2010

Five County Association of Governments

[NATURAL HAZARD MITIGATION PLAN]

DRAFT-Five Year Plan 2010 – 2014

Five County Association of Governments
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NATURAL HAZARD MITIGATION PLAN GIS METADATA 1

WHAT IS A NATURAL HAZARD MITIGATION PLAN?

Natural hazard mitigation is any sustained action taken to reduce or eliminate the long term risk to human life and property from hazards. Mitigation activities may be implemented prior to, during, or after an incident. However, it has been demonstrated that hazard mitigation is most effective when based on a comprehensive, long term plan that is developed before a disaster occurs.

This Natural Hazard Mitigation Plan has been financed and developed under the Pre-Disaster Mitigation (PDM) Program provided by the Federal Emergency Management Agency (FEMA) and the State of Utah, Department of Public Safety, Division of Homeland Security (DHS).

This Natural Hazard Mitigation Plan was developed in accordance with applicable FEMA regulations, namely 44 CFR §201.6. Generally, these regulations proliferate the following goals: to fulfill federal, state, and local hazard mitigation planning responsibilities; to promote natural hazard mitigation measures, short/long range strategies that minimize loss of life, and damage to property resulting from natural hazard occurrences to which public/private constituents are exposed; and to eliminate or minimize conditions which would have an undesirable impact on our citizens, the economy, environment, and the well-being of the Five County region.

Section 322 of the Stafford Act emphasizes the need for state and local governments to closely coordinate mitigation planning and implementation efforts. This plan is an aid in enhancing public and private awareness to the threat that natural hazards have on property and life. It identifies what can be done to help prevent or reduce the vulnerability, risk and impact of natural hazards. Another function of this Plan is to provide information to local jurisdictions regarding the availability of funding sources for natural hazard mitigation. In 2000, FEMA issued the Disaster Mitigation Act of 2000, commonly known as DMA 2000. Under this Act, states, communities, and tribal governments must complete FEMA approved natural hazard mitigation plans to be eligible for certain federal assistance programs, such as the Hazard Mitigation Grant Program (HMGP).

The goal of this plan is to assist the five counties of Southwestern Utah, namely, Beaver, Garfield, Iron, Kane and Washington Counties, in reducing the costs of natural disasters; specifically, Drought, Earthquake, Flood, Landslide, Problem Soils, Radon Gas, Severe Weather, Volcanoes, and Wildfire, through mitigation practices. This plan provides comprehensive hazard identification, risk assessment, vulnerability analysis, mitigation actions, and implementation schedule for the region.

The authors of this plan, Five County Association of Governments, met the regulations set forth by FEMA in completing the plan. Regulations, including future monitoring, evaluating, updating and implementing, will take place as new incidents occur and/ or every five years.

WHAT IS THE PLAN'S MISSION?

The mission of the Five County Association of Governments (FCAOG) Natural Hazards Mitigation Plan is to substantially reduce the vulnerability of communities, within the region, to natural hazards. The plan is intended to promote sound public policy designed to protect citizens, private property, critical facilities, and infrastructure. This can be achieved by increasing public awareness, documenting resources for risk reduction and loss-prevention, and identifying activities which enable the development of safer communities.

NATURAL HAZARD MITIGATION PLAN GOALS

In an effort to ensure that the mission of this Natural Hazard Mitigation Plan is met, the participants in the development of this plan defined and established a list of goals, which are directly related to accomplishing the mission. Mitigation plan goals are more specific statements of direction that public/private constituents alike can take while working to reduce the risk associated with natural hazards. Goals form a bridge between the broad mission statement and particular action items. The following is a list of the goals and goal statements identified by the participants of this plan. All the goals are important and achievable; as such they are not listed in any specific order.

Goal	***Goal Statement***
Education/Outreach	-Further awareness and understanding of natural hazards, potential risk and vulnerability, and options available when natural hazard events occur. -Provide information and education to all residents of the Five County region concerning natural hazards.
Emergency Services	-Minimize life safety issues. -Promote, strengthen, and coordinate emergency response plans.
Environmental Protection	Preserve and rehabilitate natural systems to serve natural hazard mitigation functions (i.e. floodplains, wetlands etc.).
Partnership/Coordination	Coordinate public/private sector participation in planning/implementing mitigation strategies.
Prevention	-Reduce the threat of loss of life and property from natural hazards. -Incorporate information on known hazards and make hazard mitigation planning a priority in land use policies and decisions.
Property Protection	Minimize the impact from natural disaster occurrences on public and private property.

HOW CAN I USE THIS PLAN?

This Natural Hazard Mitigation Plan is comprehensive in nature and affects all jurisdictions within the Five County region, including all rural unincorporated communities. While this Plan is non-regulatory in nature, it provides a framework for regional jurisdictions to plan for natural hazards. The resources and information provided herein pertain to all areas of the Five County region. It is the sincere hope of the authors of this Plan, that each respective jurisdiction use the information contained herein to adopt more stringent regulations which will provide the legal authority for hazard risk analysis and mitigation efforts at the local level.

This Plan was developed and organized within the rules and regulations established in 44 CFR §201.6. The plan contains a discussion on the purpose and methodology used to develop the plan, a profile on communities within the Five County region, as well as a hazard identification study and a vulnerability analysis of nine hazards. To assist in the explanation of the above-identified contents each County within the region is analyzed separately. The benefit of this separation is that each County is provided with a separate and distinct hazard identification, vulnerability analysis, and mitigation measures. Ultimately, this framework provides a streamlined Plan which will afford additional readability and implementation.

This Plan contains county-level geographic and demographic information, together with a risk and vulnerability assessment and mitigation strategies. The Plan details goals, objectives, and specific tasks or actions to reduce risk. Natural hazards to be addressed in the Plan were determined through an evaluation of risk and probability of those hazards being most significant to the counties within the region; namely: Drought, Earthquake, Flood, Landslide, Problem Soils, Radon Gas, Severe Weather, Volcanoes, and Wildfire.

All too often, planning documents become too comprehensive and cumbersome; in so doing this limits their ability and renders their permanent placement on the proverbial "shelf." The authors of this Plan believe that if this Plan fits within the aforementioned, then their efforts have been in vain. This being said, extreme consciousness has been afforded to ensure that this Plan is relevant, and that the goals and strategies provided herein are those that have a heightened, realistic level of achievability.

ACKNOWLEDGEMENTS

County Commissioners
Donald J. Willden, Chair- Beaver
Willie L. Dalton
Chad W. Johnson
Maloy Dodds, Chair- Garfield
Clare M. Ramsay
Dell LeFevre
Alma Adams, Chair- Iron
Lois Bulloch
Wayne Smith
Daniel W. Hulet, Chair- Kane
Douglas K. Heaton
Mark Habbeshaw
James J. Eardley, Chair- Washington
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Mayors
Mark Yardley, Beaver City
Ward Dotson, Minersville
Bryan Sherwood, Milford
Shannon Allen, Antimony
Bill Muse, Boulder
David Tebbs, Bryce Canyon
W. Jeff Stock, Cannonville
Jerry Taylor, Escalante
Kevin Eldredge, Hatch
David Roberts, Henrieville
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WaLon Brinkerhoff, Tropic
H.C. Deutschlander, Brian Head
Joe Burgess, Cedar City
Robert Rasmussen, Enoch
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Constance Robinson, Paragonah
Donald Landes, Parowan
Claren Heaton, Alton
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NHMP Planning Team- Beaver County
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Darren Janes, Community Planner
Doni Pack, Program Specialist
Kenneth Richards, GIS Intern

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WHY DEVELOP A MITIGATION PLAN?

The Five County region of southwest Utah is vulnerable to natural hazards that have the possibility of causing serious threat to the health, safety, and welfare of our citizens. The cost of response to and recovery from potential disasters can be lessened when attention is turned to mitigating their impacts and effects. This Natural Hazard Mitigation Plan (NHMP) is a fundamental step in identifying natural hazards and the impacts they may have on the residents of southwest Utah.

A mitigation plan seeks to provide resources, information and strategies for risk reduction, while helping to guide and coordinate mitigation activities. The plan provides a set of action items to reduce risk from natural hazards through education, outreach programs, the development of partnerships, and the implementation of preventative activities.

The resources and information within the mitigation plan establish: a foundation for coordination and collaboration among agencies and the public in the Five County region of southwest Utah; identify and prioritize future mitigation measures; and, assist in meeting qualifications for federal assistance programs.

NHMP Mission: to substantially reduce the vulnerability of communities, within the region, to natural hazards.

METHODOLOGY: NHMP UPDATE

This NHMP was developed and organized with adherence to Part 201.6 of the Disaster Mitigation Act of 2000. The NHMP is required to be updated every five years to comply with the aforementioned regulations. The 2010 NHMP update is developed following the same standards and guidelines that were used in the development of the original 2004 NHMP. This being said the 2004 NHMP has been incorporated into the 2010 NHMP, alongside updated materials, and is provided as a seamless planning document.

The information used in the development of this NHMP is based on research from a variety of sources. The research methods and various contributions to the plan are as follows:

- Army Corps of Engineers *Flood Hazard Identification Study,* August, 2003.
- *A Strategic Plan for Earthquake Safety in Utah,* Utah Seismic Safety Commission, 1995 http://ussc.utah.gov/publications/strategic_plan.pdf
- *Conjunctive Management of Surface and Ground Water in Utah,* State of Utah, Division of Water Resources, 2005 http://www.water.utah.gov/CMReport/CMReport1bCC.pdf
- *Disaster Mitigation Act of 2000*
- *Drought in Utah, Learning from the Past- Preparing for the Future,* State of Utah, Division of Water Resources, 2007 http://www.water.utah.gov/DroughtReport/binder2a.pdf

- *Earthquake Safety in Utah- Progress Report: July 2000 to June 2007,* Utah Seismic Safety Commission, 2008 http://ussc.utah.gov/publications/progress_rpts/ussc2007progressreport.pdf
- *Emergency Operations Plans* for Beaver, Garfield, Iron, Kane, and Washington Counties.
- FEMA *Blue Book*, July 2008
- FEMA Publication 386-5, *Using Benefit-Cost Review in Mitigation Planning,* May 2007
- FEMA Region VIII "*Crosswalk*"
- Five County Association of Governments, *Natural Hazard Mitigation Plan: A Regional Approach for Southwestern Utah,* 2004
- *Natural Hazard Mitigation Action Plan,* Jackson County, Oregon, November 2005 http://www.co.jackson.or.us/Page.asp?NavID=1514
- *Southwest Utah Regional Wildfire Protection Plan*, October 2007 http://www.fcaog.state.ut.us/wildfire.html
- State of Utah, *Hazard Mitigation Plan*, November 2007 http://site.utah.gov/dps/homelandsecurity/MitigationPla_MMtmp24d95a3b/MitigationPlan.html

THE PLANNING PROCESS

Requirement §201.6(b): In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process **shall** include:

(1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;

(2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process; and

(3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.

Requirement §201.6(c)(1): [The plan **shall** document] the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.

The Five County Association of Governments NHMP incorporates a variety of citizen input representing a diverse cross-section of our regional population. To this end, the following planning process was developed: (1) development, coordination, and implementation of County level NHMP Planning Teams; (2) soliciting information from a 'sampling' of citizens through a *Natural Hazards Questionnaire*; and (3) conducting stakeholder interviews to target the specialized knowledge of individuals working with populations or areas at risk from natural hazards. Within these planning process parameters, 10 steps are identified and outlined below.

DOCUMENTATION OF THE PLANNING PROCESS

This plan was prepared in the offices of the Five County Association of Governments by appointed staff members: Gary Zabriskie, Community and Economic Development Planning Manager, Curt Hutchings, Transportation Planning Manager, Darren Janes, Community Planner, Doni Pack, Program Specialist, and Ken Richards, GIS Intern, and was supported by Brad Bartholomew of State of Utah Division of Homeland Security. Other local agencies that aided in the process include: city and county GIS departments, elected officials, tribal leaders, local

officials, emergency managers, police and fire staff members, planning departments, and local governmental agencies. The planning process included the following steps.

STEP L: ORGANIZE RESOURCES

Five County Association of Governments established, coordinated, and implemented County level NHMP Planning Teams. The planning teams, shown in the table below, were the main constituents of the planning process and provided guidance/direction from inception to eventual plan adoption.

NHMP County-level Planning Teams

Name	***Organization***	***County***
Mayor Bryan Sherwood	Milford City Corporation	Beaver
Commissioner Chad Johnson	Beaver County Commission	Beaver
Les Whitney	LEPC-Beaver County	Beaver
Craig Davis	Building Official-Beaver Co.	Beaver
Corrina Bow	Paiute Tribe-Kanosh Band	Five County Region/ Beaver
Robert Borchardt	Paiute Tribe-Indian Peaks Band	Beaver
Commissioner Clare Ramsay	Garfield County Commission	Garfield
Brian Bremner	Public Works/Engineer- Garfield Co.	Garfield
Mayor Lowell Mecham	Tropic Town Corporation	Garfield
Rob Wolfley	Garkane	Five County Region/ Garfield
Sandrea Francisco	LEPC-Garfield County	Garfield
Justin Fischer	Planner-Garfield County	Garfield
Reed Erickson	Iron County Administrator	Iron
Todd Stowell	Planner- Iron County	Iron
Mayor Connie Robinson	Town of Paragonah	Iron
Charlie Morris	LEPC-Iron County	Iron
Anthonia Tom	Paiute Tribe-Cedar Band	Iron
Steve Platt	Engineer- Iron Co.	Iron
Mike Worthen	Natural Resource Management Specialist-Iron Co.	Iron
Alan Alldredge	LEPC-Kane County	Kane
Commissioner Douglas Heaton	Kane County Commission	Kane
Mayor Nina Laycook	Kanab City Corporation	Kane
Gary Smith	Land Use Authority-Administrator	Kane
Lou Pratt	Transportation/GIS- Kane Co.	Kane

Linda Little	Assessor- Kane Co.	Kane
Mayor Allen Brown	Rockville Town Corporation	Washington
David Hatfield	Rockville Town Corporation	Washington
Jeff Ballard	Rockville Town Corporation	Washington
Deon Goheen	Planner-Washington Co.	Washington
Commissioner James Eardley	Washington County Commission	Washington
Ron Whitehead	Public Works- Washington Co.	Washington
Dean Cox	LEPC-Washington County	Washington
Charlotte Lomeli	Paiute Tribe-Shivwits Band	Washington
Nyal Littlefield	Questar Gas	Five County Region/ Washington
Wes Hathenbruck	Rocky Mountain Power	Five County Region/ Washington
Colin Jack	Dixie Escalante Electric	Five County Region/ Washington
Russ Condie	Dixie Escalante Electric	Five County Region/ Washington
Lloyd Watkins	LaVerkin City	Washington
Bill Lund	Utah Geographical Survey	Five County Region
Ryan Pietramali	FEMA	Five County Region
Brad Bartholomew	Utah Division of Emergency Services and Homeland Security	Five County Region
Kenneth Sizemore	Five County Association of Governments	Five County Region
Curt Hutchings	Five County Association of Governments	Five County Region
Gary Zabriskie	Five County Association of Governments	Five County Region
Darren Janes	Five County Association of Governments	Five County Region
Doni Pack	Five County Association of Governments	Five County Region
Kenneth Richards	Five County Association of Governments/ Southern Utah University	Five County Region

STEP 2: PUBLIC OFFICIALS OUTREACH

To ensure the planning process had support from elected officials, a member from each County Commission, or their assign, was appointed to their respective County NHMP planning team. The intent of this appointment is that it establishes the need for the NHMP and focuses on how it can better help the communities within each respective County.

STEP 3: COORDINATION WITH COUNTY EMERGENCY MANAGERS

Each County NHMP planning team consisted of an emergency manager. These individuals proved to be valuable members of each planning team because of their overall interest and technical expertise in mitigation planning.

STEP 4: DATA ACQUISITION

Five County employed a geographic information system (GIS) intern to collect data and generate mapping sufficient to quantitatively assess regional natural hazards. Contact was made with applicable personnel in each city and county to access GIS data available at the local level. Further, current GIS data was retrieved from the State of Utah Automated Geographic Reference Center (AGRC) website: http://agrc.its.state.ut.us/. Data layers were generated which included some or all of the following: local roads, plot maps, county assessor's tax assessment data, hazard data, flood maps, topographic data, aerial photographs, and land development data. The GIS software then quantified the number of units and total market value for all structures located within each defined hazard area.

In addition to GIS data, Five County utilized numerous resources/data to craft this NHMP. These data resources were formally noted earlier in this section.

STEP 5: HAZARD RISK IDENTIFICATION AND ANALYSIS

This step was conducted by gathering data on the hazards that occurred in each respective County. This information was gathered from local, state, and federal agencies and organizations, as well as, from newspaper and other local media accounts, state and local weather records, conversations, surveys, interviews, and meetings with key informants within the planning area. From here, maps were generated using GIS and hazard data was presented to the NHMP planning teams in each County. Additionally, valuable public insight was generated from the *Natural Hazards Questionnaire*. The aforementioned resources resulted in a comprehensive, quantitative hazard risk identification and analysis.

STEP 6: VULNERABILITY ASSESSMENT

This step was conducted through a review of local base maps, topographical maps, floodplain maps, and other data. Through utilization of GIS, a detailed vulnerability analysis was completed for each county. GIS layers were created to determine vulnerability to hazards including: earthquakes, problem soils, severe weather, floods, landslides, and wildfire. GIS was used as the basic analysis tool to complete the hazard analysis. The paramount goal of the vulnerability assessment is to estimate the number of structures vulnerable to each hazard and assign a dollar value to this built environment. All the analysis takes place within the spatial context of a GIS. With the information available in spatial form, it is a simple task to overlay the natural hazards with county assessor's tax assessment data to extract the desired information. This is to say, the GIS software joins: 1) County Property Tax data as it relates to 2) structures located with a defined hazard area. The values shown are based upon utilizing the *market value* for structures in each defined severe weather hazard area. The GIS software then quantified the number of units

and total market value for all structures located within each defined hazard area, relative to specific hazards, in order to assess vulnerability.

STEP 7: COMMUNITY GOALS ASSESSMENT

This step was conducted through a review of the governing documents of the planning area, as well as, conversations, interviews, and meetings with key individuals within the planning area. This step identified what goals are already established and adopted for the planning area and whether or not they promote or deter mitigation activities.

STEP 8: MITIGATION STRATEGY DEVELOPMENT

Developing the mitigation strategies was a process in which all of the previous steps were taken into account. Specifically, through performance of the vulnerability assessment a total market value of structure loss was determined for each respective hazard. The resulting mitigation strategies were listed in accordance to their respective natural hazard, and presented in an effort to provide macro-level risk reduction. Although each mitigation measure is important and achievable, they were prioritized and listed in order of:

1) Respective amount of potential loss of life/property value as a result of a natural hazard occurrence (as quantified through GIS analysis) ; and
2) Implementation priority through utilization of the STAPLEE process (as explained in Chapter 3 of this Plan and in FEMA 386-3).

STEP 9: PRIORITIZATION OF MITIGATION STRATEGIES

The Disaster Mitigation Act of 2000 requires that a NHMP demonstrate how mitigation strategies were evaluated and prioritized. Prioritization was accomplished under the premise of total loss as it relates to each natural hazard. The underlying reason for this approach is based upon the fact that it is impossible to predict the future location, intensity, and severity of damage of any specific natural hazard. This being said, the total market value of structure loss for each respective natural hazard was used to prioritize mitigation strategies; ultimately the strategies are listed at the county level with the natural hazard containing the highest amount of total market value of structure loss being listed first with subsequent hazards following.

The STAPLEE method, explained in the FEMA *Blue Book* (July 2008), provided a technique for identifying, evaluating, and prioritizing mitigation actions based on existing local conditions; namely, Social, Technical, Administrative, Political, Legal, Economic, and Environmental. In terms of mitigation strategy implementation, careful attention was afforded to those mitigation strategies that have the highest likelihood of being implemented over the course of the next 5 years. It is the sincere intent of the authors of this Plan to provide mitigation strategies that will reach the greatest amount of people despite scarce funding resources.

STEP 10: ADOPTION

> ***Requirement §201.6(c)(5):*** For multi-jurisdictional plans, each jurisdiction requesting approval of the plan **must** document that it has been formally adopted.
>
> ***Requirement §201.6(a)(3):*** Multi-jurisdictional plans may be accepted, as appropriate, as long as each jurisdiction has participated in the process…Statewide plans will not be accepted as multi-jurisdictional plans.

