ways that the community can keep safe during an event.

FIGURE 52. SECOND TORNADO IN THORNTON NEIGHBORHOOD (NCAR)

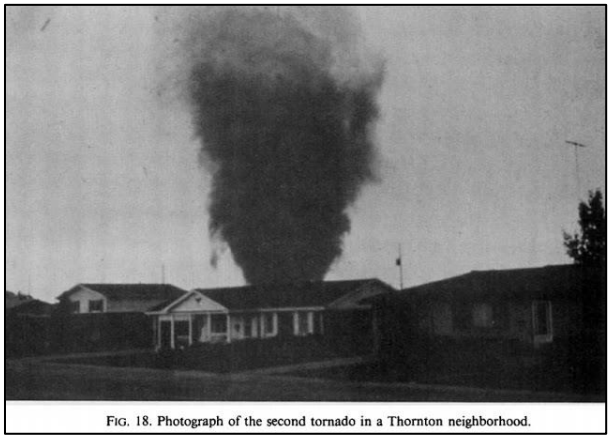


FIG. 18. Photograph of the second tornado in a Thornton neighborhood.

FIGURE 53. F2 DAMAGE FROM THORNTON TORNADO (NCAR)

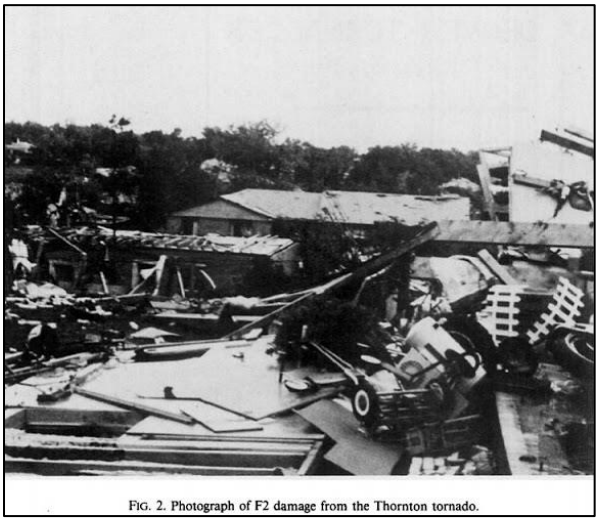


FIG. 2. Photograph of F2 damage from the Thornton tornado.

Inventory Exposed

Inventory assets exposed to severe wind is dependent on the age of the building, type, construction material used, and condition of the structure. Possible losses to critical infrastructure include:

- Electric power disruption
- Communication disruption
- Water and fuel shortages
- Road closures
- Damaged infrastructure components, such as sewer lift stations and treatment plants
- Damage to homes, structures, and shelters

All assets located in the City of Thornton can be considered at risk from tornadoes and severe wind. This includes 100% of the City's population and all buildings and infrastructure within the City.[31] Most structures, including the city's critical facilities, should be able to withstand and provide adequate protection from tornadoes. Those facilities with back-up generators should be fully equipped to handle tornado events should the power go out.

Potential Losses

Generally, straight-line wind events and tornadoes destroy private, commercial, and public property. Additional costs stem from debris removal, maintenance, repair, and response. Indirect costs include loss of industrial and commercial productivity as a result of damage to infrastructure, facilities, or interruption of services. Because no specific, citywide loss estimation exists for wind and tornado hazards, potential losses are related to historical property damage and injuries/deaths.

Over the last 66 years there have been no deaths reported in the City of Thornton due to a tornado event and no deaths or injuries due to severe wind. Monetary losses to crops are largely unknown, but due to previous events, property damage can be expected to reoccur during future events.

Probability of Future Occurrences

Reported tornadoes in Adams and Weld County over the past 66 years provide an acceptable framework for determining the future occurrence in terms of frequency for such events. The probability of the City experiencing a tornado associated with damages or injuries can be difficult to quantify. Historic frequency suggests that there is a chance of this type of event occurring somewhere in the region each year.

The probability of the City of Thornton experiencing a severe wind event associated with damages or injuries can be difficult to quantify, but based on Adams County records of five severe wind events and over $40,000 in property damage since 2009, there is a chance of risk for the planning area communities to experience future damage.

Land Use and Development

All future structures built in the City of Thornton could likely be exposed to tornado and severe wind damage. As with other large extent hazards, increased development trends will increase the vulnerability

[31] 2010 Census

of these areas. Thornton must continue to adhere to building codes and to facilitate new development that is built to the highest design standards to account for tornadoes and severe wind.

Due to the nature of tornadoes and severe wind, not all of Thornton is expected to be impacted equally. For example, older homes, which are often subject to less advanced building codes, suffer increased vulnerability to tornadoes over time. Mobile homes, which are most often occupied by low-income, socially vulnerable residents, are the most dangerous places during a tornado. Studies indicate that 45% of all fatalities during tornadoes occur in mobile homes, compared to 26% in traditional site-built homes.[32] As Thornton continues to grow to the north and to the east, it is important that local agencies monitor the inventory and locations of mobile homes, particularly in areas of high tornado risk. Moreover, when discussing mitigation actions for severe winds and tornadoes, communities or geographic locations with large numbers of mobile homes deserve added attention.

Winter Storm

Winter storms impact communities on every level and are a fairly typical occurrence for communities within the planning area. Although most communities are well-equipped to prepare for this hazard, storms have increased in recent years and more mitigation measures can created for future events.

Previous Occurrences

According to the NOAA's NCEI Storm Events Database, Adams County has experienced 64 Winter Storms since 1996 and Weld County has experienced 67. On December 28, 2006, Weld County saw the most extensive property damage of over $100,000 and no deaths or injuries. Based on historical data, it is certain that Thornton is at risk of experiencing, and being impacted by, winter storms in the coming years.

Inventory Exposed

All assets located in the City of Thornton can be considered at risk from winter storms. This includes 118,772 people, or 100% of the City's population, and all buildings and infrastructure within the City. Damages primarily occur as a result of high winds and snow-loading. Most structures, including the City's critical facilities, should be able to provide adequate protection from winter storm damage. Those facilities with back-up generators are better equipped to handle a winter storm situation should the power go out.

Potential Losses

Winter storms affect the entire planning area of the City of Thornton including all above-ground structures and infrastructure. Although losses to structures are typically minimal and covered by insurance, there can be impacts with lost time, maintenance costs, and contents within structures. A timely forecast may not be able to mitigate the property loss, but could reduce the casualties and associated injury.

Probability of Future Occurrences

Severe winter storms can be predicted with a reasonable level of certainty. Through the identification of various indicators of weather systems, and by tracking these indicators, warning time for snow storms can be as much as a week in advance. Understanding the historical frequency, duration, and spatial extent of

[32] Ashley, W.S., A.J. Krmenec, and R. Schwantes, 2008: Vulnerability due to nocturnal tornadoes. *Weather and Forecasting*, 23, 795 – 807.

severe winter weather assists in determining the likelihood and potential severity of future occurrences. The characteristics of past severe winter events provide benchmarks for projecting similar conditions into the future. The probability that Thornton will experience a severe winter storm event can be difficult to quantify. However, based on historical records and frequencies there is nearly a 100% chance of this type of event will occur somewhere in the City of Thornton at least once every year.

Land Use and Development

All future structures built in the City of Thornton are likely be exposed to severe weather extremes and damage. Since the previous statement is assumed to be uniform across the region, the location of development does not increase or reduce the risk necessarily. Although, as Thornton's population and development is expected to grow, the chances of community members and structures being at risk to winter storms will increase. Thornton must adhere to building codes, and therefore, new development should be built to current standards to account for adverse weather.

Existing Planning Mechanisms

There are numerous existing regulatory and planning mechanisms in place at the city level of government which support hazard mitigation planning efforts. These tools include city subdivision regulations and road and bridge standards, and local zoning regulations. These planning mechanisms were discussed at the Community Interview and Thornton's members of the Hazard Mitigation Planning team were encouraged to review all available technical information available for their City as they worked to develop the risk assessment and their mitigation actions.

Thornton is a participant in the National Flood Insurance Program (NFIP). Since it entered the program, the city has adopted the minimum NFIP requirements into its Charter and City Code and Ordinances. The city plans to continue compliance with all NFIP requirements in the future. Thornton is also a Class 6 CRS community. This enhanced floodplain management results in residents in the SFHA receiving a 20% reduction in flood insurance premiums (10% reductions are available for those not in the SFHA).

During the hazard mitigation planning process, the city worked to identify ways in which identified mitigation actions/projects will be incorporated into their existing planning and regulatory mechanisms over time. Moving forward, Thornton will continue to integrate the goals and actions of this Plan into their evolving local planning mechanisms, including comprehensive plans, capital improvement plans, and resource and land use regulations. They will be incorporated into existing planning mechanisms as they are updated or developed.

This HMP will serve as a source document for risk reduction, policy making, and land use planning. These planning mechanisms will enhance the city's ability to implement the actions outlined in the mitigation plan. The HMP is also be utilized as the City develops its other emergency management plans.

Mitigation Strategy

The intent of the Mitigation Strategy is to provide the participating jurisdictions with the goals that will guide future mitigation policy and project administration. The Mitigation Strategy includes a list of proposed actions deemed necessary to meet those goals and reduce the impact of natural hazards.

Summary of Goals

Mitigation Goals are general guidelines that explain what a community wants to achieve with their local hazard mitigation plan. Thornton's Goals are overarching targets and describe the ideal long-term outcomes envisioned by the community, which are listed below.

- Protect people, property, and natural resources (T1)
- Improve capability to prevent and reduce physical, economic, and social losses from disasters (T2)
- Ensure that functionality of local critical facilities are maintained in the event of a disaster (T3)
- Strengthen communication and coordination among public agencies, NGOs, businesses, and residents (T4)
- Increase public awareness of natural hazard risks and mitigation options (T5)
- Integrate hazard mitigation into other planning mechanisms (T6)
- Ensure that Hazard Mitigation will be acknowledged and supported by the Thornton Comprehensive Plan and other local plans (T7)

2010 Hazard Mitigation Plan Actions

The HMP small team was tasked with reviewing mitigation projects included in the 2010 Denver Metro NHMP. The City of Thornton's mitigation projects for 2010 were as follows:

TABLE 40. 2010 HMP PROJECTS, CITY OF THORNTON

Lead Department	Project Name	Hazard	Timeline	Status	Estimated Cost
City of Thornton, Infrastructure	144th Avenue Bridge at Big Dry Creek	Flood	Unknown, Estimated 2017	Remains high priority – not yet funded	$20,000,000
City of Thornton, Infrastructure	Holly Street Hazard Mitigation Project	Flood	Begin Spring 2011, 7mnths construction	Complete	$3,000,000
City of Thornton, Infrastructure	Niver Creek Tributary, Huron and I-25 Detention Facilities	Flood	Unknown	On-going – planning underway	$3,000,000
City of Thornton	DRCOG 1 – Continued Participation in NFIP	Flood	On-going	On-going – City remains a participants	Staff Time
City of Thornton	DRCOG 2 – Implement and improve upon effective floodplain and stormwater management practices	Flood	On-going	On-going – On-going flood studies, CRS Class 6 community	Staff Time

Lead Department	Project Name	Hazard	Timeline	Status	Estimated Cost
City of Thornton	DRCOG 3 – Work with water providers to continually identify and promote water conservation programs	Drought	On-going	On-going – Enforces water restrictions as necessary. Current 2017 action further identifies work relating to this.	Staff Time
City of Thornton	DRCOG 4 – Monitor proceedings of the Colorado Water Availability Task Force, support water providers in implementation of conservation measures	Drought	On-going	On-going – See above.	Staff Time
City of Thornton	DRCOG 5 – Integrate HMP into other planning efforts	Multi-Hazard	On-going	On-going – Will soon be updating Comprehensive Plan and integrating updated HMP, also integrating with planned EM planning efforts.	Staff Time

2017 Mitigation Actions

As part of the 2017 planning process, the following mitigation projects were identified and developed into MAGs for Thornton:

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH1) 104th & GHC South Tributary**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Flood
LOCATION: 104th & GHC South Tributary	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster
RECOMMENDATION DATE: 09/07/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Mitigate roadway flooding and risk to drivers.	
ACTION: Reconstruct culvert and/or raise roadway east of Irma Drive intersection to provide 100-year conveyance.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** TBD
SUPPORT AGENCIES:	**POTENTIAL FUNDING SOURCES:**
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH2) 112th & Cherry Street Area**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Flood
LOCATION: 112th & Cherry Street	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster
RECOMMENDATION DATE: 09/07/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Mitigate structural flooding and risk to residents in the floodplain.	
ACTION: Reconstruct/expand storm sewer system to remove homes from the floodplain.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** TBD
SUPPORT AGENCIES:	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH3) 128th Avenue & Brantner Gulch**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** Flood
LOCATION: 128th Ave. & Brantner Gulch	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster
RECOMMENDATION DATE: 09/07/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Mitigate flooding damage.	
ACTION: Replace culvert with bridge to handle 100-year flows and eliminate overtopping.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** TBD
SUPPORT AGENCIES: TBD	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH4) 136th Ave to Washington St on Big Dry Creek**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Flood
LOCATION: 136th Ave to Washington St on Big Dry Creek	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster
RECOMMENDATION DATE: 09/07/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Mitigate structural flooding and risk to residents in the floodplain.	
ACTION: Realign channel, grade north of channel, reconstruct Washington Street south of channel to contain 100-year flows. Remove developable properties north of the channel from the floodplain; minimize flooding on property west of the channel. See Big Dry Creek MDP – pg. 11 for reach in question.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** TBD
SUPPORT AGENCIES: TBD	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH5) 144th Ave at Big Dry Creek**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Flood
LOCATION: 144th Ave at Big Dry Creek	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster
RECOMMENDATION DATE: 09/07/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Mitigate roadway flooding and risk to drivers.	
ACTION: Raise roadway and reconstruct culverts/new bridge to get arterial street out of the floodplain. Presently less than a 10-year event floods the road.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** TBD
SUPPORT AGENCIES: TBD	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH6) Adopt an Emergency Operations Plan**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** Drought, Earthquake, Flood, Expansive Soils / Undermined Areas, Severe Storms, Public Health Hazards, Tornado / Severe Wind, Winter Storm, Wildland Fire
LOCATION: Citywide	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster • T4 - Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens • T5 - Increase public awareness of natural hazards and mitigation options • T7 - Ensure that Hazard Mitigation will be acknowledged and supported by the Thornton Comprehensive Plan and other local plans
RECOMMENDATION DATE: 09/08/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Ensure city is prepared to be able to manage a disaster event.	
ACTION: A city Emergency Operations Plan will be a resource for staff/volunteers to reference in the case of a hazard event. It will outline protocol and staff roles. An addition to go along with this would include training city staff to be educated about what to do in emergencies. Should cover all city departments.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** TBD
SUPPORT AGENCIES: TBD	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH7) Create and Adopt Major Transportation Route Incident Response Plans**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Drought, Earthquake, Flood, Expansive Soils / Undermined Areas, Severe Storms, Public Health Hazards, Tornado / Severe Wind, Winter Storm, Wildland Fire
LOCATION: Citywide	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster • T4 - Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens • T7 - Ensure that Hazard Mitigation will be acknowledged and supported by the Thornton Comprehensive Plan and other local plans
RECOMMENDATION DATE: 09/08/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Ensure staff is educated about dealing with incidents on I-25.	
ACTION: Create and adopt an Incident Response Plan for the major traffic corridors and highways throughout the city, so that city staff can reference proper protocol when dealing with hazard events that impact those roadways. This will involve coordinate with CDOT and other jurisdictions to obtain best available data.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** TBD
SUPPORT AGENCIES: TBD	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH8) Installation of Advanced Metering Infrastructure**	
PRIORITY: Medium	**HAZARDS ADDRESSED:** Drought
LOCATION: City of Thornton	**PLANNING GOALS ADDRESSED:** T1 - Protect people, property, and natural resources T2 - Improve capability to reduce disaster losses T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster T5 - Increase public awareness of natural hazards and mitigation options
RECOMMENDATION DATE: 09/08/2016	
TARGET COMPLETION DATE: 2020	
OBJECTIVES ADDRESSED: Advanced metering infrastructure (AMI) is an integrated system of smart water meters, communications networks, and data management systems that enables two-way communication between utilities and customers. The system allows real-time access to water usage information at each water meter, and allows customers and Thornton to better manage water usage, detect water leaks, and operate the water distribution system. Currently, water usage is measured and recorded monthly. AMI is particularly beneficial in conservation efforts and during a drought. Usage restrictions or conservation efforts can be instantly measured, and quick actions can be taken to modify water usage.	
ACTION: Install AMI infrastructure.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** $6,000,000
SUPPORT AGENCIES:	**POTENTIAL FUNDING SOURCES:** City of Thornton
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH9) Appoint a Structural Engineer Representative for Building Department**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Drought, Earthquake, Flood, Expansive Soils / Undermined Areas, Severe Storms, Public Health Hazards, Tornado / Severe Wind, Winter Storm, Wildland Fire
LOCATION: Citywide RECOMMENDATION DATE: 09/08/2016 TARGET COMPLETION DATE: TBD	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster • T4 - Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens • T5 - Increase public awareness of natural hazards and mitigation options
OBJECTIVES ADDRESSED: Increase city's building department capabilities.	
ACTION: Hire or contract out a structural engineer to represent the city that could evaluate properties for mitigation details. Building inspectors typically have one area of expertise, but it would be good to have someone who is cross-trained and can identify structures that need overall improvement to mitigate hazards. An addition to this would be to cross-train all building inspectors to check for a broad range of structural issues.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** TBD
SUPPORT AGENCIES: TBD	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH10) Big Dry Creek at RTD (UPRR) Railroad Embankment**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Flood
LOCATION: Big Dry Creek at RTD (UPRR) Railroad Embankment	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster
RECOMMENDATION DATE: 09/07/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Mitigate roadway flooding and risk to drivers.	
ACTION: Construct engineered headwall, new pipe culvert, and additional culverts through the railroad embankment to prevent overtopping of 168th Avenue west of the railroad; west of Colorado. The additional culverts will need to be controlled by a high spillway to avoid creating downstream floods in minor, much less moderate storms, that hasn't occurred since the embankment and current culvert were constructed in 1956. (See Tiff map page 15)	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** TBD
SUPPORT AGENCIES: TBD	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH11) Big Dry Creek Sanitary Sewer Interceptor**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Flood
LOCATION: Big Dry Creek Sanitary Sewer Interceptor	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster
RECOMMENDATION DATE: 09/07/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Mitigate roadway flooding and risk to drivers.	
ACTION: Reconstruct, seal, and/or raise manholes in the railroad backwater area to prevent flood flows that pond against the embankment from overwhelming the BDC Lift station on the east side of Colorado.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** TBD
SUPPORT AGENCIES: TBD	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH12) Build Relationships with AIA and SEAC**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Drought, Earthquake, Flood, Expansive Soils / Undermined Areas, Severe Storms, Public Health Hazards, Tornado / Severe Wind, Winter Storm, Wildland Fire
LOCATION: Citywide	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster • T4 - Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens • T5 - Increase public awareness of natural hazards and mitigation options
RECOMMENDATION DATE: 09/08/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Increase city's capabilities to assess structures for hazards.	
ACTION: Building relationships with the American Institute of Architects (AIA) and the Structural Engineers Association of Colorado (SEAC) to increase the city's awareness of technical structural knowledge and to increase mitigation for local hazards in order to protect infrastructure.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** TBD
SUPPORT AGENCIES: TBD	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH13) Building Code Updates**	
PRIORITY: Medium	**HAZARDS ADDRESSED:** Flood, Severe Storms, Tornado/Severe Wind, Earthquake, Extreme Temperatures, Expansive Soils/Undermined Areas, and Winter Storms.
LOCATION: City of Thornton RECOMMENDATION DATE: 07/15/2016 TARGET COMPLETION DATE: Ongoing – Every three years.	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster • T5 - Increase public awareness of natural hazards and mitigation options
OBJECTIVES ADDRESSED: Updating Thornton building codes every three years to the most recent version of the international building codes (and related codes) serves to maintain the highest level of protection in new structures.	
ACTION: Update Thornton's building codes to the most recent edition of the International Building Code and related documents, and make appropriate local amendments.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** $18,000 every three years.
SUPPORT AGENCIES: None	**POTENTIAL FUNDING SOURCES:** City of Thornton FEMA
PROGRESS MILESTONES: Budget appropriately for future updates.	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH14) Loss Prevention Project**	
PRIORITY: Med (High, Med, Low)	**HAZARDS ADDRESSED:** All-hazards
LOCATION: Floodplain Areas	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T5 - Increase public awareness of natural hazards and mitigation options
RECOMMENDATION DATE: 7/12/2016	
TARGET COMPLETION DATE: 7/12/2020	
OBJECTIVES ADDRESSED: The mitigation project would include the evaluation of city regulations for new home and commercial building construction to take into consideration potential damages from the 5 main identified hazards. This may require improved building techniques, recommendations for stronger materials, or recommendations could that reduce future losses and improve safety.	
ACTION: The project would require significant analysis of building techniques and approval from City Government and city Council for such regulatory provisions.	
LEAD AGENCY: City of Thornton – City Development, Economic Development, Planning, and Building Inspection.	**EXPECTED COST:** Not determined at this time
SUPPORT AGENCIES: City of Thornton – Risk Management,	**POTENTIAL FUNDING SOURCES:** Potential Building refunds or programs to lessen costs for these building improvements.
PROGRESS MILESTONES: List any major anticipated project milestones and/or reports about current project status.	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH15) Continuity of Operations Training for Local Businesses**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** All-Hazards
LOCATION: City-wide	**PLANNING GOALS ADDRESSED:** T1 – Protect people, property, and natural resources T2 – Improve capability to reduce disaster losses T4 – Strengthen communication and coordination among public agencies, NGOs, businesses and citizens
RECOMMENDATION DATE: 9/17/2016	
TARGET COMPLETION DATE: 9/16/2019	
OBJECTIVES ADDRESSED: The mitigation project would include public education and outreach to local businesses on the topic of business disaster preparedness and continuity of operations planning.	
ACTION: The project would include a public education/ training session, material development, and general assistance in the development of business continuity plans.	
LEAD AGENCY: City of Thornton – Economic Development and Risk Management	**EXPECTED COST:** To Be Determined
SUPPORT AGENCIES: City of Thornton – Neighborhood Services	**POTENTIAL FUNDING SOURCES:** City approved budget or potential mitigation grant
PROGRESS MILESTONES: No project milestones have been determined at this time.	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH18) Colorado Blvd at Big Dry Creek**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Flood
LOCATION: Colorado Blvd at Big Dry Creek	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster
RECOMMENDATION DATE: 09/07/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Mitigate roadway flooding and risk to drivers.	
ACTION: Reconstruct Bridge on new alignment to convey 100-year flow. New alignment would also serve to remove the Colorado Boulevard/SH 7 (160th Avenue) intersection from the Morrison Creek flood plain.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** TBD
SUPPORT AGENCIES: TBD	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH19) Uninterrupted Communications between City Departments During Emergencies**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Flooding, Severe Storms, Drought, Tornado, Wildland Fire, Subsidence, Earthquake
LOCATION: Citywide	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T4 - Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens
RECOMMENDATION DATE: 09/07/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Ensuring communication is not lost between city departments/buildings when a disaster takes place to ensure response efforts are not negatively impacted.	
ACTION: Determine which City facilities currently have radios, assess the appropriateness and feasibility of hardwiring, and investigate other options to ensure constant and uninterrupted communications is maintained during disaster events across city departments and buildings.	
LEAD AGENCY:	**EXPECTED COST:** TBD
SUPPORT AGENCIES:	**POTENTIAL FUNDING SOURCES:**
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH20) Community Emergency Response Training Expansion**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** All-hazards
LOCATION: City-wide	**PLANNING GOALS ADDRESSED:** T1 – Protect people, property, and natural resources T2 – Improve capability to reduce disaster losses T4 – Strengthen communication and coordination among public agencies, NGOs, businesses and citizens
RECOMMENDATION DATE: 9/17/2016	
TARGET COMPLETION DATE: 9/16/2018	
OBJECTIVES ADDRESSED: The mitigation project would involve expanding the current Community Emergency Response Training (CERT) Program to increase visibility, outreach, team building, and resources for attracting volunteers, training the public, building/equipping a team, and exercising for disasters.	
ACTION: The project would include funds, marketing capability, and potential part-time personnel to build upon the capability of the city CERT program.	
LEAD AGENCY: City of Thornton – Risk Management, Fire Department, and Neighborhood Services	**EXPECTED COST:** To Be Determined
SUPPORT AGENCIES: Police Department	**POTENTIAL FUNDING SOURCES:** City approved budget or potential federal grants
PROGRESS MILESTONES: No project milestones determined at this time.	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH21) Create a Crisis Communication Plan**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** Earthquake, Flood, Expansive Soils / Undermined Areas, Severe Storms, Public Health Hazards, Tornado / Severe Wind, Winter Storm, Wildland Fire
LOCATION: Citywide	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster • T4 - Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens • T5 - Increase public awareness of natural hazards and mitigation options • T6 - Integrate hazard mitigation into other planning mechanisms • T7 - Ensure that Hazard Mitigation will be acknowledged and supported by the Thornton Comprehensive Plan and other local plans
RECOMMENDATION DATE: 09/08/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Educate city staff on crisis communication.	
ACTION: The city Crisis Communication Plan will be a joint information center for staff to reference so that they're educated about proper communication during and following hazard events.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** TBD
SUPPORT AGENCIES: TBD	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH22) Purchase a Mobile Command Post**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Drought, Earthquake, Flood, Expansive Soils / Undermined Areas, Severe Storms, Public Health Hazards, Tornado / Severe Wind, Winter Storm, Wildland Fire
LOCATION: Citywide	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster • T4 - Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens • T5 - Increase public awareness of natural hazards and mitigation options • T6 - Integrate hazard mitigation into other planning mechanisms • T7 - Ensure that Hazard Mitigation will be acknowledged and supported by the Thornton Comprehensive Plan and other local plans
RECOMMENDATION DATE: 09/08/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Identify a point of contact/area for communication and education.	
ACTION: Purchase a mobile command post to be used to responding to and recovering from disasters. Plan would also have to include a warm storage area.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** $1.8 million (vehicle)
SUPPORT AGENCIES: TBD	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH23) Create an Emergency Response Unit**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Flood, Tornado / Severe Wind, Wildland Fire
LOCATION: Citywide	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster
RECOMMENDATION DATE: 05/15/2016	
TARGET COMPLETION DATE: 12/31/2021	
OBJECTIVES ADDRESSED: The City of Thornton is a city of approximately 133,000. The city does not have any type of emergency response unit to assist with natural disasters other than police, fire and infrastructure. A unit would be created that can respond to assist police and fire during natural disasters. This unit would assist with road closures, debris removal, and logistics support.	
ACTION: Create an Emergency Response Unit. Provide personnel, appropriate protective clothing, vehicles and road barricades.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** TBD
SUPPORT AGENCIES: TBD	**POTENTIAL FUNDING SOURCES:** City of Thornton, Grants from State of Colorado, and federal grants
PROGRESS MILESTONES: Summer 2017, City of Thornton 2017 Capital Improvements Program Budget will be adopted. This is a proposed project for 2017-2021.	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH24) Create citywide debris management plan**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Earthquake, Flood, Expansive Soils / Undermined Areas, Severe Storms, Tornado / Severe Wind, Winter Storm, Wildland Fire
LOCATION: Citywide	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T4 - Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens • T6 - Integrate hazard mitigation into other planning mechanisms
RECOMMENDATION DATE: 09/07/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Ensure debris caused from natural disasters are able to be managed and do not cause disruption to community members.	
ACTION: Creating a citywide debris management plan that will include mutual aid and cross communication between city departments.	
LEAD AGENCY:	**EXPECTED COST:** TBD
SUPPORT AGENCIES:	**POTENTIAL FUNDING SOURCES:**
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH25) West Cooley Reservoir Complex Spillway**	
PRIORITY: High	**HAZARDS ADDRESSED:** Flood, Severe Storms
LOCATION: City of Thornton	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster
RECOMMENDATION DATE: 07/15/2016	
TARGET COMPLETION DATE: 06/30/2018	
OBJECTIVES ADDRESSED: The West Cooley Reservoir Complex contains several water storage reservoirs that are critical components of the city's water supply. These reservoirs are adjacent to the South Platte River, and are exposed to routine flooding. Significant flooding, which has occurred twice in the past three years, has resulted in failure of the berm that separates the reservoirs from the South Platte River. Installation of spillways will help control the way that flood water moves through the complex, and will assist in minimizing damage to reservoir infrastructure.	
ACTION: Design and construction of three spillways.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** $2,650,000
SUPPORT AGENCIES: None	**POTENTIAL FUNDING SOURCES:** City of Thornton
PROGRESS MILESTONES: Fall 2016, City of Thornton 2017 Capital Improvements Program Budget will be adopted. This is a proposed project for 2017.	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH26) Emergency Management Staffing**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** All-hazards
LOCATION: City-wide	**PLANNING GOALS ADDRESSED:** T1 – Protect people, property, and natural resources T2 – Improve capability to reduce disaster losses T3 – Ensure that functionality of local critical facilities are maintained in the event of a disaster T4 – Strengthen communication and coordination among public agencies, NGOs, businesses and citizens T5 – Increase public awareness of natural hazards and mitigation options T6 – Integrate hazard Mitigation into other planning mechanisms T7 – Ensure that Hazard Mitigation will be acknowledged and supported by the Thornton Comprehensive Plan and other local plans
RECOMMENDATION DATE: 9/17/2016	
TARGET COMPLETION DATE: 9/16/2020	
OBJECTIVES ADDRESSED: The mitigation project would involve expanding the current staffing allotted to emergency management activities for the city. Currently the city has an Emergency and Safety Administrator who splits work hours between emergency management and occupational safety. This project would expand the staffing to one full-time dedicated emergency management professional, one part-time emergency management professional, and one or more internship positions.	
ACTION: The project would include the reclassification of the current position title and responsibilities to focus solely on emergency management programs, allocating funds and working space for a part-time position to support emergency management efforts, along with an internship position for additional project work.	
LEAD AGENCY: City of Thornton – City Manager's Office, Management and Budget, Management Services, and Risk Management	**EXPECTED COST:** No cost estimates at this time. Costs to be determined.
SUPPORT AGENCIES:	**POTENTIAL FUNDING SOURCES:** City approved budget or potential emergency management performance grant funds
PROGRESS MILESTONES: No project milestones determined at this time.	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH27) Emergency Operations Center (EOC) Training**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Drought, Earthquake, Flood, Expansive Soils / Undermined Areas, Severe Storms, Public Health Hazards, Tornado / Severe Wind, Winter Storm, Wildland Fire
LOCATION: Citywide	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster • T4 - Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens
RECOMMENDATION DATE: 09/08/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Increase city staff knowledge of their role and emergency protocol.	
ACTION: Implement an EOC training for city staff. This would include tabletop exercises and could be for the entire city staff. UASE puts on trainings for this and would cost approximately $10k.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** $10,000
SUPPORT AGENCIES: TBD	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH28) Emergency Shelter**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Flood, Tornado / Severe Wind, Wildland Fire
LOCATION: Citywide RECOMMENDATION DATE: 05/15/2018 TARGET COMPLETION DATE: 12/31/2021	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster
OBJECTIVES ADDRESSED: The City of Thornton is a city of approximately 133,000. The city does not have any type of dedicated emergency shelters other than using current city structures. There are no supplies provided to support a shelter facility.	
ACTION: Create Emergency Shelter facility. Provide personnel, appropriate protective clothing, and sleeping beds/cots/bags/blankets. Identify food resources.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** TBD
SUPPORT AGENCIES: TBD	**POTENTIAL FUNDING SOURCES:** City of Thornton, State and Federally funded grants
PROGRESS MILESTONES: Summer 2017, City of Thornton 2017 Capital Improvements Program Budget will be adopted. This is a proposed project for 2017-2021.	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH29) Emergency Operations Center (EOC) Development Project**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** All-hazards
LOCATION: City Hall EOC	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster • T4 - Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens
RECOMMENDATION DATE: 7/12/2016	
TARGET COMPLETION DATE: 7/12/2019	
OBJECTIVES ADDRESSED: The mitigation project would be the increase capability and resiliency of the City by expanding the functionality of the Emergency Operations Center with the purchasing of computers, desks, displaying capability, interconnection with the IMC-EOC, and more.	
ACTION: The project would be the purchase via City Funds or state grants to buy equipment and technological improvements to the current conference room used as the EOC.	
LEAD AGENCY: City of Thornton – Risk Management, Emergency and Safety Administrator	**EXPECTED COST:** To be determined
SUPPORT AGENCIES: All City Departments	**POTENTIAL FUNDING SOURCES:** City approved budget or potential Emergency Management Performance Grant opportunities.
PROGRESS MILESTONES: List any major anticipated project milestones and/or reports about current project status.	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH30) Evaluate technology backup resources**	
PRIORITY: Med (High, Med, Low)	**HAZARDS ADDRESSED:** Earthquake, Expansive Soils / Undermined Areas, Severe Storms, Tornado / Severe Wind, Winter Storm
LOCATION: Citywide	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster
RECOMMENDATION DATE: 09/07/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Ensure backup power generator and cellular systems are able to function properly during time of disaster.	
ACTION: Evaluate all critical facility backup systems. Replace/modify any systems that need it and ensure that they will all work properly in case of hazard event. Coordinate with local cell tower owners to identify infrastructure that may need backup power.	
LEAD AGENCY:	**EXPECTED COST:** TBD
SUPPORT AGENCIES:	**POTENTIAL FUNDING SOURCES:**
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH31) Evaluate current standards and specifications for city infrastructure**	
PRIORITY: Med (High, Med, Low)	**HAZARDS ADDRESSED:** Drought, Earthquake, Flood, Expansive Soils / Undermined Areas, Severe Storms, Tornado / Severe Wind, Winter Storm, Wildland Fire
LOCATION: Citywide RECOMMENDATION DATE: 09/07/2016 TARGET COMPLETION DATE: TBD	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster • T4 - Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens • T7 - Ensure that Hazard Mitigation will be acknowledged and supported by the Thornton Comprehensive Plan and other local plans
OBJECTIVES ADDRESSED: Ensure development and redevelopment meet standards that will mitigate losses from natural disasters.	
ACTION: Evaluate all standards and specifications for city infrastructure. Update or revise codes to better mitigate effects of natural disasters.	
LEAD AGENCY: Public Works & City Development	**EXPECTED COST:** TBD
SUPPORT AGENCIES:	**POTENTIAL FUNDING SOURCES:**
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH32) Evaluate lift stations exposure to flood risk**	
PRIORITY: Med (High, Med, Low)	**HAZARDS ADDRESSED:** Flood
LOCATION: Citywide - lift station locations	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster
RECOMMENDATION DATE: 09/07/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Mitigate lift station failure when a flood event occurs.	
ACTION: Evaluate each lift station citywide and determine their exposure to flood risk. Develop plans to mitigate the risk at each station.	
LEAD AGENCY:	**EXPECTED COST:** TBD
SUPPORT AGENCIES:	**POTENTIAL FUNDING SOURCES:**
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH33) Evaluate sewer/water crossings at roadways**	
PRIORITY: Low (High, Med, Low)	**HAZARDS ADDRESSED:** Flood
LOCATION: Citywide	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster
RECOMMENDATION DATE: 09/07/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Mitigate sewer/water crossings that have a potential to be affected by scour.	
ACTION: Identify all water and sewer crossings that have the potential to be exposed to scour and mitigate further degradation of crossings.	
LEAD AGENCY:	**EXPECTED COST:** TBD
SUPPORT AGENCIES:	**POTENTIAL FUNDING SOURCES:**
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH34) Expand and Improve Hazard Education for Seniors**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** All hazards
LOCATION: Community-wide	**PLANNING GOALS ADDRESSED:** T1 – Protect people, property, and natural resources T2- Improve capabilities to reduce disaster loss T3 – Ensure that functionality of local critical facilities are maintained in the event of a disaster T4 – Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens T5 – Increase public awareness of natural hazards and mitigation options T6 – Integrate hazard mitigation into other planning mechanisms
RECOMMENDATION DATE: 9/17/2016	
TARGET COMPLETION DATE: 12/31/2018	
OBJECTIVES ADDRESSED: Currently, Thornton provides emergency preparedness classes at the Thornton Senior Center. Enhancements to what is being done currently would help improve the quality, quantity, and comprehensiveness of the information being provided to our senior population.	
ACTIONS: Specific actions that could be taken include the following: Developing a web page or web site specific to emergency tips that would be useful to seniors. Providing more information about services that are available to them that could help make their homes more resilient to damage that could be caused by natural disasters. Increasing the information provided in city publications about what seniors can and should do in the event of a natural disaster. Providing information to seniors about how to file claims for property damage, hire qualified contractors to perform disaster recovery work, and avoid scams in the wake of a natural disaster. The city should consider GIS mapping of key areas with vulnerable populations and plan accordingly for assisting with disasters that may affect these areas more i.e.; mobile home parks, low income housing areas, places where language could be more of a barrier.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** $1,000 for speaker fees plus additional unknown amounts for other services
SUPPORT AGENCIES: Education providers, Senior services agencies.	**POTENTIAL FUNDING SOURCES:** City Budget, grant funds, funds from partner organizations.
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH35) Expand the CodeRed Program**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Drought, Earthquake, Flood, Expansive Soils / Undermined Areas, Severe Storms, Public Health Hazards, Tornado / Severe Wind, Winter Storm, Wildland Fire
LOCATION: Citywide	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T4 - Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens • T5 - Increase public awareness of natural hazards and mitigation options • T6 - Integrate hazard mitigation into other planning mechanisms
RECOMMENDATION DATE: 09/08/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Expanding on the CodeRed communication system.	
ACTION: Research funding for additional CodeRed costs. The program is currently being implemented in the city so that staff and citizens are alerted by phone/email when a hazard takes place. Additional enhancements can be made to the system, but it would require additional funds. The primary audience for this would be the citizens and as the city grows more enhancements would need to be made.	
LEAD AGENCY: TBD	**EXPECTED COST:** $30,000
SUPPORT AGENCIES: TBD	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH36) Fire Code Updates**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** Wildland Fire, Lightning
LOCATION: Citywide	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are
RECOMMENDATION DATE: August 1, 2016	
TARGET COMPLETION DATE: Every Three Years	
OBJECTIVES ADDRESSED: **Maintain the latest fire protection standards for the community to protect its citizens and structures.**	
ACTION: Once every three years, adopt the latest edition of the International Fire Code, related codes, and appropriate local amendments.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** $2,000 every three years
SUPPORT AGENCIES: None	**POTENTIAL FUNDING SOURCES:** Thornton General Fund
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH37) Fire Station Building Maintenance**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Preventative. Ground movement, power loss, etc.
LOCATION: All Fire Stations	**PLANNING GOALS ADDRESSED:** • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster
RECOMMENDATION DATE: 09/07/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Prevent damage and minimize impact of hazards to fire stations.	
ACTION: Annually, captains will inspect and evaluate stations for preventative needs. This will include checking windows and doors for security and function, ensuring all oxygen bottles and SCBA bottles within stations are secured, generators are being filled and functioning, and check stations for any other hazards. Building maintenance will ensure annual testing and inspections of generators by licensed contractors. All needs found will be forwarded as building maintenance requests go through chain of command for budgetary items.	
LEAD AGENCY: Thornton Fire Department	**EXPECTED COST:** Inspections should not take more than an hour of crews' time
SUPPORT AGENCIES: Building Maintenance	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES: Annual review and report generated for all City of Thornton Fire Stations.	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH38) Fire Station Emergency Procedures**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** All emergency disasters
LOCATION: Citywide	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources
RECOMMENDATION DATE: 09/07/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Describe the procedures all stations will follow in the event of a disaster within the City of Thornton.	
ACTION: The following response will be completed by each fire station in the event of a disaster. Stations will conduct a self-assessment to determine condition and functionality of station, equipment, and personnel. This will be reported to the Battalion Chief. Emergency call-back will be initiated if necessary and appropriate additional apparatus will be staffed/equipped. Crews will then initiate a windshield survey of their district with priority of assessing high value locations defined as critical infrastructure, high density populations, medical facilities, special need facilities and response support facilities. Findings will be reported to EOC. Specific hazards identified will be prioritized by EOC. Support staff will be needed to check on families of responders, respond to apparatus needs (specifically flat tires) and shuttle equipment and supplies.	
LEAD AGENCY: Thornton Fire Department	**EXPECTED COST:** TBD
SUPPORT AGENCIES: EOC, TPD, FVS	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES: Conduct a simulated exercise on an annual basis.	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH39) Flood Action Plan for Wes Brown Water Treatment Plant**	
PRIORITY: High	**HAZARDS ADDRESSED:** Flood
LOCATION: City of Thornton	**PLANNING GOALS ADDRESSED:** T1 - Protect people, property, and natural resources T2 - Improve capability to reduce disaster losses T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster
RECOMMENDATION DATE: 09/08/16	
TARGET COMPLETION DATE: 12/31/2018	
OBJECTIVES ADDRESSED: The Wes Brown Water Treatment Plant is located near the South Platte river. Although the plant is outside the 100-year floodplain, localized flooding could impact nearby homeowners who may seek shelter at the tall water treatment plant buildings. Also, flooding of local streets could impact access to the plant and limit chemical deliveries to the plant. The plant's ability to operate with large numbers of flood refugees could be challenging and lack of chemical deliveries will bring water production to a standstill.	
ACTION: Develop flood action plan for Wes Brown Water Treatment Plant. Review annually with local neighbors and businesses. Work to improved neighborhood communications and relations. Possibly develop a local association of commercial and residential interests that can respond collaboratively in an emergency.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** $150,000 for plan if consultant is hired to help develop plan. Otherwise this could be free, if the supporting agencies donate resources.
SUPPORT AGENCIES: Adams County Local homeowners association for nearby mobile home communities. Local commercial businesses	**POTENTIAL FUNDING SOURCES:** City of Thornton Adams County Local commercial and manufacturing businesses.
PROGRESS MILESTONES: (1) Consult Urban Drainage on potential flood impact areas. 12/31/16 (2) Contact local HOAs, commercial business owners, relevant City and County staff. 3/31/17 (3) Develop core planning group, organize and execute planning group meetings and action plan development 6/30/17. (4) Submit draft plan to planning group members 6/30/18. (5) Practice flood event 9/30/18. (6) Submit final plan to members. 12/31/18 (7) Host annual meeting with neighbors. Discuss any changes.	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH40) Loss Prevention Project – Regulation Update – Flood Notification System**	
PRIORITY: Med (High, Med, Low)	**HAZARDS ADDRESSED:** Flood
LOCATION: Floodplain Areas	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster • T5 - Increase public awareness of natural hazards and mitigation options
RECOMMENDATION DATE: 7/12/2016	
TARGET COMPLETION DATE: 7/12/2020	
OBJECTIVES ADDRESSED: The mitigation project would include the evaluation of city regulations for building in the 100 to 500 year flood plain. Where warranted building regulations may be improved to address potential flooding and preventing flood damage. Lastly it would include education for residents within those zones related to preparing for the potential flood risk.	
ACTION: The project is a priority for 2017 to switch over to a more up-to-date notification system and improve our reach to the community.	
LEAD AGENCY: City of Thornton – Infrastructure, Floodplain Manager City of Thornton – Risk Management, Emergency and Safety Administrator	**EXPECTED COST:** Not determined at this time
SUPPORT AGENCIES: City of Thornton – Communications Department	**POTENTIAL FUNDING SOURCES:** City of Thornton General Fund
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH41) Formulate IGA's with Schools for Inoculation Sites**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Public Health Hazards
LOCATION: Citywide	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T4 - Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens
RECOMMENDATION DATE: 09/08/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: **Make inoculation accessible for everyone.**	
ACTION: Create an IGA with local schools and identify inoculation sites. Then work with the IGA to put on trainings and events where community members can be vaccinated, preventively or during times of public health emergencies, and informed about public health hazards.	
LEAD AGENCY:	**EXPECTED COST:** TBD
SUPPORT AGENCIES:	**POTENTIAL FUNDING SOURCES:**
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH43) Gravel Lakes Rip Rap Program**	
PRIORITY: High	**HAZARDS ADDRESSED:** Flood, Severe Storms
LOCATION: City of Thornton	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster
RECOMMENDATION DATE: 07/15/2016	
TARGET COMPLETION DATE: 12/31/2021	
OBJECTIVES ADDRESSED: The City of Thornton has 16 raw water storage reservoirs that are adjacent to the South Platte River. These reservoirs are all reclaimed gravel mines, and the slopes of the reservoirs are subject to erosion due to wave and wind action. This ongoing program identifies specific areas of significant erosion which may cause damage to the facilities, and installs rip rap along the reservoir slopes for protection and stabilization.	
ACTION: Install rip rap on reservoir slopes.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** $1,000,000
SUPPORT AGENCIES:	**POTENTIAL FUNDING SOURCES:** City of Thornton
PROGRESS MILESTONES: Fall 2016, City of Thornton 2017 Capital Improvements Program Budget will be adopted. This is a proposed project for 2017-2021.	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH44) Hazard Mitigation in Comprehensive Planning and Other City Plans**	
PRIORITY: Med (High, Med, Low)	**HAZARDS ADDRESSED:** All-hazards
LOCATION: Citywide	**PLANNING GOALS ADDRESSED:** • T6 - Integrate hazard mitigation into other planning mechanisms • T7 - Ensure that Hazard Mitigation will be acknowledged and supported by the Thornton Comprehensive Plan and other local plans
RECOMMENDATION DATE: 7/12/2016	
TARGET COMPLETION DATE: 7/12/2018 for Comprehensive Plan, Others Ongoing	
OBJECTIVES ADDRESSED: The goal is to integrate natural hazard mitigation concepts into the Thornton Comprehensive plan and other plans that are developed and/or updated in Thornton.	
ACTION: The project would involve the project managers and consultants (if any) working on all City of Thornton plans to be aware of the goals and action guides of the Local Hazard Mitigation Plan and to actively work toward the integration of appropriate elements of that plan into the plan that they are writing or updating.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** Not determined at this time
SUPPORT AGENCIES: None	**POTENTIAL FUNDING SOURCES:** City of Thornton General Fund
PROGRESS MILESTONES: Appropriate inclusion in all future plans.	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH45) Hoffman Drainage**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Flood
LOCATION: 88th & 91st Avenues and nearby areas	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster
RECOMMENDATION DATE: 09/07/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Mitigate structural flooding and risk to residents in the floodplain.	
ACTION: Reconstruct culvert under 88th Avenue and improve storm sewers in Hoffman from 88th to 91st to remove homes from the mapped floodplain.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** TBD
SUPPORT AGENCIES: TBD	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH46) Identify local organizations that can assist with post-disaster needs**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Earthquake, Flood, Expansive Soils / Undermined Areas, Severe Storms, Public Health Hazards, Tornado / Severe Wind, Winter Storm, Wildland Fire
LOCATION: Citywide RECOMMENDATION DATE: 09/07/2016 TARGET COMPLETION DATE: TBD	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T4 - Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens • T5 - Increase public awareness of natural hazards and mitigation options • T6 - Integrate hazard mitigation into other planning mechanisms
OBJECTIVES ADDRESSED: Use local organizations as a resource for dealing with post-disaster needs.	
ACTION: Identify specific organizations and facilities that would be beneficial for the city to utilize with in case of a natural disaster. Establishing a point of contact and possibly creating a task force committee who can work together to plan for response efforts.	
LEAD AGENCY:	**EXPECTED COST:** TBD
SUPPORT AGENCIES:	**POTENTIAL FUNDING SOURCES:**
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: Thornton **Project Name: (TH47) Implement UDFCD Projects Identified**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Flood
LOCATION: North Floodplain within City Limits	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster
RECOMMENDATION DATE: 09/07/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Ensuring flood prone areas are studied and mitigated to prevent future disasters.	
ACTION: Implement UDFCD's recommended projects that identify potential mitigation projects in the North Floodplain within city limits.	
LEAD AGENCY:	**EXPECTED COST:** TBD
SUPPORT AGENCIES: UDFCD	**POTENTIAL FUNDING SOURCES:** List all potential funding sources, be as specific as possible.
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH48) Incorporate resiliency measures in Utility Master Plan**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Flooding, Severe Storms, Drought, Tornado, Wildland Fire, Subsidence, Earthquake
LOCATION: Citywide	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster • T6 - Integrate hazard mitigation into other planning mechanisms • T7 - Ensure that Hazard Mitigation will be acknowledged and supported by the Thornton Comprehensive Plan and other local plans
RECOMMENDATION DATE: 09/07/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Ensure local utilities can withstand future hazard events.	
ACTION: Include hazard mitigation measures or even a chapter/section relating to hazard mitigation / resiliency into the upcoming Utility Master Plan update.	
LEAD AGENCY:	**EXPECTED COST:** TBD
SUPPORT AGENCIES:	**POTENTIAL FUNDING SOURCES:**
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH49) Increase fuel, salt, and sand storage for winter storms**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Winter Storm
LOCATION: Citywide	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T6 - Integrate hazard mitigation into other planning mechanisms
RECOMMENDATION DATE: 09/07/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Increasing resources for winter storm events and other disaster events. Ensuring roads can be cleared of snow and other debris in a timely manner.	
ACTION: Identify options for increasing storage of fuel, salt, and sand across the City.	
LEAD AGENCY:	**EXPECTED COST:** TBD
SUPPORT AGENCIES:	**POTENTIAL FUNDING SOURCES:**
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH50) Increase Staffing for EM Projects**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Drought, Earthquake, Flood, Expansive Soils / Undermined Areas, Severe Storms, Public Health Hazards, Tornado / Severe Wind, Winter Storm, Wildland Fire
LOCATION: Citywide	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster • T4 - Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens • T5 - Increase public awareness of natural hazards and mitigation options • T6 - Integrate hazard mitigation into other planning mechanisms • T7 - Ensure that Hazard Mitigation will be acknowledged and supported by the Thornton Comprehensive Plan and other local plans
RECOMMENDATION DATE: 09/08/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Ensure EM resources are readily available.	
ACTION: Hire additional EM staff personnel to tackle projects relating to hazard mitigation. Identify needs and areas to improve upon (many of these MAGs are great ideas to try and implement) and assign staff to address these needs.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** TBD
SUPPORT AGENCIES: TBD	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH51) Investigating Citywide Fiber Optics**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Drought, Earthquake, Flood, Expansive Soils / Undermined Areas, Severe Storms, Public Health Hazards, Tornado / Severe Wind, Winter Storm, Wildland Fire
LOCATION: Citywide RECOMMENDATION DATE: 09/08/2016 TARGET COMPLETION DATE: TBD	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster • T4 - Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens • T5 - Increase public awareness of natural hazards and mitigation options • T6 - Integrate hazard mitigation into other planning mechanisms
OBJECTIVES ADDRESSED: Ensure fiber optics system is consistent and efficient.	
ACTION: Investigate the existing fiber optics system running through the city and identify where additional lines can be created. One known connection has been identified – but there may be opportunity for more. Redundancies are also needed and should be evaluated.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** TBD
SUPPORT AGENCIES: TBD	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH52) Lakeview Estates Drainage Corrections**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Flood
LOCATION: Lakeview Estates	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses
RECOMMENDATION DATE: 09/07/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Mitigate roadway and structure flooding along with hazard risk for residents.	
ACTION: Neighborhood south of SH 7 along Ulster Street with inadequate stormwater conveyance. Water spills into east side properties and into several homes. Stormwater system needs re-evaluated and upgraded.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** TBD
SUPPORT AGENCIES: TBD	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH53) Lightning Detectors**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Severe Storms
LOCATION: City Parks, golf course, and outdoor recreation areas	**PLANNING GOALS ADDRESSED:** T1 – Protect people, property, and natural resources T2 – Improve capability to reduce disaster losses T4 – Strengthen communication and coordination among public agencies, NGOs, businesses and citizens
RECOMMENDATION DATE: 9/16/2016	
TARGET COMPLETION DATE: 9/16/2020	
OBJECTIVES ADDRESSED: The mitigation project would include the installation of lightning detectors at City of Thornton parks, golf course, and outdoor recreation areas to increase the weather notification capability and improve safety for potentially dangerous storms conditions within a detectable mileage to allow for greater resident activities.	
ACTION: The project would be the purchase, installation, maintenance, and public education component for adding lightning detector technology at our city parks, golf course and outdoor areas.	
LEAD AGENCY: City of Thornton – Community Services, Parks, Golf, and Recreation	**EXPECTED COST:** To Be Determined
SUPPORT AGENCIES: City of Thornton – Risk Management, Emergency and Safety Administrator	**POTENTIAL FUNDING SOURCES:** City approved budget or potential mitigation grant opportunities.
PROGRESS MILESTONES: No project milestones have been determined at this time.	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH54) Loss Prevention Project – Building Resiliency**	
PRIORITY: Med (High, Med, Low)	**HAZARDS ADDRESSED:** All-hazards
LOCATION: Floodplain Areas	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses
RECOMMENDATION DATE: 7/12/2016	
TARGET COMPLETION DATE: 7/12/2020	
OBJECTIVES ADDRESSED: The mitigation project would include the evaluation of city regulations for new home and commercial building construction to take into consideration potential damages from the 5 main identified hazards. This may require improved building techniques, recommendations for stronger materials, or recommendations could that reduce future losses and improve safety.	
ACTION: The project would require significant analysis of building techniques and approval from City Government and city Council for such regulatory provisions.	
LEAD AGENCY: City of Thornton – City Development, Economic Development, Planning, and Building Inspection.	**EXPECTED COST:** Not determined at this time
SUPPORT AGENCIES: City of Thornton – Risk Management	**POTENTIAL FUNDING SOURCES:** Potential Building refunds or programs to lessen costs for these building improvements.
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH55) Niver Creek Tributary M**	
PRIORITY: High	**HAZARDS ADDRESSED:** Flooding
LOCATION: City of Thornton	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster
RECOMMENDATION DATE: 7/15/2016	
TARGET COMPLETION DATE: 12/31/2019	
OBJECTIVES ADDRESSED: There are 19 residential structures in the 100-year floodplain between Pecos Street and Huron Street. Huron Street and 92nd Avenue, both arterials, overtop during a 100-year storm event.	
ACTION: Replace culverts at Huron Street and 92nd Avenue with 100-year capacity culverts; channel improvements between 92nd Avenue and Huron Street for increased conveyance; new 60" storm sewer pipe in 92nd Avenue.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** $ 4.1 million
SUPPORT AGENCIES: Urban Drainage and Flood Control District	**POTENTIAL FUNDING SOURCES:** City of Thornton, UDFCD
PROGRESS MILESTONES: Preliminary design; final design; begin construction.	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH56) Public Warning / Notification Project**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** All-hazards
LOCATION: Throughout the City	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T5 - Increase public awareness of natural hazards and mitigation options
RECOMMENDATION DATE: 7/12/2016	
TARGET COMPLETION DATE: 7/12/2017	
OBJECTIVES ADDRESSED: The mitigation project would include the improving of our City Public Notification System to expand our capability for emergency or disaster warnings.	
ACTION: The project is a priority for 2017 to switch over to a more up-to-date notification system and improve our reach to the community.	
LEAD AGENCY: City of Thornton – Police Department, Communications Center (Dispatch) City of Thornton – Risk Management, Emergency and Safety Administrator	**EXPECTED COST:** Not determined at this time
SUPPORT AGENCIES: City of Thornton – Fire Department City of Thornton – Communications Department	**POTENTIAL FUNDING SOURCES:** City Budget Process
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH57) Public Outreach Project**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** All-hazards
LOCATION: Throughout the City	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T4 - Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens • T5 - Increase public awareness of natural hazards and mitigation options • T6 - Integrate hazard mitigation into other planning mechanisms • T7 - Ensure that Hazard Mitigation will be acknowledged and supported by the Thornton Comprehensive Plan and other local plans
RECOMMENDATION DATE: 7/12/2016	
TARGET COMPLETION DATE: 7/12/2018	
OBJECTIVES ADDRESSED: The mitigation project would include the integration of a Public Outreach Program to the Thornton Office of Emergency Management that pro-actively provides education on preparedness activities based on the identified hazards and outreach opportunities to the community. These would include the development of an OEM Website, development of preparedness literature materials, ideas for hazard mitigation actions and implementation, educational talks to organizations (schools, churches, clubs, special events).	
ACTION: The project would be become a priority for 2017 to develop a website, literature materials, and begin to build relationships in the community. In 2018 the priority would shift to improving outreach at special events, presentations, and promoting whole community planning.	
LEAD AGENCY: City of Thornton – Risk Management, Emergency and Safety Administrator	**EXPECTED COST:** Not determined at this time
SUPPORT AGENCIES: City of Thornton – Neighborhood Services City of Thornton – Communications Department	**POTENTIAL FUNDING SOURCES:** City approved budget or potential North Center Region grant opportunities for educational materials.
PROGRESS MILESTONES: List any major anticipated project milestones and/or reports about current project status.	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH58) Ozone Treatment at Wes Brown Water Treatment Plant**	
PRIORITY: High	**HAZARDS ADDRESSED:** Drought and Flood
LOCATION: City of Thornton	**PLANNING GOALS ADDRESSED:** T1 - Protect people, property, and natural resources T2 - Improve capability to reduce disaster losses T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster
RECOMMENDATION DATE: 09/08/16	
TARGET COMPLETION DATE: 12/31/2022	
OBJECTIVES ADDRESSED: During drought years Thornton will rely heavily on the South Platte water supply. This supply is subject to algal blooms, high organics and other complex chemicals in a drought year. The algal blooms emit taste and odor compounds that are difficult to treat and result in unpalatable drinking water. The organics foul the membranes. High levels of organics require additional treatment time to meet regulatory standards, thus impacting production capacity. Adding an ozone treatment component to Wes Brown would help the City produce palatable safe drinking water during a drought. The initial recommended capacity is 30 million gallons per day (MGD). During a flood the South Platte is subject to contamination from upstream industrial sites that could release complex organic chemicals. Again, ozone breaks down complex organic chemicals to produce safe drinking water. The addition of ozone would help secure the City's ability to provide safe, palatable drinking water to protect people, allow the Wes Brown WTP to function during a drought or flood and thereby reduce disaster losses (reduced water production), and ensure the functionality of the treatment plant in the event of a natural disaster.	
ACTION: Install ozone treatment process and associated pump station	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** Approximately $20,000,000 for a 30 million gallons per day system.
SUPPORT AGENCIES:	**POTENTIAL FUNDING SOURCES:** City of Thornton
PROGRESS MILESTONES: Recommend for annual CIP budgeting. Current funding does not exist in water rates to incorporate this project into the CIP plan.	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH59) Public Education on Snow Removal**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Winter Storm
LOCATION: Citywide	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster • T4 - Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens • T5 - Increase public awareness of natural hazards and mitigation options
RECOMMENDATION DATE: 09/08/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Keep snow out of the roadways to enhance public safety.	
ACTION: Create a public awareness campaign to educate citizens about not shoveling snow into the streets. Educating them about the hazards and what are the correct ways to shovel snow.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** TBD
SUPPORT AGENCIES: TBD	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH60) Purchase Portable Cell Towers**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Earthquake, Flood, Expansive Soils / Undermined Areas, Severe Storms, Tornado / Severe Wind, Winter Storm, Wildland Fire
LOCATION: Citywide	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster • T4 - Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens • T5 - Increase public awareness of natural hazards and mitigation options • T6 - Integrate hazard mitigation into other planning mechanisms
RECOMMENDATION DATE: 09/08/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Ensure communication is not lost throughout the city in a disaster event.	
ACTION: Purchase portable cell towers to enhance communication and potentially create citywide wifi. Would need to coordinate with local cell tower providers. Approximately 3-4 would be needed to cover the city. Doing so would also add the need for vehicles to transport the towers.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** $250,000 per tower. Approx. $1,000,000 purchase price plus storage and operational costs
SUPPORT AGENCIES: TBD	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH61) Reduce expansion of Emerald Ash Borer**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** **Wildfire**
LOCATION: Citywide	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T6 - Integrate hazard mitigation into other planning mechanisms
RECOMMENDATION DATE: 09/07/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Ensure vegetation losses to Emerald Ash Borer is mitigated.	
ACTION: Prioritize affected tree removal and disposal and create a plan to mitigate further loss of vegetation to Emerald Ash Borer.	
LEAD AGENCY:	**EXPECTED COST:** TBD
SUPPORT AGENCIES: Parks & Recreation	**POTENTIAL FUNDING SOURCES:**
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH62) Remote Work Capability**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** All-hazards
LOCATION: City-wide	**PLANNING GOALS ADDRESSED:** T1 – Protect people, property, and natural resources T2 – Improve capability to reduce disaster losses T3 – Ensure that functionality of local critical facilities are maintained in the event of a disaster
RECOMMENDATION DATE: 9/17/2016	
TARGET COMPLETION DATE: 9/16/2019	
OBJECTIVES ADDRESSED: The mitigation project would involve expanding current capability for essential function/ personnel to work remotely from home in an disaster or emergency situation. The current Citrix program has limitations on the number of people who can work on the online platform at one time. This would allow for greater flexibility in maintaining continuity of government for variable impacts of future disaster.	
ACTION: The project would include the essential functions/ personnel identified in the City Continuity of Operations Plan/ Continuity of Government Plan, to provide them with laptops or home computer stations to work from home, expanding the capacity of our online Citrix platform to support all essential functions at one time, a change in city philosophy/ employee policy that allows for the city close or announce delays during winter storms or other emergency events, and providing alternate communications methods for employees to hold meetings/ teleconferences from different remote locations.	
LEAD AGENCY: City of Thornton – City Manager's Office and Information Technology	**EXPECTED COST:** To Be Determined
SUPPORT AGENCIES: City of Thornton – All Departments	**POTENTIAL FUNDING SOURCES:** City approved budget or potential mitigation grant
PROGRESS MILESTONES: No project milestones determined at this time.	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH63) Bring commercial buildings out of the floodway**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Flood
LOCATION: Citywide – where commercial structures are located in the floodway	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T4 - Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens • T5 - Increase public awareness of natural hazards and mitigation options • T6 - Integrate hazard mitigation into other planning mechanisms
RECOMMENDATION DATE: 09/07/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Mitigating commercial businesses risk level when located in the floodplain/floodway.	
ACTION: Develop a plan to coordinate with local commercial building owners to relocate businesses out of the floodway.	
LEAD AGENCY:	**EXPECTED COST:** TBD
SUPPORT AGENCIES: Economic Development	**POTENTIAL FUNDING SOURCES:**
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH64) Repetitive loss structure identification**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** Flood
LOCATION: Citywide	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T5 - Increase public awareness of natural hazards and mitigation options
RECOMMENDATION DATE: 09/07/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Ensure repetitive loss structures risk is alleviated.	
ACTION: Work to identify repetitive loss structure and formulate plans for how best to mitigate, in conjunction with the property owner.	
LEAD AGENCY:	**EXPECTED COST:** TBD
SUPPORT AGENCIES:	**POTENTIAL FUNDING SOURCES:**
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH65) Reservoir Spillway Project**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** Flood
LOCATION: City Reservoir System	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster
RECOMMENDATION DATE: 7/12/2016	
TARGET COMPLETION DATE: 7/12/2025	
OBJECTIVES ADDRESSED: The mitigation project would include the building of spillways to address repetitive flood loss and damages to City reservoir system infrastructure along the South Platte River.	
ACTION: The project would ideally be a long term project to incrementally improve each of our reservoirs to prevent damage.	
LEAD AGENCY: City of Thornton – Infrastructure, Floodplain Manager City of Thornton – Risk Management, Emergency and Safety Administrator	**EXPECTED COST:** Not determined at this time
SUPPORT AGENCIES: City of Thornton – Infrastructure, Water Resources	**POTENTIAL FUNDING SOURCES:** City Budget Process
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH66) River/Stream Gauge Project**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** Flood
LOCATION: Streams and Tributaries Project location	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster
RECOMMENDATION DATE: 7/12/2016	
TARGET COMPLETION DATE: 7/12/2020	
OBJECTIVES ADDRESSED: The mitigation project would include the addition of river, stream, and tributary flood gauges to help monitor water flow rates to provide early notice for potential flooding, building historical datasets, and increasing visibility of flooding as it occurs for response purposes.	
ACTION: The project would be the purchase of additional river or stream gauges to be placed in areas that provide data to our city Floodplain Manager	
LEAD AGENCY: City of Thornton – Infrastructure, Floodplain Manager	**EXPECTED COST:** N/A
SUPPORT AGENCIES: City of Thornton – Risk Management, Emergency and Safety Administrator	**POTENTIAL FUNDING SOURCES:** City approved budget or potential mitigation grant opportunities.
PROGRESS MILESTONES: List any major anticipated project milestones and/or reports about current project status.	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH67) School Tributary**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Flood
LOCATION: School Tributary	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster
RECOMMENDATION DATE: 09/07/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Encourage Capital Improvement Plan project completion.	
ACTION: Railroad/Old Welby Road to Monroe Street; Phase 1, Catalina Apartments driveway to west of Monroe Street being jointly funded Thornton and UDFCD.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** TBD
SUPPORT AGENCIES: TBD	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH68) Incorporate Age-Restricted Communities, Nursing Homes, and other Senior Care Centers into Planning Processes**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** All hazards
LOCATION: Community-wide	**PLANNING GOALS ADDRESSED:** T1 – Protect people, property, and natural resources T2- Improve capabilities to reduce disaster loss T3 – Ensure that functionality of local critical facilities are maintained in the event of a disaster T4 – Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens T5 – Increase public awareness of natural hazards and mitigation options T6 – Integrate hazard mitigation into other planning mechanisms T7 – Ensure that hazard mitigation will be acknowledged and supported by the Thornton Comprehensive Plan and other local plans
RECOMMENDATION DATE: 9/17/2016	
TARGET COMPLETION DATE: 12/31/2018	
OBJECTIVES ADDRESSED: There are currently several age-restricted communities, nursing homes, and other Senior Care Centers throughout Thornton, and there are very likely to be more built as the population in the area continues to include a higher percentage of seniors. It is important to engage these facilities in future community planning processes, including future updates to the Thornton Comprehensive Plan.	
ACTION: Engaging senior residence and treatment facilities in future planning processes would enhance the community's ability to provide appropriate warnings to these populations of upcoming inclement weather and other natural hazard phenomena, help increase the level of understanding of how emergency services can and should be provided to seniors who are effected by hazardous events, and coordinating the relocation of these populations should that become necessary.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** Not determined at this time
SUPPORT AGENCIES: Senior living and service- provision agencies throughout the community.	**POTENTIAL FUNDING SOURCES:** City Budget , grant funds, funds from partner organizations.
PROGRESS MILESTONES:	