The plan went through a public adoption process on (date) and was adopted by:

- Beaver County
  - Beaver City, Town of Minersville, and Milford City.
- Garfield County
  - Panguitch City, Escalante City, Town of Cannonville, Town of Hatch, Town of Tropic, Town of Henrieville, Town of Boulder, and Town of Antimony.
- Iron County
  - Cedar City, Parowan City, Town of Paragonah, Town of Brian Head, Town of Kanarraville, and Enoch City.
- Kane County
  - City of Kanab, Town of Alton, Town of Glendale, Town of Orderville, and Town of Big Water.
- Washington County
  - City of St. George, Washington City, Santa Clara City, Town of Springdale, Town of Rockville, Town of New Harmony, Town of Leeds, Hildale City, Hurricane City, Ivins City, Toquerville City, Enterprise City, LaVerkin City, and the Town of Virgin.
- Paiute Indian Tribe of Utah
  - PITU Tribal Council, Cedar Band, Indian Peaks Band, Shivwits Band

PUBLIC INVOLVEMENT

Public involvement opportunities were available throughout the design and completion of the NHMP. Such opportunities included: soliciting information from a sampling of citizens through a *Natural Hazards Questionnaire*; various meetings with each county emergency manager; meetings with elected officials from each respective County; and public/private review of the NHMP at draft stage. These public involvement opportunities resulted in valuable guidance/direction in crafting the NHMP. As a whole, broad and diverse representations from each County constitute the planning process. The sincere hope is that this public representation affords the opportunity for a greater segment of the population, and its unique interests, to be represented herein.

Integrating public participation during the development of the Five County Association of Governments Natural Hazard Mitigation Plan has ultimately resulted in increased public awareness. Through citizen involvement, the mitigation plan reflects community issues, concerns, and new ideas and perspectives on mitigation opportunities and plan action items.

PLAN MAINTENANCE PROCESS

Requirement §201.6(c)(4)(i): [The plan maintenance process **shall** include a] section describing the method and schedule of monitoring, evaluating and updating the mitigation plan within a five-year cycle.

The plan maintenance portion of this document details the formal process that will ensure that the Five County NHMP remains an active and relevant document. The plan maintenance process includes a schedule for monitoring and evaluating the Plan annually and producing a plan revision every five years. This chapter describes how Five County will integrate public participation throughout the plan maintenance process. Finally, this chapter includes an explanation of how Five County intends to incorporate the mitigation strategies outlined in this Plan into existing planning mechanisms such as: County comprehensive land use plans, capital improvement plans, and building codes.

ADOPTING, COORDINATING AND IMPLEMENTING THE PLAN

The success of the Five County NHMP depends on how well the outlined action items are implemented. Periodic monitoring of the plan is required to ensure that the goals and objectives are kept current and mitigation efforts are being carried out. In an effort to ensure that the activities identified are implemented, the following steps will be taken. Each participating jurisdiction will formally adopt and promulgate the NHMP. From here, each jurisdiction will have overall responsibility for ensuring that the plan is being implemented accordingly. In so doing, they will gain eligibility for Flood Mitigation Assistance, Hazard Mitigation Grant Program and Pre-Disaster Mitigation program funds.

Five County Association of Governments staff will ensure that a regular review and update of the Plan occurs annually. Each jurisdiction adopting the Plan will be engaged in monitoring and evaluating the progress of the mitigation strategies in their area of expertise. This is to say that they will review each goal and objective to determine their relevance to changing situations at the jurisdiction level to ensure they are addressing current and expected conditions. They will also review the risk assessment portion of the Plan to determine if this information should be updated or modified. From here, Five County Association of Governments will be responsible for incorporating the changes and updates to the Plan.

Requirement §201.6(c)(4)(ii): [The plan **shall** include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans.

Each participating jurisdiction addresses planning goals and legislative requirements through its comprehensive land use plan and associated zoning regulations, capital improvement plans, and building codes. The Natural Hazard Mitigation Plan is non-regulatory in nature and provides a series of recommendations; many of which are closely related to the goals and objectives of existing planning programs. The overall intent of the NHMP is that each jurisdiction will incorporate the recommended mitigation action items into existing programs and procedures in

a variety of ways. In so doing, it will help address land-use planning goals which are developed to protect life and property. Ultimately, the NHMP can be used as an avenue to update their associated planning documents to address natural hazards.

Many of the mitigation strategies provided herein are directly related in context to the built environment. This being said, it will become very important for each respective county building, planning, and engineering departments to be diligent in their administration/enforcement of applicable building standards. Another significant opportunity for proliferation of hazard mitigation efforts is at the capital improvement level. The authors of this plan sincerely hope that jurisdictions will use the planning, research, and mapping materials provided herein, in their capital improvement due-diligence efforts. This continued diligence will undoubtedly enable risk reduction measures to be implemented at the time of development, which is the most optimal time for natural hazard mitigation.

Ultimately, this Plan shall serve as the impetus for jurisdictions to further evaluate natural hazards within their respective community. Ideally, this evaluation will translate into more stringent legislative actions being adopted which will provide the legal authority for hazard risk analysis and mitigation efforts.

Requirement §201.6(c)(4)(iii): [The plan maintenance process **shall** include a] discussion on how the community will continue public participation in the plan maintenance process.

Five County Association of Governments is dedicated to involving the public directly in the continual reshaping and updating of the Hazard Mitigation Plan. The financial and personnel resources, however, for an extensive public involvement process make this endeavor extremely difficult. Nevertheless, every five years, during the process of updating the plan, Five County staff will enable opportunities for the general public to be involved with the Plan. This involvement will be through notification in area newspapers of general circulation, postings on the Five County web site, and an online Natural Hazards Questionnaire. These opportunities will enable the public to be involved in the process and to provide feedback. Copies of the Plan will be accessible to all members of the public; they will be catalogued and kept at each respective jurisdiction's public offices. The Plan includes the address and phone number of Five County Association of Governments, who will be responsible for keeping track of public comments and concerns with regard to the Plan.

WHO WILL BENEFIT FROM THIS MITIGATION PLAN?

All mitigation occurs at the local level, and the primary responsibility for development and implementation of risk reduction strategies and policies lies with the local jurisdictions. This Natural Hazard Mitigation Plan affects the jurisdictions in the Five County region, including all rural, unincorporated communities. While this Plan has no direct influence over the affiliated jurisdictions, it provides the framework for planning for natural hazards in the region. The

resources and information provided pertain to all areas within the region and the recommendations can lay groundwork for localized mitigation plans and partnerships.

BACKGROUND

This chapter details the formal processes that will ensure the Five County Association of Government Natural Hazard Mitigation Plan remains an active and relevant document. This chapter provides a description of how the mitigation strategies identified in this Plan will be prioritized, implemented, and administered by participating jurisdictions. Ultimately, the Plan will be implemented through existing planning mechanisms (existing plans, programs and policies); such as, County comprehensive land use plans, capital improvement plans, and building codes. The success of this Plan will be measured on how well the outlined mitigation strategies are implemented. This will be accomplished by participating jurisdictions: 1) formally adopting the Plan, then conducting 2) further natural hazards evaluation within the respective community, and finally, 3) the evaluation will translate into more stringent legislative actions being adopted which will provide the legal authority for hazard risk analysis and mitigation efforts.

> ***Requirement §201.6(c)(3)(iii):*** [The mitigation strategy section **shall** include] an action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization **shall** include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.

MITIGATION STRATEGY: ECONOMIC ANALYSIS

Determining the economic feasibility of mitigating natural hazards provides decision makers with an understanding of the potential benefits and costs of a mitigation strategy, as well as a basis upon which to compare mitigation strategies. By design, the majority of mitigation strategies provided in this Plan are general in nature. The reasoning behind this lies in the fact that this Plan is non-regulatory in nature. Further, financial resources are scarce for each of the jurisdictions in the Five County region; nonetheless, the burden of planning and implementing site-specific projects rests upon the respective jurisdiction.

FEMA's methods of identifying the costs and benefits associated with natural hazard mitigation strategies fall into two general categories; benefit-cost analysis and cost-effectiveness analysis. Conducting benefit-cost analysis for a mitigation strategy can assist in determining whether a strategy is worth undertaking now, in order to avoid disaster related damages later. Cost-effectiveness analysis evaluates how best to spend a given amount of money to achieve a specific goal.

This section is not intended to provide a comprehensive benefit-cost analysis, nor is it intended to provide an economic analysis to evaluate local projects. It is intended to 1) raise benefit-cost analysis as an important issue, and 2) provide some background on how economic analysis can be used to evaluate mitigation projects. While not easily accomplished, there is value in assessing the positive and negative impacts from mitigation activities and obtaining an instructive benefit-cost comparison. Otherwise, the decision to pursue or not pursue various mitigation strategies would not be based on an objective understanding of the net benefit of loss associated with these actions.

BENEFIT-COST ANALYSIS

Benefit-cost analysis is a key method used by FEMA and other state and federal agencies in evaluating hazard mitigation projects. FEMA Publication 386-5, *Using Benefit-Cost Review in Mitigation Planning (May 2007),* outlines approaches for conducting economic analysis of natural hazard mitigation projects. It describes the importance of implementing mitigation activities, different approaches to economic analysis of mitigation strategies, and methods to calculate costs and benefits associated with mitigation strategies. Benefit-cost analysis is used in natural hazards mitigation to illustrate if the benefits to life and property protected through mitigation efforts exceed the cost of the mitigation activity.

The mitigation strategies provided in this Plan were proliferated through a process that emphasized a review of costs and benefits of each respective strategy. This process resulted in a streamlined prioritization process using the principle that those mitigation strategies which carry a smaller price tag have a higher degree of achievability, and thus easier to implement. To assess the measurable and non-measurable benefits and costs associated with each mitigation strategy provided in this Plan, the Review Tools illustrated in FEMA Publication 386-5 were utilized. Each mitigation strategy was based upon a measurement of: 1) Vulnerability, 2) Benefits, and 3) Costs. This measurement was based upon the quantitative data generated through the GIS analysis. Effectively, data collection resulted in mapping generation sufficient to quantitatively assess regional natural hazards. From here, GIS software then quantified the number of units and total market value for all structures located within each defined hazard area.

The theoretical assumption made in prioritizing mitigation strategies herein rests upon the premise that a natural hazard which has the highest amount of possible financial loss would also possess a higher probability of loss of life. Further, using the assumption that a natural hazard occurred at maximum levels of destruction (intensity and range); we can also assume that the benefits of conducting mitigation actions to prevent said losses would be a top priority. Lastly, the assumption was made that the strategies which carry a smaller price tag have a higher degree of achievability; thus having a higher degree of benefit. This being said, implementation of a mitigation strategy which requires a minimal financial contribution carried a higher weight, resulting in a higher priority. The resulting mitigation strategies for each respective county-level hazard were all prioritized with these attributes in mind.

MITIGATION STRATEGY: PRIORITIZATION

Mitigation strategies reduce the cost of disasters by minimizing property damage, injuries, and the potential for loss of life which would otherwise be incurred in the event of a natural disaster. Evaluating natural hazard mitigation provides decision makers with an understanding of the potential benefits and costs of an activity, as well as a standpoint to compare alternative projects.

Evaluating mitigation strategies is a complex and difficult process which is influenced by many variables. First, natural disasters affect all segments of the community, including citizens, businesses, and public services. Second, while some of the direct/indirect costs of natural disaster damages are measurable, some of the costs are non-financial; therefore, they are difficult

to financially quantify. Third, many of the impacts associated with a natural disaster have compounding effects on the community, which in turn increases social and economic impacts a disaster may have.

The mitigation strategies provided in this Plan are listed in accordance to their respective natural hazard and prioritized in the following manner:

1) Each natural hazard is evaluated at each respective county level.
2) At the county level, a natural hazard with the highest amount of possible financial loss is listed at the beginning of the mitigation strategies, with those of lesser financial loss listed in subsequent order.
3) Once the possible financial loss is calculated for each respective hazard and ordered as detailed in #2 above, the mitigation strategies are then prioritized with those requiring a minimal financial contribution at the beginning of the hazard mitigation strategies and those with higher funding requirements or unknown funding requirements listed towards the end of the prioritization for that specific hazard.

The theoretical assumption made in prioritizing mitigation strategies herein rests upon the premise that a natural hazard which has the highest amount of possible financial loss would also possess a higher probability of loss of life. Further, using the assumption that a natural hazard occurred at maximum levels of destruction (intensity and range); we can also assume that the benefits of conducting mitigation actions to prevent said losses would be a top priority. Lastly, the assumption was made that the strategies which carry a smaller price tag have a higher degree of achievability; thus having a higher degree of benefit. This being said, implementation of a mitigation strategy which requires a minimal financial contribution carried a higher weight, resulting in a higher priority. The resulting mitigation strategies for each respective county-level hazard were all prioritized with these attributes in mind.

PRIORITIZATION USING THE FEMA STAPLEE METHOD

In addition to the above mentioned prioritization method, mitigation strategies were selected and prioritized utilizing the concepts of the STAPLEE explained in FEMA 386-3. Normally used to evaluate alternative mitigation strategies for a single identified problem, the STAPLEE process was used as a rational basis to determine the prioritization of each mitigation strategy. Each respective County level NHMP Planning Team believes that using the STAPLEE provided a reasonable and objective means to determine relative priority of the mitigation strategies identified in this plan. The STAPLEE process allows for a review of each strategy based upon the following considerations:

- **Social**- Is the proposed action/project socially acceptable to the community and does it unfairly affect one segment of the community?
- **Technical**- Is the action/project feasible from a technical standpoint? Can it be accomplished using available engineering practices?
- **Administrative**- Is there adequate staffing, funding and maintenance available for the proposed mitigation project?

- **Political**- Is there political support for the proposed action/project?
- **Legal**- Does the jurisdiction possess the appropriate legal authority to undertake the action/project?
- **Economic**-Are there sources of funding to accomplish the action/project? What benefits does the action/project provide and are the estimated costs in line with the benefits the action/project would provide?
- **Environmental**-Will the proposed action/project have an adverse effect on the environment (land, water, endangered species) and will the action/project comply with applicable environmental laws?

These factors were all considered in determining the relative priority for each mitigation strategy listed in each respective county level mitigation strategies section. The resulting mitigation strategies, listed in accordance with their respective natural hazard, are presented in an effort to provide macro-level risk reduction.

MITIGATION STRATEGY: IMPLEMENTATION & ADMINISTRATION

This Natural Hazard Mitigation Plan is non-regulatory in nature and provides a series of recommendations, many of which are closely tied to existing planning mechanisms. The authors of this Plan sincerely hope that each participating jurisdiction will incorporate the recommended mitigation strategies into existing programs and procedures. The police powers afforded to jurisdictions enable the protection/ preservation of health, safety, and welfare within the community. This plan serves the purpose of accomplishing these goals by protecting life and property from natural disasters and hazards. This Plan provides an inventory of known areas of natural hazards in an effort to encourage development to be limited by the degree to which the natural hazard occurs within the areas of proposed development. Additionally, the jurisdiction can use this Plan as a resource in their development of a Natural Hazards element in their jurisdictional general plan, which will in turn precipitate more stringent zoning regulations and/or planning documents.

Many of the mitigation strategies provided herein are directly related in context to the built environment. This being said, it will become very important for each respective county building, planning, and engineering departments to be diligent in their administration/enforcement of applicable building standards. Another significant opportunity for proliferation of hazard mitigation efforts is at the capital improvement level. This Plan provides planning, research, and mapping materials, which can be used in a jurisdictions capital improvement due-diligence efforts. This continued diligence will undoubtedly enable risk reduction measures to be implemented at the time of development, which is the most optimal time for natural hazard mitigation.

NHMP Mission: to substantially reduce the vulnerability of communities, within the region, to natural hazards.

Ultimately, this Plan shall serve as the impetus for jurisdictions to further evaluate natural hazards within their respective community. Ideally, this evaluation will translate into more stringent legislative actions being adopted which will provide the legal authority for hazard risk analysis and mitigation efforts.

Requirement §201.6(c)(2)(i): [The risk assessment **shall** include a] description of the…location and extent of all natural hazards that can affect the jurisdiction. The plan **shall** include information on previous occurrences of hazard events and on the probability of future hazard events.

WHY PLAN FOR NATURAL HAZARDS?

Across the United States, natural hazards cost communities billions of dollars, taking a toll on the built environment, human life, and the local economy. The Five County region of southwestern Utah is no exception. Since its settlement in the mid 1800s, the region and its residents have been subject to financial loss and property damage from flooding, landslides, wildfires, and severe weather. Using the past as an indicator, it is fair to presume that natural hazards will inevitably impact the region in the future. This fact illustrates the critical need for strategies to reduce risk from natural hazards.

> It's interesting how there's never enough money to prevent problems, but we always find the money to correct problems.
> -Unknown Author

Events such as flooding and wildfires are part of natural processes. They become natural disasters when they impact the built environment. The growing population of the region highlights the interface between people, property, and the natural environment, and places them at risk from natural hazards. The population table listed below illustrates the rapid population growth experienced in the Five County region over the past 10 years. As a whole the region saw an increase in population of 88,800 or 64.5%. Iron and Washington counties experienced the most dramatic amount of population growth. This is in large part due to the uniquely dynamic economy stimulated by the abundance of environmental resources found within the area. And it's not likely that the growth will stop there. According to population estimates provided by the Governor's Office of Planning and Budget, by 2050 the population of the region is projected to be 891,890 or an increase of 294% from the 2009 population.

Population: Five County region

County	2009	1999	Population change	% change
Washington	159,084	88,105	70,979	80.6%
Iron	49,080	32,879	16,201	49.3%
Kane	6,703	6,073	630	10.4%
Beaver	6,547	5,951	596	10.0%
Garfield	5,044	4,650	394	8.5%
Total	226,458	137,658	88,800	64.5%

Source: Governor's Office of Planning and Budget: 2008 Baseline Projections

DEMOGRAPHICS

The Five County region has changed dramatically over the course of the past decade. As illustrated above, the late 90's and early 00's brought a population boom to most of the area. Although the five counties of the southwestern Utah share common geographic boundaries, the economic make-up of the individual counties varies considerably. The three counties that share access to Interstate 15 (Beaver, Iron and Washington) exhibit more diverse economic bases and more resilient economies. The two more remote counties (Garfield and Kane) are dependent upon tourism as their primary economic base. Recreational uses have grown in importance to the region, driving population growth and providing the bases for an increasingly important tourism sector of the regional economy.

The Five County region's economy may be vulnerable to natural hazard events if highways, streets and railroads become impassable due to flooding, landslides, wildfires, earthquakes or other natural hazard events. The southwestern portion of Utah is traversed by Interstate 15, U.S. Highway 89 and several State Highways. These roadways bring visitors in and through our area and provide access for residents. Employees would be unable to get to work while products and business inventory, including perishable foods, would be stalled along the way. The region's tourism industry would be impacted as well. As business and industry recover from inventory damage, transportation delays, disruption of communication and utilities, and ultimately loss of customers in the wake of a natural hazard event, the entire region can suffer severe economic consequences.

THE FIVE COUNTY LANDSCAPE

The geography and environment of a region play important roles in community planning. As towns, cities, and counties develop, planners must consider the "lay of the land" and the many environmental issues that come with it. The Five County region has many unique issues pertaining to its distinct geography and environment. As such, it is vitally important that we understand the land on which we develop, and its accompanying limitations and potential problems.

The Five County region is mostly semi-arid and generally dry. The aridity in the region is accentuated by its lower latitude, which makes it warmer than most regions to the north. Much of this area is characterized by lower elevation, which also increases the mean annual temperature. Though scholars classify most of the region as "desert," only the areas with lower elevations are considered "hot" deserts, or regions where the winters average above 32 degrees

Fahrenheit. This would include most of Washington County which usually does not have snow in the winter, and has extremely warm summers. The rest of the region, which consists of higher elevations, is considered to be a "cool" desert, with snowy winters and warm summers. Some exceptions exist over the highest elevations, mountainous regions such as Brian Head, which are classified as "undifferentiated highlands" since they experience cooler temperatures and higher humidity than the rest of the area. These mountainous regions generally have very cold, snowy winters and cool summers.

The nature of the climate in this region leaves it susceptible to a few severe weather occurrences. Although most of the country is subject to flash floods, they are particularly damaging in this region since the soil is dry, somewhat un-vegetated, and easily eroded. Threats to human life and damage to property are not only a result of rapidly rising waters, but of catastrophic mud slides as well. Mountainous areas of the region possess a higher potential for blizzards, cold spells, and avalanches in the winter. The entire region is susceptible to fires resulting from lighting strikes in the spring and summer.

The Five County region contains two major physiographic provinces. Most of Beaver, Iron, and Washington County lay within the Basin and Range province, which generally consists of north-south trending mountain ranges separated by broad arid valleys with interior drainage. Garfield and Kane counties are located in the Colorado Plateau, which consists of uplifted sedimentary rock strata. The soil in this area consists mostly of aridisols, an iron rich desert soil that can be quite productive if cultivated. Native to the valleys throughout most the region is a variety of grasses, junipers, and pinion pines, while xerophytes and desert scrub are native to the lower elevations.

The Five County region is also speckled with a variety of topographic features. Some of this area has experienced a great amount of volcanic activity, which is evident in extinct volcanoes, mountains, great lava fields, and mesas. Geologic forces have uplifted huge portions of the land, and have created great rifts in others. Of particular notoriety are the erosive features of the area including the great canyons and cliffs carved by water and wind that make up the numerous national and state parks.

THE PLAN

Requirement §201.6(c)(2): The plan shall include a risk assessment that provides the factual basis for activities proposed in **the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable** the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.

The Five County Natural Hazard Mitigation Plan compiles data for nine natural hazards and establishes mitigation goals and activities that should be revisited annually. Updating the Plan allows for the introduction of new data and technical resources, and maintains strong ties between cooperating agencies, organizations, non-profits, and governments. The continuous integration of new knowledge improves the assessment of each of the hazards in this plan, and improves the region's ability to plan for, and withstand, the impacts of natural hazard events.

Conducting a hazard assessment can provide information on the location of the hazard, the value of existing land and property in the hazard location, and an analysis of risk to life, property and the environment that may result in a natural hazard event. Specifically, the three levels of hazard assessment are:

1. **Hazard Identification** identifies the geographic context of the hazard, the intensity of the hazard, and the probability of its occurrence. Maps are frequently used to display hazard identification data.
2. **Vulnerability Assessment** combines hazard identification with an inventory of the existing property and population exposed to a hazard.
3. **Risk Analysis** involves estimating the damage, injuries, and financial losses likely to be sustained in a geographic area over a given period of time.

Hazard assessments are subject to the availability of hazard specific data. Gathering of data for a hazard assessment requires a commitment of resources on the part of participating organizations and agencies. Each hazard specific section of this Plan includes a section on hazard identification using data and information from county or state agency sources.

CHRONIC NATURAL EVENTS

Chronic hazards occur with some degree of frequency and include flooding, landslides, severe weather, wildfires, problem soils, drought, and radon gas. These hazards impact communities with devastating economic consequences. The following is a summarization of natural hazard events occurring in the Five County region.

FLOODING

In the southwest, as elsewhere, flooding, erosion, and sediment discharge are responsible for loss of life, land, and infrastructure, along with damage to reservoirs and natural habitats. Stream

flooding is the most prevalent and destructive (annually) of the geologic hazards that affect Utah. This destructive trend is nowhere more evident than in the southwest part of the state. During the period of April 28, 2005 until June 29, 2005, frequent rainfall events, warm spring temperatures, and abundant snowpack melting at accelerated rates resulted in significant flooding and numerous landslide events in nine Utah Counties and two Indian Reservations. As pertaining to this region, Beaver, Iron and Kane counties experienced damages when large peak discharges, as a result of near record snowpacks, were encountered in the Sevier River basin. This resulted in substantial damage to public and private property. A Presidential Disaster Declaration was declared on August 1, 2005.

A stalled storm system containing abundant moisture caused significant flooding in Washington and Kane Counties between January 8-12, 2005. Higher snowfall and water equivalent totals equaled 70" at Cedar Breaks, and 60" at Kolob-Zion National Park. It is estimated that $300 million dollars in damages was sustained along the Santa Clara and Virgin Rivers. 30 homes were destroyed in the flood and another 20 homes were significantly damaged(NCDC, 2005). One fatality associated with this event resulted when a man and his wife in their vehicle were caught in floodwaters in the Red Cliff Recreation Area near the Quail Creek Reservoir. Six other injuries were reported. A Presidential Disaster Declaration was declared on February 1, 2005. .

The Quail Creek Dam, located in Washington County, failed in the early hours of January 1, 1989. In the months prior to the failure, leakage of the dam was the result of the solubility of the gypsum in the soil, which dissolved some of the mechanisms used to transport water. Water released by this dam failure entered the Virgin River and destroyed a bridge on Utah 9 in Hurricane. Failure of the dam resulted in losses to agriculture, livestock, public facilities, roads, bridges, and golf courses. Additionally, 30 homes, 58 apartments and 9 businesses were flooded. Estimates placed the total damage at $11,959,732.

In 1984 statewide flooding occurred which resulted in serious property damage in the Five County region. As a result of greater than average snow pack and above normal precipitation, the Beaver River, near Beaver City, flooded on May 24, 1984. The flooding resulted in property damages estimated at $2,380,952.

LANDSLIDE

Nationwide, estimated losses from damaging landslides equal $3.5 billion annually (USGS, 2005). In Utah, documented losses from damaging landslides in 2001 exceeded $3 million, including the costs to repair and stabilize hillsides along state and federal highway (Ashland, 2003). Total landslide dollar losses are hard to determine from past events because a standard for documenting them do not exist. Several state and local agencies track landslide losses with inconsistent formats often resulting in several different totals for a single event.

During the period of April 28, 2005 until June 29, 2005, frequent rainfall events, warm spring temperatures, and abundant snowpack melting at accelerated rates resulted in significant flooding and numerous landslide events in nine Utah Counties and two Indian Reservations. As pertaining to this region, Beaver, Iron and Kane counties experienced damages when large peak discharges, as a result of near record snowpacks, were encountered in the Sevier River basin. This resulted in substantial damage to public and private property. A Presidential Disaster Declaration was declared on August 1, 2005.

On March 12, 2005 a 100 ft. long by 60 ft. high vertical stream-cut along Kanab Creek failed. This rock fall occurred within the city limits of Kanab, killing one boy and partially burying tow children. This earth-fall type landslide was most likely the result of long-term gravitational effects on over-steepened, unconsolidated material in the arroyo walls (Lund, 2005).

SEVERE WEATHER

The term severe weather, as it pertains to this plan, is used to represent a broad range of weather phenomena which affect southwestern Utah, namely; downburst, lightning, heavy snowstorms, avalanches, and tornados. Severe weather events are the most deadly type of natural hazard in Utah. Interestingly, more people have died in avalanches in Utah than by any other natural hazard. Between 1958 and 2006 avalanches killed 85 people.

Since 1950, lightning has killed 60 people statewide and injured another 144. In southwestern Utah the most common type of severe weather activity is related to lightning. Since 1950 a total of 5 lightning deaths and 10 lightning injuries have been recorded within the region.

A tornado is a violently rotating column of air extending from a thunderstorm to the ground. Most tornados have winds less than 112 miles per hour and zones of damage less than 100 feet wide. According to the National Weather Service, a total of 12 tornados have been observed in southwestern Utah. Of this amount, Iron and Beaver counties contain the highest amounts at 5 and 4 respectively.

A stalled storm system containing abundant moisture caused significant flooding in Washington and Kane Counties between January 8-12, 2005. Higher snowfall and water equivalent totals equaled 70" at Cedar Breaks, and 60" at Kolob-Zion National Park. It is estimated that $300 million dollars in damages was sustained along the Santa Clara and Virgin Rivers. 30 homes were destroyed in the flood and another 20 homes were significantly damaged. One fatality associated with this event resulted when a man and his wife in their vehicle were caught in floodwaters in the Red Cliff Recreation Area near the Quail Creek Reservoir. Six other injuries were reported. A Presidential Disaster Declaration was declared on February 1, 2005. .

WILDFIRE

When discussing wildfires it is important to remember that fires are part of a natural process and are needed to maintain a healthy ecosystem. Since its settlement in the mid 1800s, the region and its residents have been subject to the annual threat of wildfire. This is in large part due to the environmental conditions, namely low annual precipitation and high amount of public lands. Lightning is the primary cause of wildfire in the Five County region. However, the potential risk for human caused fires increases as more people move into the wildland urban interface.

Many of Utah's wildland urban interface areas are located in our most fire prone wildland fuels. Generally, these fuels are found on drier, lower elevation sites which are often very desirable for real estate development. To address these issues, a multi-jurisdictional group of agencies, organizations, and individuals collaborated to develop the *Southwest Utah Regional Wildfire Protection Plan* (October 2007). The purpose of this plan is to be a tool in the effort to protect human life and reduce property loss due to catastrophic wildland fires in the communities and surrounding areas located in the southwest Utah counties of Beaver, Garfield, Iron, Kane and Washington. Specific hazard identification, assessment of vulnerability, and mitigation measures will be provided in each respective County specific chapter found within this NHMP.

PROBLEM SOILS

Humans have no influence on the distribution of problem soil and rock, but their activities are often adversely affected by them. As a result, urbanized areas of southwestern Utah are susceptible to damage from these deposits. As development encroaches on less suitable terrain, damage from problem soil and rock has, and will increase. Detailed geotechnical studies are needed in areas of problem soil and rock to identify and mitigate potential problems, and avoid costly corrective measures. Six types of problem soil and rock are present in southwestern Utah. Expansive soil and rock is the most extensive. Most expansive soil problems are related to bentonitic shales near St. George.

Collapsible soil has caused extensive damage in and around Cedar City. Holocene alluvial fan and debris flow deposits are the sources of collapsible soil in southwestern Utah. Soil and rock containing gypsum are also susceptible to subsidence. Ground water and introduced waters from irrigation dissolve gypsum causing subsidence.

Limestone susceptible to dissolution and subsidence occurs south of St. George. Structures have not been damaged by ground collapse or subsidence related to limestone karst, but because karst ground-water systems have little filtering capacity, contamination of ground water is a major concern. In fine-grained Holocene incised by streams piping is a common problem. Collapse of soil pipes and subsequent erosion has damaged roads and agricultural land. Sand dunes in the Escalante Desert and west of Kanab can migrate across roads and bury structures in areas where active dunes are present. (Excerpted from Lund, UGS unpublished information)

DROUGHT

Drought information in Southwest Utah is based upon the Palmer Drought Severity Index Chart. The Palmer Index was developed by Wayne Palmer in the 1960s and uses temperature and rainfall information in a formula to determine dryness – it has become the semi-official drought index used today. The Palmer Index is most effective in determining long term drought. The advantage of Palmer Index is that it is standardized to local climate, so it can be applied to any part of the country to demonstrate relative drought or rainfall conditions. The negative is that it is not as good for short term forecasts, and is not particularly useful in calculating supplies of water locked up in snow (NOAA's Drought Information Center).

There are four Climate Divisions in Southwest Utah based: Division 1 – Western, Division 2 – Dixie, Division 4 – South Central, and Division 7 – Southeast.

Division 1- The Western Division comprises 4,290 square miles or 24% of the total land area of the Five Counties, and is found in the western parts of Beaver, Iron, and Washington counties. Historically the Western Division has followed a drought pattern of normal to wet for 20 years, then having a severe to extreme drought problem that persist for six or seven years. However, 17 of the last 20 years have been severe to extreme drought.

Division 2- The Dixie Division comprises 1,423 square miles or 8% of the total land area of the Five Counties, the majority is found in Washington County with a small portion found in Kane County. Dixie Division has had three major drought periods since 1895, with the third one currently happening. The last two lasted at least seven years each and were about 50 years apart.

Division 4- The South Central Division comprises 9,097 square miles or 52% of the total land area of the Five Counties. The South Central Division is found in all five counties, mainly found in the central part of the Five Counties. The South Central Division has been pretty consistent throughout the 100+ years of record keeping. Until the mid 60's there has been a period of drought every 20 years on average, after the mid 60's the droughts have been more frequent, primarily every 10 to 15 years.

Division 7- The Southeast Division comprises 2,813 square miles or 16% of the total land area of the Five Counties. The Southeast Division is found in the eastern half of Kane and Garfield counties. The Southeast Division had an eight year drought just as the other divisions did. Between 1896 to 1904 it was in the extreme part of the index. After this long extreme drought there were basically fifty years of normal to wetter than normal years followed by a four year

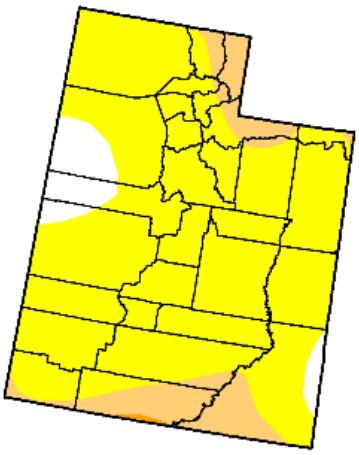
drought in the mid fifties. Since the drought in the mid fifties there has been a two to three year extreme drought every 10 to 13 years.

U.S. Drought Monitor
Utah

February 23, 2010
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	6.4	93.6	11.6	0.3	0.0	0.0
Last Week (02/16/2010 map)	5.5	94.5	12.3	0.3	0.0	0.0
3 Months Ago (12/01/2009 map)	34.7	65.3	18.8	3.2	0.0	0.0
Start of Calendar Year (01/05/2010 map)	29.2	70.8	18.8	3.2	0.0	0.0
Start of Water Year (10/06/2009 map)	69.3	30.7	3.6	0.0	0.0	0.0
One Year Ago (02/24/2009 map)	55.7	44.3	15.4	0.0	0.0	0.0



Intensity:

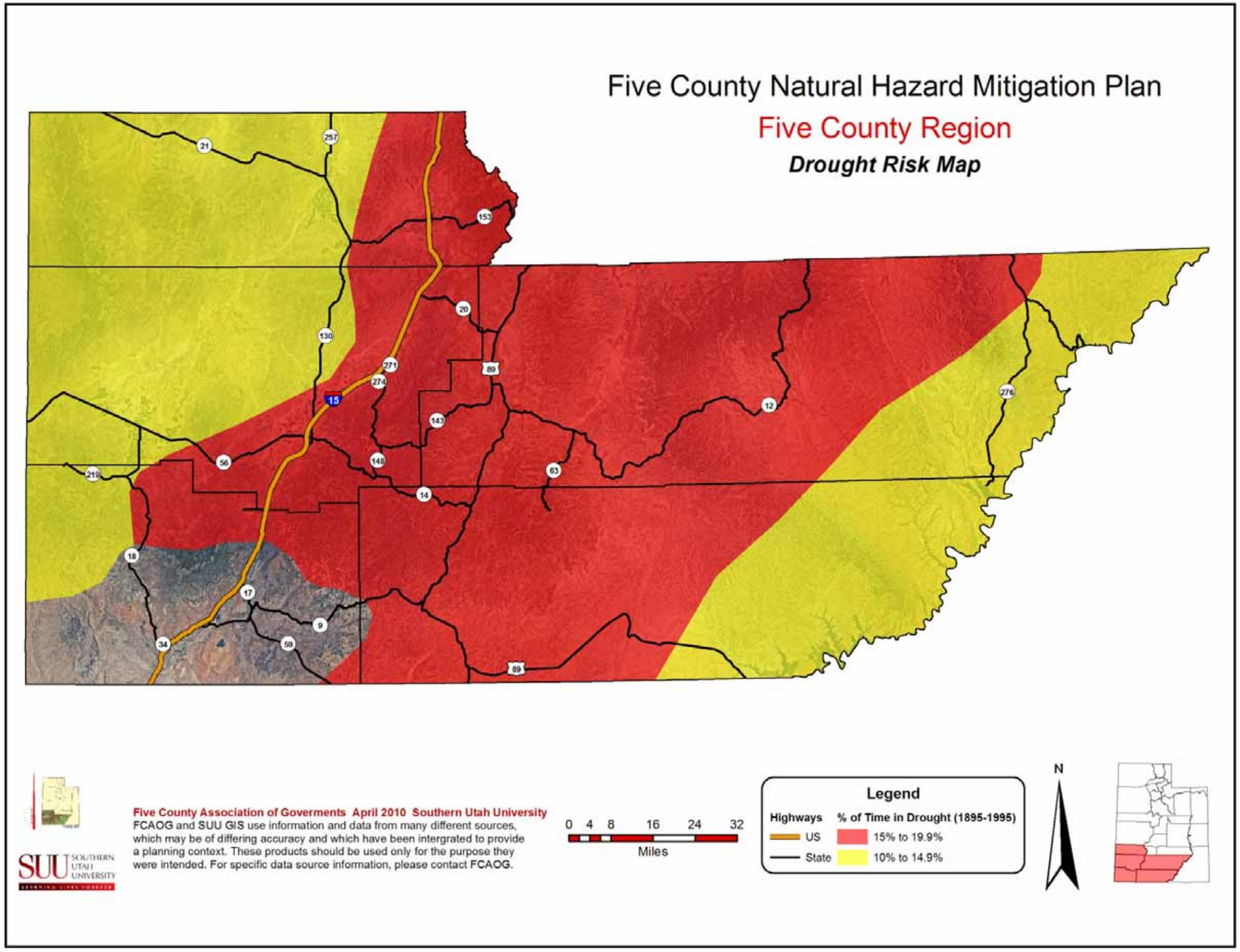
- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements

http://drought.unl.edu/dm

Released Thursday, February 25, 2010
Author: Brad Rippey, U.S. Department of Agriculture

In summary, the drought history of the four different divisions in the Five County area has been very similar, with the exception of the Southeast division. The Southeast Division is a bit different than the other Divisions, instead of a longer period in-between a drought and then followed with a drought lasting between five to eight years; the Southeast has a shorter period in-between a drought and the droughts are only 2 to 3 years long. As of February 2010, the Five County region as a whole is categorized as "Abnormally Dry" and "Drought-Moderate". In regards to drought intensity, both of these categorizations are at the lower end of the spectrum.


Five County Natural Hazard Mitigation Plan
Five County Region
Drought Risk Map
Five County Association of Goverments April 2010 Southern Utah University
FCAOG and SUU GIS use information and data from many different sources, which may be of differing accuracy and which have been intergrated to provide a planning context. These products should be used only for the purpose they were intended. For specific data source information, please contact FCAOG.
0 4 8 16 24 32
Miles
Legend
Highways
US
State
% of Time in Drought (1895-1995)
15% to 19.9%
10% to 14.9%
N

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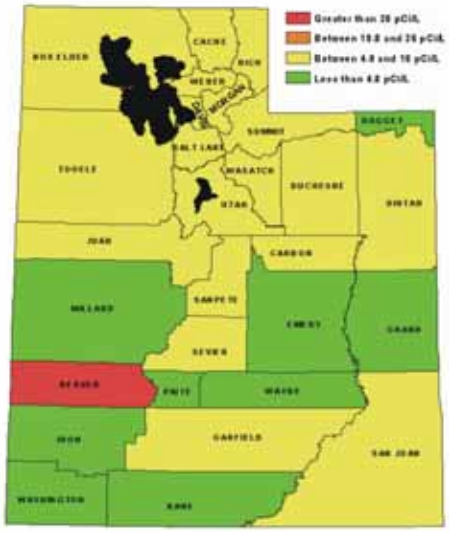
RADON GAS

Radon is a radioactive gas of geologic origin that is found in many buildings in sufficient concentrations to represent a health hazard to building occupants. Radon is an odorless, tasteless, and colorless radioactive gas which forms as a product in three radioactive decay series. Most common of these is the uranium-decay series. In nature, radon is found in small concentrations in nearly all rocks and soils. Potential radon-hazard areas in southwestern Utah are widespread, and are generally underlain by silicic igneous rocks of low-grade metasedimentary deposits.

Surveys conducted by the Utah Department of Environmental Quality/Division of Radiation Control indicate that 20% of homes in Utah are at concentrations above the U.S. Surgeon General's guidance of 4.0 pCi/L. Despite this relative high percentage, radon gas remediation is relatively simple and inexpensive. However, it can become a laborious process because the only way to know if a building is subject to radon hazard is for that building to be tested.



Installing a radon resistant system during the construction of a new home is not difficult, nor is it very expensive if a small amount of planning is done in advance. Furthermore, the skills needed for installing the various parts of these systems are skills already available within existing trades used during construction of a typical new home. Installing radon reduction systems during construction makes good sense and provides a healthy home for years to come; however, if a home is constructed without a radon reduction system there are many cost effective methods which can be implemented to minimize the hazards. The quickest way to test is with short-term tests. Short-term tests remain in the home for two days to 90 days, depending on the device. For example, charcoal canister detectors are most commonly used for short-term testing and provide results quickly. For purposes of this document, citizens in the Five County region should be encouraged by local building officials to evaluate the radon levels associated with their homes.