City of Thornton Northglenn Federal Heights

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH69) Stockpiling Emergency Shelters**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Drought, Earthquake, Flood, Expansive Soils / Undermined Areas, Severe Storms, Public Health Hazards, Tornado / Severe Wind, Winter Storm, Wildland Fire
LOCATION: Emergency shelters accessed by the city	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T4 - Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens • T5 - Increase public awareness of natural hazards and mitigation options
RECOMMENDATION DATE: 09/08/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Ensuring resources are available in emergencies.	
ACTION: Creating stockpiles in each of the city's emergency shelters. This could include water, heat blankets, education materials, food, etc. Staffing would also need to be planned out. An added layer to this would be to identify additional areas to add as emergency shelters.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** TBD
SUPPORT AGENCIES: TBD	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton, Fire Department **Project Name: (TH70) Stockpiling Fire Stations**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** Disasters requiring special attention
LOCATION: All fire stations	**PLANNING GOALS ADDRESSED:** • T2 - Improve capability to reduce disaster losses
RECOMMENDATION DATE: 09/07/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Identify alternative uses for Fire Stations in the event of disasters.	
ACTION: All stations shall be inspected and evaluated for alternative staffing and uses in the event of a disaster. Stations will be measured for sleeping space and staffing of extra apparatus. Station 5 shall be evaluated as alternative EOC and/or dispatch site. Station 5 also houses Emergency Management trailer with extra cots and bedding.	
LEAD AGENCY: Thornton Fire Department	**EXPECTED COST:** Inspection time 15-30 minutes per station. Station 5 will need plan developed to bring in computers, phones and radios if used for an alternative EOC or dispatch site.
SUPPORT AGENCIES: Emergency Manager	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES: Annual review and report generated to determine the overall Fire Department capability to support incident operations and recovery from an event.	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH71) Tertiary Data Center Location**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** All hazards
LOCATION: Other	**PLANNING GOALS ADDRESSED:** T2- Improve capabilities to reduce disaster loss T3 – Ensure that functionality of local critical facilities are maintained in the event of a disaster
RECOMMENDATION DATE: 9/17/2016	
TARGET COMPLETION DATE: 12/31/2018	
OBJECTIVES ADDRESSED: The mitigation project would involve creating a third "data center" that all Primary City services are replicated and can be accessed by other City facilities. This would include internet, telephony, and data services. This site could be a City owned facility, but would be more effective being outside the City boundaries, to provide the best level of coverage and resiliency. This site could also be used as a "live test" site, which would allow the City to actually validate and test disaster recovery or business continuity plans.	
ACTION: The project would focus on identifying a new data center location, as well as resources to house there. An option could be "cloud" based, which would provide access from anywhere, but would require a significant shift in ownership and housing of City data. Internet services would be validated and enhanced to provide multiple connections and replication of City data. Services would need to be ordered to facilitate the new server and storage needs, as well as testing to validate connectivity.	
LEAD AGENCY: City of Thornton – IT Department	**EXPECTED COST:** Not determined at this time
SUPPORT AGENCIES: City of Thornton – All Departments	**POTENTIAL FUNDING SOURCES:** City Budget Process or grant funding
PROGRESS MILESTONES: Evaluate locations and determine new facility (physical or cloud) Purchase and/or upgrade necessary hardware and software Deploy new hardware and/or software Train City staff	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH72) Thornton as Emergency Transportation Provider for Seniors**	
PRIORITY: Low Medium	**HAZARDS ADDRESSED:** All Hazards
LOCATION: City of Thornton	**PLANNING GOALS ADDRESSED:** T1 - Protect people, property, and natural resources T2 - Improve capability to reduce disaster losses T4 – Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens T5 – Increase public awareness of natural hazards and mitigation options
RECOMMENDATION DATE: 09/08/16	
TARGET COMPLETION DATE: Ongoing	
OBJECTIVES ADDRESSED: Senior citizens are particularly vulnerable to natural hazards including severe temperatures and heavy snowfalls. Thornton can provide temporary, emergency transportation for seniors who are unable to transport themselves or use other means of transportation as a result of a large snowfall, ice, flooding, or other natural hazards.	
ACTION: Identify and organize city staff and city vehicles, and/or work to mobilize volunteers within the community to provide necessary transportation for seniors in emergency situations to access required medicines, medical treatments, food, or other necessary services, equipment, or provisions.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** To Be Determined
SUPPORT AGENCIES:	**POTENTIAL FUNDING SOURCES:** City of Thornton
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH73) Thornton Facilities as Temporary Shelter for Seniors**	
PRIORITY: Medium	**HAZARDS ADDRESSED:** All Hazards
LOCATION: City of Thornton	**PLANNING GOALS ADDRESSED:** T1 - Protect people, property, and natural resources T2 - Improve capability to reduce disaster losses T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster T4 – Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens T5 – Increase public awareness of natural hazards and mitigation options
RECOMMENDATION DATE: 09/08/16	
TARGET COMPLETION DATE: Ongoing	
OBJECTIVES ADDRESSED: Senior citizens are particularly vulnerable to natural hazards including severe temperatures and heavy snowfalls. Thornton can provide temporary, emergency shelter at the Margaret Carpenter Recreation Center and at the Thornton Senior Center for seniors whose homes are damaged by natural disasters and rendered uninhabitable and can increase its ability to do so in the future.	
ACTION: Maintain and enhance the city of Thornton's ability and capacity to provide emergency shelter for senior citizens whose homes have been damaged by one or more natural hazards. Such improvements may include maintaining and improving relationships with the Red Cross and other organizations.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** To Be Determined
SUPPORT AGENCIES: Red Cross	**POTENTIAL FUNDING SOURCES:** City of Thornton Adams County Local commercial and manufacturing businesses.
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH74) Community Tornado Shelters**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Tornadoes and Severe Storms
LOCATION: City-wide	**PLANNING GOALS ADDRESSED:** T1 – Protect people, property, and natural resources T2 – Improve capability to reduce disaster losses T4 – Strengthen communication and coordination among public agencies, NGOs, businesses and citizens
RECOMMENDATION DATE: 9/16/2016	
TARGET COMPLETION DATE: 9/16/2023	
OBJECTIVES ADDRESSED: The mitigation project would include the building of community tornado shelters or safe rooms in manufactured home parks that consist of predominantly low and moderate income households.	
ACTION: The project would include the building and training of local manufactured home communities to use and maintain local tornado shelters.	
LEAD AGENCY: City of Thornton – City Development and Neighborhood Services.	**EXPECTED COST:** To Be Determined
SUPPORT AGENCIES: City of Thornton – Risk Management	**POTENTIAL FUNDING SOURCES:** City approved budget, potential mitigation grant, or community development block grant/funding opportunities.
PROGRESS MILESTONES: No project milestones determined at this time.	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH75) Tornado Sirens**	
PRIORITY: Low (High, Med, Low)	**HAZARDS ADDRESSED:** Tornadoes and Severe Storms
LOCATION: City-wide	**PLANNING GOALS ADDRESSED:** T1 – Protect people, property, and natural resources T2 – Improve capability to reduce disaster losses T4 – Strengthen communication and coordination among public agencies, NGOs, businesses and citizens
RECOMMENDATION DATE: 9/17/2016	
TARGET COMPLETION DATE: 9/16/2023	
OBJECTIVES ADDRESSED: The mitigation project would include the building of tornado sirens in the city to provide an additional method for notifying the community of impending tornado risks. They would be strategically placed to provide an audible warning to all neighborhoods and homes in the City of Thornton.	
ACTION: The project would include the installing, maintenance, training, and public education that is necessary to implement the routine use of tornado sirens.	
LEAD AGENCY: City of Thornton – Police Department Communications Center (Dispatch), City Development and Neighborhood Services	**EXPECTED COST:** To Be Determined
SUPPORT AGENCIES: City of Thornton – Risk Management	**POTENTIAL FUNDING SOURCES:** City approved budget, potential mitigation grant, or community development block grant/funding opportunities.
PROGRESS MILESTONES: No project milestones determined at this time.	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH76) Urban Drainage Master Plan Updates**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** Flood
LOCATION: Citywide	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster • T4 - Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens • T7 - Ensure that Hazard Mitigation will be acknowledged and supported by the Thornton Comprehensive Plan and other local plans
RECOMMENDATION DATE: 09/07/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Increase city staff knowledge of current assessments and future needs.	
ACTION: Review master plans to identify flood hazards and mitigation measures to implement. Three identified in near term: • "Original Thornton" (UDFCD "Basin 4100 and Direct Flow Area 0056) • Woodglen basin (see 112th & Cherry, above) • Brantner Gulch	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** TBD
SUPPORT AGENCIES: TBD	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH77) Utilize Local Organizations for Messaging**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Drought, Earthquake, Flood, Expansive Soils / Undermined Areas, Severe Storms, Public Health Hazards, Tornado / Severe Wind, Winter Storm, Wildland Fire
LOCATION: Citywide	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T4 - Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens • T5 - Increase public awareness of natural hazards and mitigation options
RECOMMENDATION DATE: 09/08/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Increase public education and awareness and ensure efficient response efforts.	
ACTION: Work with local organizations like Community Faith United to notify community members about hazards. These orgs are a great outlet for distributing news and resources. They are great places to utilize message for post disaster events and to increase people's awareness about local hazards.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** TBD
SUPPORT AGENCIES: TBD	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH78) Villages North Detention Basin Emergency Overflow Structure**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Flood
LOCATION: Villages North Detention (Basin 4100)	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster
RECOMMENDATION DATE: 09/07/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Mitigate roadway and structure flooding, decrease hazard risk for residents.	
ACTION: (Basin 4100) Detention basin south of Thornton Parkway, west of the tracks has a modeled 100-year pond and outlet structure. However, if the outlet structure were to become clogged, there is no overflow out of the basin before water would rise to the point that it floods structures west and north (proposed) of the basin.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** TBD
SUPPORT AGENCIES: TBD	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH79) Volunteer Emergency Response Units**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Drought, Earthquake, Flood, Expansive Soils / Undermined Areas, Severe Storms, Public Health Hazards, Tornado / Severe Wind, Winter Storm, Wildland Fire
LOCATION: Citywide	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster • T4 - Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens
RECOMMENDATION DATE: 09/08/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Ensure that the city meets all emergency response needs with additional help from volunteers.	
ACTION: Create a group for volunteers that could be called upon for emergency response. This could be an expansion of the Citizens Police Academy Unit – there are a number of trained members of this group that could volunteer. Existing programs that could be referenced include one in Longmont and the Boulder Emergency Squad (BES). A part of this would include purchasing more radio units to create efficient communication.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** TBD
SUPPORT AGENCIES: TBD	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH80) Washington St and GHC South Tributary**	
PRIORITY: (High, Med, Low)	**HAZARDS ADDRESSED:** Flood
LOCATION: Washington St and GHC South Tributary	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster
RECOMMENDATION DATE: 09/07/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: **Mitigate roadway flooding and risk to drivers.**	
ACTION: Reconstruct culvert to convey 100-year storm – may require lowering the Denver Water - Broomfield water main.	
LEAD AGENCY:	**EXPECTED COST:** TBD
SUPPORT AGENCIES:	**POTENTIAL FUNDING SOURCES:**
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH81) Water Conservation Plan Update and Implementation**	
PRIORITY: Medium	**HAZARDS ADDRESSED:** Drought
LOCATION: City of Thornton	**PLANNING GOALS ADDRESSED:** T1 - Protect people, property, and natural resources T2 - Improve capability to reduce disaster losses T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster T5 - Increase public awareness of natural hazards and mitigation options
RECOMMENDATION DATE: 09/08/2016	
TARGET COMPLETION DATE: 2017	
OBJECTIVES ADDRESSED: The City of Thornton adopted a Water Conservation Plan in 2009 that identified water conservation programs and measures the city would implement. The Water Conservation Plan will be updated in 2017. This update will identify new and existing conservation programs to for the city to implement over the following seven years. Included in those programs will be a focus on water use and drought awareness, as well as educational and incentive programs for water-wise, drought-resistant landscapes.	
ACTION: Update Water Conservation Plan in 2017. Implement conservation programs as identified in the plan, including but not limited to promoting xeriscaping , water conservation programs, and public outreach efforts.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** $30,000 for the Conservation Plan Update $3,500,000 over seven years for Conservation Program implementation (~$500,000/year)
SUPPORT AGENCIES: Colorado Water Conservation Board	**POTENTIAL FUNDING SOURCES:** City of Thornton
PROGRESS MILESTONES: Water Conservation Plan approved by City Council and the Colorado Water Conservation Board in 2017. Annual implementation of Conservation programs.	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH82) West Sprat Platte Reservoir Spillway**	
PRIORITY: High	**HAZARDS ADDRESSED:** Flood, Severe Storms
LOCATION: City of Thornton	**PLANNING GOALS ADDRESSED:** Protect people, property, and natural resources Improve capability to reduce disaster losses Ensure that functionality of local critical facilities are maintained in the event of a disaster
RECOMMENDATION DATE: 07/15/2016	
TARGET COMPLETION DATE: 12/31/2020	
OBJECTIVES ADDRESSED: The West Sprat Platte Reservoir is a water storage reservoir that is a critical component of the city's water supply. This reservoir is adjacent to the South Platte River, and is exposed to routine flooding. Installation of a spillway will help control the way that flood water moves through the complex, and will assist in minimizing damage to reservoir infrastructure.	
ACTION: Design and construction of three spillways.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** $750,000
SUPPORT AGENCIES: Urban Drainage Flood Control District	**POTENTIAL FUNDING SOURCES:** City of Thornton FEMA
PROGRESS MILESTONES: Fall 2016, City of Thornton 2017 Capital Improvements Program Budget will be adopted. This is a proposed project for 2020.	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH83) York St & Big Dry Creek, E-479 to York**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Flood
LOCATION: York St & Big Dry Creek, E-479 to York	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses • T3 - Ensure that functionality of local critical facilities are maintained in the event of a disaster
RECOMMENDATION DATE: 09/07/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Mitigate roadway flooding and risk to drivers.	
ACTION: Replace bridge to handle 100-year flows, eliminate overtopping. Realign channel upstream of York to improve hydraulic efficiency (see "map" page 14 in the Tiff directory)	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** TBD
SUPPORT AGENCIES: TBD	**POTENTIAL FUNDING SOURCES:** TBD
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Thornton **Project Name: (TH84) Hazardous Tree Mitigation**	
PRIORITY: Medium	**HAZARDS ADDRESSED:** Severe Storms, Tornados and Severe Winds, Winter Storms, Floods
LOCATION: City of Thornton	**PLANNING GOALS ADDRESSED:** • T1 - Protect people, property, and natural resources • T2 - Improve capability to reduce disaster losses
RECOMMENDATION DATE: 07/15/2016	
TARGET COMPLETION DATE: 2018	
OBJECTIVES ADDRESSED: Reduce the threat of falling branches and trees during inclement weather events or as a result of sick or dead trees.	
ACTION: Develop and implement a plan to conduct a city-wide assessment of trees located on public lands and rights of way to determine and catalog the status of their health and if the potential of falling branches or entire trees pose a threat to people and improvements in the area. Implement actions to remove dangerous limbs and dead, sick, or dying trees to reduce the threat that they pose.	
LEAD AGENCY: City of Thornton	**EXPECTED COST:** TBD
SUPPORT AGENCIES: None	**POTENTIAL FUNDING SOURCES:** City of Thornton
PROGRESS MILESTONES:	

Strategy Implementation and Plan Maintenance

Having a plan for monitoring, evaluating, maintaining, and implementing this HMP is critical to maintaining its value and success. Ensuring effective implementation of mitigation activities paves the way for continued momentum in the planning process and gives direction for the future. This section explains who will be responsible for maintenance activities and what those responsibilities entail. It also provides a methodology and schedule of maintenance activities including a description of how the public will be involved on a continual basis.

The City of Thornton's Council has authorized the submission of this Plan to both the Colorado Division of Homeland Security and Emergency Management (DHSEM) and the Federal Emergency Management Agency (FEMA) for their respective reviews and subsequent approvals. Upon state and federal approval, the City will act to formally adopt this plan.

FIGURE 54. RECENT PUBLIC INFORMATIVE FLYER

Plan Integration, Existing Capabilities and Resources

The City of Thornton plans to integrate this HMP in a number of ways. The City is planning to update its Comprehensive Plan in 2017 and will incorporate relevant findings of this HMP into that process. The City's Emergency Manager also plans to utilize this HMP as other emergency management planning documents are created.

The following capability assessment examines the ability of Thornton to implement and manage the comprehensive mitigation strategy laid out in this Plan. The strengths, weaknesses, and resources of the City are identified here as a means for evaluating and maintaining effective and appropriate management of the town's hazard mitigation program.

Local Personnel

The ability of a community to implement a comprehensive mitigation strategy depends, in part, on available resources, including people and staff. The table below outlines the participating community's capabilities as they relate to key personnel.

TABLE 41. THORNTON'S KEY PERSONNEL

Title	Full Time	Part Time	None or Not-Identified
Emergency Manager		X	
Floodplain Administrator		X (City Engineer)	
Community Analyst	X		
GIS Analyst	X		
Grant Writer			X

Land Use Planning and Codes

Local land use plans and building codes are tremendous tools for evaluating local policies related to hazard mitigation and risk reduction. Additionally, comprehensive master plans, capital improvement plans, stormwater plans and zoning ordinances all present opportunities for enhanced local capabilities. The table below outlines the participating community's current capabilities as they relate to land use plans ordinances and codes.

TABLE 42. THORNTON'S CURRENT ORDINANCES OR CODES

Land Use Planning or Codes	Adopted
Zoning Ordinance	Y
Hazard-Specific Ordinance	Y
Local Building Codes	Y
Comprehensive Plan/Master Plan	Y
Capital Improvements Plan	Y
Stormwater Plan	Y
Continuity of Operations Plan (COOP)	Y
Emergency Operations Plan (EOP)	Y (update currently underway)
Long-Term Recovery Plan	N
Parks and Open Space Master Plan	Y
Participates in NFIP	Y

Plan Maintenance and Resources

The City did not have any record of past maintenance activities tied to the 2010 DRCOG Plan.

The City of Thornton will actively maintain the 2017 Thornton, Federal Heights, and Northglenn Hazard Mitigation Plan by coordinating an annual review across City departments of all mitigation actions included in the 2017 HMP. This process will be led by the City's Planning Department. The annual review will occur in the first quarter of each year. Scheduling this prior to the yearly budget planning will allow for potential inclusion of these projects into the CIP. This resulting information will be reported to the public during a publically held meeting and citizens will be invited to participate and share ideas for new mitigation projects to consider implementing. Attempts to align this with the State and county's Preparedness Month will be considered as well.

The following table shows records of Thornton's annual maintenance, for every year up until its five-year expiration date.

TABLE 43. CITY OF THORNTON HMP MAINTENANCE TABLE

Review Year	City Department	Name of Representative	Signature of Representative
2018			
2019			
2020			
2021			
2022			

Appendix B - Community Profile - The City of Federal Heights

The City of Federal Heights is located within Adams County, which is one of the more densely populated counties in the state. Federal Heights lies just northwest of Denver and is within close proximity to Interstate 25, which lies to the east of the city. Federal Heights only encompasses approximately 1.7 square miles of total land area, but ranks sixth statewide in density with more than 6,449 persons per square mile. The city's urban extent has not changed since 2000, and is not expected to grow between 2006 and 2035.

Demographics

The City of Federal Heights is comprised of a diverse array of household types. During the 1970s and 1980s, Federal Heights grew at a significantly higher rate than adjacent communities. This has been attributed mostly to the outward expansion of the Denver Metropolitan Area and annexation of several mobile home parks. Since then, the City's population has actually decreased. The City had a population of 11,467 people in 2010, which is lower than the City's 2008 population of 12,109 residents[33]. The median age of the Federal Height's population is 31.2 and the median household income is $37,754. In 2000, about 9.2% of families and 11.2% of the population were below the poverty line. In 2010, the City was made up of 49.42% Caucasian, 33% Hispanic, and 12.34% who identified as "other race"[34]. Federal Heights has seen a significant increase in Hispanic populations since 2000, when the demographic split was 80.03% Caucasian and 22.62% Hispanic. This is much like growth in other north metro region communities, where the city has seen a higher percentage of Hispanic growth and a lower percentage of Caucasian growth in recent years. Federal Heights' largest population cohort is 29.59% of residents who are between the ages of 25 to 44.

Social Vulnerability

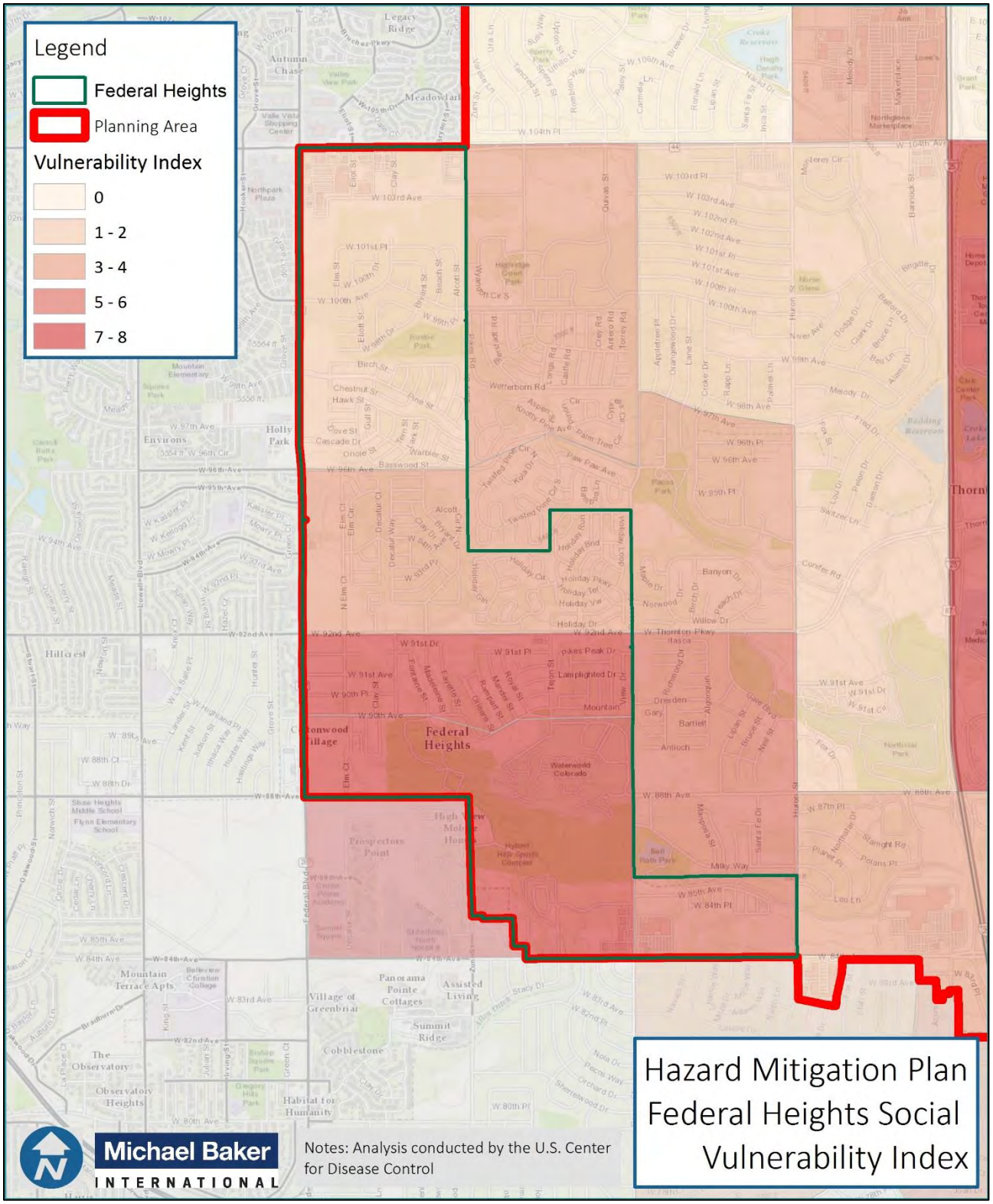
Federal Heights' population is made up of 12% residents who are 65 or older. This is slightly higher than the statewide average at about 11%, and is worth noting as older populations are at higher risk if a hazardous event should takes place. Elderly residents who live alone and may be impaired or less mobile require assistance and advanced warning in case of an emergency. There are several local facilities that provide services for seniors and are a crucial resource for emergency management planning.

The Federal Heights Community Interview addressed several other vulnerabilities that the residents and business owners face when it comes to emergency planning. The biggest concern addressed was how to make a positive impact on non-English speaking community members and the low-moderate income population. Since this community is a higher percentage than in Thornton or Northglenn, it's more important to provide multilingual information and work with local community organizations to reach out to Federal Heights residents.

The results of the social vulnerability assessment are displayed on the following figure. Social vulnerability is represented at the census tract level by five classes of vulnerability: Low (bottom 20% of the county), Medium-Low(20%-40%), Medium(40%-60%), Medium-High(60%-80%), and High (top 20% of the county). The City of Federal Height's social vulnerability map shows wide variability across the community.

[33] DRCOG Community Profile: Federal Heights (2015)
[34] DRCOG Community Profile: Federal Heights (2015)

FIGURE 55. FEDERAL HEIGHTS SOCIAL VULNERABILITY MAP



City of Thornton Northglenn Federal Heights

Federal Heights is characterized by a mix of low to high levels of social vulnerability. The south area, between 92nd Avenue and 4th Avenue, has higher levels of social vulnerability to disasters than the rest of the community. A closer look at the individual social vulnerability indicators within Federal Heights will give local emergency managers, planners, and stakeholders an even clearer picture of where resources should be prioritized in order to reduce vulnerability in the community. Over time, Federal Heights should continue to monitor their social vulnerability as demographic, economic, and housing related conditions change.

Housing

Federal Heights is made up of a variety of dwelling types. The average household size is 2.6 persons per household and family households make up the majority at nearly 71%. As previously mentioned, the City saw a significant growth period during the 1970s and 1980s, but has since experienced a population decrease. This is thought to be attributed to the lack of large parcels available for residential development. For the 2010 census data, there were 4,876 housing units with an approximate 9% vacancy rate[35]. The total housing units in 2010 is lower than in 2000 when there were 5,125 households. Approximately 29% of these households had children under the age of 18 living with them and about 40% were married couples living together. Approximately 14% of all households had a female householder with no husband present, 31% were made up of individuals, and 10% had someone living alone who was 65 years of age or older. The median value for all owner-occupied housing units in Federal Heights is $34,200, which is significantly lower than the County's median home value of $186,600[36].