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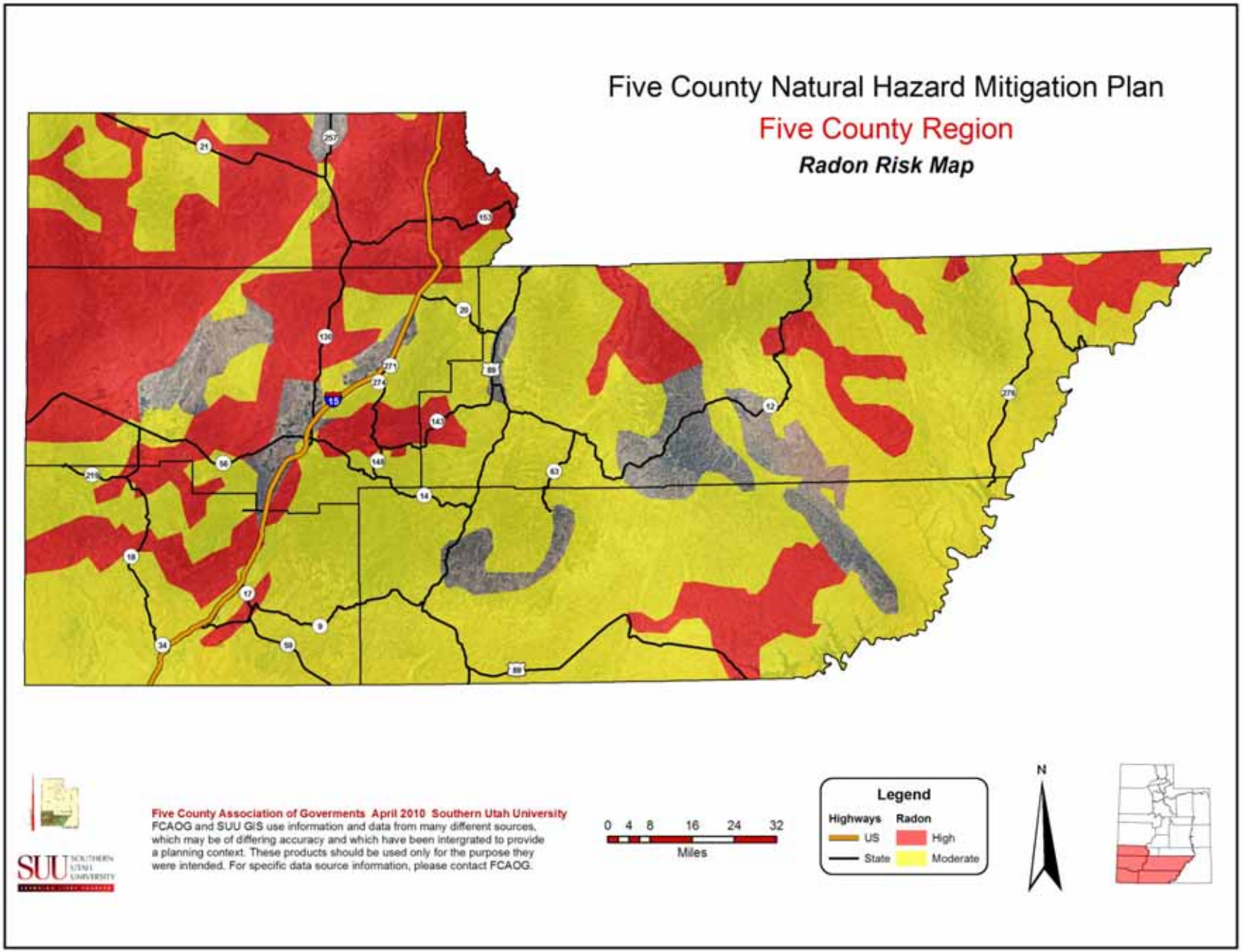
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0 4 8 16 24 32
Miles
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Highways
US
State
Radon
High
Moderate
N

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CATASTROPHIC NATURAL HAZARD EVENTS

Catastrophic events do not occur with the same frequency as chronic hazards, but can have devastating consequences. Earthquakes and volcanoes are two types of catastrophic hazards. These types of natural hazards are difficult to predict, affect a wide geographic area, and can severely impact entire regions.

EARTHQUAKE

In Utah most earthquakes are associated with the Intermountain seismic belt (Smith and Sbar, 1974; Smith and Arabasz, 1991), an approximately 160-kilometer-wide (100 miles), north-south trending zone of earthquake activity that extends from northern Montana to northwestern Arizona. Since 1850, there have been at least 16 earthquakes of magnitude 6.0 or greater within this belt (Eldredge and Christenson, 1992). Included among those 16 events are Utah's two largest historical earthquakes, the 1901 Richfield earthquake with an estimated magnitude of 6.5, and the 1934 Hansel Valley magnitude 6.6 earthquake, which produced Utah's only historical surface fault rupture. In an average year Utah experiences more than 700 earthquakes, but most are too small to be felt. Moderate magnitude (5.5 – 6.5) earthquakes happen every several years on average, the most recent being the magnitude 5.8 St. George earthquake on September 2, 1992. Large magnitude earthquakes (6.5 – 7.5) occur much less frequently in Utah, but geologic evidence shows that most areas of the state within the Intermountain seismic belt, including southwestern Utah, have experienced large surface-faulting earthquakes in the recent geologic past.

Fault-related surface rupture has not occurred in southwestern Utah historically, but the area does have a pronounced record of seismicity. At least 20 earthquakes greater than magnitude 4 have occurred in southwestern Utah over the past century (Christenson and Nava, 1992); the largest events were the estimated magnitude 6 Pine Valley earthquake in 1902 (Williams and Trapper, 1953) and the magnitude 5.8 St. George earthquakes in 1992 (Christenson, 1995). The Pine Valley earthquake is pre-instrumental and poorly located, and therefore, is not associated with a recognized fault. However, the epicenter is west of the surface trace of the Hurricane fault, so the event may have occurred on that structure. Pechmann and others (1995) have tentatively assigned the St. George earthquake to the Hurricane fault. The largest historical earthquake in nearby northwestern Arizona is the 1959 Fredonia, Arizona, earthquake (approximate magnitude 5.7; DuBois and others, 1982). Since 1987 the northwest part of Arizona has been quite seismically active (Pearthree and others, 1998), experiencing more than 40 events with magnitudes >2.5.

Despite the lack of an historical surface-faulting earthquake in southern Utah, available geologic data for faults in the region indicate a moderate rate of long-term Quaternary activity. Mid-Quaternary basalt flows are displaced hundreds of meters at several locations and alluvial and colluvial deposits are displaced meters to tens of meters in late Quaternary time.

Because earthquakes result from slippage on faults, from an earthquake-hazard standpoint, faults are commonly classified as active, capable of generating damaging earthquakes, or inactive, not capable of generating earthquakes. The term "active fault" is frequently incorporated into regulations pertaining to earthquake hazards, and over time the term has been defined differently for different regulatory and legal purposes. In fact, faults possess a wide range of activity levels. Some, such as the San Andreas fault in California, produce repeated large earthquakes and associated surface faulting every few hundred years, while others, like Utah's Wasatch fault and many of the faults in the Basin and Range Province, generate large earthquakes and surface faulting every few thousand to tens of thousands of years. Therefore, depending on the area of interest or the intended purpose, the definition of "active fault" may change. The time period over which faulting activity is assessed is critical because it determines which faults are ultimately classified as hazardous and therefore in need of regulatory mitigation (National Research Council, 1986).

VOLCANISM

Southwestern Utah experienced prolonged volcanism during the Cenozoic time. Tumultuous eruptions of calc-alkaline volcanics and deposition of volcaniclastic debris dominated early to mid-Cenozoic volcanism. The active volcanic centers in the southwestern district area include the Escalante Deserts in the Basin and Range Province; the High Plateaus and adjacent areas in the Colorado Plateau Province; and the Pine Valley Mountains-St. George Basin and surrounding areas. The youngest vents and flows in southwestern Utah are less than 1,000 years old. Remote eruptive centers present Utah's most imminent and potentially damaging volcanic hazard.

From late Oligocene to early Miocene, stratovolcanoes and caldera complexes generated lavas and layer upon layer of volcaniclastic debris throughout the Basin and Range Province. Straddling the Utah-Nevada border and circling the southern portion of the Needles Range of Beaver and Iron Counties, the Indian Peak caldera complex served as the source for the calc-alkaline volcanics of the 29.5 million year old Wah Wah Springs Formation.

The Bullion Canyon Volcanics and the Mount Belknap Volcanics originated from calderas of the Tushar Mountains in Beaver and Piute Counties. Flows, pyroclastics, and associated rocks from this caldera complex range in age from 25 to 14 million years. South-Central Utah's mid-Cenozoic stratovolcanoes shed volcanistics onto low lands to the south and east, forming an apron of debris that eventually became the southwestern High Plateaus.
Local, violent eruptions of andesitic and rhyolitic materials are no longer a hazard in Utah. Between 8 and 6 million years ago basaltic and rhyolitic magmas formed domes, plugs, cones, and shield-like volcanic features in the Great Basin and Range of Southwest Utah.

These predominately mafic-composition volcanics have augmented the present-day landforms in the three volcanic regions of southwestern Utah. Geomorphically fresh features and textures, geothermal anomalies, and recent eruptive histories present convincing arguments for the continuation of volcanic events in southwestern Utah.

There has been caldera-type eruptive volcanic activity in southwestern Utah dated as occurring in the early Cenozoic period. As the geologic conditions that created those types of eruptions has long since disappeared there is zero chance of their repetition. The current hazard relating to volcanic activity is strictly limited to localized, small, cinder cone basaltic eruptions. According to geologists, the hazard is real, but extremely infrequent and would be limited to a relatively small area. Because of the remote potential of these volcanic events affecting the built environment, and threatening people, this hazard is not considered in the same vein as many of the other natural hazards that this plan addresses.

Local, violent eruptions are no longer a hazard in Utah. Further, it should be noted that there have been no reports of property damaged or human injuries or deaths attributed to any type of volcanic activity in southwestern Utah, since records have been kept. According to geologists, the hazard is real, but extremely infrequent and would be limited to a relatively small area. As the geologic conditions that created those types of eruptions have long since disappeared there is zero chance of their repetition. Because of the remote potential of these volcanic events affecting the built environment, and threatening people, this hazard is not considered in the same vein as many of the other natural hazards that this plan addresses.

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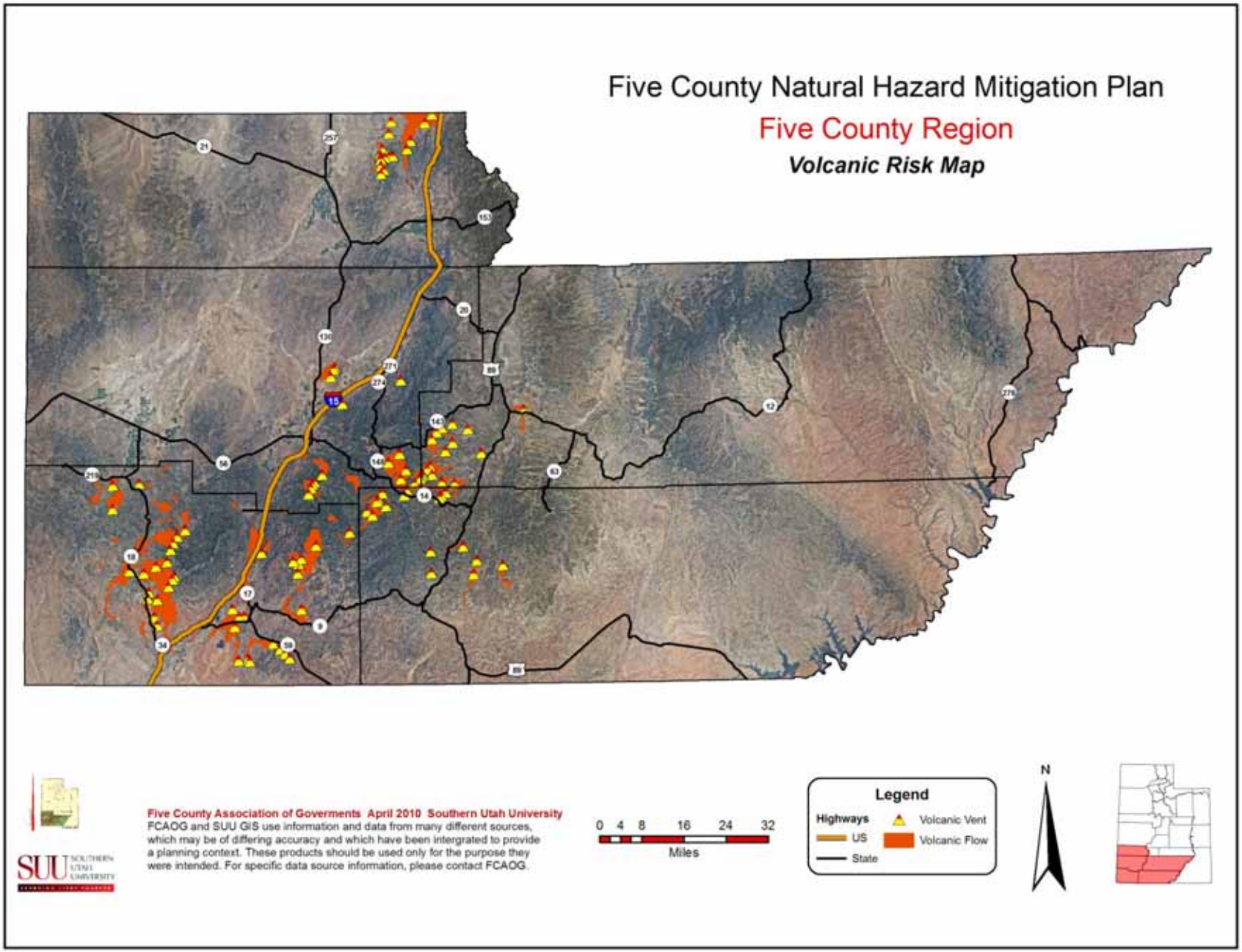
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0 4 8 16 24 32
Miles
Legend
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US
State
Volcanic Vent
Volcanic Flow
N

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DROUGHT

Water is a scarce resource in southwest Utah's semi-arid climate. As the population continues to grow, the demand for water and potential strain on the water supply will also increase and likely compound future drought impacts. By employing sound mitigation strategies, the future water demand of the region may be satisfied without increasing the current susceptibility to drought. The impacts of drought can be comprehensively mitigated through cooperative partnerships and efforts of numerous and varied agencies. With this in mind, the following mitigation strategies are generalized in nature with the knowledge that drought is a macro-level risk. Ideally these mitigation strategies will provide the foundation for more specific, locally determined drought mitigation projects.

Drought Mitigation Strategy #1	
Objective:	To provide education to the general public with regard to drought and water conservation.
Action:	1-County-level distribution of water conservation information via newsletter and/or website to affiliated constituents. 2-Water purveyors distribute water conservation information to affiliated constituents.
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	State and Federal grants; Local government operating budget; Water purveyors.
Responsible Agencies:	Local, jurisdictional level.

Drought Mitigation Strategy #2	
Objective:	To conserve water within the agricultural sector.
Action:	Develop/demonstrate water conservation practices for agricultural use.
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	State and Federal grants; Water purveyors.
Responsible Agencies:	Local, jurisdictional level.

Drought Mitigation Strategy #3	
Objective:	Establish specific county-level water conservation measures.
Action:	County-level implementation of mitigation strategies identified in "*Drought in Utah- Learning from the Past-Preparing for the Future.*" http://www.water.utah.gov/
Timeline:	3-5 years
Estimated Cost:	Unknown
Possible Funding:	State and Federal grants; Local government operating budget; Water purveyors.
Responsible Agencies:	Local, jurisdictional level.

RADON GAS

Despite relative high concentrations of radon gas in southwestern Utah, radon gas remediation is relatively simple and inexpensive. The radon gas mitigation strategies provided herein are simplistic in terms of implementation; however, they will enable significant risk reduction which will undoubtedly improve the health, safety, and welfare of citizens in the region.

Radon Gas Mitigation Strategy #1	
Objective:	Promote radon gas reduction measures through non-structural improvements.
Action:	Increase public education related to radon gas hazards by distributing Utah Dept. of Environmental Quality informational brochures to County and City planning and engineering departments.
Timeline:	Ongoing
Estimated Cost:	Very Minimal: request Utah Dept. of Environmental Quality to deliver brochures; and/or download brochures directly from: http://www.radon.utah.gov
Possible Funding:	County and City operating budget; Utah Dept. of Environmental Quality operating budget.
Responsible Agencies:	Local, jurisdictional level.

Radon Gas Mitigation Strategy #2	
Objective:	To reduce radon gas risk as it relates to the built environment.
Action:	Utilize the Radon Risk Map provided in this plan as a tool to assess radon gas risks as it relates to any building/subdivision proposals. If deemed necessary, jurisdiction should require the builder/developer to conduct a site-specific radon hazard identification study and implement applicable control techniques.
Timeline:	Ongoing
Estimated Cost:	$25- $1,200 (per http://www.epa.gov/radon/)
Possible Funding:	Private funds/ developer; County or City government operating budget (where applicable).
Responsible Agencies:	Private property owner; Local, jurisdictional level.

VOLCANISM

Volcanic activity, in terms of hazard assessment and risk analysis, is ranked at the bottom of the list for natural hazards found within the Five County region. This is based solely upon the fact that the probability of volcanic activity is extremely low. Although, the region contains an intensification of volcanic vents and flows, local violent eruptions are no longer a hazard. This being said geologists note: that, 1) the hazard is real, 2) volcanic activity is extremely infrequent and 3) the geologic conditions that precipitated volcanic activity in the region have long since disappeared. Because of the remote potential of volcanic events affecting the regional built environment, this hazard is not considered in the same vein as many of the other natural hazards that this plan addresses. Therefore, no mitigation measures have been provided herein.

Chapter 6 **BEAVER COUNTY**

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A PICTURE OF BEAVER COUNTY

DEMOGRAPHICS

Beaver County is approximately halfway between Salt Lake City and Las Vegas. Interstate Highway I-15 passes through the eastern part of the county at Beaver City and is the main traffic route north to Salt Lake City, about 210 miles, and south to Las Vegas, about 220 miles, as well as to major destinations in between. Fillmore, county seat of Millard County, is just 58 miles to the north; Cedar City is 50 miles to the south. The Union Pacific Railroad, running north-south through the center of the county at Milford, is becoming increasingly important as a mover of goods and natural resources to and from Utah.

Recreation importance of the region is increasing, with growing numbers of tourists attracted to the National Parks and Recreation Areas. Beaver County hosts many travelers for short periods as they pass through to the major attractions of the region. The county itself is also a destination for thousands of hunters, fishermen, hikers, bikers, ATV's, and campers looking for a high country outdoor experience. A major attraction in Beaver County is Elk Meadows Ski and Summer Resort, located just 18 miles east of Beaver.

Until recent times the three main sources of income for the County have been agriculture, mining, and the railroad. Agriculture includes high quality grazing land, a variety of crops that are either consumed locally or transported to other areas, and a sizeable dairy industry. More recently Circle Four Farms has brought to Beaver County a modern swine producing operation. The mineral wealth of the county was world renown in the 1880's, at its peak. Though now at a more modest level, mining is experiencing resurgence. Since 1880 the railroad has provided transportation advantages, a steady level of income to a substantial portion of the population, and retirement income for many older residents. Trade and services are increasing in importance, with the development of the tourist potential. The need for outdoor recreation experiences for today's fast paced families is readily available in the Beaver County desert to mountain areas.

Beaver City, the Beaver County seat, is located just south of the I-15 and I-70 Interchange. Beaver City is located 200 miles south of Salt Lake City and 105 miles north of St. George.

DEVELOPMENT TRENDS

Beaver County suffered from three decades of out-migration before it started growing again in the 1980s. During the1990s population grew by 29 percent. Growth in the County slowed to 8.7% from 2000 to 2009; however, according to growth projections provided by the Governor's Office of Planning and Budget, Beaver County can expect significant increases in population over the next 20 years. The projected population increase from 2010 to 2020 is 40.2% and 44.8% from 2020 to 2030. Overall this translates to 103% growth projected over the next 20 years, which will surpass the State of Utah growth projections of 49.9% over the same period.

The projected increase in population is not expected to change the rural nature of the County. If the present population pattern continues, most of the population increase is expected to occur in established developed areas of the County. It is also anticipated that the established trend for population growth in the unincorporated part of the County will continue. Much of this growth in the unincorporated area is expected to occur near Beaver City in the proximity of Beaver Canyon and Elk Meadows.

The Beaver County General Plan (Amended February 1999) stipulates, "As a basis for all land use decisions affecting land within the County's jurisdiction, it is recommended that new development, including residential subdivisions and commercial and industrial activities…be permitted to occur only within the boundaries of incorporated communities or, immediately adjacent to such communities." Growth is further managed through implementation of growth boundaries which specifically state that County land which contains natural constraints, such as critical areas (environmentally-sensitive land) be preserved.

BEAVER COUNTY LANDSCAPE

The County is 90 miles in length from east to west and 30 miles wide from north to south, with an area of 2,568 square miles. It is crossed by a number of short mountain ranges oriented generally on a north-south axis, the highest being the Tushar range in the eastern portion with peaks over 12,000 feet high. The Beaver River originates in this area and flows in a westerly and north-westerly direction to disappear into Millard County at the southern end of the Great Basin drainage area. The elevation of Beaver Valley in the eastern section is 5,970 feet, while the elevation of Milford Valley in the western portion is 4,962 feet. Generally, the climate is temperate and not subject to either extreme heat or cold. There are four well-defined seasons. Precipitation averages 11.65 inches annually in Beaver Valley and 8.5 inches in the Milford area.

Situated on the west side of the Tushar range of the Wasatch Mountains, Beaver County is rich in natural resources. The Beaver River originates in the Tushar range and flows in a westerly and north-westerly direction. The entire eastern portion of the County lies within the Beaver River drainage areas. The remainder of the County is drained by intermittent streams.