Critical Facilities

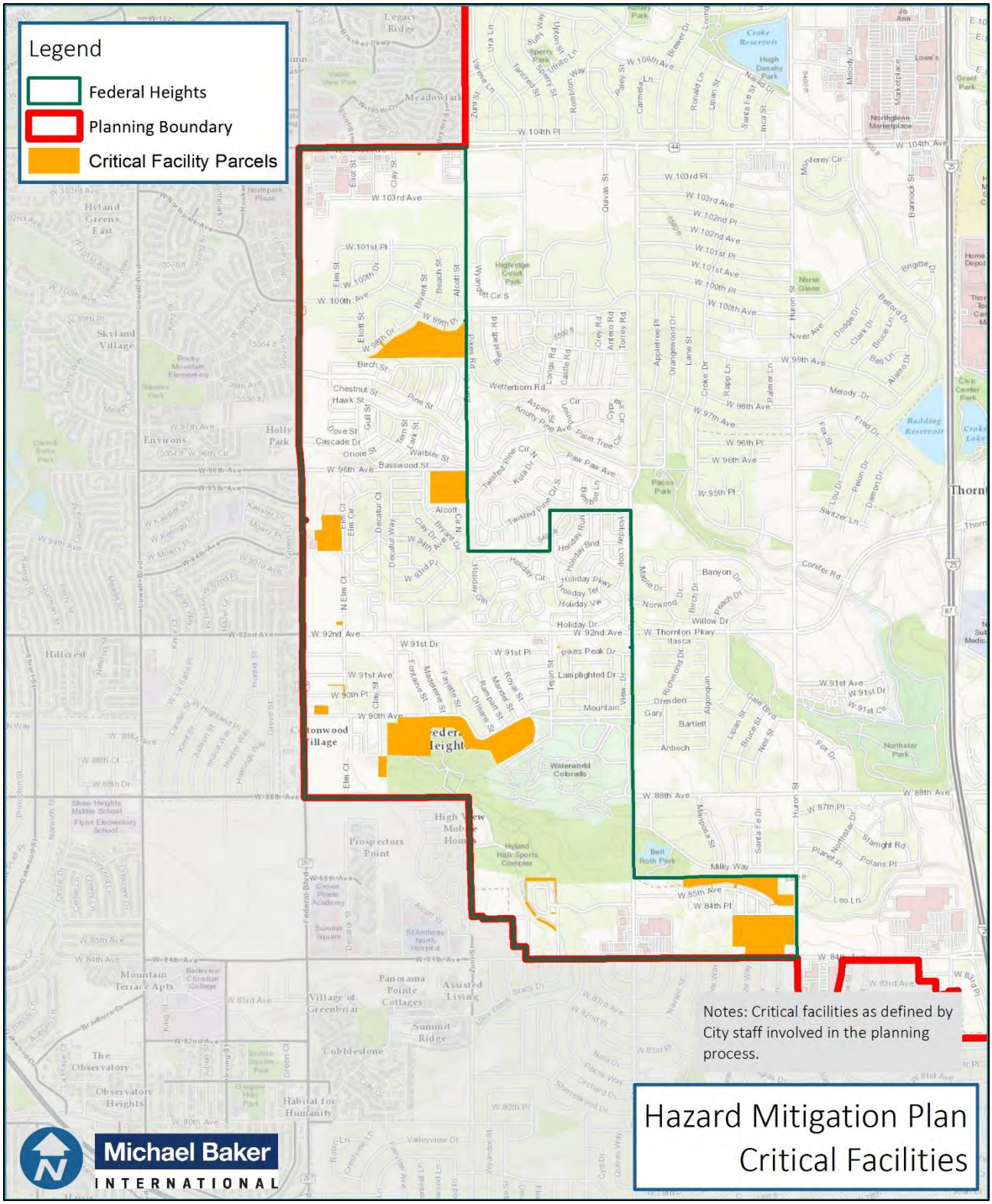
For the purpose of this Multi-Jurisdictional Hazard Mitigation Plan, 'critical facilities' are defined as local assets vital to the health, safety, and well-being of residents and visitors during time of natural disaster. These facilities include community centers, churches, hospitals, libraries, non-profits, post offices, water treatment centers, police & fire stations, and city administration buildings. Critical facilities are essential to a community's long-term disaster resilience as they are important delivery pathways for diverse crisis management services and resources. As part of the HMP planning process, each jurisdiction identified those facilities being termed as critical by utilizing the best available data from the Adams County assessor's office. There are currently 31 parcels within Federal Heights that are considered as containing critical facilities, with those structures being assessed at over $35 million.

Although not considered a critical facility, it should be noted that the city is home to a popular water park called, "Water World". At times, this park can attract up to 7,000 people and would be considered a high-risk area in case of a hazardous event.

There are three schools and one fire station located within city limits. There are also plans to incorporate more fiber connectivity throughout the region, which the city welcomes, but will be at higher risk for damage in the case of a hazardous event. The following figure shows where those critical facilities in Federal Heights are located.

[35] DRCOG Community Profile: Federal Heights (2015)
[36] City of Federal Heights Comprehensive Plan Update

FIGURE 56. FEDERAL HEIGHTS CRITICAL FACILITIES



City of Thornton Northglenn Federal Heights

Future Development

Adams County as a whole is expected to grow 22% from 2010 to 2020. The City of Federal Heights is not expected to increase its urbanized area by 2035, therefore significant population growth is not expected. In fact, according to the Denver Metro NHMP, there is a 0% annual percent increase in urbanized area between 2006 and 2035[37] within Federal Heights. The city has very little vacant, residentially-zoned land available for future development, and is already very dense. There is a possibility that redevelopment of existing mobile home parks could take place, which would emphasize mixed-use commercial/residential development[38].

Hazard Identification

Introduction and Update Summary

Although Federal Heights was included in the DRCOG Hazard Mitigation Plan, community representatives did not feel that the plan adequately addressed hazards that were specific to the city. However, the risk assessment portion of the plan was found to be helpful, but needed to be updated in order to reflect current and improved mitigation measures.

Climate Change and Hazards

In the Federal Heights Community Interview, community members identified four hazards that were of highest concern. Those hazards include: tornadoes, blizzards, localized flooding, and public health hazards such as obesity. Tornadoes seemed to cause the biggest concern with residents since most of the city is made up of mobile homes and there is only one tornado-approved evacuation center within city limits. Although Federal Heights has hosted emergency management tornado planning classes, past participation was lacking and feedback is difficult to obtain.

As part of the Community Interview, interviewees were asked to categorize the profiled hazards in terms of high, medium, or low risk. As a result of those discussions, hazards were ranked as follows:

<u>High</u>

- Flood
- Tornado/Severe Wind
- Winter Storm
- Public Health Hazards

<u>Med</u>

- Drought
- Extreme Temperatures
- Severe Storms

[37] Denver Metro Natural Hazard Mitigation Plan (2010)
[38] City of Federal Heights Comprehensive Plan Update

Low

- Earthquake
- Expansive Soils/Undermined Areas
- Wildland Fire

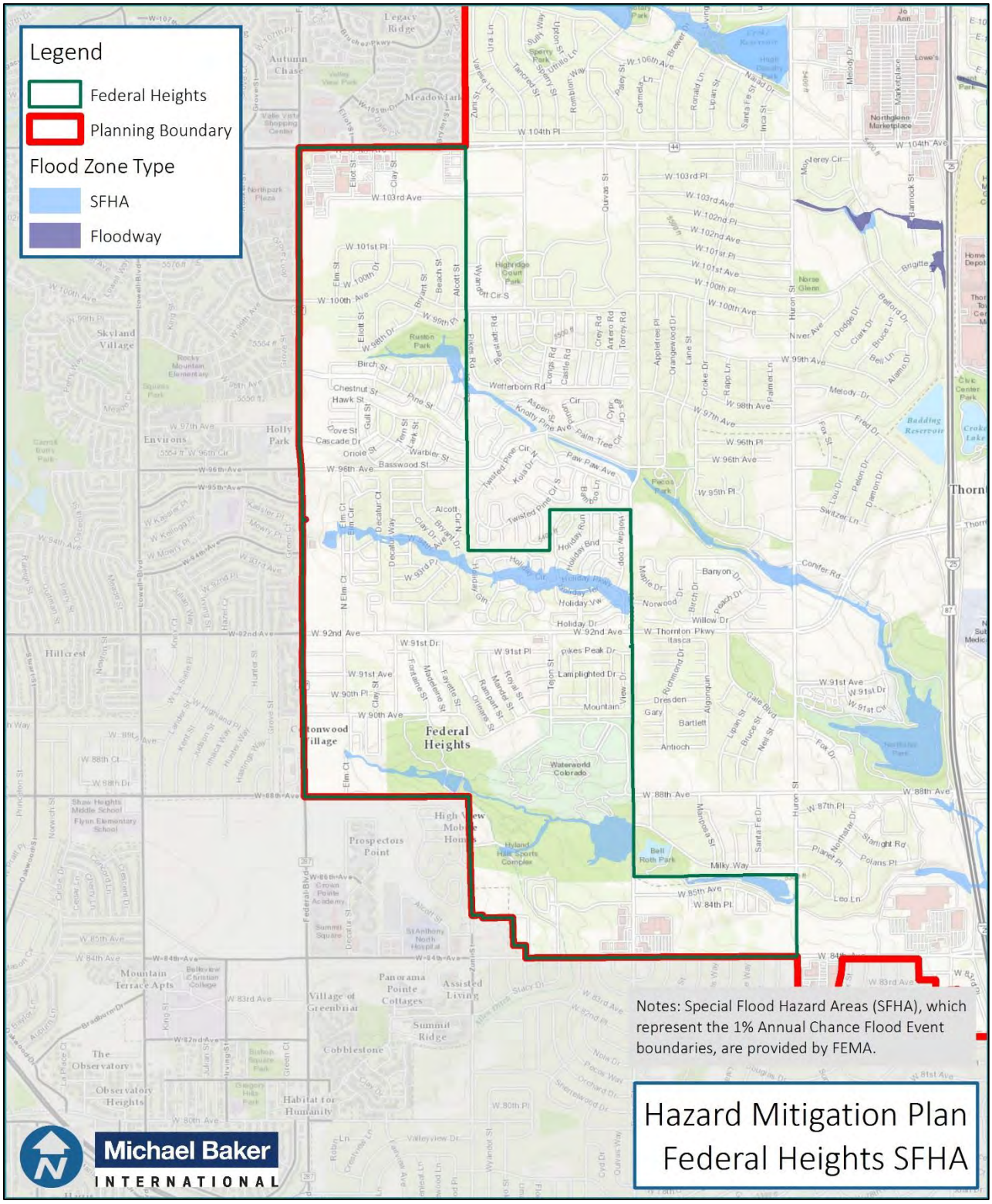
Hazard Profiles

This section provides a refined risk and vulnerability assessment, specific to the City of Federal Heights, for those hazards that were identified as being rated high in the preceding section. This analysis was conducted separately from that of the planning area-wide vulnerability assessment to specifically focus on the population, structures, infrastructure, and other assets unique to the City.

Flood

Major flooding has occurred within the State of Colorado and it's Front Range in recent years and Federal Heights has been directly impacted. The figure below presents the Special Flood Hazard Areas (SFHA) in Federal Heights, where the 1% chance 100-year flood event could occur.

FIGURE 57. FEDERAL HEIGHTS SPECIAL FLOOD HAZARD AREA



City of Thornton Northglenn Federal Heights

Previous Occurrences

According to NOAA's NCEI Storm Events Database there have been no reported injuries, deaths, property loss, or crop damage in the City of Federal Heights caused by flooding. On August 17, 2000 there was one reported death caused by flooding in the west central portion of Adams County.

A significant flooding event occurred from September 12-16 (2013) when nearly 6-18 inches of rain fell across Colorado's Front Range and I-25 corridor. According to the Adams County Flood Insurance Study, severe flood runoff is often transported through the City of Federal Heights. There are several steep slopes and mobile homes within close proximity to Niver Creek. Existing stormwater runoff culverts have proven to be inadequate and could cause extensive flooding. Based on the historic flooding impacts in the region and existing conditions of stormwater infrastructure, there is great potential for future flooding events to occur at any given time.

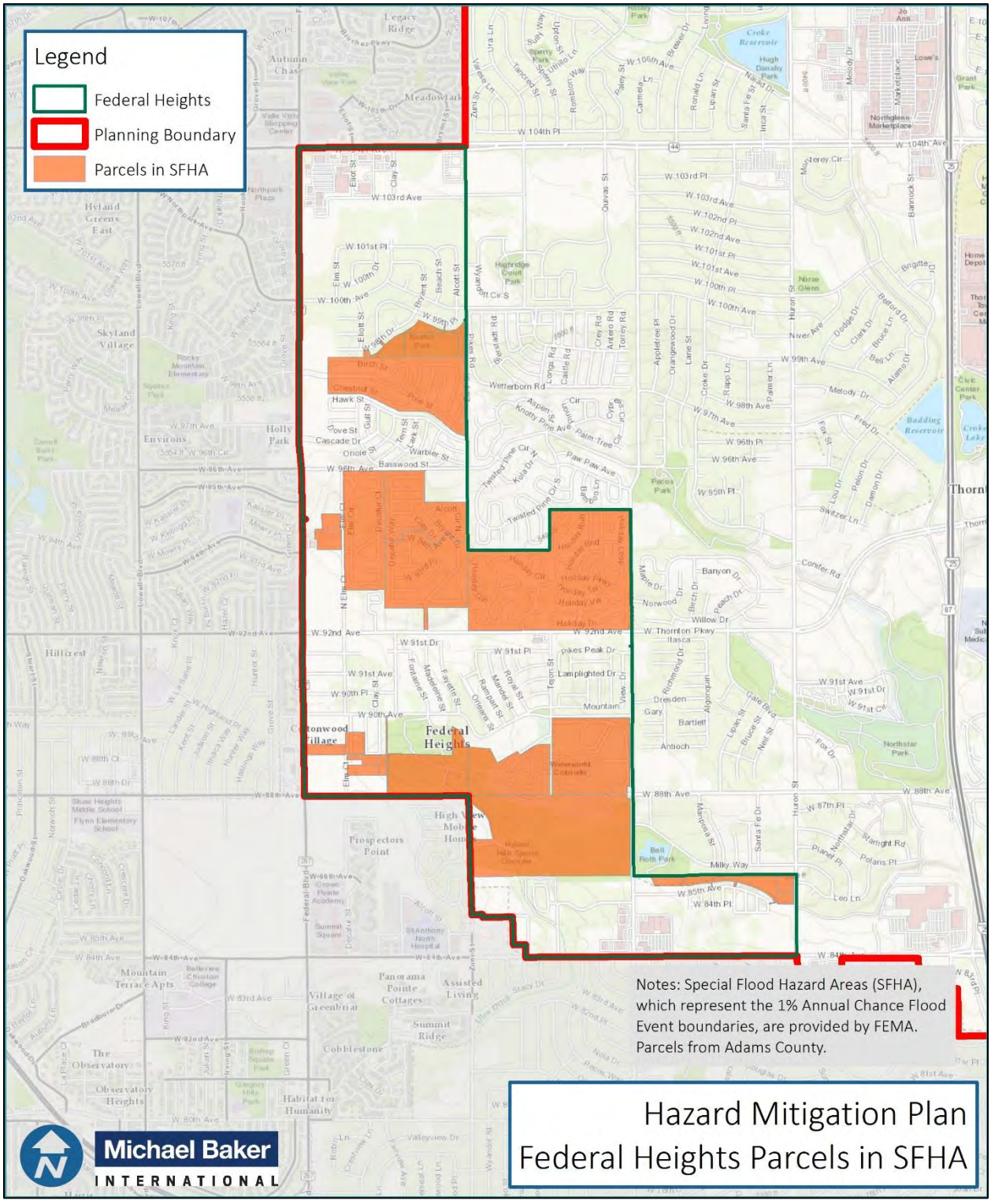
There are currently no NFIP Repetitive Loss (RL) or Severe Repetitive Loss (SRL) structures in the City.

Inventory Exposed

There are 23 parcels, which include 42 structures, located within or near the SFHA and the improved value of those is estimated to be over $11 million. The following figure shows these parcels located in the SFHA.

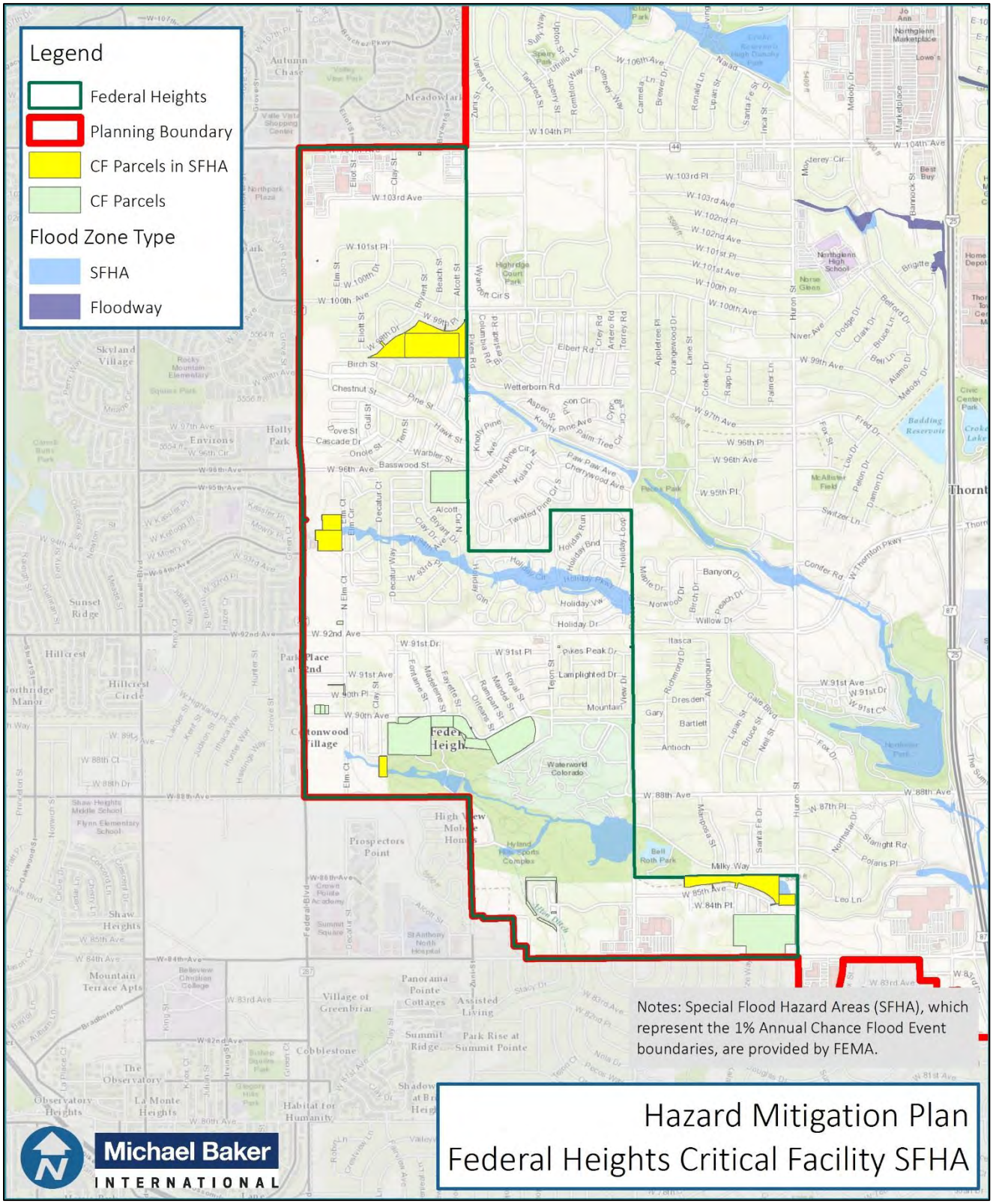
Critical facilities are essential to the health and welfare of the whole population and are especially important both during and after hazard events. Critical structures or areas that overlap or touch the SFHA are considered "flood prone." The critical facility and structure exposure analysis estimates that there are 7 critical facility parcels in the City of Federal Heights that are flood prone (not including the total miles of flood prone infrastructure). These parcels contain 12 structures whose appraised value is over $270,000. The second following figure represents the critical facilities located in or within close proximity to the SFHA and floodway planning area.

FIGURE 58. FEDERAL HEIGHTS PARCELS IN THE SFHA



City of Thornton Northglenn Federal Heights

FIGURE 59. FEDERAL HEIGHTS CRITICAL FACILITIES IN THE SPECIAL FLOOD HAZARD AREA



City of Thornton Northglenn Federal Heights

Potential Losses

The methodology used to determine potential losses to flooding was conducted using FEMA's Hazus loss estimation software. For this Plan, a 100-year flood scenario was modeled for the City. The results are presented below.

Hazus 100-Year Flood Scenario

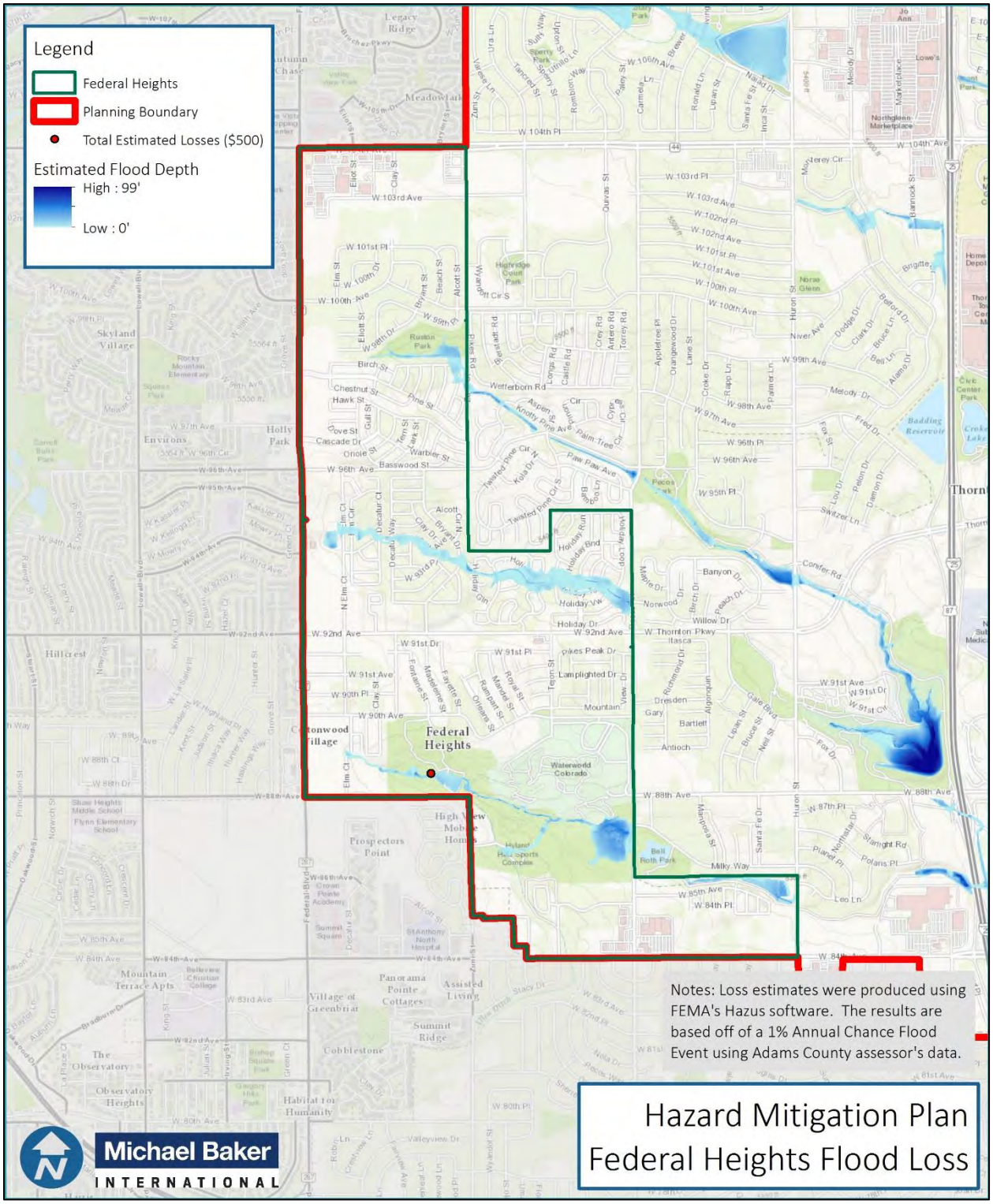
In addition to the SFHA boundaries, the flood risk analysis for this Plan integrates DFIRM depth grids, a digital dataset that shows flood depths at various locations within the floodplain. This enhanced data input allows Hazus to more accurately approximate floodplain boundaries and their associated flood depths for a 100-year flood event.

Hazus is a national loss estimation model developed by FEMA and the National Institute of Building Science. The primary purpose of Hazus is to provide a methodology and software application to develop flood and earthquake loss at a regional scale. There are two types of Hazus analyses, standard and enhanced. A standard Hazus analysis requires no specialized knowledge on the part of the user and leverages the default inventory, hazard, and engineering (damage function) data present in the program. This is also known as an "out of the box" or Level 1 analysis. An enhanced analysis requires the user to have localized knowledge and data in order to provide updated inventory, hazard and/or engineering (damage function) data that overwrites the default data present in the program. Historically, this has been known as a Level 2 (inventory or hazard updates) or Level 3 (engineering updates) Hazus analysis.

Utilizing Hazus 3.0, FEMA's loss estimation and hazard modeling software, a detailed flood analysis was conducted for structures within Adams County, specifically around the City of Federal Heights. The risk assessment leveraged locally managed parcel inventory as well as Light Imaging, Detection, And Ranging (LiDAR) terrain data. A project area Digital Elevation Model was created using this terrain data, also used in the flood analysis was a 100 year flood Depth Grid derived from FEMA's National Flood Hazard Layer (NFHL) data. In addition to these custom datasets we also created User Defined Structures (UDS points) for all parcels that were impacted by the FEMA effective floodplains. The Hazus analysis was then performed at every one these locations to estimate the flood damages associated with the impacted structures.

A 100-year flood scenario was defined in Hazus and losses were calculated for each point that intersected the depth grid based on the Hazus depth damage curves for specific structure attributes (such as foundation type, building type, and first flood height). The map below shows the results of the Hazus 100-year flood scenario economic loss analysis for the City of Federal Heights.

FIGURE 60. FEDERAL HEIGHTS FLOOD LOSS MAP



City of Thornton Northglenn Federal Heights

Hazus estimates for the City of Federal Heights estimate that for a 100-year flood event, only one building will be damaged. The total economic loss estimated for the 100-year flood in the City is estimated to be about $500. A number of variables are included in Hazus analyses in order to arrive at the estimated values of loss due to flooding. For this reason, it is important to note that the Hazus loss estimates should not be used as a precise measure, but rather viewed from the perspective of the potential magnitudes of expected losses.

Probability of Future Occurrences

Frequency of previously reported flood events in the City of Federal Heights provide an acceptable framework for determining the probability of future flood occurrence in the area. Based on the historic flooding impacts in the region and existing conditions of stormwater infrastructure, there is great potential for future flooding events to occur at any given time.

Severe flooding has the potential to inflict significant damage to people and property in the City. Mitigating flood damage requires that communities remain diligent and notify local officials of potential flood (and flash flood) prone areas near infrastructure such as roads, bridges, and buildings.

Land Use and Development

It is essential that zoning and land use plans take into account not only the dollar amount of damage that buildings near waterways could incur, but also the added risk of floodplain development activity that alters the natural floodplain of the area (for example, narrowing the floodplains by building new structures close to rivers and streams). The city should plan for the likelihood of increased exposure of property and humans to flood events.

Existing floodplain management ordinances are intended to address methods and practices to minimize flood damage to new and substantial home improvement projects as well as to address zoning and subdivision ordinances and state regulations. Currently, Federal Heights is a National Flood Insurance Program (NFIP) participant and continues to support floodplain management activity at the local scale.

The greatest protection against flooding is afforded by quality construction and compliance with local ordinances which exceed NFIP requirements. Code adoption by local jurisdictions, compliance by builders, and local government inspection of new homes and substantial improvements can greatly reduce the risk of flooding. Moving forward, Federal Heights will continue to support monitoring, analysis, modeling, and the development of decision-support systems and geographic information applications for floodplain management activities.

In addition to land-use planning, zoning, and codes applicable to new development, flood mitigation measures include structural and non-structural measures to address susceptibility of existing structures. Flood mitigation measures such as acquisition, relocation, elevation-in-place, wet/dry flood proofing, and enhanced storm drainage systems all have the potential to effectively reduce the impact of flood in Federal Heights.

Public Health Hazards

Hazards related to public health can impact large groups of people and affect many aspects of social and economic life. Like many other hazards, a public health event is unpredictable and can affect many different regions and communities.

Previous Occurrences

Public health hazards can manifest as primary events by themselves, or they may be secondary to another disaster or emergency, such as a flood, a severe storm, or a hazardous materials incident. The common characteristic of most public health emergencies is that they adversely impact, or have the potential to adversely impact, a large number of people.

The Colorado Department of Public Health and Environment releases an annual reportable disease summary for each county. Events in Adams County between 2009 and 2014 can be seen in Chapter 3 of this report.

Inventory Exposed

The information in the table below is from the Impact Analysis of Potential for Detrimental Impacts of Hazards for the Emergency Management Accreditation Program (EMAP). The following table explains possible impacts to various subjects due to public health emergencies.

TABLE 44. IMPACTS TO SUBJECTS IMPACTED BY PUBLIC HEALTH EMERGENCIES

Subject	Detrimental Impacts
Health and Safety of Persons in the Area as the Time of Incident	Adverse impacts are expected to be severe for unprotected personnel and moderate to light for protected personnel.
Health and Safety of Persons Responding to the Incident	Adverse impacts are expected to be severe for unprotected personnel and uncertain for trained and protected personnel, depending on the nature of the incident.
Continuity of Operations	Danger to personnel in the area of the incident may require relocation of operations and lines of succession execution.
Property, Facilities, and Infrastructure	Access to facilities and infrastructure in the area of the incident may be denied until decontamination is complete.
Delivery of Services	Stress on resources and facilities due to increased volume and demand may overwhelm and/or extensively postpone delivery of services.
The Environment	Incident may cause denial or delays in the use of some areas.
Economic and Financial Condition	Local economy and finances may be adversely affected, possibly for an extended period of time.
Regulatory and Contractual Obligations	Regulatory waivers may be needed. Fulfillment of contracts may be difficult. Demands may exceed the ability to deliver.
Reputation of, or Confidence in, Management and Response Authorities	Ability to respond and recover may be questioned and challenged if planning, response, and recovery are not timely and effective.

Potential Losses

FluWorkLoss 1.0 is a tool developed by the CDC to estimate the potential impact of pandemic influenza on a community in terms of cost. Based on local demographic data, the tool allows communities to estimate the potential number of days lost from work due to a pandemic. Users of FluWorkLoss can change input values, such as the number of workdays lost due to a worker staying home to care for a family member. Users can also change the length and virulence of the pandemic so that a range of possible impacts can be estimated.

Days missed from work cost both employees (in lost wages) and employers (in work not completed). The following table shows the total estimated number of days lost from work in Federal Heights due to a four-

week long influenza pandemic with a 25% clinical attack rate. The available workdays are calculated as a product of the total population in the working age group (Census 2010), the employment rate of the city (Census 2010), and the number of workdays in a week (5).

TABLE 45. TOTAL WORKDAYS LOST

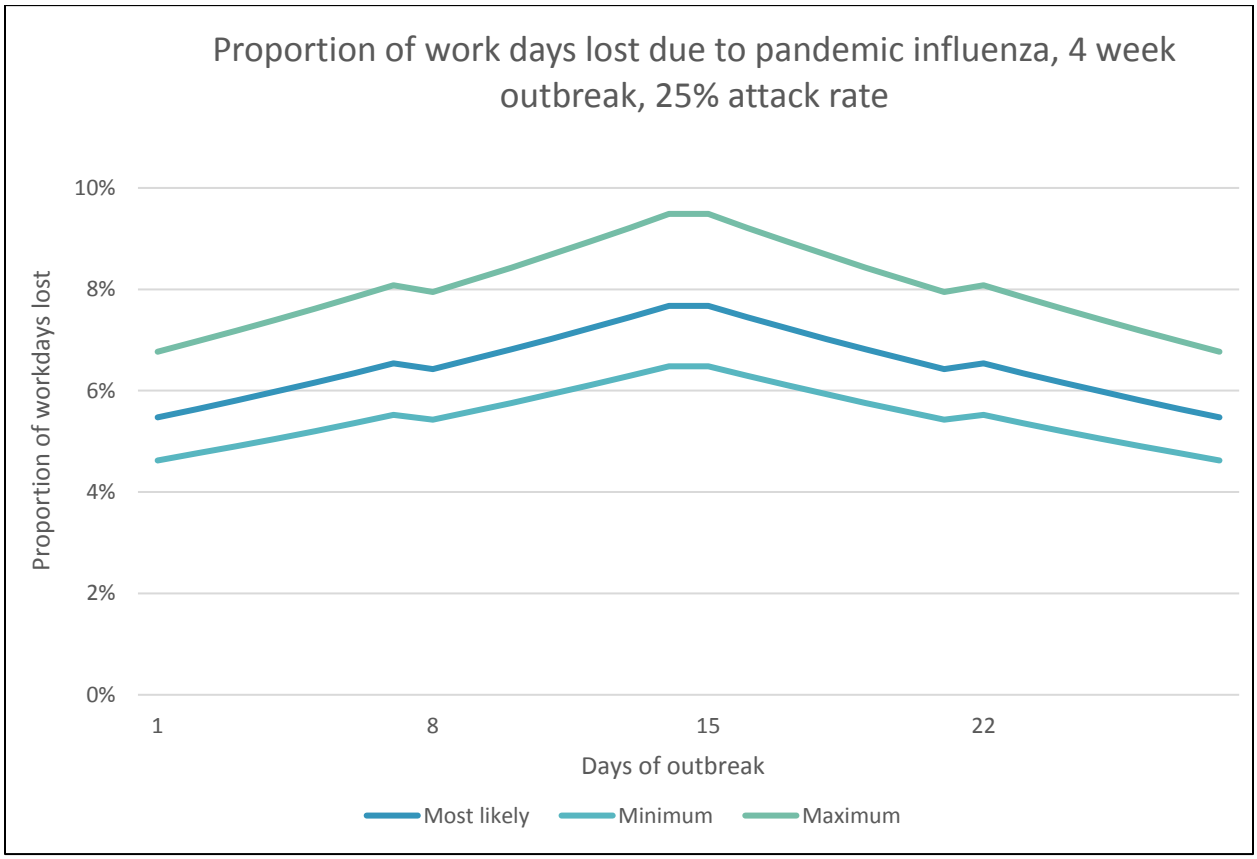
Scenario	Workdays Lost
Most Likely Scenario	6,449
Minimum Loss Scenario	5,447
Maximum Loss Scenario	7,975

Source: FluWorkLoss 1.0, CDC

The number of workdays lost includes the workdays lost for both self-care and care of sick family members due to the pandemic. Although the workdays lost do not include those lost due to factors such as fear and school closings, the model does provide a general picture of the impact on the productivity of the local economy due to an influenza pandemic. Results are estimated to create three scenarios of pandemic impact: the minimum (the best case scenario), which estimates the fewest possible number of hospitalizations/outpatient visits/deaths (i.e., the fewest possible days lost from work); the mean (the most likely scenario); and the maximum (the worst case scenario), which estimates the largest number of hospitalizations/outpatient visits/deaths (i.e., the largest possible number of days lost from work).

The following graph shows the proportion of workdays lost for each day of the modeled influenza outbreak for the three loss scenarios. Again, the scenario assumes a four-week long pandemic with a 25% clinical attack rate.

FIGURE 61. PROPORTION OF WORKDAYS LOST IN FEDERAL HEIGHT DUE TO PANDEMIC INFLUENZA



(SOURCE: CENSUS 2010, CDC)

The available workdays are calculated as a product of the total Census 2010 population of the working age group in Federal Heights, the local employment rate (Census 2010), and the number of workdays in a week. The number of workdays lost includes the workdays lost for both self-care and care of sick family members due to the pandemic. It does not include workdays lost due to usual illnesses. Also, it does not include workdays lost due to other factors such as fear, school closings, etc.

The numbers and projections generated through FluWorkLoss are not considered predictions of what *will* happen during an influenza pandemic. Rather, the results should be treated as estimates of what *could* happen.

Probability of Future Occurrences

Climate change threatens to increase the spread of infectious diseases because changing heat, rain, and humidity levels allow disease carrying vectors and pathogens to come into closer contact with humans. Climate change has the potential to expand the habitats and infectivity of disease-carrying insects and rodents, thus increasing the risk of disease transmission. For example, mosquitoes capable of transmitting West Nile virus are already present in Colorado. If Colorado's climate becomes warmer, mosquito populations could swell, making the region more favorable for disease transmission.

Hantavirus is another infectious disease that may pose a higher risk to Federal Heights residents in the future. Deer mice are the primary reservoir for Hantaviruses and climate change (warmer weather) plays a role in elevated seasonal deer mouse populations.

Based on historical record of 5,753 cases of diseases in Adams County, public health hazards have affected residents and visitors significantly and more than once every year from 2009 through 2014. The historic frequency suggests that there is a 100% chance of some type of public health hazard will affect the City of Federal Heights every year.

Due to the nature of public health hazards, communities with higher numbers of vulnerable individuals are expected to be impacted to a greater extent than others. In the context of public health hazards, the most vulnerable people are:

- The elderly (people over 65 years of age)
- Children (under 5 years old)
- The infirm
- People living in poverty

The following table highlights a number of key pandemic vulnerability factors in the Federal Heights and the neighboring Cities of Thornton and Northglenn. Federal Heights stands out as having a larger percentage of their population over the age of 65 than both Northglenn and Thornton. Additionally, Federal Heights has a higher percentage of residents living below poverty level than its neighboring cities. This indicates that in the event of a pandemic, Federal Heights may experience a larger share of the impacts than Thornton and Northglenn and may have a more challenging time recovering from a large public health hazard.

TABLE 46. KEY PANDEMIC VULNERABILITY FACTOR DATA

Jurisdiction	Age: 5 and Under (%)	Age: 65 and Over (%)	Persons Below Poverty Level (%)
Colorado	10.9	12.9	34.5
City of Thornton	6.5	9.2	29.7
City of Federal Heights	11.1	18.7	48.0
City of Northglenn	11.3	13.6	41.5

Source: Census 2010

Land Use and Development

Although the physical footprint of Federal Heights is not expected to grow substantially in the future, future development around the city (as well as population growth) has the potential to change how infectious diseases spread through the community and impact human health in both the short and long

term. New development may increase the number of people and facilities exposed to public health hazards and greater population concentrations (often found in special needs facilities and businesses) put more people at risk. During a disease outbreak those in the immediate isolation area would have little to no warning, whereas, the population further away in the dispersion path may have some time to prepare and mitigate against disease depending on the hazard, its transmission, and public notification.

Tornado/Severe Wind

Although large tornadoes are a rare event along the Front Range of Colorado, this hazard, along with severe winds, is a concern for representatives and residents of the City.

Previous Occurrences

NCEI's Storm Events Database estimates that no tornadoes have touched down in, or moved through, Federal Heights between 1950 and 2015. No injuries or deaths have occurred within Federal Heights due to severe wind events. There have been three recorded strong wind events in west Adams County between 2009 and 2014 causing approximately $21,000 in damages. All portions of Federal Heights have the potential to be affected by tornadoes. Historically, tornadoes have been relatively small on the EF Scale but F1 tornadoes can still produce dangerous winds up to 112mph. High winds can cause damage to buildings (tearing shingles from roofs, tearing awnings, collapsing structures, etc.).

Inventory Exposed

Inventory assets exposed to severe wind is dependent on the age of the building, type, construction material used, and condition of the structure. Possible losses to critical infrastructure include:

- Electric power disruption
- Communication disruption
- Water and fuel shortages
- Road closures
- Damaged infrastructure components, such as sewer lift stations and treatment plants
- Damage to homes, structures, and shelters

All assets located in the City of Federal Heights can be considered at risk from tornadoes and severe wInd. This includes 100% of the City's population and all buildings and infrastructure within the City.[39] Most structures, including the city's critical facilities, should be able to withstand and provide adequate protection from tornadoes. Those facilities with back-up generators should be fully equipped to handle tornado events should the power go out.

Potential Losses

Generally, straight-line wind events and tornadoes destroy private, commercial, and public property. Additional costs stem from debris removal, maintenance, repair, and response. Indirect costs include loss of industrial and commercial productivity as a result of damage to infrastructure, facilities, or interruption of services. Because no specific, citywide loss estimation exist for wind and tornado hazards, potential losses are related to historical property damage and injuries/deaths.

[39] 2010 Census

Over the last 66 years there have been no deaths reported in the City of Federal Heights due to a tornado event and no deaths or injuries due to severe wind.

Due to limited funding resources, Federal Heights does not currently have a siren system in place. Although the City has a reverse 911 Program, there will still be more community members who are at risk because they are not alerted in time.

Probability of Future Occurrences

Reported tornadoes in Adams and Weld County over the past 66 years provide an acceptable framework for determining the future occurrence in terms of frequency for such events. The probability of the City experiencing a tornado associated with damages or injuries can be difficult to quantify, but based on historically recorded tornadoes near Federal Heights that have either caused damages to buildings and infrastructure or resulted in an injury or death, it can reasonably be assumed that this type of event could occur at any time.

Similarly, reported straight-line wind events over the past provide an acceptable framework for determining the future occurrence in terms of event. The probability of the City of Federal Heights experiencing a severe wind event associated with damages or injuries can be difficult to quantify, but based on historical record, there is a high chance of this type of event occurring each year.

Land Use and Development

All future structures built in the City of Federal Heights could likely be exposed to tornado and severe wind damage. As with other large extent hazards, increased and aging population growth will increase the vulnerability of these areas. Federal Heights must continue to adhere to building codes and to facilitate new development that is built to the highest design standards to account for tornadoes and severe wind.

Due to the nature of tornadoes and severe wind, not all of Federal Heights is expected to be impacted equally. For example, older homes, which are often subject to less advanced building codes, suffer increased vulnerability to tornadoes over time. Mobile homes, which are most often occupied by low-income, socially vulnerable residents, are the most dangerous places during a tornado. Studies indicate that 45% of all fatalities during tornadoes occur in mobile homes, compared to 26% in traditional site-built homes.[40] It is important that local agencies monitor the inventory and locations of mobile homes, particularly in areas of high tornado risk. Moreover, when discussing mitigation actions for severe winds and tornadoes, communities or geographic locations with large numbers of mobile homes deserve added attention.

Winter Storm

Winter storms impact communities on every level and are a fairly typical occurrence for communities within the planning area. Although most communities are well-equipped to prepare for this hazard, storms have increased in recent years and more mitigation measures can created for future events.

[40] Ashley, W.S., A.J. Krmenec, and R. Schwantes, 2008: Vulnerability due to nocturnal tornadoes. *Weather and Forecasting*, 23, 795 – 807.

Previous Occurrences

According to the best available data from NOAA's NCEI Storm Events Database, the Adams County has experienced 64 Winter Storms since 1996 with no recorded injuries, death and property or crop damage. Based on historical data, it is certain that the City of Federal Heights is at high risk of experiencing, and being impacted by, winter storms in the coming years.

Inventory Exposed

All assets located in the City of Federal Heights can be considered at risk from winter storms. This includes 11,467 people, or 100% of the City's population, and all buildings and infrastructure within the City. Damages primarily occur as a result of high winds and snow-loading. Most structures, including the City's critical facilities, should be able to provide adequate protection from winter storm damage. Those facilities with back-up generators are better equipped to handle a winter storm situation should the power go out.

Potential Losses

Winter storms affect all portions of the City of Federal Heights including all above-ground structures and infrastructure. Although losses to structures are typically minimal and covered by insurance, there can be impacts with lost time, maintenance costs, and contents within structures. A timely forecast may not be able to mitigate the property loss, but could reduce the casualties and associated injury.

It appears possible to forecast these extreme events with some skill, but further research needs to be done to test the existing hypothesis about the interaction between the convective storm and its environment that produces the extensive swath of high winds. Winter storms will remain a highly likely occurrence for the City of Federal Heights.

Probability of Future Occurrences

Severe winter storms can be predicted with a reasonable level of certainty. Through the identification of various indicators of weather systems, and by tracking these indicators, warning time for snow storms can be as much as a week in advance. Understanding the historical frequency, duration, and spatial extent of severe winter weather assists in determining the likelihood and potential severity of future occurrences. The characteristics of past severe winter events provide benchmarks for projecting similar conditions into the future. The probability that Federal Heights will experience a severe winter storm event can be difficult to quantify. However, based on historical records and frequencies there is nearly a 100% chance of this type of event will occur somewhere in the City of Federal Heights at least once every year.

Land Use and Development

All future structures built in the City of Federal Heights will likely be exposed to severe weather extremes and damage. Since the previous statement is assumed to be uniform across the region, the location of development does not increase or reduce the risk necessarily. Federal Heights must adhere to building codes, and therefore, new development should be built to current standards to account for adverse weather.

Existing Planning Mechanisms

There are numerous existing regulatory and planning mechanisms in place at the city level of government which support hazard mitigation planning efforts. These tools include city subdivision regulations and road and bridge standards, and local zoning regulations. These planning mechanisms were discussed at the Community Interview and the Federal Heights members of the Hazard Mitigation Planning team were encouraged to review all available technical information available for their city as they worked to develop the risk assessment and their mitigation actions.

Federal Heights is a participant in the National Flood Insurance Program (NFIP). Since it entered the program, the city has adopted the minimum NFIP requirements into its Charter and City Code and Ordinances. The city plans to continue compliance with all NFIP requirements in the future.

During the hazard mitigation planning process, the city worked to identify ways in which identified mitigation actions/projects will be incorporated into their existing planning and regulatory mechanisms over time. Moving forward, Federal Heights will continue to integrate the goals and actions of this Plan into their evolving local planning mechanisms, including comprehensive plans, capital improvement plans, and resource and land use regulations. They will be incorporated into existing planning mechanisms as they are updated or developed. As this Plan is being finalized, the City's Comprehensive Plan is in the process of being updated, and the City is working on ways to integrate relevant portions of this HMP as appropriate.

This HMP will serve as a source document for risk reduction, policy making, and land use planning. These planning mechanisms will enhance the city's ability to implement the actions outlined in the mitigation plan.

Mitigation Strategy

The intent of the Mitigation Strategy is to provide the participating jurisdictions with the goals that will guide future mitigation policy and project administration. The Mitigation Strategy includes a list of proposed actions deemed necessary to meet those goals and reduce the impact of natural hazards.

Summary of Goals

Mitigation Goals are general guidelines that explain what a community wants to achieve with their local hazard mitigation plan. Goals are overarching targets and describe the ideal long-term outcomes envisioned by the community, which are listed below.

- Improve capability to reduce disaster losses (F1)
- Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens (F2)
- Increase public awareness of natural hazards and mitigation options (F3)
- Integrate hazard mitigation into other planning mechanisms (F4)
- Increase the city's resilience to hazards during all phases of the Emergency Management Cycle (F5)
- Increase individual resilience to hazards (F6)

2010 Hazard Mitigation Plan Actions

The HMP small team was tasked with reviewing mitigation projects included in the 2010 Denver Metro NHMP. The City of Federal Height's mitigation projects for 2010 were as follows:

TABLE 47. 2010 HMP PROJECTS, CITY OF FEDERAL HEIGHTS

Lead Department	Project Name	Hazard	Timeline	Status	Estimated Cost
City of Federal Heights, Community Services	96th Retaining Wall	Land Subsidence	2011	Deferred – at this point in time City Council has decided to not pursue	$800,000
City of Federal Heights, Community Services	Tributary L of Niver Creek Stormwater Improvement Project (near West 89th Avenue)	Flood	2014	On-going – UDFCD currently performing an updated study	$1,000,000
City of Federal Heights	DRCOG 1 – Continued Participation in NFIP	Flood	On-going	On-going – City remains a participant	Staff Time
City of Federal Heights	DRCOG 2 – Implement and improve upon effective floodplain and stormwater management practices	Flood	On-going	On-going – Stormwater plan is being produced and on-going flood studies of Niver Creek	Staff Time
City of Federal Heights	DRCOG 3 – Work with water providers to continually identify and promote water conservation programs	Drought	On-going	On-going – Water comes from Westminster, enforce water restrictions as necessary. Implemented restrictions 4-5 years ago and usage numbers have remained at those lower levels since.	Staff Time

Lead Department	Project Name	Hazard	Timeline	Status	Estimated Cost
City of Federal Heights	DRCOG 4 – Monitor proceedings of the Colorado Water Availability Task Force, support water providers in implementation of conservation measures	Drought	On-going	On-going – See above.	Staff Time
City of Federal Heights	DRCOG 5 – Integrate HMP into other planning efforts	Multi-Hazard	On-going	On-going – Currently updating Comprehensive Plan and integrating updated HMP	Staff Time

2017 Mitigation Actions

As part of the 2017 planning process, the following mitigation projects were identified and developed into MAGs:

Mitigation Action Guide

City or Organization: City of Federal Heights & Tri County Health **Project Name: (FH1) Coordinate with Tri-County Health – Public Health Incident Response**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** Public Health
LOCATION: Adams, Arapahoe, and Douglas Counties	**PLANNING GOALS ADDRESSED:** F1 – Improve capacity to reduce disaster losses F2 – Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens F4 – Integrate hazard mitigation into other planning mechanisms F5 – Increase the city's resilience to hazards during all phases of the Emergency Management Cycle F6 – Increase individual resilience to hazards
RECOMMENDATION DATE: August 9, 2016	
TARGET COMPLETION DATE: Ongoing	
OBJECTIVES ADDRESSED: There is an all hazards plan through the Tri-County Health Department that forms a comprehensive management structure of the public health response to incidents within Adams, Arapahoe, and Douglas Counties	
ACTION: The plan designates roles and responsibilities to Tri-County Health Department and its divisions. To be efficient in executing the plan, there has to be coordinated planning and training prior to an event.	
LEAD AGENCY: Tri County Health	**EXPECTED COST:** To Be Determined
SUPPORT AGENCIES: All agencies in the three county plan.	**POTENTIAL FUNDING SOURCES:** To Be Determined
PROGRESS MILESTONES: The plan has been established. Complete trainings annually.	

Mitigation Action Guide

City or Organization: City of Federal Heights **Project Name: (FH2) Hazardous Tree Mitigation**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** High Winds / Tornado
LOCATION: Project location: City of Federal Heights	**PLANNING GOALS ADDRESSED:** Which 2016 LHMP goals does this project address? F1 - Improve capability to reduce disaster losses
RECOMMENDATION DATE: 07/01/2015	
TARGET COMPLETION DATE: Ongoing	
OBJECTIVES ADDRESSED: Promote public health, safety, and general welfare and to minimize public and private losses due to high winds or tornado like conditions in specific areas by provisions designed to: (1) Protect human life and health; (2) Minimize the need for rescue and relief efforts associated with high winds / tornados and generally undertaken at the expense of the general public; (3) Minimize prolonged business interruptions; (4) Minimize damage to critical facilities, infrastructure and other public facilities such as water, sewer and gas mains; electric and communications stations; and streets;	
LEAD AGENCY: City of Federal Heights	**EXPECTED COST:** $201,000 annually.
SUPPORT AGENCIES:	**POTENTIAL FUNDING SOURCES:** The City of Federal Heights general fund. Privately funded for non- City trees.
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Federal Heights **Project Name: (FH3) Maintaining Current Building Codes**	
PRIORITY: Medium (High, Med, Low)	**HAZARDS ADDRESSED:** Flood, Severe Storms, Tornado/Severe Wind, Earthquake, Extreme Temperatures, Expansive Soils/Undermined Areas, and Winter Storms.
LOCATION: City of Federal Heights	**PLANNING GOALS ADDRESSED:** F1 – Improve capability to reduce disaster losses F6 – Increase individual resilience to hazards
RECOMMENDATION DATE: August 9, 2016	
TARGET COMPLETION DATE: Updated every 3 years	
OBJECTIVES ADDRESSED: Adopting the most recent version of the international building codes (and related codes) in order to maintain the highest level of protection in new structures.	
ACTION: Adopt the most recent edition of the International Building Code and related documents, and make appropriate local amendments.	
LEAD AGENCY: City of Federal Heights	**EXPECTED COST:** $2,600 Every three years
SUPPORT AGENCIES: N/A	**POTENTIAL FUNDING SOURCES:** City of Federal Heights annual budget
PROGRESS MILESTONES: Ensure budgeting every 3 years	

Mitigation Action Guide

City or Organization: City of Federal Heights **Project Name: (FH4) Maintaining Current Uniform Fire Code**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** Wildland Fire
LOCATION: City of Federal Heights	**PLANNING GOALS ADDRESSED:** F1 – Improve capacity to reduce disaster losses F6 – Increase individual resilience to disasters
RECOMMENDATION DATE: August 9, 2016	
TARGET COMPLETION DATE: Updated every 3 years	
OBJECTIVES ADDRESSED: Adopting the most recent version of the international fire codes to maintain the highest level of protection for the citizens and structures of Federal Heights.	
ACTION: Adopt the most recent edition of the International Fire Code and make appropriate local amendments.	
LEAD AGENCY: City of Federal Heights	**EXPECTED COST:** $2,000 Every three years
SUPPORT AGENCIES: N/A	**POTENTIAL FUNDING SOURCES:** City of Federal Heights annual budget
PROGRESS MILESTONES: Ensure budgeting every 3 years	

Mitigation Action Guide

City or Organization: City of Federal Heights

Project Name: (FH5) Improve Upon Hazard Mitigation Efforts Relating to Winter Storms - Large Snow/Ice Accumulation Events throughout Federal Heights

PRIORITY: High	**HAZARDS ADDRESSED:** Winter Storms
LOCATION: City of Federal Heights	**PLANNING GOALS ADDRESSED:** • F1 - Improve capability to reduce disaster losses • F2 - Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens • F6 - Increase individual resilience to hazards
RECOMMENDATION DATE: Fall 2015	
TARGET COMPLETION DATE: Summer 2017	

OBJECTIVES ADDRESSED: Improvement of existing infrastructure systems.

ACTION: GENERAL MITIGATION APPROACHES

Hazard Management

Structures in winter storm hazard areas should be designed and built to withstand the projected snow (and ice) loads. Non-occupancy buildings, such as greenhouses and storage sheds, which are not subject to building codes, should be given special attention. High-cost or difficult-to-replace property should not be stored outside in high-risk areas. Critical facilities in areas of high storm hazard should be designed and managed to withstand likely storm impacts such as power outages, personnel shortages, and property damage.

Information/Outreach and Public Education

Residents and property owners should be informed of storm hazards and educated in safety and mitigation techniques.

Infrastructure

Snow fencing and related technologies should be constructed in areas where important highways are at risk of blockage during storm events. Utility lines should be placed underground where feasible. Aboveground utility lines should be kept free of potentially damaging vegetation.

Regulatory

Adoption and enforcement of appropriate building codes and construction standards can significantly reduce damages caused by severe storms.

LEAD AGENCY: City of Federal Heights	**EXPECTED COST:** **Approximately $6,000,000**
SUPPORT AGENCIES: N/A	**POTENTIAL FUNDING SOURCES:** City of Federal Heights Urban Renewal District

PROGRESS MILESTONES:

Mitigation Action Guide

City or Organization: Urban Drainage and Flood Control District - City of Federal Heights **Project Name: (FH6) Ruston Park Detention**	
PRIORITY: High	**HAZARDS ADDRESSED:** Flooding
LOCATION: City of Federal Heights	**PLANNING GOALS ADDRESSED:** • F1 - Improve capability to reduce disaster losses • F3 - Increase public awareness of natural hazards and mitigation options
RECOMMENDATION DATE: 7/15/2016	
TARGET COMPLETION DATE: 12/31/2019	
OBJECTIVES ADDRESSED: There are 15 residential structures in the 100-year floodplain upstream of Zuni Street. Zuni Street overtops during a 100-year storm event.	
ACTION: Increase the volume of the existing detention pond in Ruston Park to 6.7 acre-feet to reduce peak flows downstream. Provide a 54" pipe outlet to convey discharges from the pond to the channel on the east side of Zuni Street.	
LEAD AGENCY: City of Federal Heights	**EXPECTED COST:** $ 3 million
SUPPORT AGENCIES: UDFCD	**POTENTIAL FUNDING SOURCES:** City of Federal Heights, UDFCD
PROGRESS MILESTONES: Preliminary design; final design; begin construction.	

Mitigation Action Guide

City or Organization: City of Federal Heights **Project Name: (FH7) Water Quality**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** Flooding
LOCATION: Project location City of Federal Heights	**PLANNING GOALS ADDRESSED:** F1 - Improve capability to reduce disaster losses
RECOMMENDATION DATE: 07/01/2015	
TARGET COMPLETION DATE: Annual.	
OBJECTIVES ADDRESSED: Promote public health, safety, and general welfare and to minimize public and private losses due to flood conditions in specific areas by provisions designed to: (1) Protect human life and health; (2) Minimize expenditure of public money for costly flood control projects; (3) Minimize the need for rescue and relief efforts associated with flooding and generally undertaken at the expense of the general public; (4) Minimize prolonged business interruptions; (5) Minimize damage to critical facilities, infrastructure and other public facilities such as water, sewer and gas mains; electric and communications stations; and streets and bridges located in floodplains; (6) Help maintain a stable tax base by providing for the sound use and development of flood-prone areas in such a manner as to minimize future flood blight areas; and (7) Insure that potential buyers are notified that property is located in a flood hazard area. (Ord. No. 13-14, § 1, 8-20-2013)	
Actions: The city of Federal Heights actively regulates all flood related building, development, and improvement procedures through the use of a formal building and improvement process that involves review by a planning and review department, building and engineering professionals as well as city administrators. The city also has adopted multiple flood control and improvement guidelines outlined in Chapter 34 articles I-V of the City of federal Heights adopted municipal code. In addition to actively managing all building and development within the designated flood zones of Federal Heights city staff also maintain a drainage utility program that focuses on ensuring clean and unobstructed drains in the event of flooding incidents. As part of the drainage utility program the city contracts street sweeping operations 6 times each year and conducts storm drain/inlet clean out after each major storm event. Along with the external drain mitigation efforts the city public works department also operates a 3 year rotating plan for cleaning out and maintaining the cities internal flood drain traps/boxes.	
LEAD AGENCY: City of Federal Heights	**EXPECTED COST:** $201,000 annually.
SUPPORT AGENCIES: US EPA	**POTENTIAL FUNDING SOURCES:** The city of Federal Heights general fund. Utility fees
PROGRESS MILESTONES:	

Strategy Implementation and Plan Maintenance

Having a plan for monitoring, evaluating, maintaining, and implementing this HMP is critical to maintaining its value and success. Ensuring effective implementation of mitigation activities paves the way for continued momentum in the planning process and gives direction for the future. This section explains who will be responsible for maintenance activities and what those responsibilities entail. It also provides a methodology and schedule of maintenance activities including a description of how the public will be involved on a continual basis.

The City of Federal Heights's Council has authorized the submission of this Plan to both the Colorado Division of Homeland Security and Emergency Management (DHSEM) and the Federal Emergency Management Agency (FEMA) for their respective reviews and subsequent approvals. Upon state and federal approval, the City will act to formally adopt this plan.

Plan Integration, Existing Capabilities and Resources

The City of Federal Heights plans to integrate this HMP in a number of ways. As mentioned previously, the City is currently in the process of updating its Comprehensive Plan and will incorporate applicable portions of this plan within that document and will work to leverage resulting HMP components into the planning process. The City will also look to integrate identified mitigation projects/actions into the five-year Capital Improvement Plan. Federal Heights HMP planning lead also plans to identify opportunities to inform and educate the City Council members relating to this HMP.

The following capability assessment examines the ability of Federal Heights to implement and manage the comprehensive mitigation strategy laid out in this Plan. The strengths, weaknesses, and resources of the City are identified here as a means for evaluating and maintaining effective and appropriate management of the town's hazard mitigation program.

Local Personnel

The ability of a community to implement a comprehensive mitigation strategy depends, in part, on available resources, including people and staff. The table below outlines the participating community's capabilities as they relate to key personnel.

TABLE 48. FEDERAL HEIGHT'S KEY PERSONNEL

Title	Full Time	Part Time	None or Not-Identified
Emergency Manager	X		
Floodplain Administrator		X (City Engineer)	
Community Planner	X		
GIS Specialist	X		
Grant Writer		X	

Land Use Planning and Codes

Local land use plans and building codes are tremendous tools for evaluating local policies related to hazard mitigation and risk reduction. Additionally, comprehensive master plans, capital improvement plans, stormwater plans and zoning ordinances all present opportunities for enhanced local capabilities. The table below outlines the participating community's current capabilities as they relate to land use plans ordinances and codes.

TABLE 49. FEDERAL HEIGHT'S CURRENT ORDINANCES OR CODES

Land Use Planning or Codes	Adopted
Zoning Ordinance	Y
Hazard-Specific Ordinance	Y
Local Building Codes	Y (currently being updated)
Comprehensive Plan/Master Plan	Y (currently being updated)
Capital Improvements Plan	Y
Stormwater Plan	N (currently being written)
Continuity of Operations Plan (COOP)	N
Emergency Operations Plan (EOP)	Y
Long-Term Recovery Plan	N
Participates in NFIP	Y

Plan Maintenance and Resources

The City did not have any record of past maintenance activities tied to the 2010 DRCOG Plan.

The City of Federal Heights will actively maintain the 2017 Thornton, Federal Heights, and Northglenn Hazard Mitigation Plan by coordinating an annual review across City departments of all mitigation actions included in the 2017 HMP. This process will be led by the City's Emergency Manager. The annual review will occur during a public meeting and citizens will be invited to participate and share ideas for new mitigation projects to consider implementing.

The following table shows records of Federal Height's annual maintenance, for every year up until its five-year expiration date.

TABLE 50. CITY OF FEDERAL HEIGHTS HMP MAINTENANCE TABLE

Review Year	City Department	Name of Representative	Signature of Representative
2018			
2019			
2020			
2021			
2022			

Appendix C - Community Profile - The City of Northglenn

The City of Northglenn is located northeast of Denver, encompassing land mostly in Adams County but also a small portion in Weld County (see Figure 2 for reference). It's surrounded by Broomfield and Westminster to the west, Thornton to the North. Its central location makes for easy access to Interstate 25, Downtown Denver, Boulder and DIA.