A variety of land uses are represented in Beaver County. The major land uses in Beaver County are indicative of the ownership by federal and state governments. The Bureau of Land Management (BLM) areas are used primarily for grazing, mining, recreation, and open space. Most of the forested areas in the county are contained in National Forest boundaries. The National Forest lands have multiple uses which include recreation, timber cultivation and harvest, grazing, wildlife habitat, and watersheds. Privately owned lands, which

account for the smallest percentage of the total land are in Beaver County, are given to the most diverse uses.

The majority of urban land uses, including residential, commercial, industrial and public uses are located in or near the three incorporated municipalities in Beaver County: Beaver City, Milford City and the town of Minersville. Beaver City and Milford City are the County's primary centers for commerce and social activity. Beaver City is the County seat and derives a considerable portion of its income from the tourism market. Milford is a railroad and agricultural center. Minersville and the unincorporated communities in Beaver County are primarily agricultural in character.

HAZARD IDENTIFICATION

Requirement §201.6(c)(2): The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.

Requirement §201.6(c)(2)(i): [The risk assessment **shall** include a] description of the…location and extent of all natural hazards that can affect the jurisdiction. The plan **shall** include information on previous occurrences of hazard events and on the probability of future hazard events.

Requirement §201.6(c)(2)(ii)(C): [The plan **should** describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

Requirement §201.6(c)(2)(iii): For multi-jurisdictional plans, the risk assessment must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.

WILDFIRE

When discussing wildfires it is important to remember that fires are part of a natural process and are needed to maintain a healthy ecosystem. Since its settlement in the mid 1800s, the region and its residents have been subject to the annual threat of wildfire. This is in large part due to the environmental conditions, namely low annual precipitation and high amount of public lands. Lightning is the primary cause of wildfire in the county. However, the potential risk for human caused fires increases as more people move into the wildland urban interface.

Many of Utah's wildland urban interface areas are located in our most fire prone wildland fuels. Generally, these fuels are found on drier, lower elevation sites which are often very desirable for real estate development. To address these issues, a multi-jurisdictional group of agencies, organizations, and individuals collaborated to develop the *Southwest Utah Regional Wildfire Protection Plan* (October 2007). The purpose of this plan is to be a tool in the effort to protect human life and reduce property loss due to catastrophic wildland fires in the communities and surrounding areas located in the southwest Utah counties of Beaver, Garfield, Iron, Kane and Washington.

Beaver County is almost exclusively covered in Forest and Shrub/Rangelands with 95% of the land area in that category (1,574,720 acres). Grass/Pasture/Haylands make up 3% of the County's land area (46,463 acres. Water/Wetlands (16,576 acres and Urban/Developed (16,576 acres) each comprise about 1% of the County's land area. Most of the forest and rangeland in

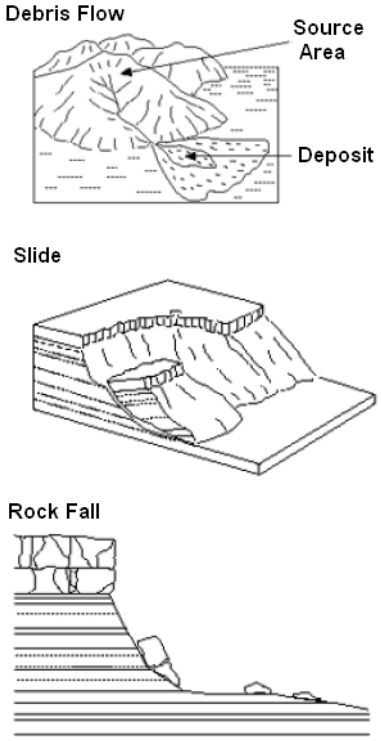
Beaver County is found on federal USFS and BLM lands. Grass/Pasture/Haylands areas in the County may include cheatgrass, fescue, sedges, yucca, wheatgrass and bluegrass. A portion of Beaver County is comprised of Farmland. Grass/Pasture/Haylands includes approximately 7,000 acres of Grass Pasture and/or grass hay in the Beaver City area. Shrub/Rangelands consist of oak savanna, juniper/pinion pine and other open areas.

Using National Fire Plan guidelines, the Utah Division of Forestry, Fire, and State Lands (UDFFSL) has worked with national and local wildland fire officials to create a statewide list of Communities at Risk (CARs). As of 2005, there were over 600 communities listed statewide and 148 are located in the southwestern Utah region. Beginning in 2000, the Color Country Fuels Committee (CCFC) undertook an intensive assessment of the 148 identified CARs in the Color Country fire management response area. These assessments have been the foundation for prioritizing fuels treatments, determining focus areas, and targeting the development of Community Wildfire Protection Plans within the Color Country Interagency Fire Management area.

LANDSLIDE

Nationwide, estimated losses from damaging landslides equal $3.5 billion annually (USGS, 2005). In Utah, documented losses from damaging landslides in 2001 exceeded $3 million, including the costs to repair and stabilize hillsides along state and federal highway (Ashland, 2003). Total landslide dollar losses are hard to determine from past events because a standard for documenting them do not exist. Several state and local agencies track landslide losses with inconsistent formats often resulting in several different totals for a single event.

The majority of landslides identified in Beaver County occur in the Tushar Mountains east of Beaver. The U.S. Forest Service identified over 300 landslides in the Beaver, Piute and western Sevier County area. Most of these have occurred in Tertiary volcanic tuffs. Although most of the landslides mapped in this area likely occurred in prehistoric times, a number of landslides in the Tushar Mountains have reactivated as a result of road-building activity. There has been renewed landsliding in ash-flow tuffs in the mountains east of Beaver. Approximately 104 landslides occurred between 1978 and 1981 along a 3-mile stretch of Utah State Route 153 in Beaver Canyon. Highway widening and over steepening of slopes begun in 1962 are cited for the increase in frequency of landsliding and the reactivation of some of these older slope failures. Although major landslide movements in the area have decreased in recent years, rock falls and shallow slope failures continue to impact this road.



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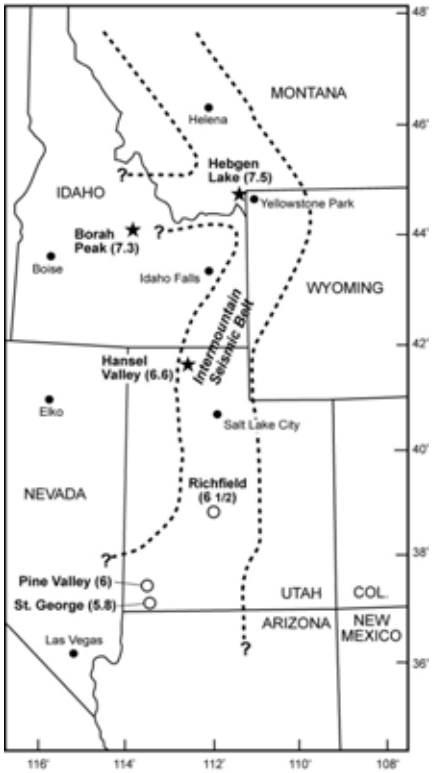
Fault-related surface rupture has not occurred in southwestern Utah historically, but the area does have a pronounced record of seismicity. At least 20 earthquakes greater than magnitude 4 have occurred in southwestern Utah over the past century (Christenson and Nava, 1992); the largest events were the estimated magnitude 6 Pine Valley earthquake in 1902 (Williams and Trapper, 1953) and the magnitude 5.8 St. George earthquakes in 1992 (Christenson, 1995). The Pine Valley earthquake is pre-instrumental and poorly located, and therefore, is not associated with a recognized fault. However, the epicenter is west of the surface trace of the Hurricane fault, so the event may have occurred on that structure. Pechmann and others (1995) have tentatively assigned the St. George earthquake to the Hurricane fault. The largest historical earthquake in nearby northwestern Arizona is the 1959 Fredonia, Arizona, earthquake (approximate magnitude 5.7; DuBois and others, 1982). Since 1987 the northwest part of Arizona has been quite seismically active (Pearthree and others, 1998), experiencing more than 40 events with magnitudes >2.5.



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Because earthquakes result from slippage on faults, from an earthquake-hazard standpoint, faults are commonly classified as active, capable of generating damaging earthquakes, or inactive, not capable of generating earthquakes. The term "active fault" is frequently incorporated into regulations pertaining to earthquake hazards, and over time the term has been defined differently for different regulatory and legal purposes. In fact, faults possess a wide range of activity levels. Some, such as the San Andreas Fault in California, produce repeated large earthquakes and associated surface faulting every few hundred years, while others, like Utah's Wasatch fault and many of the faults in the Basin and Range Province, generate large earthquakes and surface faulting every few thousand to tens of thousands of years. Therefore, depending on the area of interest or the intended purpose, the definition of "active fault" may change. The time period over which faulting activity is assessed is critical because it determines which faults are ultimately classified as hazardous and therefore in need of regulatory mitigation (National Research Council, 1986).

SEVERE WEATHER

The term severe weather, as it pertains to this plan, is used to represent a broad range of weather phenomena which affect southwestern Utah, namely; downburst, lightning, heavy snowstorms, avalanches, and tornados. Severe weather events are the most deadly type of natural hazard in Utah. Interestingly, more people have died in avalanches in Utah than by any other natural hazard. Between 1958 and 2006 avalanches killed 85 people.

Since 1950, lightning has killed 60 people statewide and injured another 144. In southwestern Utah the most common type of severe weather activity is related to lightning. Since 1950 a total of 5 lightning deaths and 10 lightning injuries have been recorded within the region.

A tornado is a violently rotating column of air extending from a thunderstorm to the ground. Most tornados have winds less than 112 miles per hour and zones of damage less than 100 feet wide. According to the National Weather Service, a total of 12 tornados have been observed in southwestern Utah. Of this amount, Iron and Beaver counties contain the highest amounts at 5 and 4 respectively.

Climate- Most of the moisture in the winter comes from fronts that develop in the Gulf of Alaska and move from west to east across the State. Tropical air from the Gulf of Mexico enters the state from the south and west during July through September and is the source of severe thunderstorms. Tropical Pacific air masses from the southwest at times have caused extreme floods in the southwest part of the State. The mountains form barriers to the flow of moisture-laden air, and orographic precipitation may occur any time during the year. Rain shadows, which

are areas of reduced precipitation, on the leeward side of the mountains account for the low normal annual rainfall in many of the interior valleys in the region.

Cloudburst storms and resultant floods occur principally during the summer. All parts of the State are subject to these storms, even the flat desert areas of the western portion. However, they occur more frequently along the west slope of the Wasatch Range, the Colorado Plateaus, and the southwest part of the State.

Tornados- Generally speaking, atmospheric conditions are rarely favorable for the development of tornadoes in Utah due to its dry climate and mountainous terrain. In fact, Utah ranks as having one of the lowest incidences of tornadoes in the nation, averaging only about two tornadoes per year, with only one F2 or stronger tornado once every seven years.

In the central U.S., tornadoes are commonly one-fourth of a mile wide and often cause considerable destruction and death. However, Utah tornadoes are usually smaller in size, often no more than 60 feet wide (at the base), with a path length usually less than a mile and a life span of only a few seconds to a few minutes. They normally follow a path from a southwesterly to a northeasterly direction and usually precede the passage of a cold front. About 73% of all Utah tornadoes have occurred in May, June, July and August, when severe thunderstorms occasionally frequent Utah.

Avalanches occur when a cohesive slab of snow fractures as a unit and slides on top of weaker snow, breaking apart as it slides. Slab avalanches occur when additional weight is added quickly to the snow pack, overloading a buried weaker layer. Dry snow avalanches usually travel between 60-80 miles per hour, reaching this speed within 5 seconds of the fracture, resulting in the deadliest form of snow avalanche.

Wet avalanches occur when percolating water dissolves the bonds between the snow grains in a pre-existing snow pack, this decreases the strength of the buried weak layer. Strong sun or warm temperatures can melt the snow and create wet avalanches. Wet avalanches usually travel about 20 miles per hour.

According to the Colorado Avalanche Information Center (CAIC), over the last 10 winters in the United States an average of 25 people died in avalanches every year. In Utah, this translates to approximately 4 avalanche related fatalities every year. Generally speaking, the lion share of avalanche fatalities have occurred in northern Utah. Since every fatal accident is investigated and reported, the numbers can be reported with some certainty. However, there is no way to determine the number of people caught or buried in avalanches each year, because non-fatal avalanche incidents are increasingly under reported. Unfortunately, statistical data pertaining to avalanche related fatalities in southern Utah is underprovided.

PROBLEM SOILS

There are six types of problem soils and rocks that are found in southwestern Utah; namely, Expansive Soil, Collapsible Soil, Limestone (Karsts Terrain), Gypsiferous Soil/Rock, Soils subject to Piping, and Sand Dunes.

Expansive soil and rock is the most common type of problem deposit in southwestern Utah. In particular, the Jurassic-age Arapien and Cretaceous-age Tropic Shale's, and the Triassic-age Chinle and Moenkopi Formations are sources for expansive materials. Expansive deposits contain clay minerals that expand and contract with changes in moisture content. Clays absorb water when wetted, causing the soil or rock to expand. Conversely, as the material dries, the loss of water between clay crystals or grains causes the deposit to shrink. Expansive deposits are extensive around St. George, Washington, and Santa Clara. In these areas expansive clays in the Chinle Formation have been most damaging to structures. Common problems are cracked formations, heaving and cracking of floor slabs and walls, and failure of wastewater disposal systems. Sidewalks and roads are particularly susceptible to damage.

Collapsible Soil- Subsidence of the ground surface due to collapsible soil has caused extensive damage in and around Cedar City and the Hurricane cliffs, where it is most prevalent. Collapsible soil is common in Holocene alluvial-fan and debris-flow deposits in southwestern Utah. Soil and rock containing gypsum are also susceptible to subsidence. Collapse occurs when susceptible soils are wetted to a depth below that normally reached by rainfall, destroying the clay-bonds between bands. Collapsible soil is present in geologically young materials such as Holocene-age alluvial-fan and debris-flow sediments, and in some wind-blown silts.

Limestone (Karst Terrains) susceptible to dissolution and subsidence occurs throughout mountains west of Sevier Lake, west of Richfield, and south of St. George. Karsts terrain is characterized by closed depressions (sinkholes), caverns, and streams that abruptly disappear underground. Most karsts terrain in southwestern Utah is relict and relates to moisture climates during the Pleistocene, or may have been created by ground water prior to the rock being uplifted and tilted during basin and range faulting. No known damage has occurred to structures from ground collapsing or subsidence related to limestone karsts, but because karsts ground-water systems have little filtering capacity, contamination of ground water is a major concern.

Gypsiferous Soil/ Rock deposits are subject to settlement caused by the dissolution of gypsum, which creates a loss of internal structure and volume within the deposit. Gypsiferous soil and rock deposits are common in southwestern Utah, particularly along the base of the Hurricane cliffs. Gypsum in these deposits can cause damage to foundations, and induce land subsidence and sinkholes similar to those seen in limestone terrain.

Soils subject to Piping- Piping is subsurface erosion by ground water that moves along permeable, non-cohesive layers in unconsolidated materials and exists at a free face, usually along a stream bank or cliff that intersects the layer. Deposits susceptible to piping are common in the southwestern part of the state. Holocene-age alluvial fill in canyon bottoms is the most common material susceptible to piping in Utah. Collapse of soil pipes and subsequent erosion

has damaged roads and agricultural land. Piping can cause damage to roads, bridges, culverts, and any structure built over soils subject to piping. Earth-fill structures such as dams may also be susceptible to piping.

Sand Dunes are common surficial deposits in arid areas where sand derived from weathering of rock or unconsolidated deposits is blown by the wind into mounds or ridges. In areas where development encroaches on dunes, inactive or vegetated dunes may be reactivated, allowing them to migrate over roads and bury structures. Sand Dunes occur in the Escalante Desert and west of Kanab. Migration of dunes across roads and burial structures are common problems in areas where active dunes are present. Avoidance of dunes is the best way to prevent damage to structures. However, active dunes usually are a maintenance problem only and do not preclude development.

FLOOD

In the southwest, as elsewhere, flooding, erosion, and sediment discharge are responsible for loss of life, land, and infrastructure, along with damage to reservoirs and natural habitats. Stream flooding is the most prevalent and destructive (annually) of the geologic hazards that affect Utah. This destructive trend is nowhere more evident than in the southwest part of the state.

The two types of stream flooding events which typically occur in southwestern Utah are riverine floods and flash floods. Riverine floods are usually regional in nature, last for several hours or days, and have recurrence intervals of 25 to more than 100 years. They commonly result from the rapid melt of a winter snow pack or from periods of prolonged heavy rainfall. Flash floods result from thunderstorm cloudbursts. They are localized, quickly reach a maximum flow, and then quickly diminish. Recurrence intervals for flash floods are erratic, ranging from a few hours to decades or longer for a given drainage. Both types of flooding have caused extensive damage in southwestern Utah.

Four major riverine floods have affected southwestern Utah since the area was settled. They occurred in 1966, 1983, 1984 and 2005. The 1966 flood on the Santa Clara River near Pine Valley resulted from an intense three-day rainstorm that produced record peak flows on the Virgin River. This three-day storm produced between 1 and 12 inches of rain and resulted in total damage of approximately $1.4 billion (Butler and Mundorff, 1970). The 1983 and 1984 floods occurred in response to the rapid melting of maximum-of-record and greater-than-average snow packs respectively. The 1983 and 1984 floods caused several landslides and a dam failure. Total damage was in excess of $640 million and the President issued a disaster declaration for 22 Utah counties. Lastly, a stalled storm-system containing abundant moisture caused significant flooding in Washington and Kane Counties between January 8-12, 2005. It is estimated that $300 million dollars in damages was sustained along the Santa Clara and Virgin Rivers in Washington County. 30 homes were destroyed in the flood and another 20 homes were significantly damaged (NCDC, 2005). A Presidential Disaster Declaration was declared February 1, 2005.

According to statistics provided by SHELDUS, Beaver County has experienced a total of 7 major flooding events; the first event occurring August 20, 1971 and the most recent occurring

May 21, 2005. The total property damage (not adjusted for inflation) for these flood events was $ 2,423,633.

By nature flash floods are sudden, intense, and localized. Many undoubtedly occur every summer along isolated drainages in southwestern Utah and are never recorded. Flash floods have damaged every major town in southwestern Utah. Many communities have implemented flood-control measures to reduce flash flood hazard; however, as communities expand into unprotected areas, new development is again subject to flash flooding. As a whole, any new development in southwestern Utah must consider the potential for stream flooding, and mitigate any flood hazard that may exist.

VULNERABILITY ASSESSMENT

Requirement §201.6(c)(2)(ii): [The risk assessment **shall** include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description **shall** include an overall summary of each hazard and its impact on the community.

Requirement §201.6(c)(2)(ii)(A): The plan **should** describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area.

Requirement §201.6(c)(2)(ii)(B): [The plan **should** describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph *(c)(2)(ii)(A)* of this section and a description of the methodology used to prepare the estimate.

WILDFIRE

One of the core elements of providing a wildfire vulnerability assessment is developing an understanding of the risk of potential losses during a wildfire. The Healthy Forests Restoration Act, the National Fire Plan, and the National Association of State Foresters all provide guidance on conducting a wildfire hazard and risk assessment. As illustrated in the *Southwest Utah Regional Wildfire Protection Plan,* the Color Country Fuels Committee Risk Assessment Teams approached the wildfire risk assessment with a comprehensive review of potential risk from the Communities at Risk (CARs) list. These risk assessments have been reviewed and are presented in this section.

As illustrated in the *Southwest Utah Regional Wildfire Protection Plan* the Color Country Fuels Committee (CCFC) compiled data that included standardized internal and external risk assessments, digital photos, maps, and other information to prioritize hazardous fuels target areas and to aid in suppression efforts. Each CARs was given a score ranging from 0 (no risk) to 12 (extreme risk) based on the sum of multiple risk factors (e.g., fire history, local vegetation, firefighting capabilities) analyzed in every area. The scoring system allows Utah's fire prevention program officials to assess the relative risk in a given area of the state and open communication channels with these communities to help them better prepare for wildfire.

Beaver County- Communities at Risk and Risk Score (2005)	
Elk Meadow	12
Baker Canyon	11
Sulpherdale	11
North Creek	10
Puffer Lake	9
High-Low	9
Greenville	8
Adamsville	7
Minersville	7
Eagle Estates	7
Source: Southwest Utah Regional Wildfire Protection Plan (October 2007)	

In addition to the above analysis, the vulnerability assessment was conducted using GIS software to join: 1) County Property Tax data as it relates to 2) structures located within a respective hazard area. This analysis was based upon the most recent (2009) County Property Tax data provided by each County Assessor's office. The values shown are based upon utilizing the market value for structures in each defined hazard area. Where applicable, if a critical facility was located within a defined hazard area, this valuation was included within the commercial structure category. The GIS software then quantified the number of units and total market value for all structures located within each defined hazard area.