Demographics

Northglenn is like most other Adams County metro regions in that the population is comprised of mostly families. In 2010, the city had a total population of 35,789[41]. The median age is 33.1 and the median household income is $52,149. Based on the 2010 census report, Northglenn is 61% Caucasian and 24% Hispanic. The city is relatively young in terms of demographics; with approximately 24% under the age of 18 and 11% who are 65 or over[42]. In comparison to the region, Northglenn has actually seen a downward trend in population growth.

Social Vulnerability

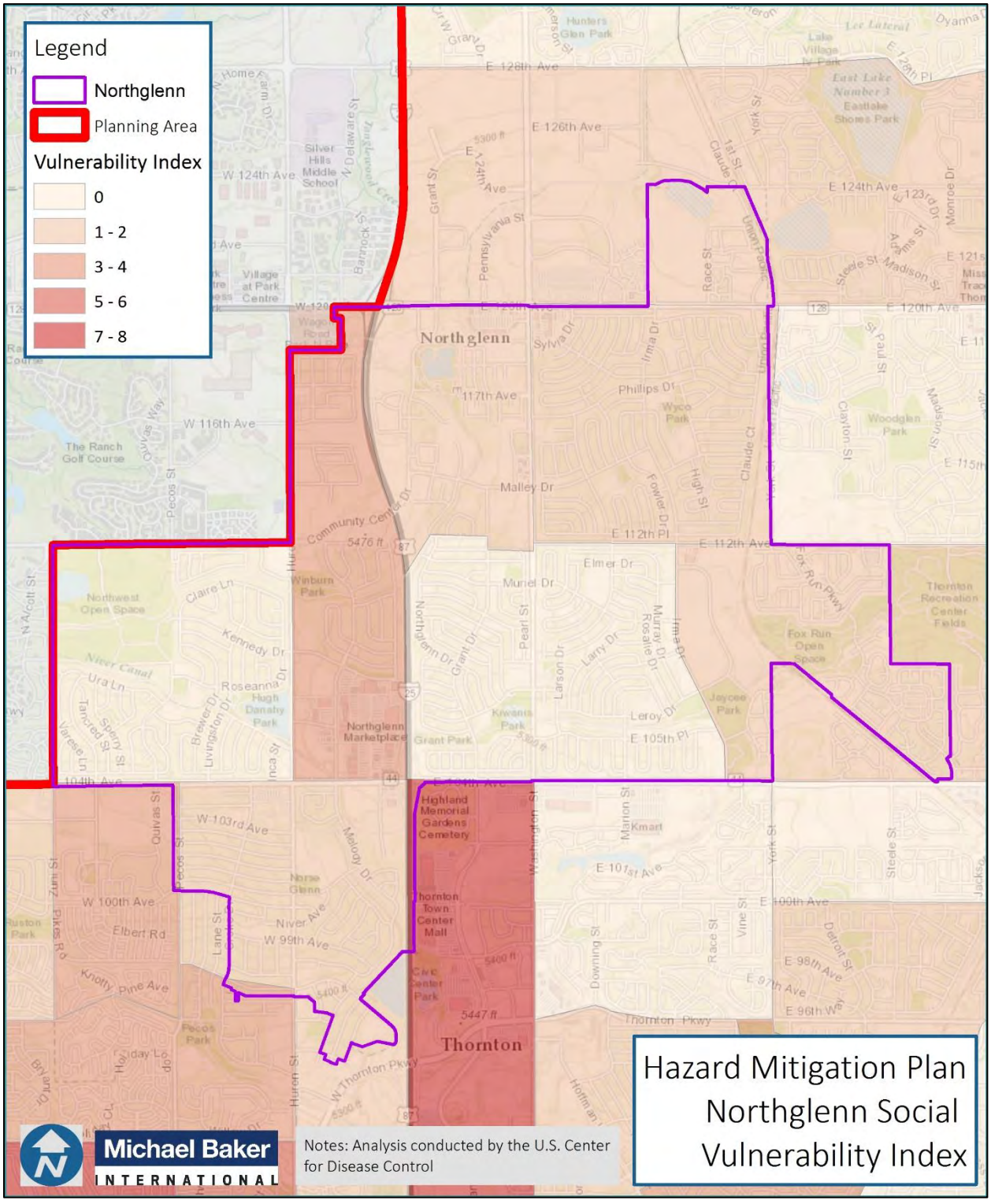
Like many of the other north Denver metro cities, Northglenn has a large Hispanic population with many who are non-English speaking. Having a diverse community means that Northglenn will need to expand upon its outreach efforts and work to implement bilingual information within community.

With nearly one out of four residents in Northglenn being under the age of 18, the city will also need to plan for assisting younger citizens in case of a hazard event.

The results of the social vulnerability assessment are displayed on the map below. On the map, social vulnerability is represented at the census tract level by five classes of vulnerability: Low (bottom 20% of the county), Medium-Low (20%-40%), Medium (40%-60%), Medium-High (60%-80%), and High (top 20% of the county). The City of Northglenn's social vulnerability map shows social vulnerability within the community.

[41] DRCOG Community Profile: Northglenn (2015)
[42] City of Northglenn Comprehensive Plan (2010)

FIGURE 62. NORTHGLENN SOCIAL VULNERABILITY MAP



City of Thornton Northglenn Federal Heights

Northglenn is characterized by mostly a mix of low to medium levels of social vulnerability. Communities along I-25 seem to have higher levels of social vulnerability to disasters than the rest of the community. Low-medium levels are seen near the northeast side as well as center of the City. There are areas of high social vulnerability east of Interstate 25 in the southern portion of the city. A closer look at the individual social vulnerability indicators within Northglenn will give local emergency managers, planners, and stakeholders an even clearer picture of where resources should be prioritized in order to reduce vulnerability in the community. Over time, Northglenn should continue to monitor their social vulnerability as demographic, economic, and housing related conditions change.

Housing

Northglenn contains many single-family detached dwelling units and 65% of all the city's land is used for housing[43]. The average household size is 2.6 people and most housing units are owner-occupied. Non-family households make up 36% of all households in Northglenn. In 2010, Northglenn had 14,274 housing units, 5% of which were vacant. In 2007, 66% of the homes were single-unit structures and were built between 1950 and 1980. Roughly 30% of all housing units in the city were built between 1990 and 2010. The city saw a decline in growth during the Great Recession. During the 2010 Comprehensive Plan Update, the City decided to focus on reinvesting in the existing older homes, which would prove to sustain and revitalize Northglenn's neighborhoods[44]. An advantage of the city is that it is known to be an affordable community.

Families comprise 64% of households in Northglenn. The average family size in Northglenn has increased from 3.41 people in 2009 to 3.47 people in 2013. Statistically, families are younger in Northglenn when compared to the region. While median household income has decreased in the past five years, it still remains higher than the region at $63,000 per family compared to $58,000 regionally[45].

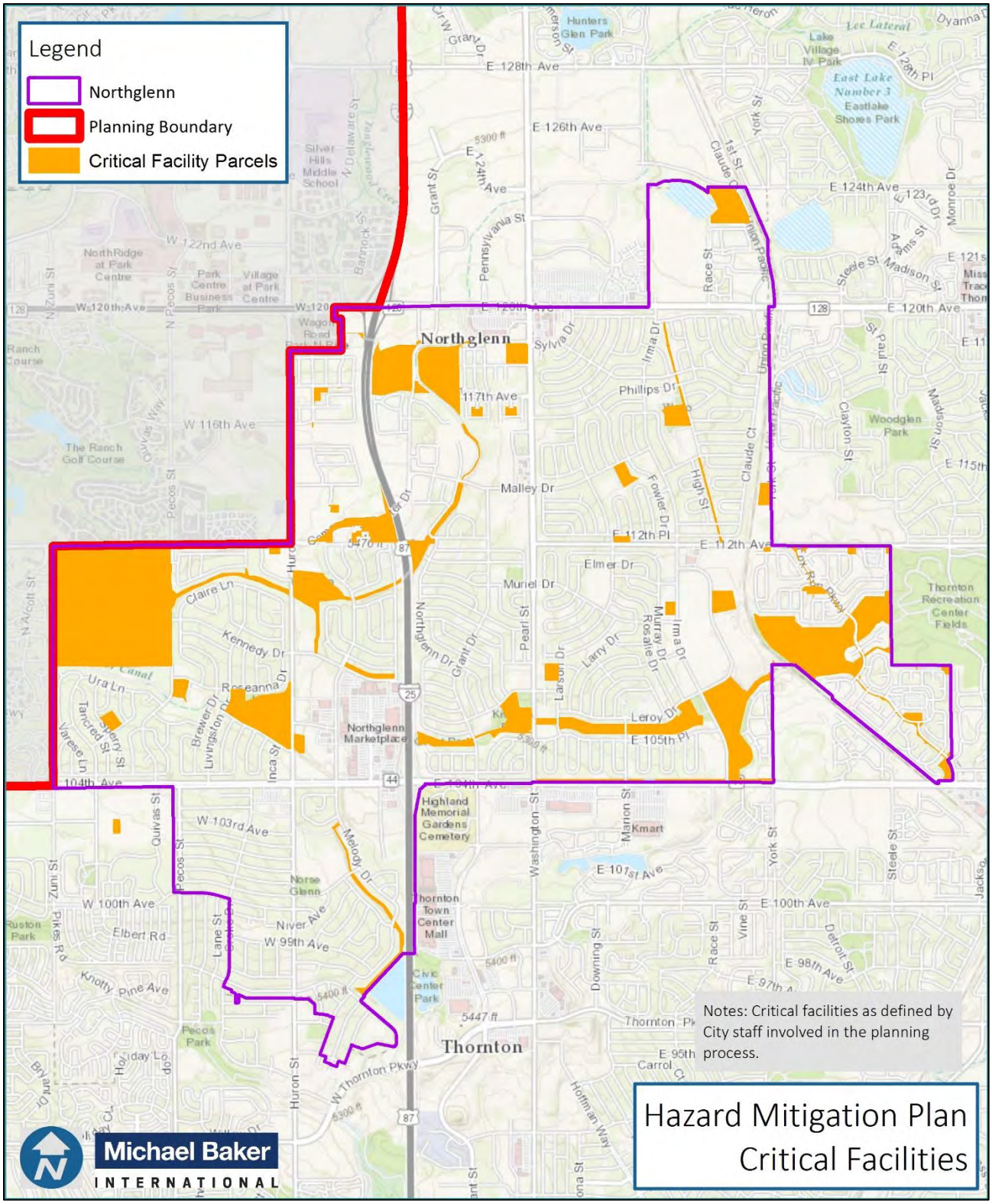
Critical Facilities

For the purpose of this multi-jurisdictional Hazard Mitigation Plan, 'critical facilities' are defined as local assets vital to the health, safety, and well-being of residents and visitors during time of natural disaster. These facilities include community centers, churches, hospitals, libraries, non-profits, post offices, water treatment centers, police & fire stations, and city administration buildings. Critical facilities are essential to a community's long-term disaster resilience as they are important delivery pathways for diverse crisis management services and resources. As part of the HMP planning process, each jurisdiction identified those facilities being termed as critical by utilizing the best available data from the Adams County assessor's office. There are currently 145 parcels within Northglenn that are considered as containing critical facilities, with those structures being assessed at over $23 million.

Included in this group are two large nursing homes in the City that are discussed in the City's Emergency Operations Plan. There are also a number of low-quality multi-family apartments and some Section 8 housing that would be vulnerable to hazard events and have thusly been included in this analysis. The following figure shows the locations of those critical facilities located in Northglenn.

[43] City of Northglenn Comprehensive Plan (2010)
[44] City of Northglenn Comprehensive Plan (2010)
[45] 2014 Year End Housing & Population Report

FIGURE 63. NORTHGLENN CRITICAL FACILITIES



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Future Development

The Denver region has seen significant growth since the 2000 census. Adams County as a whole is expected to grow 22% by 2020 and Northglenn will most likely see its suburban growth increase. The City is mostly encompassed by surrounding suburban communities and is nearly fully developed, but infill and relocation may increase the population and density altogether. The 2010 Northglenn Comprehensive Plan identified areas along I-25 as places that will attract new business and residents.

Hazard Identification

Introduction and Update Summary

The City of Northglenn has several staff members who have emergency management capabilities. They are as follows; full-time Floodplain Administrator, Community Planner, and GIS Specialist, and a part-time Emergency Manager. The City also has an Emergency Operations Plan and several ordinances and master plan updates that are a great resource to use when planning for emergency management.

Climate Change and Hazards

In the Northglenn Community Interview, three possible hazard events were highlighted. These events discussed included tornadoes, flooding, and winter storm events. These have either impacted the city directly or are of highest concern for community members. The interviewers were also asked to categorize the profiled hazards in terms of high, medium or low risk. As a result of those discussion, hazards were ranked as follows:

<u>High</u>

- Drought
- Flood
- Severe Storms
- Winter Storm

<u>Med</u>

- Wildland Fire
- Tornado/Severe Wind
- Extreme Temperatures

<u>Low</u>

- Earthquake
- Expansive Soils / Undermined Areas
- Public Health Hazards

Hazard Profiles

This section provides a refined risk and vulnerability assessment, specific for the City of Northglenn, for those hazards that were identified as being rated high in the preceding section. This analysis was conducted separately from that of the planning area-wide vulnerability assessment to specifically focus on the population, structures, infrastructure, and other assets unique to the City.

Drought

Drought is often hard to predict and not easily identifiable, but its impacts can be severe and put a community at risk for catastrophic economic, social, and environmental impacts.

Previous Occurrences

According to NOAA's NCEI Storm Events Database, there have been three drought events in Adams County and Weld County, which have occurred between 2002 and 2011. There were no injuries, deaths, or crop damages recorded within the City of Northglenn due to drought but there is potential for a future drought event to occur at any given time.

TABLE 51. HISTORY OF DROUGHT, ADAMS AND WELD COUNTY

Beginning Date	Location	Injuries	Death	Damage
4/1/2002	Adams and Weld County	0	0	0
6/9/2002	West Adams County	0	0	0
3/1/2011	Weld and Adams County	0	0	0

Source: NOAA, NCEI Storm Events Database

Starting in 2002, Colorado's Front Range cities began to experience one of the worst droughts in over 300 years and Northglenn felt the impacts significantly. 2002 was recorded as the driest year on record for the region and the state. Reports showed that snowpack was about 50% of what it would have typically been in the early months of the year, indicating that water supplies would be low.

Inventory Exposed

Drought typically does not have a direct impact on critical facilities or structures. Drought conditions evolve slowly over time and communities typically have ample time to prepare for the effects. Should a drought affect the water available for public water systems or individual wells, the availability of clean drinking water could be compromised. This situation would require emergency actions and could possibly overwhelm the local government and financial resources.

Impacts from drought can include the following:

- Economic losses to agricultural producers (crops and livestock)
- Physical and mental health issues
- Water supply interruption for business and industry
- Water quality problems
- Reduced soil and vegetation moisture
- Vegetation mortality, insect infestations
- Impacts to fish and wildlife populations
- Increase in wildland fires and associated losses

Potential Losses

Possible losses/impacts to critical facilities include the loss of critical function due to low water supplies. Severe droughts can negatively affect drinking water supplies. Should a public water system be affected,

the losses could total into the millions of dollars if outside water is shipped in. Private springs/wells could also dry up. Possible losses to infrastructure include the loss of potable water.

Although drought events rarely pose immediate risks to public health, they can impact local public health in numerous ways. Examples of drought-induced public health impacts include: increased respiratory ailments due to increased particulate matter in the air; sickness due to decreased availability of clean water; increased disease caused by wildlife concentrations; population migrations (rural to urban areas); loss of human life (e.g. from heat stress, suicides); and impacts on behavioral health (due to unemployment in the agricultural sector, stress on the tourism and other businesses related to the natural environment and/or water).

The impacts of drought on local vegetation and wildlife can include death from dehydration and spread of invasive species or disease because of stressed conditions. In general, environmental impacts from drought are more likely at the interface of the human and natural world. The loss of crops or livestock due to drought can have far-reaching economic effects on communities, wind and water erosion can alter the visual landscape, and dust can damage property. Water-based recreational resources are also heavily affected by drought conditions. Indirect impacts from drought arise from wildfire, which may have additional effects on the landscape and sensitive resources such as historic or archeological sites.

Probability of Future Occurrences

Due to the nature of drought, it is an extremely difficult hazard to predict. However, identifying various indicators of drought, and tracking these indicators, provides us with a crucial means of monitoring drought. Additionally, understanding the historical frequency, duration, and spatial extent of drought assists in determining the likelihood and potential severity of future droughts. The characteristics of past droughts provide benchmarks for projecting similar conditions into the future.

Historic frequency suggests that there is a 50% chance of this type of event occurring each year. The Colorado Climate Report, published in 2015 by the Colorado Water Conservation Board (CWCB), include climate models that project Colorado will warm by 2.5°F by 2025 and 4°F by 2050, relative to the 1950-1999 baseline. If these projections are accurate, changes in the quantity and quality of water are likely to occur due to warning, even in the absence of precipitation changes.

Although it is unlikely that drought conditions will affect existing buildings, infrastructure, and critical infrastructure, economic livelihoods in the City of Northglenn could be negatively impacted due to crop loss, water shortages, and wildfires as a result of drought. Possible losses/impacts to critical facilities include the loss of critical function due to low water supplies.

Land Use and Development

Society's vulnerability to drought is affected largely by population growth, urbanization, demographic characteristics, technology, water use trends, government policy, social behavior, and environmental awareness. These factors are continually changing, and society's vulnerability to drought may rise or fall in response to these changes. For example, increasing and shifting populations puts increasing pressure on water and other natural resources—more people need more water.

Future development greatly impacts drought hazards by stressing both surface and ground water resources. Agricultural and industrial water users consume large amounts of water. Expansion of water-

intensive enterprises is limited in a time when water resources are strained. In rapidly growing communities, new water and sewer systems or significant well and septic sites could use up more of the water available, particularly during periods of drought. Public water systems are monitored, but individual wells and septic systems are not as strictly regulated. Therefore, future development could have a impact on the vulnerability of the City of Northglenn to drought.

Related to both current land use and future development trends, the use of turf grass affects the available water supplies. Maintaining lush, green lawns in the semi-arid climate of the Front Range requires large amounts of water. Urban lawn watering is the single largest water demand on most municipal supplies. Outdoor water use accounts for about 55% of the residential water use in the Front Range urban area, most of which is used on turf. [46] Residential and commercial landscaping can greatly impact future drought events and future water use regulations may be able to mitigate this trend.

As the City of Northglenn continues to grow, they should revisit existing standards for determining the impacts of drought such as measuring the economic value of water in alternative uses and objective methods for quantifying non-market impacts of drought on those uses. Additionally, the City of Northglenn should continue to follow guidance found within the State of Colorado's Multi-Hazard Mitigation Plan as well as the Colorado Drought Mitigation and Response Plan.

Flood

Major flooding has occurred within the State of Colorado in recent years. As climate has changed, communities along the Front Range have seen devastating effects and the City of Northglenn has been directly impacted. The figure below presents the Special Flood Hazard Area (SFHA) in Northglenn, where the 1% annual chance flood (100-year flood) event could occur.

Previous Occurrences

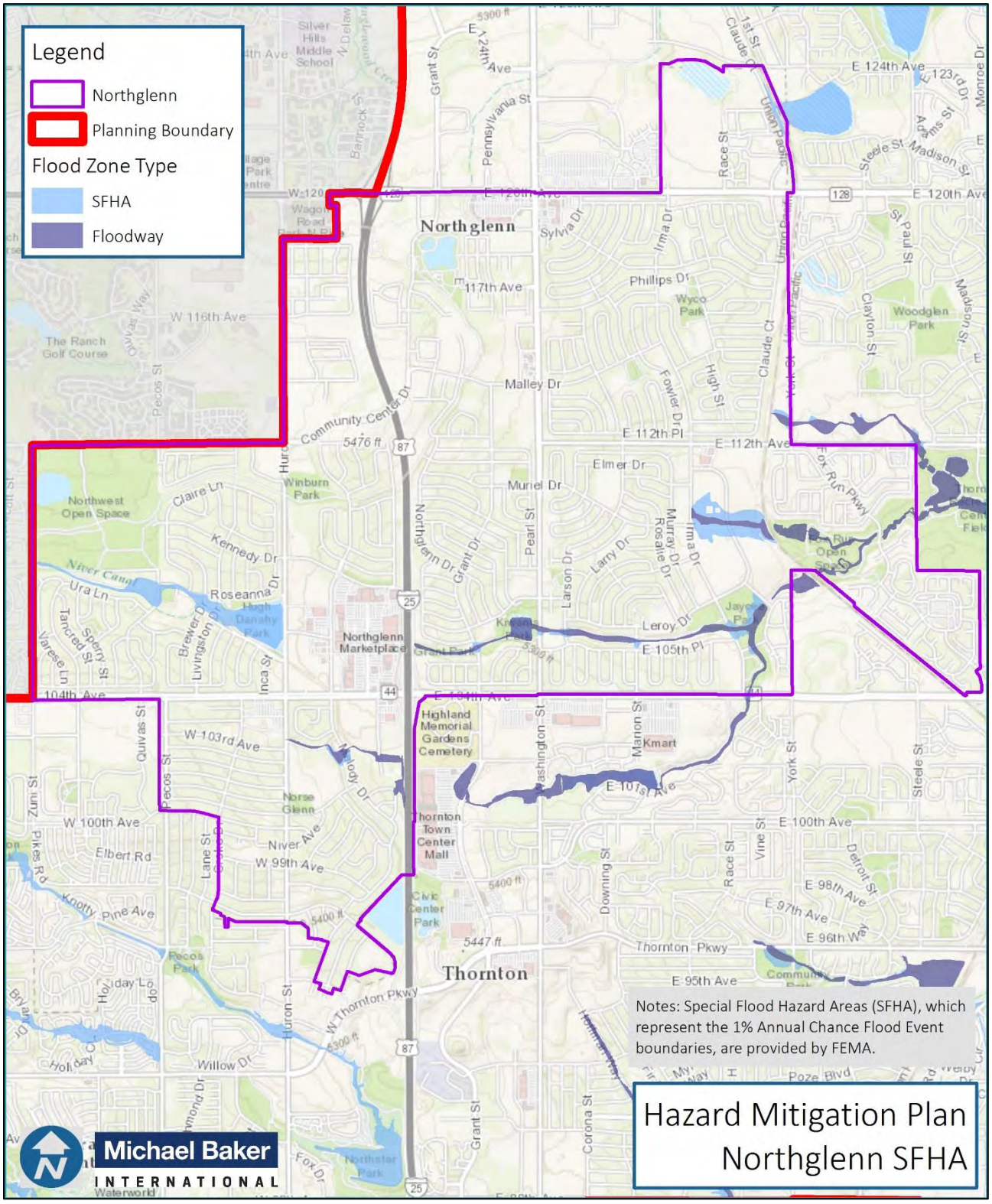
According to NOAA's NCEI Storm Events Database there have been no reported injuries, deaths, property loss, or crop damage in the City of Northglenn caused by flooding. On August 17, 2000 there was one reported death caused by flooding in the west central portion of Adams County. Based on the Adams County Flood Insurance Study, Northglenn mainly sees flooding due to cloudbursts during May through August. Although historic documentation is sparse, local streams are known to cause overland inundation of homes and streets (no discharge or damage estimates have been recorded).

A significant flooding event occurred from September 12-16 (2013) when nearly 6-18 inches of rain fell across Colorado's Front Range and I-25 corridor. Northglenn's close proximity to bodies of water have made the community susceptible to flood hazards. Population and development increases have also increased the community's risk for flood damage as urbanization increases runoff two to six times over what would occur on natural terrain. Based on the historic data showing hazardous impacts on the district and the community's expected growth, there is great potential for future flooding events to occur at any given time.

There are currently no NFIP Repetitive Loss (RL) or Severe Repetitive Loss (SRL) structures in the City.

[46] http://www.ext.colostate.edu/pubs/consumer/09952.html

FIGURE 64. NORTHGLENN SPECIAL FLOOD HAZARD AREA



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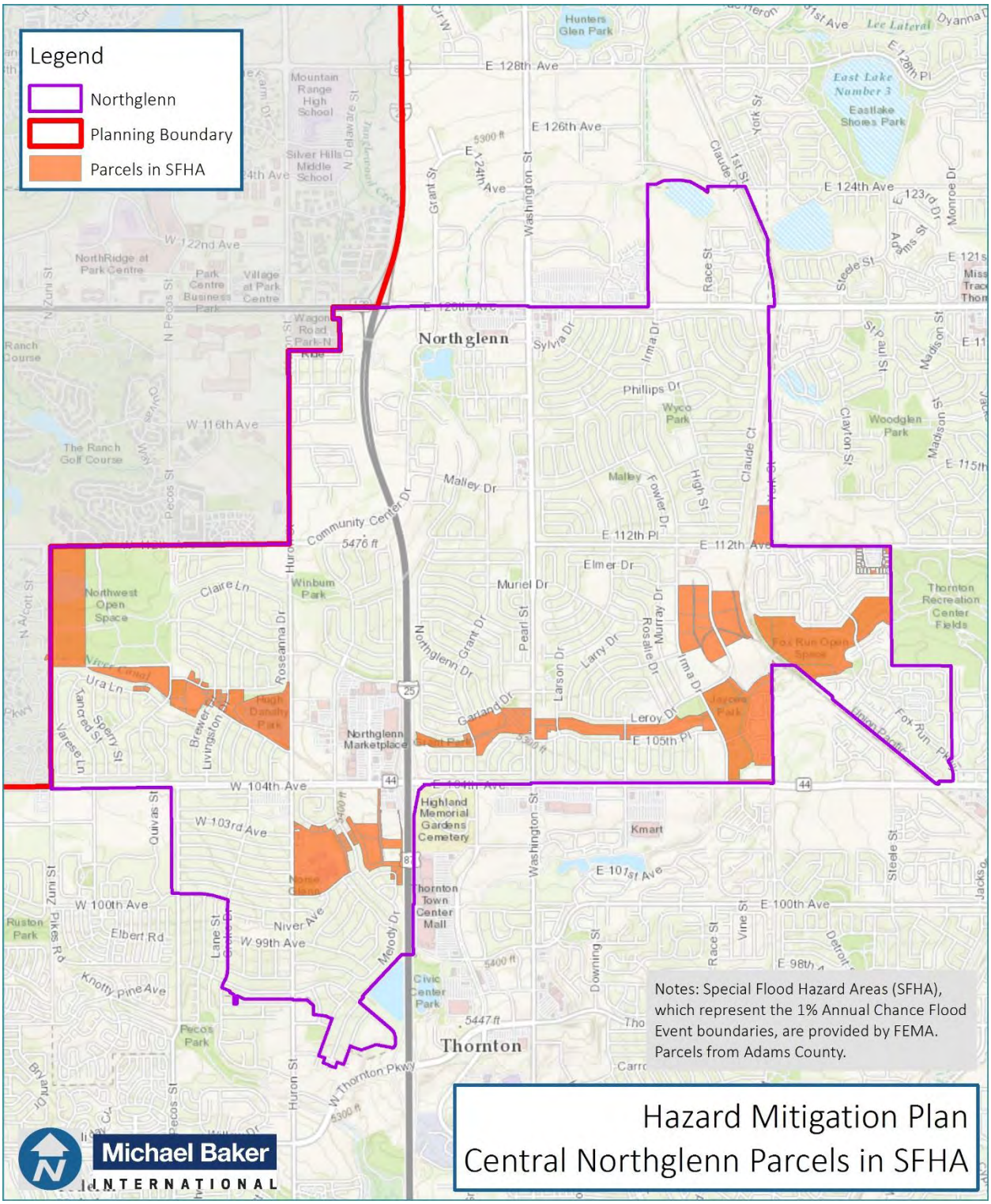
Inventory Exposed

There are 110 parcels, which include 173 structures/units, located within or near the SFHA and the improved value of those is estimated to be over $33 million. The following figure shows these parcels located in the SFHA.

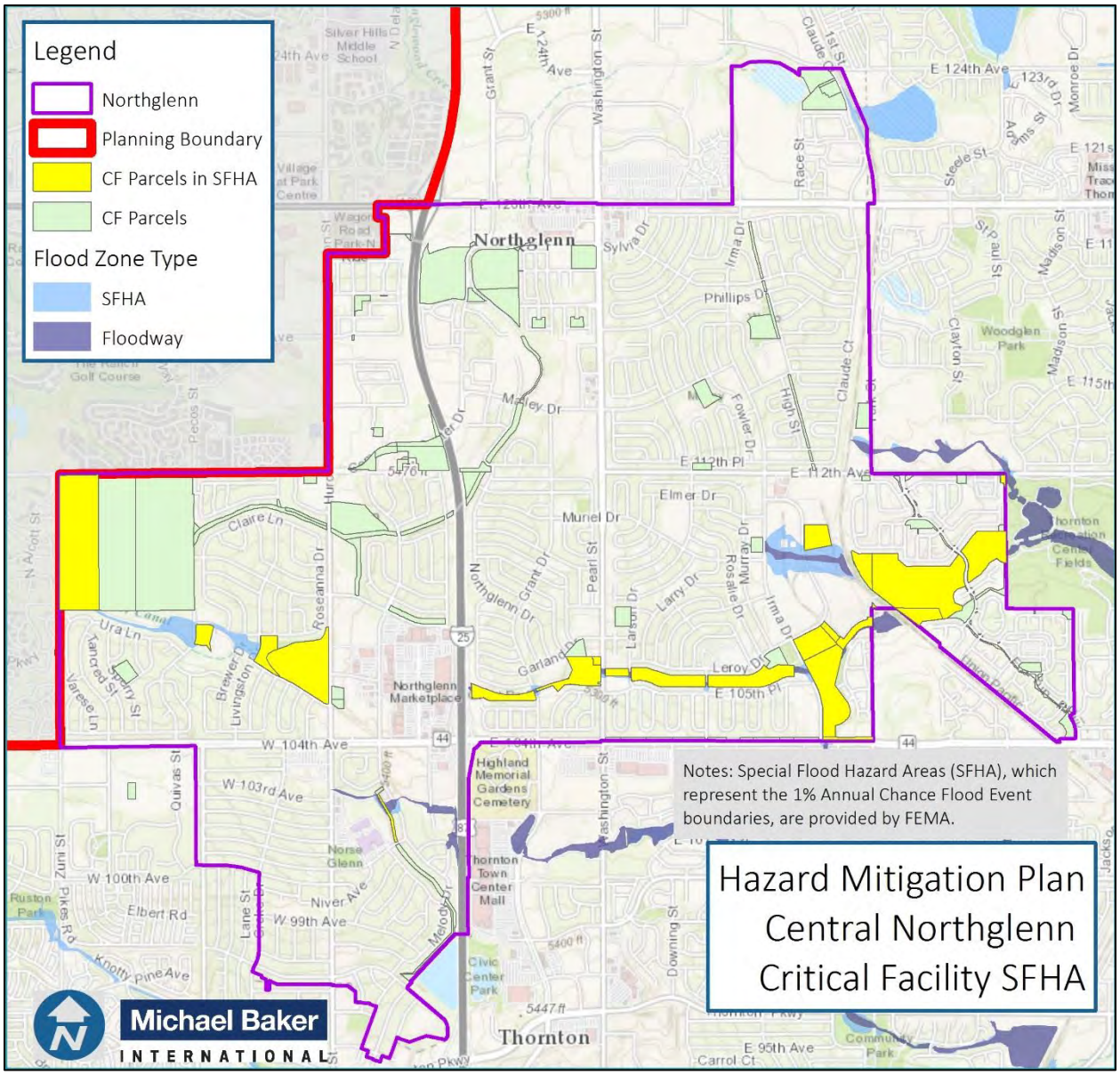
Critical facilities are essential to the health and welfare of the whole population and are especially important both during and after hazard events. Critical structures or areas that overlap or touch the SFHA are considered "flood prone." The critical facility and structure exposure analysis estimates that there are 21 critical facility parcels in or near the SFHA (not including the total miles of flood prone infrastructure). These parcels contain 26 structures whose appraised value is over $15 million. The second following figure represents the critical facilities located in or within close proximity to the SFHA and floodway planning area.