Beaver County - Wildfire			
Type of Structure	Market Value of Structures		Number of Structures
	Wildfire Risk Area-High	Wildfire Risk Area-Medium	
Residential	$7,363,141		107
Commercial	$144,274		2
Residential		$36,428,012	435
Commercial		$1,661,115	9
Total	**$7,507,415**	**$38,089,127**	**553**
Overall Total		**$45,596,542**	**553**

In addition to structures located within a defined hazard area, there is also an overwhelming amount (in terms of quantity and value) of infrastructure that is not captured by the GIS analysis. This is in large part due to the fact that compilation of this data would be exhaustive; nevertheless, the following provides a summarization of infrastructure at risk from wildfire.

Infrastructure at Risk from Wildfire			
Location	Miles of Major Roadways	Miles of Railroad Track	Miles of Utility Powerlines
Beaver County	60	5	87
Garfield County	104	0	154

Iron County	110	117	180
Kane County	59	0	50
Washington County	80	0	155
Paiute Indian Lands	10	0	0
Region Totals	**423**	**122**	**626**

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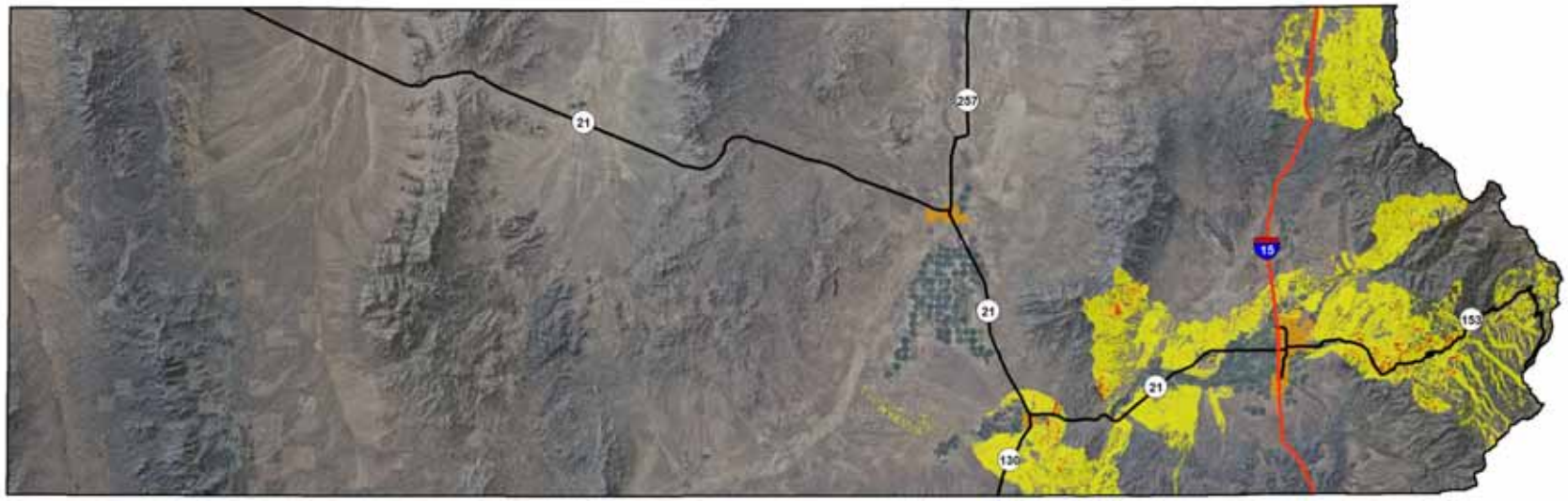
Five County Natural Hazard Mitigation Plan

Beaver County

Wildfire Risk Map



Five County Association of Goverments April 2010 Southern Utah University
FCAOG and SUU GIS use information and data from many different sources, which may be of differing accuracy and which have been integrated to provide a planning context. These products should be used only for the purpose they were intended. For specific data source information, please contact FCAOG.

0 1 2 4 6 8
Miles

Legend

Highways	Wildfire Risk
US	Medium
State	High
Municipalities	

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LANDSLIDE

According to the USGS, landslides are a widespread geologic hazard that can occur in all 50 states. On average, landslides cause $1-2 billion annually in damages and claim 25 lives per year. Urban development in and along hillside areas increase the number of people threatened by landslide events each year (USGS, 2007). Many factors contribute to overall landslide vulnerability; including local weather, soil moisture, duration and intensity of precipitation, wildfire history, and development pressure. Typically, landslides result from other natural disasters such as earthquakes, volcanoes, wildfires and floods (USGS, 2007). The table below illustrates landslide susceptibility by hazard category.

Beaver County- Landslide susceptibility by hazard category				
County	High Hazard (square miles)	Moderate Hazard (square miles)	Low Hazard (square miles)	**Total (square miles)**
Beaver	46.6	579	236.1	**861.7**
Garfield	3.7	193.8	223.5	**421**
Iron	20.5	738.2	333	**1,091.7**
Kane	42	1,638.5	672.9	**2,353.4**
Washington	28.1	1,079.9	423.2	**1,531.2**
Source: State of Utah, Natural Hazard Mitigation Plan, November 2007.				

In addition to the above analysis, the vulnerability assessment was conducted using GIS software to join: 1) County Property Tax data as it relates to 2) buildings located with a respective hazard area. This analysis was based upon the most recent County Property Tax data provided by each County Assessor's office. The values shown are based upon utilizing the ***market value*** for structures in each defined hazard area. The GIS software then quantified the number of units and total market value for all structures located within each defined hazard area.

Beaver County - Landslide			
Type of Structure	Market Value of Structures		Number of Structures
	Landslide Risk Area- High	Landslide Risk Area- Medium	
Residential			
Commercial			
Residential		$22,177,201	279
Commercial		$177,032	6
Total		**$22,354,233**	**285**
Overall Total		**$22,354,233**	**285**

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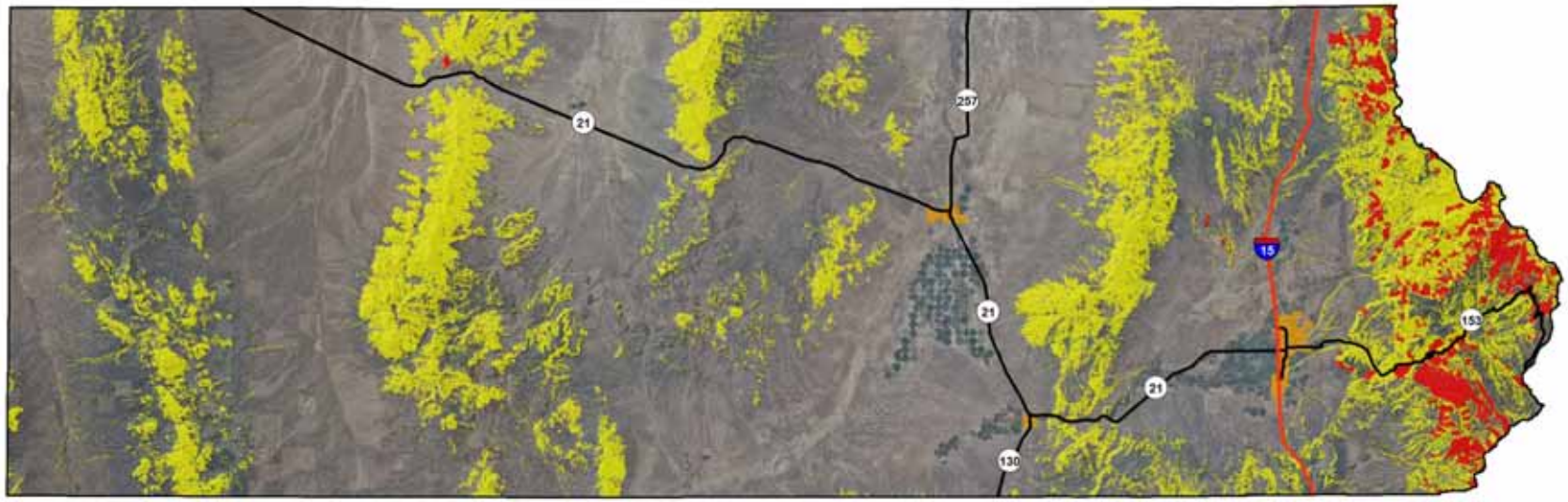
Five County Natural Hazard Mitigation Plan

Beaver County

Landslide Risk Map



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0 1 2 4 6 8
Miles

Legend

Highways	Landslide
US	Medium
State	High
Municipalities	

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EARTHQUAKE

When assessing the vulnerability of structures as a result of an earthquake, an understanding of the building code, to which the structure was designed, is of extreme importance. Utah building codes began to address seismic design as early as 1976; although, the state did not adopt building codes fully addressing seismic safety until 1989. It is fairly safe to assume that structures constructed prior to 1976 will not perform in an earthquake as well as structures built following 1976. This is to say that an increased understanding of seismic events coupled with advances in building design has greatly increased our ability to design and construct buildings which perform better in earthquakes.

Earthquakes are regional hazards affecting multi-county areas, and because almost the entire state could experience a seismic event, all communities contain some degree of risk. The degree of risk is determined by several factors; however, the paramount factor is naturally the likelihood and magnitude of the earthquake. This being said, building design is a key factor when discussing potential structural damage. Vulnerability of structures was determined through age of construction with those structures built before 1976 considered to possess a higher risk.

Age of Housing Stock			
County	Structures built before 1976	Total Structures	**% of Structures built before 1976**
Beaver	1,559	2,660	**59%**
Garfield	1,497	2,767	**54%**
Iron	5,336	13,618	**39%**
Kane	1,398	3,767	**37%**
Washington	6,777	36,478	**19%**
Source: U.S. Census, November 2000.			

In addition to the above analysis, the vulnerability assessment was conducted using GIS software to join: 1) County Property Tax data as it relates to 2) buildings located with a respective hazard area. This analysis was based upon the most recent County Property Tax data provided by each County Assessor's office. The values shown are based upon utilizing the ***market value*** for structures in each defined hazard area. The GIS software then quantified the number of units and total market value for all structures located within each defined hazard area. The quantitative earthquake data provided below includes all structures which are: 1) on a fault line, or 2) within a 500' to 1,000' fault line buffer area. The range provided for the fault line buffer area is a determination made by Utah Geological Survey as it relates to the fault being studied or unstudied.

Beaver County - Earthquake		
Type of Structure	Market Value of Structures	Number of Structures
Residential	$5,209,071	61
Commercial	$2,008,147	11
Total	**$7,217,218.00**	**72**

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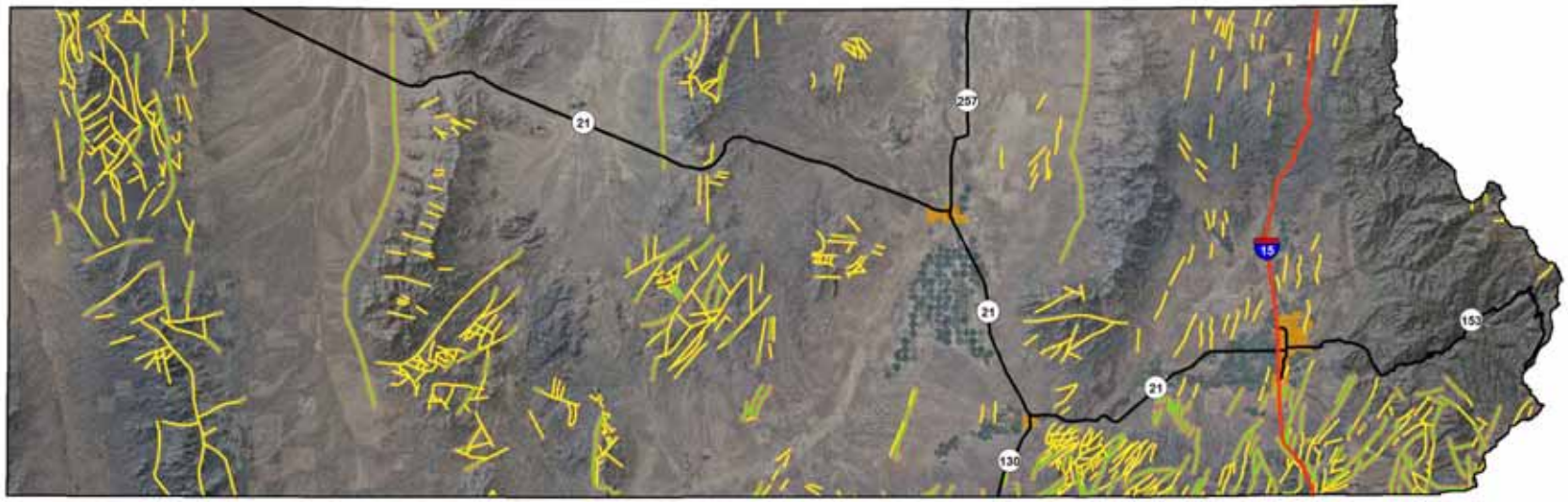
Five County Natural Hazard Mitigation Plan

Beaver County

Earthquake Risk Map



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0 1 2 4 6 8
Miles

Legend

Highways	Fault Locations
US	Certain (Studied)
State	Concealed (Unstudied)
Municipalities	Surface Rupture Areas

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SEVERE WEATHER

There are many qualitative factors that point to potential vulnerability. Severe weather can cause power outages, transportation and economic disruptions, significant property damage, and pose a high risk for injuries and loss of life. The event can also be typified by a need to shelter and care for individuals impacted by the event. On numerous occasions, severe weather have brought economic hardship and affected the life of the residents of southwestern Utah. Higher elevations in the Five County region have greater exposure to snow and ice, but may be less economically vulnerable because they are sparsely populated. Quantitative assessment of severe weather vulnerability and determining which counties are more vulnerable is very challenging. However, using the principle of the past being the key to the future is effective. For example, one would assume that an area that has exhibited a large number of occurrences would continue to exhibit the same.

A quantitative vulnerability assessment is difficult based upon the simple fact that severe weather occurrences are random and difficult to predict. Several factors limit a determination of potential losses, they include:

- Limited GIS data availability;
- Lack of research on location;
- The entire state of Utah shares similar, if not identical risks; and
- Most hazards are tied to weather and cannot be predicted with location.

This being said, the vulnerability assessment was conducted using GIS software to join: 1) County Property Tax data as it relates to 2) buildings located with an area that has exhibited severe weather occurrences. This analysis was based upon the most recent County Property Tax data provided by each County Assessor's office. The values shown are based upon utilizing the ***market value*** for structures in each defined severe weather hazard area. The GIS software then quantified the number of units and total market value for all structures located within each defined severe weather hazard area.

Beaver County – Severe Weather		
Type of Structure	Market Value of Structures	Number of Structures
Residential	$391,848	5
Commercial	$210,288	1
Total	**$602,136.00**	**6**

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Five County Natural Hazard Mitigation Plan

Beaver County

Severe Weather Risk Map

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0 1 2 4 6 8
Miles

Legend

Highways
- US
- State
- Municipalities

Lightning Death
Tornado Touchdown

Lightning Intensity
- Medium
- High

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PROBLEM SOILS

Geologic materials with characteristics that make them susceptible to volumetric changes, collapse, subsidence, or other engineering-geologic problems are referred to as problem soils. Geologic and climatic conditions in southwestern Utah provide a variety of both localized and widespread occurrences of these materials. Soil and rock related geologic problems occur in a variety of geologic settings and are some of the most widespread and costly geologic hazards. Six types of problem soil and rock are present in southwestern Utah. Six types of problem soil and rock are found in southwestern Utah: (1) expansive soil and rock with high shrink/swell potential, (2) collapsible soil, (3) limestone (Karsts Terrain) susceptible to dissolution under some hydro geologic conditions, (4) gypsiferous soil/rock susceptible to dissolution, (5) soil subject to piping (localized subsurface erosion), and (6) active dunes. Some materials, such as expansive soil and limestone, cover large areas, whereas others, like active dunes, are of limited extent. The most extensive problem soils found in the region are expansive soil and rock.

Expansive Soils and rock are the most common type of problem soils in southwestern Utah. Expansive deposits contain clay minerals that expand and contract with changes in moisture content. Clays absorb water when wetted, causing the soil or rock to expand. Conversely, as the material dries, the loss of water between clay crystals or grains causes the deposit to shrink.

Expansive deposits are extensive around St. George, Washington, and Santa Clara in Washington County. In these areas expansive clays in the Chinle Formation have been most damaging to structures. In Santa Clara, many homes and a church were damaged by expansive clays in the Chinle Formation. Common problems are cracked foundations, heaving and cracking of floor slabs and walls, and failure of wastewater disposal systems. Sidewalks and roads are particularly susceptible to damage. The majority of expansive soil problems are found in Washington and Iron Counties.

Collapsible Soil- The phenomenon of hydrocompaction, which causes subsidence in collapse prone soil, occurs in loose, dry, low density deposits that decrease in volume or collapse when saturated for the first time following deposition. Collapse occurs when susceptible soils are wetted to a depth below that normally reached by rainfall, destroying the clay bonds between grains. Collapsible soil is present in geologically young materials such as Holocene age alluvial fan and debris flow sediments. When saturated, the soil collapses and the ground surface subsides, damaging property and structures. Human activities that involve some form of water application such as irrigation, water impoundment, lawn watering, and alterations to natural drainage or wastewater disposal commonly initiate hydrocompaction.

Collapsible soil is present particularly near Cedar City (Iron County) and the Hurricane Cliffs (Washington County). In Cedar City approximately $3 million in damage to public and private structures has been attributed to collapsible soil. Other areas in southwestern Utah with a potential collapsible soil problem are along mountain fronts where young alluvial fan deposits containing fine-grained sediments are present. Climate also plays a role in the distribution of collapsible soils. Drier areas, such as the Basin and Range and Colorado Plateau provinces, provide the best conditions for development of collapsible soil. Soil and rock containing gypsum

are also susceptible to subsidence. Ground water and introduced waters from irrigation dissolve gypsum causing subsidence.

Limestone (Karsts Terrain) is characterized by sinkholes, caverns, and streams that abruptly disappear underground. Karsts features are caused by ground and surface water dissolution of calcareous rocks, such as limestone. Cavernous subterranean openings in karst terrain often collapse, leaving sinkholes at the surface.

Limestone susceptible to dissolution and subsidence occurs throughout mountains west of Sevier Lake, west of Richfield, and south of St. George. No known damage to structures has occurred from ground collapse or subsidence related to limestone karsts; however, the potential for damage exists where susceptible units are present. In addition, because karsts ground-water systems have little filtering capacity, contamination of ground water is a major concern.

Gypsiferous soil/rock are subject to settlement caused by the dissolution of gypsum, which creates a loss of internal structure and volume within the deposit. Gypsum in soil can also form in other ways - including as a secondary mineral deposit leached from surficial layers and concentrated lower in the soil profile or wind-blown dust, and in the St. George area (Washington County) by the evaporation of ground water.

Gypsiferous soil and rock deposits are common in southwestern Utah, particularly along the base of the Hurricane Cliffs. Much of the gypsum is derived from erosion of gypsum rich rock units. Gypsum in these deposits can cause damage to foundations, and induce land subsidence and sinkholes similar to those seen in limestone terrain. Water introduced into the subsurface for irrigation and landscaping or into wastewater disposal systems, can cause underground solution cavities to develop, which may ultimately cause surface collapse. Gypsum is also a weak material with low bearing strength, which can cause problems when loaded with the weight of a structure. In addition, gypsum dissolved in water forms sulfuric acid and sulphate, which react with certain types of cement and weaken foundations.

Soils Subject to Piping- Piping is subsurface erosion by ground water that moves along permeable, non-cohesive layers in unconsolidated materials and exits at a free face, usually along a stream bank or cliff that intersects the layer. Removal of fine-grained particles by this process creates voids within the material that act as minute channels which direct the movement of water. As channels enlarge, water moving through the conduit increases velocity and removes more material, forming a "pipe." The pipe becomes a preferred avenue for ground-water drainage and enlarges as more water is intercepted. Increasing the size of the pipe removes support from the walls and roof, causing eventual collapse.

Deposits susceptible to piping are common in southwestern Utah. Piping can cause damage to roads, bridges, culverts, and any structure built over soils subject to piping. In areas where piping is common, roads are frequently damaged where they parallel stream drainages and cross-cut pipes. Road construction can contribute to the piping problem by disturbing natural runoff and concentrating water along paved surfaces, allowing greater infiltration and potential for pipes to develop.