FIGURE 65. NORTHGLENN PARCELS IN THE SFHA



City of Thornton Northglenn Federal Heights

Figure 66. Northglenn Critical Facilities in the Special Flood Hazard Area



Potential Losses

The methodology used to determine potential losses to flooding was conducted using FEMA's Hazus loss estimation software. For this Plan, a 100-year flood scenario was modeled for the City. The results are presented below.

Hazus 100-Year Flood Scenario

In addition to the SFHA boundaries, the flood risk analysis for this Plan integrates DFIRM depth grids, a digital dataset that shows flood depths at various locations within the floodplain. This enhanced data input

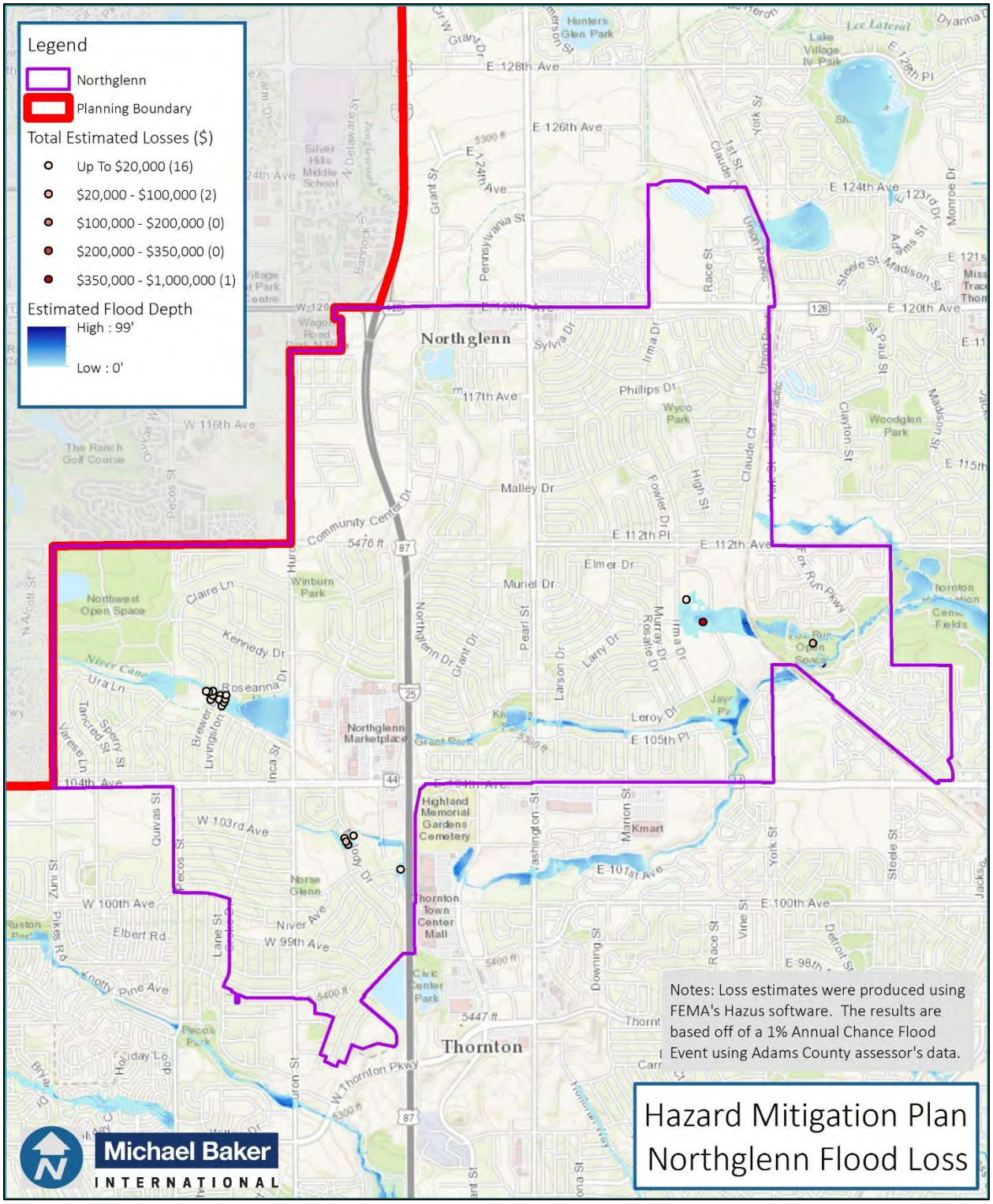
allows Hazus to more accurately approximate floodplain boundaries and their associated flood depths for a 100-year flood event.

Hazus is a national loss estimation model developed by FEMA and the National Institute of Building Science. The primary purpose of Hazus is to provide a methodology and software application to develop flood and earthquake loss at a regional scale. There are two types of Hazus analyses, standard and enhanced. A standard Hazus analysis requires no specialized knowledge on the part of the user and leverages the default inventory, hazard, and engineering (damage function) data present in the program. This is also known as an "out of the box" or Level 1 analysis. An enhanced analysis requires the user to have localized knowledge and data in order to provide updated inventory, hazard and/or engineering (damage function) data that overwrites the default data present in the program. Historically, this has been known as a Level 2 (inventory or hazard updates) or Level 3 (engineering updates) Hazus analysis.

Utilizing Hazus 3.0, FEMA's loss estimation and hazard modeling software, a detailed flood analysis was conducted for structures within Adams County, specifically around the City of Northglenn. The risk assessment leveraged locally managed parcel inventory as well as Light Imaging, Detection, And Ranging (LiDAR) terrain data. A project area Digital Elevation Model was created using this terrain data, also used in the flood analysis was a 100 year flood Depth Grid derived from FEMA's National Flood Hazard Layer (NFHL) data. In addition to these custom datasets we also created User Defined Structures (UDS points) for all parcels that were impacted by the FEMA effective floodplains. The Hazus analysis was then performed at every one these locations to estimate the flood damages associated with the impacted structures.

A 100-year flood scenario was defined in Hazus and losses were calculated for each point that intersected the depth grid based on the Hazus depth damage curves for specific structure attributes (such as foundation type, building type, and first flood height). The map below shows the results of the Hazus 100-year flood scenario economic loss analysis for the City of Northglenn.

FIGURE 67. NORTHGLENN FLOOD LOSS MAP



City of Thornton Northglenn Federal Heights

The map of total building losses illustrates a clear loss pattern in which damages are clustered around existing bodies of water and streams where there are structures nearby. These places represent areas where resources and people are concentrated, making those areas of high potential loss and clear priority areas for focused mitigation action.

Hazus estimates for the City of Northglenn estimate that for a 100-year flood event, approximately 19 buildings will be damaged. The total economic loss estimated for the 100-year flood is over $500,000. A number of variables are included in Hazus analyses in order to arrive at the estimated values of loss due to flooding. For this reason, it is important to note that the Hazus loss estimates should not be used as a precise measure, but rather viewed from the perspective of the potential magnitudes of expected losses.

Probability of Future Occurrences

Frequency of previously reported flood events in the City of Northglenn provide an acceptable framework for determining the probability of future flood occurrence in the area. The probability that the city will experience a flood event can be difficult to predict or quantify, but it is expected that localized flooding will be experienced yearly.

Severe flooding has the potential to inflict significant damage to people and property in the district. Mitigating flood damage requires that communities remain diligent and notify local officials of potential flood (and flash flood) prone areas near infrastructure such as roads, bridges, and buildings.

Land Use and Development

As population continues to increase in the Denver metro region and potentially in Northglenn, future development trajectories can be expected to put more people and property (both private and public) at risk of flooding. It is essential that zoning and land use plans take into account not only the dollar amount of damage that buildings near waterways could incur, but also the added risk of floodplain development activity that alters the natural floodplain of the area (for example, narrowing the floodplains by building new structures close to rivers and streams). The city should plan for the likelihood of increased exposure of property and humans to flood events.

Existing floodplain management ordinances are intended to address methods and practices to minimize flood damage to new and substantial home improvement projects as well as to address zoning and subdivision ordinances and state regulations. Currently, Northglenn is a National Flood Insurance Program (NFIP) participant and continues to support floodplain management activity at the local scale.

The greatest protection against flooding is afforded by quality construction and compliance with local ordinances which exceed NFIP requirements. Code adoption by local jurisdictions, compliance by builders, and local government inspection of new homes can greatly reduce the risk of flooding. Moving forward, Northglenn will continue to support monitoring, analysis, modeling, and the development of decision-support systems and geographic information applications for floodplain management activities.

In addition to land-use planning, zoning, and codes applicable to new development, flood mitigation measures include structural and non-structural measures to address susceptibility of existing structures. Flood mitigation measures such as acquisition, relocation, elevation-in-place, wet/dry flood proofing, and enhanced storm drainage systems all have the potential to effectively reduce the impact of flood in Northglenn.

Severe Storm

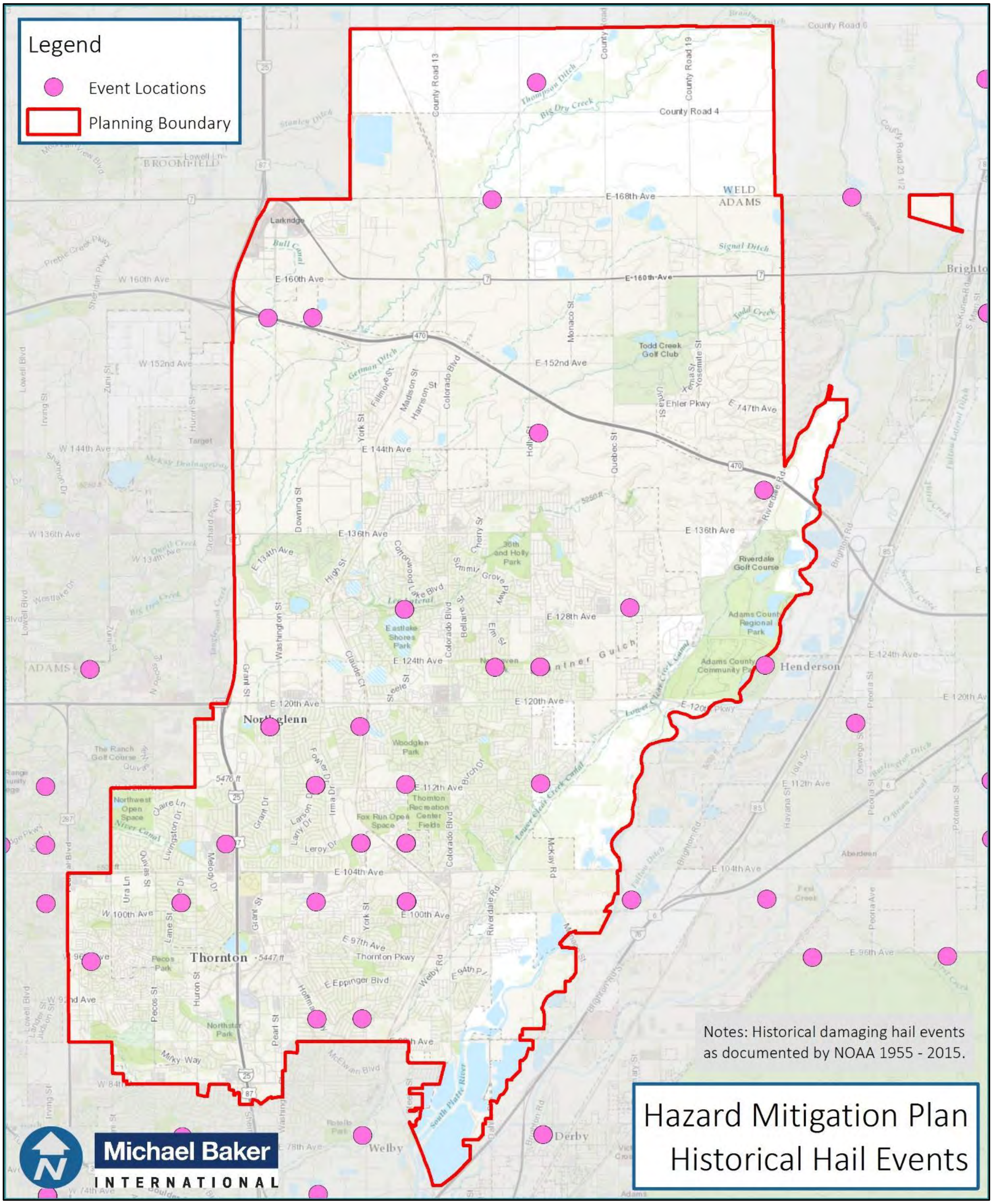
Spring and summer weather can often be unpredictable in the Denver metro region; sometimes producing significant hail and lightning events. Damage due to these events has risen over the years and can be expected to steadily increase and further put communities at risk.

Previous Occurrences

Hail

According to the 2010 Denver Metro Natural Hazard Mitigation Plan, Northglenn has seen 8 major hail events from 1955-2007 with no injuries or fatalities (NHMP, pg. 52). Additional data detailed that between 1955 and 2014, there were 125 hail events within Adams County. One of those events caused property damage of approximately $120 million, although there were no reported injuries or deaths during this time period. Weld County had 737 hail events with no deaths or injuries. Over $10 million in property damage and over $30 million in crop damage was seen because of these numerous hail storms. Within the Denver region, there has been extensive hail damage to crops, roofs and automobiles. On July 11, 1990, the Front Range experienced three hours of hailstones the size of marbles to tennis balls. The damage from this totaled more than $600 million, mostly affecting roofs and automobiles (NHMP, pg. 50). Historic data shows that hail hazards occur in areas that are within close proximity to the tri-city planning area. Therefore, these planning area communities should be prepared for future hail events.

Figure 68. Historical Hail Events within the Planning Area



City of Thornton Northglenn Federal Heights

Lightning

Lightning is a leading hazard in Colorado, which ranks 11th in the U.S. in both injuries and deaths (NHMP, pg. 58). No historic data shows hazardous impacts on Northglenn specifically, but there is great potential for lightning to occur at any given time. While lightning losses are often quantified, the best available data sources included the following information for Adams County between 1950 and 2015 (Weld County data was not available).

TABLE 52. LIGHTNING EVENTS FOR ADAMS COUNTY: 1950-2015

County	Number of Recorded Events	Injuries	Fatalities	Property Damage
Adams	19	3	2	$391,000

Source: NOAA, NCEI Storm Events Database

Inventory Exposed

All assets located in the City of Northglenn can be considered at risk from severe storms. This includes 35,789 people, or 100% of the city's population and all buildings and infrastructure within the city. Damages primarily occur as a result of high winds, lightning strikes, hail, snow-loading, and flooding. Most structures, including the city's critical facilities, should be able to provide adequate protection from hail but the structures could suffer broken windows and dented exteriors. Those facilities with back-up generators are better equipped to handle severe weather situations should the power go out.

Inventory assets exposed to severe wind are dependent on the age of the building, type, construction material used, and condition of the structure. Possible losses to critical infrastructure include:

- Electric power disruption
- Communication disruption
- Water and fuel shortages
- Road closures
- Damaged infrastructure components, such as sewer lift stations and treatment plants
- Damage to homes, structures, and shelters

Potential Losses

Severe storms affect the entire planning area of the City of Northglenn including all above-ground structures and infrastructure. Although losses to structures are typically minimal and covered by insurance, there can be impacts with lost time, maintenance costs, and contents within structures. A timely forecast may not be able to mitigate the property loss, but could reduce the casualties and associated injuries.

It appears possible to forecast these extreme events with some skill, but further research needs to be done to test the existing hypothesis about the interaction between the convective storm and its environment that produces the extensive swath of high winds. Severe storms will remain a highly likely occurrence for the City of Northglenn. It is likely that lightning and hail will also be experienced in the area due to such storms.

Probability of Future Occurrences

Severe storms can be predicted with a reasonable level of certainty. Through the identification of various indicators of weather systems, and by tracking these indicators, warning time for severe storms can be as much as a week in advance. Understanding the historical frequency, duration, and spatial extent of severe weather assists in determining the likelihood and potential severity of future occurrences. The characteristics of past severe events provide benchmarks for projecting similar conditions into the future. The probability that the City of Northglenn will experience a severe storm event can be difficult to quantify. However, based on historical records and frequencies there is nearly a 100% chance this type of event will occur somewhere in the City of Northglenn at least once every year.

Land Use and Development

All future structures built in the City of Northglenn will likely be exposed to severe weather extremes and damage. Since the previous statement is assumed to be uniform to the tri-city planning area, the location of development does not increase or reduce the risk necessarily. Northglenn must adhere to building codes, and development should be built to current standards in case of adverse weather

Winter Storm

Winter storms impact communities on every level and are a fairly typical occurrence for communities within the planning area. Although most communities are well-equipped to prepare for this hazard, storms have increased in recent years and more mitigation measures can created for future events.

Previous Occurrences

According to the NOAA's NCEI Storm Events Database, Adams County has experienced 64 Winter Storms since 1996 and Weld County has experienced 67. On December 28, 2006, Weld County saw the most extensive property damage of over $100,000 and no deaths or injuries. Based on historical data, it is certain that Northglenn is at risk of experiencing, and being impacted by, winter storms in the coming years.

Inventory Exposed

All assets located in the City of Northglenn can be considered at risk from winter storms. This includes 35,789 people, or 100% of the City's population, and all buildings and infrastructure within the City. Damages primarily occur as a result of high winds and snow-loading. Most structures, including the City's critical facilities, should be able to provide adequate protection from winter storm damage. Those facilities with back-up generators are better equipped to handle a winter storm situation should the power go out.

Potential Losses

Winter storms affect the entire planning area of the City of Northglenn including all above-ground structures and infrastructure. Although losses to structures are typically minimal and covered by insurance, there can be impacts with lost time, maintenance costs, and contents within structures. A timely forecast may not be able to mitigate the property loss, but could reduce the casualties and associated injury.

It appears possible to forecast these extreme events with some skill, but further research needs to be done to test the existing hypothesis about the interaction between the convective storm and its

environment that produces the extensive swath of high winds. Winter storms will remain a highly likely occurrence for the City of Northglenn.

Probability of Future Occurrences

Severe winter storms can be predicted with a reasonable level of certainty. Through the identification of various indicators of weather systems, and by tracking these indicators, warning time for snow storms can be as much as a week in advance. Understanding the historical frequency, duration, and spatial extent of severe winter weather assists in determining the likelihood and potential severity of future occurrences. The characteristics of past severe winter events provide benchmarks for projecting similar conditions into the future. The probability that Northglenn will experience a severe winter storm event can be difficult to quantify. However, based on historical records and frequencies there is nearly a 100% chance of this type of event will occur somewhere in the City of Northglenn at least once every year.

Land Use and Development

All future structures built in the City of Northglenn will likely be exposed to severe weather extremes and damage. Since the previous statement is assumed to be uniform across the region, the location of development does not increase or reduce the risk necessarily. Although, as Northglenn's population and development is expected to grow, the chances of community members and structures being at risk to winter storms will increase. Northglenn must adhere to building codes, and therefore, new development should be built to current standards to account for adverse weather.

Existing Planning Mechanisms

There are numerous existing regulatory and planning mechanisms in place at the city level of government which support hazard mitigation planning efforts. These tools include city subdivision regulations and road and bridge standards, and local zoning regulations. These planning mechanisms were discussed at the Community Interview and Northglenn members of the Hazard Mitigation Planning team were encouraged to review all available technical information available for their City as they worked to develop the risk assessment and their mitigation actions.

Northglenn is a participant in the National Flood Insurance Program (NFIP). Since it entered the program, the city has adopted the minimum NFIP requirements into its Charter and City Code and Ordinances. The city plans to continue compliance with all NFIP requirements in the future.

During the hazard mitigation planning process, the city worked to identify ways in which identified mitigation actions/projects will be incorporated into their existing planning and regulatory mechanisms over time. Moving forward, Northglenn will continue to integrate the goals and actions of this Plan into their evolving local planning mechanisms, including comprehensive plans, capital improvement plans, and resource and land use regulations. They will be incorporated into existing planning mechanisms as they are updated or developed.

This HMP will serve as a source document for risk reduction, policy making, and land use planning. These planning mechanisms will enhance the city's ability to implement the actions outlined in the mitigation plan. Northglenn recently adopted its Emergency Operations Plan, going forward the City wants to ensure

all other emergency management plans are aligned so there is consistency in emergency management execution.

Mitigation Strategy

The intent of the Mitigation Strategy is to provide the participating jurisdictions with the goals that will guide future mitigation policy and project administration. The Mitigation Strategy includes a list of proposed actions deemed necessary to meet those goals and reduce the impact of natural hazards.

Summary of Goals

Mitigation Goals are general guidelines that explain what a community wants to achieve with their local hazard mitigation plan. Goals are overarching targets and describe the ideal long-term outcomes envisioned by the community, which are listed below.

- Protect people, property, and natural resources (N1)
- Improve capability to reduce disaster losses (N2)
- Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens (N3)
- Increase public awareness of natural hazards and mitigation options (N4)

2010 Hazard Mitigation Plan Actions

The HMP small team was tasked with reviewing mitigation projects included in the 2010 Denver Metro NHMP. The City of Northglenn did not adopt the 2010 plan, so there are no past actions to report on.

Recent mitigation projects to highlight include:

- Underpass project and drainage improvements due to the light rail expansion along Grange Hall Creek (flood map revision coordinated with UDFCD)
- Culvert and drainage ditch improvements to Washington Street

2017 Mitigation Actions

As part of the 2017 planning process, the following mitigation projects were identified and developed into MAGs:

Mitigation Action Guide

City or Organization: City of Northglenn **Project Name: (NG1) Drought Communication Outreach**	
PRIORITY: High	**HAZARDS ADDRESSED:** Drought
LOCATION: City of Northglenn	**PLANNING GOALS ADDRESSED:** • N1 – Protect People, property, and natural resources • N2 – Improve capability to reduce disaster losses • N4 – Increase public awareness of natural hazards and mitigation options
RECOMMENDATION DATE: 7/15/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Improve and refine current drought programmatic information for community education and outreach	
ACTION: Update current community outreach public information regarding water conservation measures for defined drought conditions	
LEAD AGENCY: City of Northglenn	**EXPECTED COST:** TBD
SUPPORT AGENCIES: N/A	**POTENTIAL FUNDING SOURCES:**
PROGRESS MILESTONES: Update program, implement education outreach program.	

Mitigation Action Guide

City or Organization: City of Northglenn **Project Name: (NG2) Fire Code Updates**	
PRIORITY: High (High, Med, Low)	**HAZARDS ADDRESSED:** Wildland Fire, Lightning
LOCATION: Citywide	**PLANNING GOALS ADDRESSED:** • N1 – Protect people, property, and natural resources • N2 – Improve capability to reduce disaster losses • N3 - Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens. • N4 – Increase public awareness of natural hazards and mitigation options.
RECOMMENDATION DATE: August 1, 2016	
TARGET COMPLETION DATE: Every six (6) Years	
OBJECTIVES ADDRESSED: **Maintain the latest fire protection standards for the community to protect its citizens and structures.**	
ACTION: Once every six (6) years, adopt the latest edition of the International Fire Code, related codes, and appropriate local amendments.	
LEAD AGENCY: City of Northglenn	**EXPECTED COST:** $2,000 every six (6) years
SUPPORT AGENCIES: None	**POTENTIAL FUNDING SOURCES:** Northglenn General Fund
PROGRESS MILESTONES:	

Mitigation Action Guide

City or Organization: City of Northglenn **Project Name: (NG3) Grange Hall Creek**	
PRIORITY: High	**HAZARDS ADDRESSED:** Flooding & Severe Storm
LOCATION: City of Northglenn	**PLANNING GOALS ADDRESSED:** • N1 – Protect people, property, and natural resources • N2 – Improve capability to reduce disaster losses
RECOMMENDATION DATE: 7/15/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: There are two residential collector streets that are subject to inundation in the 100-year floodplain, that will overtop and/or damage/blow out the ROW improvements and existing utilities.	
ACTION: Improve capacity at both streets to accommodate 100-year event; channel improvements between Washington St and Irma Dr. for increased conveyance.	
LEAD AGENCY: City of Northglenn	**EXPECTED COST:** $ 2.6 million
SUPPORT AGENCIES: Urban Drainage and Flood Control District	**POTENTIAL FUNDING SOURCES:** City of Northglenn & UDFCD
PROGRESS MILESTONES: Preliminary design; final design; begin construction.	

Mitigation Action Guide

City or Organization: City of Northglenn **Project Name: (NG4) Winter Storm Communication Outreach**	
PRIORITY: High	**HAZARDS ADDRESSED:** **Winter Storm**
LOCATION: City of Northglenn	**PLANNING GOALS ADDRESSED:** • N1 – Protect people, property, and natural resources • N2 – Improve capability to reduce disaster losses • N3 – Strengthen communication and coordination among public agencies, NGOs, businesses, and citizens • N4 – Increase public awareness of natural hazards and mitigation options
RECOMMENDATION DATE: 7/15/2016	
TARGET COMPLETION DATE: TBD	
OBJECTIVES ADDRESSED: Maintain current public information efforts related for winter storm and severe weather conditions	
ACTION: The City current employs an extensive outreach program focused on notification of server weather events, snow routes, and winter weatherization efforts on an annual basis. This is accomplished through news letters, mailers, social media, and municipal cable access channel	
LEAD AGENCY: City of Northglenn	**EXPECTED COST:** N/A
SUPPORT AGENCIES: N/A	**POTENTIAL FUNDING SOURCES:**
PROGRESS MILESTONES: Continue to maintain current levels of service for outreach and education.	

Mitigation Action Guide

City or Organization: City of Northglenn **Project Name: (NG5) Building Code Updates**	
PRIORITY: Medium	**HAZARDS ADDRESSED:** Flood, Severe Storms, Tornado/Severe Wind, Earthquake, Extreme Temperatures, Expansive Soils/Undermined Areas, and Winter Storms.
LOCATION: City of Northglenn RECOMMENDATION DATE: 07/15/2016 TARGET COMPLETION DATE: Ongoing – Every six (6) years.	**PLANNING GOALS ADDRESSED:** • N1 – Protect people, property, and natural resources • N2 – Improve capability to reduce disaster losses • N4 – Increase public awareness of natural hazards and mitigation options
OBJECTIVES ADDRESSED: Updating Northglenn's building codes every six (6) years to the most recent version of the international building codes (and related codes) serves to maintain the highest level of protection in new structures.	
ACTION: Update International Building Codes to the most recent edition of the International Building Code and related documents, and make appropriate local amendments.	
LEAD AGENCY: City of Northglenn	**EXPECTED COST:** $18,000 every six (6) years.
SUPPORT AGENCIES: None	**POTENTIAL FUNDING SOURCES:** City of Northglenn FEMA
PROGRESS MILESTONES: Budget appropriately for future updates.	

Strategy Implementation and Plan Maintenance

Having a plan for monitoring, evaluating, maintaining, and implementing this HMP is critical to maintaining its value and success. Ensuring effective implementation of mitigation activities paves the way for continued momentum in the planning process and gives direction for the future. This section explains who will be responsible for maintenance activities and what those responsibilities entail. It also provides a methodology and schedule of maintenance activities including a description of how the public will be involved on a continual basis.

The City of Northglenn's Council has authorized the submission of this Plan to both the Colorado Division of Homeland Security and Emergency Management (DHSEM) and the Federal Emergency Management Agency (FEMA) for their respective reviews and subsequent approvals. Upon state and federal approval, the City will act to formally adopt this plan.

Plan Integration, Existing Capabilities and Resources

The City of Northglenn plans to integrate this HMP in a number of ways. The City is planning to update its Zoning Ordinance in 2017 and will incorporate relevant findings of this HMP into that process.

The following capability assessment examines the ability of Northglenn to implement and manage the comprehensive mitigation strategy laid out in this Plan. The strengths, weaknesses, and resources of the City are identified here as a means for evaluating and maintaining effective and appropriate management of the town's hazard mitigation program.

Local Personnel

The ability of a community to implement a comprehensive mitigation strategy depends, in part, on available resources, including people and staff. The table below outlines the participating community's capabilities as they relate to key personnel.

TABLE 53. NORTHGLENN'S KEY PERSONNEL

Title	Full Time	Part Time	None or Not-Identified
Emergency Manager		X	
Floodplain Administrator		X	
Community Planner	X		
GIS Specialist	X		
Grant Writer*		X	

**Northglenn does not have a full-time Grant Writer, but several city staff (from Parks, Public Works, Planning, Finance, and Economic Development) are responsible for grant writing. Under the Emergency Operations Plan there are designated staff for these grant writing efforts.*

Land Use Planning and Codes

Local land use plans and building codes are tremendous tools for evaluating local policies related to hazard mitigation and risk reduction. Additionally, comprehensive master plans, capital improvement plans, stormwater plans and zoning ordinances all present opportunities for enhanced local capabilities. The

table below outlines the participating community's current capabilities as they relate to land use plans ordinances and codes.

TABLE 54. NORTHGLENN'S CURRENT ORDINANCES OR CODES

Land Use Planning or Codes	Adopted
Zoning Ordinance	Y
Hazard-Specific Ordinance	Y
Local Building Codes	Y
Comprehensive Plan/Master Plan	Y
Capital Improvements Plan	Y
Stormwater Plan	Y
Continuity of Operations Plan (COOP)	N
Emergency Operations Plan (EOP)	Y
Long-Term Recovery Plan	N
Participates in NFIP	Y

Plan Maintenance and Resources

As this is Northglenn's first HMP, the City did not have any maintenance activities to report on.

The City of Northglenn will actively maintain the 2017 Thornton, Federal Heights, and Northglenn Hazard Mitigation Plan by coordinating an annual review across City departments of all mitigation actions included in the 2017 HMP. This process will be led by the City's Emergency Manager. The annual review will align with the newly Adopted Emergency Operations Plan so that the two plans are aligned. This resulting information will be reported to the public during a publically held meeting and citizens will be invited to participate and share ideas for new mitigation projects to consider implementing.

The following table shows records of Northglenn's annual maintenance, for every year up until its five-year expiration date.