Sand Dunes are common surficial deposits in arid areas where sand derived from weathering of rock or unconsolidated deposits is blown by the wind into mounds or ridges. In areas where development encroaches on dunes, inactive or vegetated dunes may be reactivated, allowing them to migrate over roads and bury structures. Another problem is the contamination of local ground water from wastewater disposal in dunes. The uniform size of the sand grains comprising dunes makes them highly permeable. Dunes are present in many areas of southwestern Utah, especially in the Escalante Desert (Iron County) and west of Kanab (Kane County). Avoidance of dunes is the best way to prevent damage to structures. (Excerpted from Lund, UGS unpublished information).

Conclusions- In addition to the above analysis, the vulnerability assessment was conducted using GIS software to join: 1) County Property Tax data as it relates to 2) buildings located with a respective hazard area. This analysis was based upon the most recent County Property Tax data provided by each County Assessor's office. The values shown are based upon utilizing the ***market value*** for structures in each defined hazard area. The GIS software then quantified the number of units and total market value for all structures located within each defined hazard area.

Beaver County – Problem Soils		
Type of Structure	Market Value of Structures	Number of Structures
Residential	$24,142	2
Commercial		
Total	**$24,142.00**	**2**

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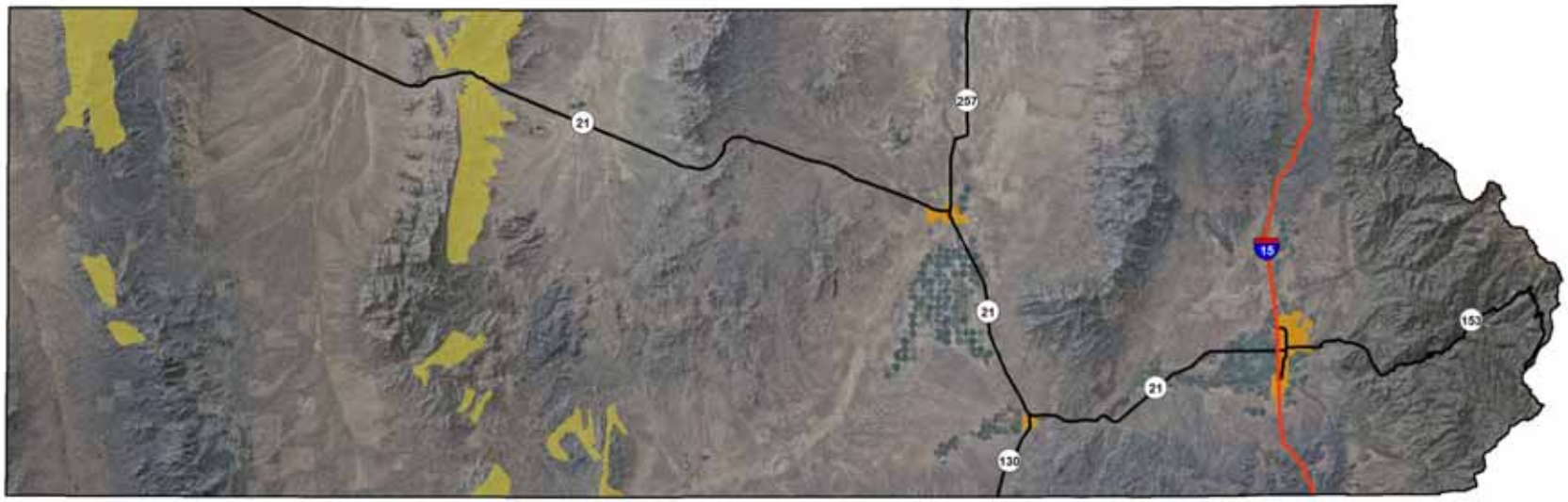
Five County Natural Hazard Mitigation Plan

Beaver County

Problem Soils Risk Map



Five County Association of Goverments April 2010 Southern Utah University
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0 1 2 4 6 8
Miles

Legend

Highways
- US
- State
- Municipalities

- Dunes
- Expansive Soil or Rock
- Limestone

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FLOOD

The Army Corps of Engineers conducted a *Flood Hazard Identification Study* for the Five County region in August, 2003. The intent of this study is to aid in detailing natural hazards associated with fluvial process for entities within the region. The study evaluates and identifies areas with a high flood hazard and identifies potential mitigation solutions. Municipalities within the region were studied if they met the following criteria: 1) Jurisdiction has not been mapped by FEMA; and 2) Jurisdiction mapped by FEMA as a Zone D, area of undetermined flood hazard. The following information is provided from the Study.

Dams are a critical support function for water managers in the State, and also can act as a flood control measure. If a dam remains stable, does not get overtopped, or is not impaired as the result of an earthquake, then at a minimum, they do provide incidental flood control. If not then they can add to the flood threat. There are 145 dams within the Five County region, of those 33 have received a high hazard rating by Utah Division of Water Right Dam Safety Section. The State Dam Safety Section has developed a hazard rating system for all non-federal dams in Utah. Downstream uses, size height, volume, and incremental risk/damage assessments are a variable used to assign dam safety classification. High hazard dams would cause a possible loss of life in the event of a rupture. The following are high hazard dams in Beaver County: Manderfield, Three Creeks, Kents Lake-Middle, Kents Lake-Upper, and Rocky Ford.

Only about 20% of Beaver County residents live in the unincorporated county. The County does participate in the National Flood Insurance Program (NFIP). However, FEMA 100yr. flood plain mapping is generally non-existent; with the exception of one small flood plain mapped on the south end of Main Street in Beaver City. No major rivers threaten existing urban development. Potential flood sources include the Beaver River and its tributaries, and other potential flood sources such as the reservoirs and lakes. Vulnerability assessment as it relates to specific developed area in unincorporated Beaver County includes the following:

- Adamsville: Little threat as Indian creek runs quite a way east of the community.
- Greenville: At some risk due to Dry Creek running through town.
- Manderfield: A large channel just east of the main street appears to pose a moderate flood threat.

Vulnerability assessment as it relates to specific developed area in incorporated Beaver County includes the following:

- Beaver: The town is susceptible to flooding primarily on the very south end of town from Beaver Creek and on the very north end of town from North Creek.
- Milford: An existing, large Corps of Engineers project, Big Wash Diversion Dam and Channel, provide adequate flood protection resulting in this community's NSFHA designation.
- Minersville: Relatively protected from flood threat due to the Minersville Dam being just a few miles upstream (to the east) and due to the long and relatively large interceptor levee that extends for close to 2 miles along the foothills southeast of town.

In addition to the above analysis, the vulnerability assessment was conducted using GIS software to join: 1) County Property Tax data as it relates to 2) buildings located with a respective hazard

area. This analysis was based upon the most recent County Property Tax data provided by each County Assessor's office. The values shown are based upon utilizing the *market value* for structures in each defined hazard area. The GIS software then quantified the number of units and total market value for all structures located within each defined hazard area. Unfortunately, Beaver County FEMA 100yr. flood plain mapping is generally non-existent; with the exception of one small flood plain mapped on the south end of Main Street in Beaver City. Based upon this fact, the aforementioned GIS analysis could not be performed.

MITIGATION STRATEGY

The following table provides a brief synopsis of the Beaver County mitigation strategies. Additional information for each specific hazard, including specific mitigation strategies and associated information, are found following this table.

Beaver County- Mitigation Strategies

Mitigation Strategy	Action	Timeline	Estimated Cost	Plan Goals Addressed					
				Education/ Outreach	Emergency Services	Environmental Protection	Partnership/ Coordination	Prevention	Property Protection
Wildfire-Mitigation Strategy #1	Promote public awareness campaign for property owners living in wildland urban interface areas.	Ongoing	Unknown	●			●	●	●
Wildfire-Mitigation Strategy #2	1-Voluntary site visits (to CARS) by fire crews to consult with landowners about specific ways to reduce risk to their property.	Ongoing	Unknown	●	●		●	●	●
	2-Develop local code enhancements that require utilization of defensible space tactics.	Ongoing	Unknown					●	●
Wildfire-Mitigation Strategy #3	Enhance existing wildfire training programs, equipment procurement, and fire fighting resources for wildfire suppression.	Ongoing	Unknown		●		●	●	●

Landslide-Mitigation Strategy #1	Increase public education related to landslide hazards by distributing UGS landslide informational brochures to local municipality level emergency mgmt., engineering, and planning departments.	Ongoing	Very minimal	●	●		●	●	
Landslide-Mitigation Strategy #2	Drafting/updating zoning and/or landslide ordinances to prevent development of structures near debris flows, landslides, and rock fall areas.	Ongoing	Minimal					●	●
Landslide-Mitigation Strategy #3	1-Address landslide risk at the building/construction level by requiring all subdivision proposals to have a geotechnical report.	Ongoing	Minimal					●	●
	2-If jurisdiction does not have trained staff to review the geotechnical report, the jurisdiction can, upon request, have UGS perform a review of the report.	Ongoing	Minimal				●	●	●
Earthquake-Mitigation Strategy #1	Increase public education related to earthquake hazards by distributing Utah Seismic Safety Commission informational brochures to County and City emergency management agencies.	Ongoing	Very minimal	●			●		
Earthquake-Mitigation Strategy #2	Continued dedication/vigilance in enforcing the seismic standards established in the International Building Code.	Ongoing	Minimal					●	●

Earthquake-Mitigation Strategy #3	1-Utilize the Earthquake Risk Map provided in this plan as a tool to assess earthquake risks as it relates to any building/subdivision proposals. If deemed necessary, jurisdiction should require the builder/developer to conduct a site-specific earthquake hazard identification/mapping study.	Ongoing	$1,000-$5,000					●	●
	2- At the County level, contract with UGS to formally study/map earthquake hazard areas.	3-5 years	$7,109-$14,218 per jurisdiction				●	●	●
Severe Weather-Mitigation Strategy #1	Continued dedication/vigilance in enforcing the standards established in the International Building Code as it relates to wind-loading, electrical grounding, snow-loading, and other weather-related hazards.	Ongoing	Minimal					●	●
Severe Weather-Mitigation Strategy #2	1-Enhance the Emergency Alert System (tv & radio)	Ongoing	Unknown	●	●		●		
	2-Enhance NOAA Weather Radio All Hazard coverage.	Ongoing	Unknown	●	●		●		
Severe Weather-Mitigation Strategy #3	At the county Local Emergency Planning Committee (LEPC) level, meet the program guidelines then apply to the National Weather Service StormReady Program.	3-5 years	Minimal		●		●	●	●

Problem Soils-Mitigation Strategy #1	1-Address problem soils at the building/construction level by requiring all subdivision proposals to have a geotechnical report.	Ongoing	$1,000-$5,000					●	●
	2- If jurisdiction does not have trained staff to review the geotechnical report, the jurisdiction can, upon request, have UGS perform a review of the report.	Ongoing	Minimal				●	●	●
Problem Soils-Mitigation Strategy #2	Utilize the Problem Soils Risk Map provided in this plan as a tool to assess problem soils risks as it relates to any building/subdivision proposals. If deemed necessary, jurisdiction should require the builder/developer to conduct a site-specific geotechnical (soils) report.	Ongoing	$1,000-$5,000					●	●
Problem Soils-Mitigation Strategy #3	Through mapping, identify areas which contain collapsible and expansive soils. Require soils testing at the building/construction level and ensure that engineer's recommendations are followed.	Ongoing	$1,000-$5,000					●	●
Flood-Mitigation Strategy #1	Work with Army Corps of Engineers to map potential flood areas.	2.5 years	Unknown		●	●	●	●	●

Flood-Mitigation Strategy #2	Nonstructural measures appear to be the most prudent option for the county to implement. Zoning to prevent development of structures near all rivers, creeks, and lakes (100' min. setback).	Ongoing	Minimal		●		●		●
Flood-Mitigation Strategy #3	Address flood control at the building/construction level by requiring all subdivision proposals to have a storm water drainage system.	Ongoing	Minimal			●		●	●
Flood-Mitigation Strategy #4	Clear debris and other material from all waterways	Ongoing	Minimal			●		●	●
Flood-Mitigation Strategy #5	Identify areas of inundation from possible failure of the Rocky Flood Irrigation Dam (Minersville Reservoir).	2-5 years	Minimal		●			●	●
Flood-Mitigation Strategy #6	Indian Peaks Band of Paiute Indians-Prevent future roadway erosion of the road which leads to the water tank.	1-5 years	Unknown					●	●
Flood-Mitigation Strategy #7	Officially recognize Minersville as a NSFHA. Draft and adopt a NSFHA ordinance.	1-5 years	Minimal	●			●	●	●
Drought-Mitigation Strategy #1	1-County-level distribution of water conservation information via newsletter and/or website to affiliated constituents.	Ongoing	Minimal	●		●	●	●	
	2- Water purveyors distribute water conservation information to affiliated constituents.	Ongoing	Minimal	●		●	●	●	

Drought-Mitigation Strategy #2	Develop/demonstrate water conservation practices for agricultural use.	Ongoing	Minimal	●		●	●	●	●
Drought-Mitigation Strategy #3	County-level implementation of mitigation strategies identified in *"Drought in Utah-Learning from the Past-Preparing for the Future."*	3-5 years	Unknown			●	●	●	●
Radon Gas-Mitigation Strategy #1	Increase public education related to radon gas hazards by distributing Utah Dept. of Environmental Quality informational brochures to County and City planning and engineering departments.	Ongoing	Very minimal	●		●	●	●	●
Radon Gas-Mitigation Strategy #2	Utilize the Radon Risk Map provided in this plan as a tool to assess radon gas risks as it relates to any building/ subdivision proposals. If deemed necessary, jurisdiction should require the builder/ developer to conduct a site-specific radon hazard identification study and implement applicable control techniques.	Ongoing	$25- $1,200	●		●		●	●

Requirement §201.6(c)(3): The plan shall include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.

The following mitigation strategies, listed in accordance to their respective natural hazard, are presented in an effort to provide macro-level risk reduction. Although each mitigation measure is important and achievable, they have been prioritized and listed in order of:

1) Respective amount of potential loss of life/property value as a result of a natural hazard occurrence (as quantified through GIS analysis) ; and

2) Implementation priority through utilization of the STAPLEE process (as explained in Chapter 3 of this Plan and in FEMA 386-3).

WILDFIRE

The Color Country Interagency Fire Center Fuels Committee has identified the general location of ten "Focus Areas" within the southwest Utah region. The selection of these specific areas was based on the need for fuels reductions as understood by fuels specialists and fire wardens, risk levels in the Regional Wildfire Protection Plan risk assessment, values at risk in the area, firefighting concerns including access and evacuation routes, the presence of Communities At Risk (CARs), and local interest in the community documented by having a Community Wildfire Protection Plan in place.

The Color Country Interagency Fire Center Fuels Committee has not prioritized these ten focus areas. The Committee determined that to do so would have the effect of minimizing the fact that every one of these areas is in need of treatment and all are of concern. Each focus area also includes a list of general goals resulting from activities and treatments for the area.

Goals common to all treatment areas include fuels reduction, public education, and increases in equipment and training available to firefighting personnel. Goals that are generally applicable to all of the focus areas include the following:

- Protection of human life, firefighter and public safety as the highest priority.
- Public education and partnerships with citizens or community-centered approaches to manage fire risks and hazards in WUI areas located in the focus area, including effort aimed towards the implementation and maintenance of defensible space projects to reduce risk to homes and personal property.
- Protection of high value resources and watersheds through fuels reduction treatments as determined locally.
- Restoration and maintenance of ecosystems consistent with land uses and historic fire regimes. Restoration of vegetation to the appropriate Condition Classes and Fire Regimes.
- Maintenance and/or improvement of fire prevention and road/structure identification signage. Dissemination of fire restriction information through appropriate signage and/or visitor contacts when necessary.
- Improvement of wildland firefighting equipment, training and information for volunteer fire departments located in the focus area, including the improvement of GIS and road data.

The ten Focus Areas developed by the Color Country Interagency Fire Center Fuels Committee do not include areas within Beaver County. This being said, the Communities at Risk within Beaver County (from high to medium risk) include: Elk Meadow, Baker Canyon, Sulpherdale, North Creek, Puffer Lake, High-Low, Greenville, Adamsville, Minersville, and Eagle Estates.

Wildfire Mitigation Strategy #1	
Objective:	Promote public awareness campaign for property owners living in wildland urban interface areas.
Action:	Mailings; Printed Information; Public Service Announcements;
Timeline:	Ongoing
Estimated Cost:	Unknown
Possible Funding:	State and Federal wildfire grant programs
Responsible Agencies:	State and Federal government

Wildfire Mitigation Strategy #2	
Objective:	To encourage and assist local governments to require property owners and developers to utilize defensible space tactics.
Action:	1-Voluntary site visits (to CARs) by fire crews to consult with landowners about specific ways to reduce risk to their property. 2-Develop local code enhancements that require utilization of defensible space tactics.
Timeline:	Ongoing
Estimated Cost:	Unknown
Possible Funding:	Local government operating budget; Special Service District operating budget
Responsible Agencies:	Community & local government entities

Wildfire Mitigation Strategy #3	
Objective:	Provide training, equipment, and resources for fire departments to fight wildfires.
Action:	Enhance existing wildfire training programs, equipment procurement, and fire fighting resources for wildfire suppression.
Timeline:	Ongoing
Estimated Cost:	Unknown
Possible Funding:	State CIB funding; Federal wildfire grant programs
Responsible Agencies:	Federal Government

LANDSLIDE

Factors included in assessing landslide risk include built property distribution in the hazard area, the frequency of landslide or debris flow occurrences, slope steepness, and soil characteristics. This type of analysis generates estimates of the damages to the county due to a landslide or debris flow event on the current built environment. The mitigation strategies listed below identify cost effective measures that will yield measurable benefits toward reducing the risk of landslide hazards.

Landslide Mitigation Strategy #1	
Objective:	Increase the level of knowledge related to landslides.
Action:	Increase public education related to landslide hazards by distributing Utah Geological Survey (UGS) landslide informational brochures to local municipality level emergency management, engineering and planning departments.
Timeline:	Ongoing
Estimated Cost:	Very Minimal: request UGS to deliver brochures; and/or download brochures directly from: http://geology.utah.gov
Possible Funding:	Local, jurisdictional level.
Responsible Agencies:	Local, jurisdictional level.

Landslide Mitigation Strategy #2	
Objective:	Minimize future landslide damage in the unincorporated County.
Action:	Drafting/updating zoning and/or landslide ordinances to prevent development of structures near debris flows, landslides, and rock fall areas.
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	Local government operating budget; State and Federal planning grant programs.
Responsible Agencies:	Local government

Landslide Mitigation Strategy #3	
Objective:	To reduce landslide risk as it relates to the built environment.
Action:	1-Address landslide risk at the building/construction level by requiring all subdivision proposals to have a geotechnical report. 2-If jurisdiction does not have trained staff to review the geotechnical report, the jurisdiction can, upon request, have Utah Geological Survey (UGS) perform a review of the report.
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	Private funds/ developer; Local government operating budget; Utah Geologic Survey operating budget.
Responsible Agencies:	Local, jurisdictional level; Utah Geological Survey

EARTHQUAKE

Earthquake mitigation strategies include general mitigation actions that agencies are capable of implementing during the next five years, given their existing resources and authorities. In addition to the earthquake mitigation strategies provided herewith, this Natural Hazard Mitigation Plan endorses any seismic mitigation proffered by the Utah Seismic Safety Commission. In particular, numerous and varied earthquake mitigation strategies are provided in

A Strategic Plan for Earthquake Safety in Utah (January, 1995) completed by the Utah Seismic Safety Commission. It is highly recommended that jurisdictions whom desire to provide more specific earthquake mitigation strategies consult the aforementioned plan, which can be accessed at: http://ussc.utah.gov/.

Earthquake Mitigation Strategy #1	
Objective:	Promote building safety through non-structural improvements.
Action:	Increase public education related to earthquake hazards by distributing Utah Seismic Safety Commission informational brochures to County and City emergency management agencies.
Timeline:	Ongoing
Estimated Cost:	Very Minimal: request Utah Seismic Safety Commission to deliver brochures; and/or download brochures directly from: http://ussc.utah.gov/
Possible Funding:	County and City operating budget; Utah Seismic Safety Commission operating budget.
Responsible Agencies:	Local, jurisdictional level.

Earthquake Mitigation Strategy #2	
Objective:	To reduce earthquake risk as it relates to the built environment.
Action:	Continued dedication/vigilance in enforcing the seismic standards established in the International Building Code (IBC).
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	County or City government operating budget (where applicable).
Responsible Agencies:	County or City government (where applicable).