TABLE 55. CITY OF NORTHGLENN HMP MAINTENANCE TABLE

Review Year	City Department	Name of Representative	Signature of Representative
2018			
2019			
2020			
2021			
2022			

Appendix D – Meeting Agendas & Sign-In Sheets

Local Hazard Mitigation Plan
For the Cities of Thornton, Northglenn, and Federal Heights

Kickoff Meeting Agenda
Thornton City Hall, City Development Conference Room D
Wednesday, October 14, 2015 9:30AM

I. Welcome
- A. Jeff Coder, Deputy City Manager of City Development
- B. Glenda Lainis, Policy Planning Manager

II. Introductions
- A. Michael Baker Team
- B. City Representatives – Thornton, Northglenn, Federal Heights

III. Working Together Effectively – Standards of Participation
- A. Billing and Payment
- B. Communication expectations and preferences
- C. Meeting planning, preparation, and leadership
- D. Senior management updates/direction
- E. Council planning sessions and meetings
- F. Other considerations

IV. Project Timeline
- A. Update project schedule to accomplish the following:
  1. Approved Pending Adoption (APA) status by October 2016
  2. All three cities adopt the plan by November 2016
- B. Next steps and task assignments

V. Determining the Planning Area
- A. Entirety of existing three city's incorporated areas
- B. Areas likely to be annexed in the next decade
- C. Growth area of each city
- D. Additional area that may be prudent to include due to range or influence of hazards
- E. Other considerations
- F. Next steps and task assignments

VI. Existing Resources of Each City
- A. GIS / mapping information
- B. History of hazards
- C. Comprehensive, regional, master, and other relevant planning documents
- D. Existing ordinances, resolutions, processes, capabilities, ratings, etc.
- E. Next steps and task assignments

VII. Planning Team Development
- A. Defining the Planning Team
  1. Number of members
  2. Organizational / departmental representation
- B. Roles and Responsibilities of the Planning Team
- C. Communication with the Planning Team
- D. Planning Team meeting schedule
- E. Next steps and task assignments

City of Thornton Northglenn Federal Heights

VIII. Stakeholder Group Development
- A. Defining the Stakeholder Group
  - 1. Number of members
  - 2. Organizational / departmental representation
- B. Roles and Responsibilities of the Stakeholder Group
- C. Communication with the Stakeholder Group
- D. Stakeholder Group meeting schedule
- E. Next steps and task assignments

IX. Outreach and Public Input
- A. Project website
- B. Outreach strategy ideas
- C. Public information gathering concepts
- D. Action Steps and Task Assignments

X. Next Meeting

Project Participants and Contact Information

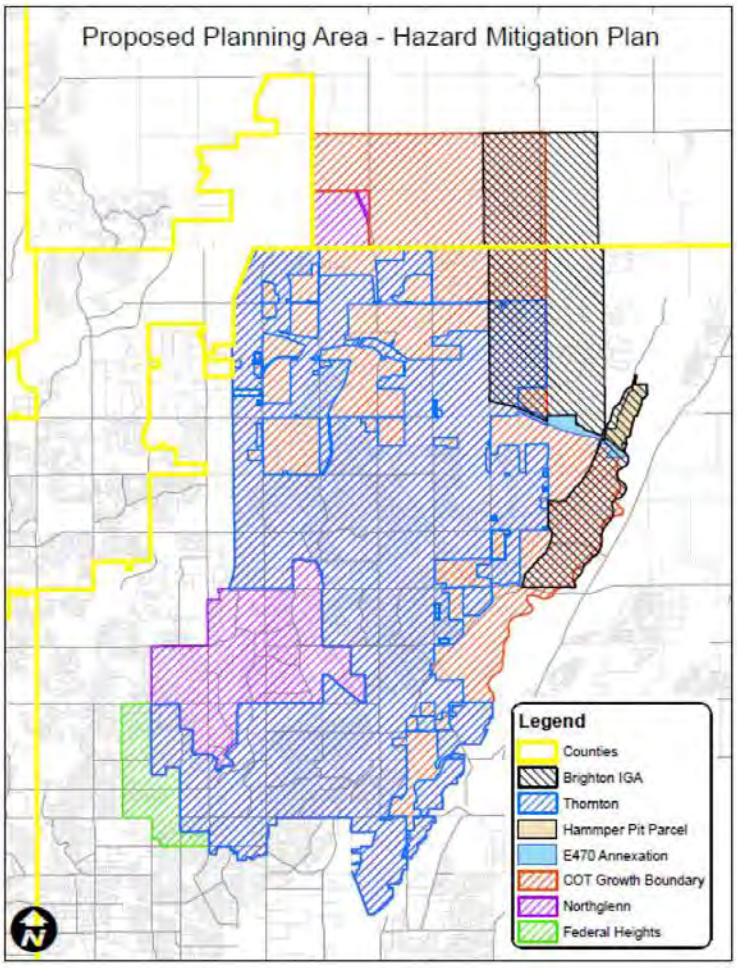
Mike Garner, Community Planning & Design Lead, Michael Baker International, 720-514-1105, mgarner@mbakerintl.com
Enessa Janes, Planner II, Michael Baker International, 720-479-3162, enessa.janes@mbakerintl.com

Jeff Coder, Deputy City Manager of City Development, City of Thornton, 303-538-7606, jeff.coder@cityofthornton.net
Glenda Lainis, Policy Planning Manager, City of Thornton, 303-538-7438, glenda.lainis@cityofthornton.net
Martin Postma, Senior Policy Analyst, City of Thornton, 303-538-7631, martin.postma@cityofthornton.net
Margaret Carew, GIS Analyst II, City of Thornton, 303-538-7611, margaret.carew@cityofthornton.net
Jim Kaiser, Senior Civil Engineer, Floodplain Manager, City of Thornton, 720-977-6266, jim.kaiser@cityofthornton.net
Ryan Doyle, Emergency and Safety Administrator, City of Thornton, 303-538-7586, ryan.doyle@cityofthornton.net
Dennis Laurita, Contract Administrator, City of Thornton, 303-538-7649, dennis.laurita@cityofthornton.net
JoAnn Koenig, Senior Accountant, City of Thornton, 303-538-7362, joann.koenig@cityofthornton.net

Brook Svoboda, Director of Planning and Development, City of Northglenn, 303-450-8937, bsvoboda@northglenn.org
Scott Myers, Finance Director, City of Federal Heights, 303-412-3531, smyers@fedheights.org

Martin Postma <Martin.Postma@cityofthornton.net>; Glenda Lainis <Glenda.Lainis@cityofthornton.net>; Margaret Carew <Margaret.Carew@cityofthornton.net>; Jim Kaiser <Jim.Kaiser@cityofthornton.net>; Ryan Doyle <Ryan.Doyle@cityofthornton.net>; smyers@fedheights.org; bsvoboda@northglenn.org

Mike Garner & Enessa Janes



December 2, 2015
Hazard Mitigation Planning Meeting

Hazards to Profile in the 2016 Hazard Mitigation Plan

2010 Denver Regional Natural Hazard Mitigation Plan	2013 Colorado Natural Hazards Mitigation Plan	2016 Thornton, Northglenn, Federal Heights Multi Hazard Mitigation Plan
Avalanche	Avalanche	Drought
Drought	Drought	Earthquake
Earthquake	Earthquake	Extreme Temperatures (Heat / Cold)
Flood	Erosion and Deposition	Flood (including mention of stream erosion and deposition, dam failure, levee failure)
Hail	Expansive Soils	Expansive Soils / Undermined Areas
Heat Wave	Extreme Heat	Severe Storms (Hail, Lightning)
Landslide	Flood	Public Health Hazards (including invasive species and pests)
Land Subsidence	Hail	Tornado + Severe Wind (including downbursts/microbursts)
Thunderstorm and Lightning	Landslide, Mud/Debris Flow, Rockfall	Winter Storm
Tornado	Lightning	Wildland Fire
Severe Storm and Wind	Pest Infestation	
Winter Storm and Freezing	Severe Wind	
Wildfire	Subsidence	
Public Health Hazards	Tornado	
	Winter Storm	
	Wildfire	

Michael Baker INTERNATIONAL

Agenda

2016 Local Hazard Mitigation Plan – Community Interview

The City of Federal Heights
January 20th, 2016

Hazard Mitigation: *Sustained action taken to reduce or eliminate long-term risk to people and property from hazards and their effects.*

Goals for the 2016 Local Hazard Mitigation Plan

Mitigation Goals: *General guidelines that explain what you want to achieve with the plan* (see handout)

Thinking about the Past

1. Progress on Federal Heights' previous mitigation actions (see handout)
2. 5-Year Plan Review
3. Historical hazard/disaster events

Local Capabilities and Critical Facilities

Capabilities and Resources:

1. Available Staff (Full Time, Part Time, None)
2. Participation in the NFIP and CRS
3. Adoption of mitigation/hazard related plans, codes, and/or ordinances
4. Experience applying for grants and other mitigation-related funding mechanisms?

Critical Facilities:

1. What are the city's "critical facilities" and how will they be included (or excluded) from the 2016 Plan?

Working with the Public

1. Identifying special-needs and socially vulnerable community members/groups
2. Public engagement and stakeholder outreach strategies

Keeping the Plan Current

1. Integrating Hazard Mitigation into other city planning efforts
2. Developing a plan implementation strategy

Hazard Risk Analysis/Understanding Your Hazard Risk

1. Based on your knowledge of Federal Heights, how would you categorize the hazards profiled in the 2016 Plan in terms of high, medium, or low risk? (see handout)

165 S. Union Blvd., Suite 200 | Lakewood CO 80228 | T 720 514 1100

City of Thornton Northglenn Federal Heights

Michael Baker INTERNATIONAL

Sign-In Sheet

2016 Thornton, Northglenn, Federal Heights Multi-Hazard Mitigation Plan
Federal Heights Community Interview
January 20th, 2016

Name	Department	Email or Phone
Tim Williams	Community Development	twilliams@fedheights.org
Sean Ellis	Fire	sellis@fedheights.org
Patti Lowell	City Clerk	plowell@fedheights.org
KARL WILMES	POLICE	KWilmes@FEDHEIGHTS.ORG
Scott Myers	Finance	smyers@fedheights.org
DON STAHURSKI	PUBLIC WORKS	dstahurski@fedheights.org
MIKE GARNER	MBI	
Enessa Jones	MBI	

Michael Baker INTERNATIONAL

Agenda

2016 Local Hazard Mitigation Plan – Community Interview

The City of Northglenn
January 22nd, 2016

Hazard Mitigation: *Sustained action taken to reduce or eliminate long-term risk to people and property from hazards and their effects.*

Goals for the 2016 Local Hazard Mitigation Plan

Mitigation Goals: *General guidelines that explain what you want to achieve with the plan* (see handout)

Thinking about the Past

1. Historical hazard/disaster events
2. Completed/Ongoing hazard risk reduction projects

Local Capabilities and Critical Facilities

Capabilities and Resources:

1. Available Staff (Full Time, Part Time, None)
2. Participation in the NFIP and CRS
3. Adoption of mitigation/hazard related plans, codes, and/or ordinances
4. Experience applying for grants and other mitigation-related funding mechanisms?

Critical Facilities:

1. What are the city's "critical facilities" and how will they be included (or excluded) from the 2016 Plan?

Working with the Public

1. Identifying special-needs and socially vulnerable community members/groups
2. Public engagement and stakeholder outreach strategies

Keeping the Plan Current

1. Integrating Hazard Mitigation into other city planning efforts
2. Developing a plan implementation strategy

Hazard Risk Analysis/Understanding Your Hazard Risk

1. Based on your knowledge of Northglenn, how would you categorize the hazards profiled in the 2016 Plan in terms of high, medium, or low risk? (see handout)

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City of Thornton Northglenn Federal Heights

Michael Baker INTERNATIONAL

Sign-In Sheet

2016 Thornton, Northglenn, Federal Heights Multi-Hazard Mitigation Plan
Northglenn Community Interview
January 22nd, 2016

Name	Department	Email or Phone
STEVE GRACE	PUBLIC WORKS	sgrace@northglenn.org
David Willett	Public Works	dwillett@northglenn.org
[illegible]	PLANNING	
MIKE GARVER	MBI	
Enessa Janes	MBI	
Ron Osgood	Police	rosgood@northglenn.org

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City of Thornton Northglenn Federal Heights

Michael Baker INTERNATIONAL

Agenda

2016 Local Hazard Mitigation Plan – Community Interview

The City of Thornton
February 15th, 2016

Hazard Mitigation: *Sustained action taken to reduce or eliminate long-term risk to people and property from hazards and their effects.*

Goals for the 2016 Local Hazard Mitigation Plan

Mitigation Goals: *General guidelines that explain what you want to achieve with the plan* (see handout)

Thinking about the Past

1. Progress on Thornton's previous mitigation actions (see handout)
2. 5-Year Plan Review
3. Historical hazard/disaster events

Local Capabilities and Critical Facilities

Capabilities and Resources:

1. Available Staff (Full Time, Part Time, None)
2. Participation in the NFIP and CRS
3. Adoption of mitigation/hazard related plans, codes, and/or ordinances
4. Experience applying for grants and other mitigation-related funding mechanisms?

Critical Facilities:

1. What are the city's "critical facilities" and how will they be included (or excluded) from the 2016 Plan?

Working with the Public

1. Identifying special-needs and socially vulnerable community members/groups
2. Public engagement and stakeholder outreach strategies

Keeping the Plan Current

1. Integrating Hazard Mitigation into other city planning efforts
2. Developing a plan implementation strategy

Hazard Risk Analysis/Understanding Your Hazard Risk

1. Based on your knowledge of Thornton, how would you categorize the hazards profiled in the 2016 Plan in terms of high, medium, or low risk? (see handout)

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City of Thornton Northglenn Federal Heights

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Sign-In Sheet

2016 Thornton, Northglenn, Federal Heights Multi-Hazard Mitigation Plan
Thornton Community Interview
February 3rd, 2016

Name	Department	Email or Phone
Lisa Ranalli	Com. Services	lisa.ranalli@cityofthornton.net
Martin Bethea	City Dev / Policy Planning	303-538-7631
Robin Brown	City Dev / Neighb. Svcs Code Comp.	303-538-7579
Margaret Chacon	CityDev/	303-538-7611
Todd Barnes	Communications	303-538-7279
Robb Kolstad	City Manager's office	303.538.7693
Lane Smyth	City Dev/Neighborhood Svcs	303-538-7296
Glenda Laiti's	CityDev / Policy Planning	303-538-7438

Michael Baker INTERNATIONAL

Sign-In Sheet

2016 Thornton, Northglenn, Federal Heights Multi-Hazard Mitigation Plan
Thornton Community Interview
February 15th, 2016

Name	Department	Email or Phone
Ryan Doyle	Thornton OEM	ryan.doyle@cityofthornton.net 303-538-7586
Steve Kelley	Thornton Fire	stephen.kelley@cityofthornton.net 303-538-7276
Ralph Mitchell	Utilities Ops	ralph.mitchell@cityofthornton.net 720-977-6227
MARTIN POSMA	City Dev.	3-538-7631
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MARGHRET CAREW	City Dev GIS	margaretcarew@cityofthornton.net 303-538-7611

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We Make a Difference

Thornton, Federal Heights, and Northglenn 2016 Multi-Jurisdictional Hazard Mitigation Plan Update
Multi-Hazard Risk and Vulnerability Assessment Meeting

Where and When?

- Carpenter Recreation Center, 11151 Colorado Blvd., Thornton, CO 80233
- May 19th, 2016, 2:00 – 4:00 PM

What is the purpose of this meeting?
At this meeting we will discuss the details of the 2016 Local Hazard Mitigation Plan (including the scope, timeline, and key milestones), we will review the results of the multi-hazard risk assessment, and we will discuss next steps towards creating a safer, more resilient community.

Agenda:

1. Introductions
2. Project Overview
3. Hazard Risk Ranking Exercise
4. Overview of Risk Assessment Results
5. Hazard Risk Rankings Revisited
6. Review of the 2016 Mitigation Strategy Goals
7. Overview of Mitigation Actions
8. 2016 Mitigation Actions (How to Develop a Mitigation Action Guide)
9. Mitigation Project Brainstorming Exercise and Q&A
10. Schedule and Key Milestones

Post-Meeting Action Items:

1. Visit Project Website: http://www.thorntonhmp.com/
   a. Complete survey and share with others
   b. Review the online risk assessment: http://arcg.is/1VyamFv
2. Start brainstorming potential mitigation actions/projects for the 2016 Plan
   a. Use Mitigation Action Guides as a brainstorming tool: http://www.thorntonhmp.com/home/plan-documents

www.ThorntonHMP.com

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Sign-In Sheet

Thornton, Federal Heights, and Northglenn 2016 Multi-Jurisdictional Hazard Mitigation Plan
Multi-Hazard Risk and Vulnerability Assessment Meeting
May 19th 2016

Name	Organization	Email or Phone
Rick Constance	Home Depot	specialtyASM_1503 @ Homedepot.com
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Emily Hunt	Thornton	7209776504
Cliff Brown	Thornton PD	720-977 5368
Elaine Hassinger	TCHD	720-200-1583
David Sauer	Mapleton	3 853-1787
Abel Montoya	ADCO	7 523 6990
Branson Young	Immaculate Heart	720.341.2524
Liz Candelario	Walmart	720-936-2413
Jeff Walker	Xcel Energy	jeffrey.a.walker@xcelenergy.com
Cody Horn	Xcel	Cody.d.Horn@xcel.com
Joshua Wood	Home Depot	asm.1503@homedepot.com
Glenda Laws	City of Thornton	glenda.laws@cityofthornton.net

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Thornton, Federal Heights, and Northglenn 2016 Multi-Jurisdictional Hazard Mitigation Plan
Multi-Hazard Risk and Vulnerability Assessment Meeting
May 19th 2016

Name	Organization	Email or Phone
Daniel Dick	Fed Heights	ddick@fedheights.org
Michele Gulrud	Crossroads	michele.gulrud@crossroadsdd.org
Beth Tirrell	B&B Blending	btirrell@bbblending.com
Lisa Ranalli	Thornton SR. CTR	Lisa.Ranalli@cityofthornton.net
Lisa Hollander	MWRD	lhollander@mwrd.dst.co.us.net
Ryan Doyle	Thornton GIS	ryan.doyle@cityofthornton.net
MARGARET CAREW	Thornton GIS	margaretcarew@cityofthornton.net
Jon Hardman	Quebec Run HOA Lake Avery Estates	Jhardman@45HOA.com
Jim Kaiser	Thornton floodplain	jim.kaiser@city...
Kathy Huff	H & H Metals	khuff@h-hmetals.com
Takarri Peemoeller	Thornton City Dev.	takarri.peemoeller@cityofthornton.net
Amber Oeltjenbruns	Pinnacle charter school	aoeltjenbruns@pinnacleschool.org
Michelle Martin	Weld County	mmartin@co.weld.co.us

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City of Thornton Northglenn Federal Heights

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Sign-In Sheet

Thornton, Federal Heights, and Northglenn 2016 Multi-Jurisdictional Hazard Mitigation Plan
Multi-Hazard Risk and Vulnerability Assessment Meeting
May 19th 2016

Name	Organization	Email or Phone
Carolina VanHorn	Adams County, Long Range Planning	cvanhorn@adcogov.org
Nancy Ross	School District 27J	nross@sd27j.net
Steve Kelly	Thornton Fire	skelly@cityofthornton.net
Lisa Nelson	CPWD	Lisa@cpwd.org
Pam Smith	Anythink	psmith@anythinklibraries.org
Len Kpw	The Senior Hub	3/26 4408
JOHN EWY	RTD	3/299-6903
Catherine Anderson	NSMC	catherine.anderson@healthonecares.com
KEVIN STEWART	UDFCD	kstewart@udfcd.org
Julia Ferguson	Adams Co.	julia.ferguson@adcogov.org
Sean Ellis	Federal Heights	sellis@fedheights.org
TOM Green	United Power	tgreen

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City of Thornton Northglenn Federal Heights

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We Make a Difference

Thornton, Federal Heights, and Northglenn 2016 Multi-Jurisdictional Hazard Mitigation Plan Update
Mitigation Strategy Workshop

Where and When?

- Carpenter Recreation Center, 11151 Colorado Blvd., Thornton, CO 80233
- August 3rd, 2016, 1:00 – 3:00 PM

What is the purpose of this workshop?
At this workshop we will work on finalizing the mitigation actions/projects to be included in the HMP. This information will be compiled into Mitigation Action Guide (MAG) templates for inclusion into the HMP document.

Agenda:

1. Introductions
2. Project Overview / Remaining Schedule
3. Public Survey Results
4. Presentation of Mitigation Action/Project Ideas
5. Jurisdictional Break-Out Session to Finalize MAGs

Post-Meeting Action Items:

1. Share draft plan for Planning Team & Public review & comment
2. Visit Project Website: http://www.thorntonhmp.com/

Thanks for everyone's participation in our hazard mitigation planning process!

www.ThorntonHMP.com

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City of Thornton Northglenn Federal Heights

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Sign-In Sheet

Thornton, Federal Heights, and Northglenn 2016 Multi-Jurisdictional Hazard Mitigation Plan
Mitigation Strategy Workshop
August 3rd 2016

Name	Organization	Email or Phone
Yong Song	RTD	303-299-2172
Matt Stockton	City of Thornton	720-977-6511
Rachel Bacon	Adams County	720-523-6992
DAVE SAYLES	TRI-STATE G+T	DSAYLES@TRISTATEGT.ORG
Tom Green	Chile & Pow-	Tgreen @ unitedpower.com
MARTIN POSTMA	City of Thornton	martin.postma @ cityofthornton.net
Catherine Anderson	North Suburban Medical Center	catherine.anderson2@healthonecares.com
Jeff Walker	Xcel Energy	jeffrey.a.walker@xcelenergy.com
Matthew Eberly	City of Thornton	matt.eberly@cityofthornton.net
Kathy Huff	Holt Metals	303 429-0609
Nancy Ross	School District 27J	nross@sd27j.net
KEVIN STEWART	UDFCD	kstewart@udfcd.org

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We Make a Difference

Sign-In Sheet

Thornton, Federal Heights, and Northglenn 2016 Multi-Jurisdictional Hazard Mitigation Plan
Mitigation Strategy Workshop
August 3rd 2016

Name	Organization	Email or Phone
Brandon Young	Immaculate Heart of Mary	Brandon.y@ihmco.org
Matt Manning	Crossroads Church	Matt.manning@crossroadsabc.com
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City of Thornton Northglenn Federal Heights

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Sign-In Sheet

Thornton, Federal Heights, and Northglenn 2016 Multi-Jurisdictional Hazard Mitigation Plan
City of Thornton Mitigation Strategy Workshop (1 of 2)
September 7th, 2016

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City of Thornton Mitigation Strategy Workshop (2 of 2)
September 8th, 2016

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Appendix E - Glossary

100-Hundred Year Floodplain: Also referred to as the Special Flood Hazard Area (SFHA). An area within a floodplain having a 1% or greater chance of flood occurrence in any given year.

Aftershocks: Earthquakes that follow the largest shock of an earthquake sequence. They are smaller than the mainshock and within 1-2 rupture lengths distance from the mainshock. Aftershocks can continue over a period of weeks, months, or years. In general, the larger the mainshock, the larger and more numerous the aftershocks, and the longer they will continue.

Agricultural: The science, art, or occupation concerned with cultivating land, raising crops, and feeding, breeding, and raising livestock.

Centroid: The geometric center of a Geographical Information Systems (GIS) feature. For line, polygon, or three-dimensional features, it is the center of mass (or center of gravity) and may fall inside the feature, as shown below for a triangle, or outside the feature, as shown below for a complex line. For multipoints, polylines, or polygons with multiple parts, it is computed using the weighted mean center of all feature parts.

Colorado Reportable Disease Statistics: Public health data, analyzed by the Colorado Department of Public Health and Environment (CDPHE). Statistics are analyzed at the county level and are broken out by year. Each year includes information on age, county, and the data report month.

Colorado Wildfire Risk Assessment Portal (COWRAP): The primary mechanism for the Colorado State Forest Service to deploy risk information and create awareness about wildfire issues across the state. It is comprised of a suite of applications tailored to support specific workflow and information requirements for the public, local community groups, private landowners, government officials, hazard-mitigation planners, and wildland fire managers. Collectively these applications will provide the baseline information needed to support mitigation and prevention efforts across the state.

Derecho: A series of downbursts associated with a line of severe storms. They're associated with bands of rapidly moving showers or thunderstorms variously known as bow echoes, squall lines, or quasi-linear convective systems. Damage typically occurs in one direction along a relatively straight path.

Enhanced Fujita Scale (EF-Scale): Measures tornado strength and associated damages and classifies tornadoes into six intensity categories. Implemented in place of the Fujita Scale.

Epidemic: The rapid spread of infectious disease to a large number of people in a given population within a short period of time, usually two weeks or less. Epidemics are generally caused by several factors including a change in the ecology of the host population.

Farm Services Agency (FSA): A federal agency within the U.S. Department of Agriculture (USDA) that is responsible for implementing farm conservation and regulation laws around the nation. The FSA administers farm commodity, crop insurance, credit, environmental, conservation, and emergency assistance programs for farmers and ranchers.

Federal Emergency Management Agency (FEMA): A federal agency within the U.S. Department of Homeland Security. The agency's primary purpose is to coordinate the response to a disaster that has occurred in the United States and that overwhelms the resources of local and state authorities.

Flood Insurance Rate Map (FIRM): Map of a community, prepared by FEMA that shows the special flood hazard areas and the risk premium zones applicable to the community.

Foreshocks: Relatively smaller earthquakes that precede the largest earthquake in a series, which is termed the mainshock. Not all mainshocks have foreshocks.

Fujita Scale: A well-known scale that uses damage caused by a tornado and relates to the damage to the fastest 1/4 –mile wind at the height of a damaged structure.

Hazard: A source of potential danger or adverse condition. Hazards include both natural and human-caused events. A natural event is a hazard when it has the potential to harm people or property and may include events such as floods, earthquakes, tornadoes, tsunami, coastal storms, landslides, and wildfires that strike populated areas. Human-caused hazard events originate from human activity and may include technological hazards and terrorism. Technological hazards arise from human activities and are assumed to be accidental and/or have unintended consequences (e.g., manufacture, storage and use of hazardous materials). While no single definition of terrorism exists, the Code of Federal Regulations defines terrorism as "…unlawful use of force and violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives."

Hazus: A GIS-based nationally standardized earthquake, flood and high wind event loss estimation tool developed by FEMA.

Hydrologic Drought: Associated with the effects of periods of precipitation (including snowfall) shortfalls on surface or subsurface water supply (i.e., streamflow, reservoir and lake levels, groundwater). The frequency and severity of hydrological drought is often defined on a watershed or river basin scale.

Liquefaction: The phenomenon that occurs when ground shaking (earthquake) causes loose soils to lose strength and act like viscous fluid. Liquefaction causes two types of ground failure: lateral spread and loss of bearing strength.

Meteorological Drought: Defined on the basis of the degree of dryness. Must be considered as region specific since the atmospheric conditions that result in deficiencies of precipitation are highly variable from region to region.

Modified Mercalli Intensity (MMI): The MMI is a scale that is composed of increasing levels of intensity that range from imperceptible shaking to catastrophic destruction and is designated by Roman numerals. It does not have a mathematical basis; instead it is an arbitrary ranking based on observed effects.

National Centers for Environmental Information (NCEI): A combined center made up of the National Climatic Data Center, the National Geophysical Data Center, and the National Oceanographic Data Center. NCEI was created due to demand for high-value environmental data and information and is

responsible for hosting and providing access to comprehensive atmospheric, coastal, oceanic, and geophysical data.

National Flood Insurance Program (NFIP): A program of flood insurance coverage and floodplain management administered under The National Flood Insurance Act of 1968. It is made up of three components; to provide flood insurance, to improve floodplain management and to develop maps of flood hazard zones.

National Institute of Building Sciences (NIBS): A non-profit, non-governmental organization that successfully brings together representatives of government, the professions, industry, labor and consumer interests, and regulatory agencies to focus on the identification and resolution of problems and potential problems that hamper of the construction of structures for throughout the U.S.

National Oceanic and Atmospheric Administration (NOAA): A scientific agency within the United States Department of Commerce that focuses on the conditions of the oceans and the atmosphere. NOAA warns of dangerous weather, charts seas, guides the use and protection of ocean and coastal resources, and conducts research to improve understanding and stewardship of the environment.

Paleoclimatology: The study of past climate and what existed before humans began collecting instrumental measurements of weather. This study uses natural environmental (or "proxy") records to infer past climate conditions.

Palmer Drought Severity Index (PDSI): Semi-official drought index for risk assessment and hazard analysis. Indicates the relative dryness or wetness affecting water sensitive economies. Data is provided in graphical and tabular formats.

Pandemic: An epidemic occurring worldwide, or over a very wide area, crossing international boundaries and usually affecting a large number of people. It does not have an element of severity.

Peak Ground Acceleration (PGA): Equal to the maximum ground acceleration that occurred during earthquake shaking at a particular location. Represents the rate in change of motion of the earth's surface during an earthquake as a percent.

Quaternary Faults: Faults that have slipped in the last 1.8 million years. These faults are believed to be the most likely source of future great earthquakes and it's important to identify their locations and their potential impact.

Repetitive Loss Properties (RL): A property that is currently insured for which two or more National Flood Insurance Program losses (occurring more than ten days apart) of at least $1,000 each have been paid within any 10-year period since 1978.

Richter Magnitude Scale: A logarithmic scale devised by seismologist C.F. Richter in 1935 to express the total amount of energy released by an earthquake. While the scale has no upper limit, values are typically between 1 and 9, and each increase of 1 represents a 32-fold increase in released energy.

Risk: The estimated impact that a hazard would have on people, services, facilities, and structures in a community; the likelihood of a hazard event resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms such as a high, moderate, or low likelihood of

sustaining damage beyond a particular threshold due to a specific type of hazard event. It also can be expressed in terms of potential monetary losses associated with the intensity of the hazard.

Riverine Flooding: Dynamics of riverine flooding vary with terrain. In relatively flat areas, land may stay covered with shallow, slow-moving floodwater for days and even weeks. In hilly and mountainous areas, floods may come minutes after a heavy rain. This can be particularly dangerous because of the short notice.

Ruptures: Refers to an event that generates seismic energy as a result of a slip along a fault line. This may be represented as a portion of a fault that slips during an event or simply as a point source.

Scarp: A feature on the surface of the earth that looks like a step caused by slip on the fault.

Seiches: Standing waves set up on rivers, reservoirs, ponds, and lakes when seismic waves from an earthquake pass through the area.

Severe Repetitive Loss Property (SRL): A residential property that is covered under an NFIP flood insurance policy and: a) has at least four NFIP claim payments (including building and contents) over $5,000 each, and the cumulative amount of such claims payments exceeds $20,000; or, b) a property for which at least two separate claim payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building. For both a) and b) above, at least two of the referenced claims must have occurred within any ten-year period, and must be greater than ten days apart.

Socioeconomics: How economic activity affects and is shaped by social processes.

Subsidence: The motion of a surface as it shifts downward relative to a datum such as sea-level. Typically, this occurs when large amounts of groundwater have been withdrawn from certain types of rocks, such as fine-grained sediments.

Vulnerability: Describes how exposed or susceptible to damage an asset is. Vulnerability depends on an asset's construction contents, and the economic value of its functions. Like indirect damages, the vulnerability of one element of the community is often related to the vulnerability of another. For example, many businesses depend on uninterrupted electrical power – if an electric substation is flooded, it will affect not only the substation itself, but a number of businesses as well. Often, indirect effects can be much more widespread and damaging than direct effects.

Wildland-urban Interface (WUI): Areas where homes are built near or among land prone to wildland fire.