Earthquake Mitigation Strategy #3	
Objective:	To reduce earthquake losses by mapping and identifying earthquake hazard areas.
Action:	1-Utilize the Earthquake Risk Map provided in this plan as a tool to assess earthquake risks as it relates to any building/subdivision proposals. If deemed necessary, jurisdiction should require the builder/developer to conduct a site-specific earthquake hazard identification/mapping study. 2-At the County level, contract with Utah Geological Survey (UGS) to formally study/map earthquake hazard areas.
Timeline:	Action 1-Ongoing Action 2- 3 to 5 years
Estimated Cost:	Action 1-$1,000 to $5,000 Action 2- $7,109 to $14,218 per jurisdiction (1995 cost as reflected in *A Strategic Plan for Earthquake Safety in Utah* adjusted for inflation)

Possible Funding:	Action 1-Private funds/ developer. Action 2- Local government operating budget; Utah Geologic Survey operating budget.
Responsible Agencies:	Local, jurisdictional level; Private property owner; Utah Geological Survey

SEVERE WEATHER

Quantitative assessment of severe weather vulnerability and determining which specific areas of the county are more vulnerable is very challenging. This being said, the vulnerability assessment quantified the number of units and total market value for all structures located within a defined severe weather hazard area; said area includes: known lightning deaths, lightning intensity (based upon actual lighting strike data), and tornado touchdowns. The following severe weather hazard mitigation strategies are specific to the aforementioned severe weather hazards.

Severe Weather Mitigation Strategy #1	
Objective:	To reduce severe weather risk as it relates to the built environment.
Action:	Continued dedication/vigilance in enforcing the standards established in the International Building Code (IBC) as it relates to wind-loading, electrical grounding, snow-loading, and other weather-related hazards.
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	County or City government operating budget (where applicable).
Responsible Agencies:	County or City government (where applicable).

Severe Weather Mitigation Strategy #2	
Objective:	Ensure that the general public is warned of severe weather occurrences via broadcast media.
Action:	1-Enhance the Emergency Alert System (television and radio). 2-Enhance NOAA Weather Radio All Hazard coverage.
Timeline:	Ongoing
Estimated Cost:	Unknown
Possible Funding:	Federal and State government operating budget.
Responsible Agencies:	Federal and State government.

Nearly 90% of all presidentially declared disasters are weather related. In an effort to guard against the negative effects of severe weather, the National Weather Service has designed the StormReady program. This program is a nationwide community preparedness program that uses an approach which helps communities develop plans to handle all types of severe weather. To be classified as a StormReady community several criteria must be met; however, the county Local Emergency Planning Committee (LEPC) is positioned well to satisfy the StormReady application/program guidelines. Ultimately the benefit of becoming formally recognized as a

StormReady community lies in the additional planning/preparation/preparedness for severe weather occurrences; however, some grant opportunities are available through the National Weather Service as well as possible adjustment to insurance rates through the Insurance Services Organization (ISO).

Severe Weather Mitigation Strategy #3	
Objective:	Guard against the negative effects of severe weather by becoming a StormReady community.
Action:	At the county Local Emergency Planning Committee (LEPC) level, meet the program guidelines then apply to the National Weather Service StormReady program.
Timeline:	3 to 5 years
Estimated Cost:	Minimal
Possible Funding:	County and City operating budget.
Responsible Agencies:	County and City government.

PROBLEM SOILS

Problem soils pose a significant hazard to the current/future built environment. This being said, many of these problems can be dramatically reduced through proper assessment of the risk and adherence to applicable mitigation measures. Factors included in assessing problem soils risk include built property distribution in the hazard area. This type of analysis generates estimates of the damages in the county due to problem soils occurrences in the current built environment. The mitigation strategies listed below identify cost effective measures that will yield measurable benefits toward reducing the risk of problem soils as they relate to the built environment. Further, these mitigation strategies include general actions that agencies are capable of implementing during the next five years, given their existing resources and authorities.

Problem Soils Mitigation Strategy #1	
Objective:	Lessen the risk to buildings from problem soils.
Action:	1-Address problem soils at the building/construction level by requiring all subdivision proposals to have a geotechnical report. 2-If jurisdiction does not have trained staff to review the geotechnical report, the jurisdiction can, upon request, have Utah Geological Survey (UGS) perform a review of the report.
Timeline:	Ongoing
Estimated Cost:	$1,000 to $5,000
Possible Funding:	Private funds/ developer; Local government operating budget; Utah Geologic Survey operating budget.
Responsible Agencies:	Local, jurisdictional level; Utah Geological Survey

Problem Soils Mitigation Strategy #2	
Objective:	To reduce problem soils related losses by mapping and identifying problem soils hazard areas.
Action:	Utilize the Problem Soils Risk Map provided in this plan as a tool to assess problem soils risks as it relates to any building/subdivision proposals. If deemed necessary, jurisdiction should require the builder/developer to conduct a site-specific geotechnical (soils) report.
Timeline:	Ongoing
Estimated Cost:	$1,000 to $5,000
Possible Funding:	Private funds/ developer; Local government operating budget
Responsible Agencies:	Local, jurisdictional level; Private property owner.

Problem Soils Mitigation Strategy #3	
Objective:	Lessen the risk to buildings from collapsible and expansive soils.
Action:	Through mapping, identify areas which contain collapsible and expansive soils. Require soils testing at the building/construction level and ensure that engineer's recommendations are followed.
Timeline:	Ongoing
Estimated Cost:	$1,000 to $5,000
Possible Funding:	Private funds/ developer; Local government operating budget.
Responsible Agencies:	Local, jurisdictional level.

FLOOD

The Army Corps of Engineers *Flood Hazard Identification Study* (August, 2003), identifies areas with a high flood hazard and identifies potential mitigation solutions. The following prioritized mitigation strategies are provided from this Study as well as from the Five County *Natural Hazard Mitigation Plan (2004).*

Beaver County FEMA 100yr. flood plain mapping is generally non-existent; with the exception of one small flood plain mapped on the south end of Main Street in Beaver City. Based upon this fact, the #1 Priority flood mitigation strategy is to provide much needed mapping in flood prone areas of the County. Additionally, local zoning regulations need to be drafted/implemented (where applicable) to ensure that development is adequately setback from areas which pose risk due to flooding.

Flood Mitigation Strategy #1	
Objective:	Identify flood prone areas in the County.
Action:	Work with Army Corps of Engineers to map potential flood areas.
Timeline:	2-5 years
Estimated Cost:	Unknown
Possible Funding:	Federal flood programs
Responsible Agencies:	Federal (FEMA & Army Corps of Engineers)

Flood Mitigation Strategy #2	
Objective:	Minimize future flood damage in the unincorporated County.
Action:	Nonstructural measures appear to be the most prudent option for the county to implement. Zoning to prevent development of structures near all rivers, creeks, and lakes (100' min. setback).
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	Local government operating budget; State and Federal flood and planning grant programs
Responsible Agencies:	Local government

Flood Mitigation Strategy #3	
Objective:	To reduce flooding risk as it relates to the built environment.
Action:	Address flood control at the building/construction level by requiring all subdivision proposals to have a storm water drainage system.
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	Private funds/ developer.
Responsible Agencies:	Local, jurisdictional level.

Flood Mitigation Strategy #4	
Objective:	To reduce flooding risk at the community level.
Action:	Clear debris and other material from all waterways.
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	Related public/private property owners.
Responsible Agencies:	Private property owners, irrigation companies, local jurisdictions.

As illustrated in the vulnerability assessment, the Rocky Ford Irrigation Dam (Minersville Reservoir) poses a high risk to dam failure due to a seismic event. As such, the following mitigation strategy is provided:

Flood Mitigation Strategy #5	
Objective:	To reduce flooding impact of Rocky Ford Irrigation Dam (Minersville Reservoir) failure due to a seismic event.
Action:	Identify areas of inundation from possible failure of the Rocky Flood Irrigation Dam (Minersville Reservoir).
Timeline:	2-5 years
Estimated Cost:	Minimal
Possible Funding:	Local government operating budget; State and Federal flood programs
Responsible Agencies:	State, Local, and Five County AOG

The Indian Peaks Band of Paiute Indians has indicated that there are several areas of the "water tank" roadway that experience drainage problems as a result of rain and/or snow melt.

Flood Mitigation Strategy #6	
Objective:	Indian Peaks Band of Paiute Indians- Prevent future roadway erosion of the road which leads to the water tank.
Action:	Add culverts to keep water off of the road.
Timeline:	1-5 years
Estimated Cost:	Unknown
Possible Funding:	Federal flood grant programs
Responsible Agencies:	Indian Peaks Band of Paiute Indians

As a result of the Army Corps of Engineers *Flood Hazard Identification Study* (August, 2003), the following mitigation strategy is provided.

Flood Mitigation Strategy #7	
Objective:	Officially recognize Minersville as a NSFHA.
Action:	Draft and adopt a Non-Special Flood Hazard Area (NSFHA) ordinance.
Timeline:	1-5 years
Estimated Cost:	Minimal
Possible Funding:	Local government operating budget; State and Federal flood grant programs
Responsible Agencies:	Local government

Chapter 7 **GARFIELD COUNTY**

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A PICTURE OF GARFIELD COUNTY

DEMOGRAPHICS

Garfield County is bordered on the west by Iron County, on the south by Kane County, on the east by the Colorado River and San Juan County, and on the north by Piute and Wayne counties. Within Garfield County there are several state and federal highways, the most prominent being Federal Highway 89 and State Route (SR) 12. US-89 runs in a north-south direction and is located in the extreme western portion of the County. SR-12 begins at US-89 midway between Hatch and Panguitch, and runs east/southeast where it makes connection with SR-24 in Wayne County.

The variety of cultural and natural resources within the Count provides a number of diverse opportunities. The mountains, forests, deserts, high plateaus, and water resources, continue to provide wonderful settings for traditional recreation uses such as hunting, fishing, and camping, as well as currently popular activities such as mountain biking, all-terrain vehicle riding, and cross-country skiing. The County is the "gateway" to many of the regions parks and recreational areas. A large number of non-residents pass through the County each year.

The strongest sectors of employment in Garfield County have historically been agriculture and services. However, in the last several years there has been a significant drop in agricultural employment, and the County has seen dramatic increase in government employment and in the transportation/tourism service industries. The tourism industry in Garfield County is one of the major revenue producers. The County can boast of three national parks, one national recreation area, two national forests, three state parks and pristine mountain and desert areas.

DEVELOPMENT TRENDS

After experiencing net out-migration in the 1950's and 1960's, Garfield County has typically shown population growth rates hovering between the state and national averages. During the1990's population grew by 19 percent. Growth in the County slowed to 5.9% from 2000 to 2009; however, according to growth projections provided by the Governor's Office of Planning and Budget, Garfield County can expect noteworthy increases in population over the next 20 years. The projected population increase from 2010 to 2020 is 14.8% and 16.8% from 2020 to 2030. Overall this translates to 34% growth projected over the next 20 years. This growth projection is much lower than the State of Utah growth projection of 49.9% over the same period. The projected increase in population is not expected to change the rural nature of the County. If the present population pattern continues, most of the population increase is expected to occur in established developed areas of the County.

The Garfield County General Plan (Amended January 1998) stipulates, "The health, general welfare, and safety of County residents and visitors is one of the primary purposes for local land use plans. Because of this basis, the location and extent of potentially hazardous natural conditions will be identified and disclosed to present and future residents and visitors." Growth as it relates to natural hazard conflicts is further managed through implementation of policy statements which discourage development within identified FEMA 100-year floodplains,

incorporation of wildfire protection measures, and limiting development in areas of known earthquake faults.

GARFIELD COUNTY LANDSCAPE

High wooded plateaus, fertile river valleys, steep rugged mountains and canyons, deserts, and picturesque red sandstone rock formations contribute to the varied landscape of Garfield County. A portion of the boundary that separates the Colorado Plateau and the Great Basin runs through the County. This geographic boundary enters the area at the Utah-Arizona border, south of Hurricane, and follows a north-easterly course to the Beaver-Millard County line. The northeast trending Hurricane Fault which passes through the area is the approximate break between the two provinces. Eastward from this boundary are found the high plateaus of Utah, which make up a portion of the Colorado Plateau. Westward lies the basin and range of western Utah. A portion of the Great Basin is characterized by elaborately faulted and folded strata, arranged as north to south trending ridges, generally less than 9,000 feet in elevation, separated by broad, semiarid valleys.

Elevations in Garfield County range from less than 5,000 feet to over 10,000 feet. This wide range of elevation has marked influence on the climate of the County. Annual precipitation shows a direct relationship to change in elevation, and ranges from less than 10" at the lower levels to more than 20" a year in the higher mountains. Summers are characterized by hot, dry weather with average maximum temperatures of 100 degrees at lower elevations to temperatures in the 80's at elevations above 6,000 feet. Winters are relatively severe because of the mountains acting as barriers. Winter snowfall can be less than 5" in lower valleys to over 60" in higher elevations.

The most striking characteristic of land ownership in Garfield County is the large percentage of government owned land. Only 4% of the land found within the County is privately owned. Parts of three national parks, a national recreation area, and national forest are found in the County. The largest category of land ownership is the national resource lands managed by the Bureau of Land Management.

The predominant use of private land in Garfield County is agriculture. Pasture and rangeland comprise the greatest amount of private agricultural land while irrigated croplands comprise the smallest. Land which is considered urban or "built-up" (cities, towns, industrial sites, cemeteries, airports, golf courses, institutional and public administrative facilities, and roads) is also a small portion of the County land area. Much of the increase in urban land is due to towns annexing large tracts of unincorporated land.

Requirement §201.6(c)(2): The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.

Requirement §201.6(c)(2)(i): [The risk assessment **shall** include a] description of the…location and extent of all natural hazards that can affect the jurisdiction. The plan **shall** include information on previous occurrences of hazard events and on the probability of future hazard events.

Requirement §201.6(c)(2)(ii)(C): [The plan **should** describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

Requirement §201.6(c)(2)(iii): For multi-jurisdictional plans, the risk assessment must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.

FLOOD

In the southwest, as elsewhere, flooding, erosion, and sediment discharge are responsible for loss of life, land, and infrastructure, along with damage to reservoirs and natural habitats. Stream flooding is the most prevalent and destructive (annually) of the geologic hazards that affect Utah. This destructive trend is nowhere more evident than in the southwest part of the state.

The two types of stream flooding events which typically occur in southwestern Utah are riverine floods and flash floods. Riverine floods are usually regional in nature, last for several hours or days, and have recurrence intervals of 25 to more than 100 years. They commonly result from the rapid melt of a winter snow pack or from periods of prolonged heavy rainfall. Flash floods result from thunderstorm cloudbursts. They are localized, quickly reach a maximum flow, and then quickly diminish. Recurrence intervals for flash floods are erratic, ranging from a few hours to decades or longer for a given drainage. Both types of flooding have caused extensive damage in southwestern Utah.

Four major riverine floods have affected southwestern Utah since the area was settled. They occurred in 1966, 1983, 1984 and 2005. The 1966 flood on the Santa Clara River near Pine Valley resulted from an intense three-day rainstorm that produced record peak flows on the Virgin River. This three-day storm produced between 1 and 12 inches of rain and resulted in total damage of approximately $1.4 billion (Butler and Mundorff, 1970). The 1983 and 1984 floods occurred in response to the rapid melting of maximum-of-record and greater-than-average snow packs respectively. The 1983 and 1984 floods caused several landslides and a dam failure. Total damage was in excess of $640 million and the President issued a disaster declaration for 22 Utah counties. Lastly, a stalled storm-system containing abundant moisture caused significant flooding in Washington and Kane Counties between January 8-12, 2005. It is estimated that $300 million dollars in damages was sustained along the Santa Clara and Virgin Rivers in Washington County. 30 homes were destroyed in the flood and another 20 homes were significantly damaged (NCDC, 2005). A Presidential Disaster Declaration was declared February 1, 2005.

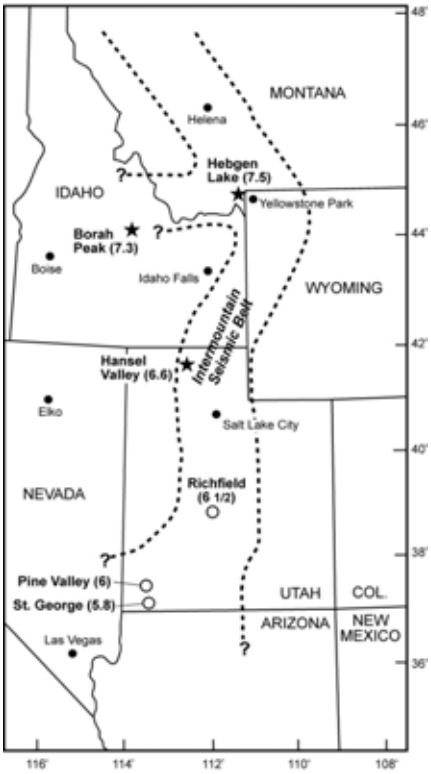
According to statistics provided by SHELDUS, Garfield County has experienced a total of 10 major flooding events; the first event occurring August 25, 1982 and the most recent occurring July 6, 2004. The total property damage (not adjusted for inflation) for these flood events was $ 3,262,221.

By nature flash floods are sudden, intense, and localized. Many undoubtedly occur every summer along isolated drainages in southwestern Utah and are never recorded. Flash floods have damaged every major town in southwestern Utah. Many communities have implemented flood-control measures to reduce flash flood hazard; however, as communities expand into unprotected areas, new development is again subject to flash flooding. As a whole, any new development in southwestern Utah must consider the potential for stream flooding, and mitigate any flood hazard that may exist.

LANDSLIDE

Nationwide, estimated losses from damaging landslides equal $3.5 billion annually (USGS, 2005). In Utah, documented losses from damaging landslides in 2001 exceeded $3 million, including the costs to repair and stabilize hillsides along state and federal highway (Ashland, 2003). Total landslide dollar losses are hard to determine from past events because a standard for documenting them do not exist. Several state and local agencies track landslide losses with inconsistent formats often resulting in several different totals for a single event.

EARTHQUAKE



In Utah most earthquakes are associated with the Intermountain seismic belt (Smith and Sbar, 1974; Smith and Arabasz, 1991), an approximately 160-kilometer-wide (100 miles), north-south trending zone of earthquake activity that extends from northern Montana to northwestern Arizona. Since 1850, there have been at least 16 earthquakes of magnitude 6.0 or greater within this belt (Eldredge and Christenson, 1992). Included among those 16 events are Utah's two largest historical earthquakes, the 1901 Richfield earthquake with an estimated magnitude of 6.5, and the 1934 Hansel Valley magnitude 6.6 earthquake, which produced Utah's only historical surface fault rupture. In an average year Utah experiences more than 700 earthquakes, but most are too small to be felt. Moderate magnitude (5.5 – 6.5) earthquakes happen every several years on average, the most recent being the magnitude 5.8 St. George earthquake on September 2, 1992. Large magnitude earthquakes (6.5 – 7.5) occur much less frequently in Utah, but geologic evidence shows that most

areas of the state within the Intermountain seismic belt, including southwestern Utah, have experienced large surface-faulting earthquakes in the recent geologic past.

Fault-related surface rupture has not occurred in southwestern Utah historically, but the area does have a pronounced record of seismicity. At least 20 earthquakes greater than magnitude 4 have occurred in southwestern Utah over the past century (Christenson and Nava, 1992); the largest events were the estimated magnitude 6 Pine Valley earthquake in 1902 (Williams and Trapper, 1953) and the magnitude 5.8 St. George earthquakes in 1992 (Christenson, 1995). The Pine Valley earthquake is pre-instrumental and poorly located, and therefore, is not associated with a recognized fault. However, the epicenter is west of the surface trace of the Hurricane fault, so the event may have occurred on that structure. Pechmann and others (1995) have tentatively assigned the St. George earthquake to the Hurricane fault. The largest historical earthquake in nearby northwestern Arizona is the 1959 Fredonia, Arizona, earthquake (approximate magnitude 5.7; DuBois and others, 1982). Since 1987 the northwest part of Arizona has been quite seismically active (Pearthree and others, 1998), experiencing more than 40 events with magnitudes >2.5.

Despite the lack of an historical surface-faulting earthquake in southern Utah, available geologic data for faults in the region indicate a moderate rate of long-term Quaternary activity. Mid-Quaternary basalt flows are displaced hundreds of meters at several locations and alluvial and colluvial deposits are displaced meters to tens of meters in late Quaternary time.

Because earthquakes result from slippage on faults, from an earthquake-hazard standpoint, faults are commonly classified as active, capable of generating damaging earthquakes, or inactive, not capable of generating earthquakes. The term "active fault" is frequently incorporated into regulations pertaining to earthquake hazards, and over time the term has been defined differently for different regulatory and legal purposes. In fact, faults possess a wide range of activity levels. Some, such as the San Andreas fault in California, produce repeated large earthquakes and associated surface faulting every few hundred years, while others, like Utah's Wasatch fault and many of the faults in the Basin and Range Province, generate large earthquakes and surface faulting every few thousand to tens of thousands of years. Therefore, depending on the area of interest or the intended purpose, the definition of "active fault" may change. The time period over which faulting activity is assessed is critical because it determines which faults are ultimately classified as hazardous and therefore in need of regulatory mitigation (National Research Council, 1986).

WILDFIRE

When discussing wildfires it is important to remember that fires are part of a natural process and are needed to maintain a healthy ecosystem. Since its settlement in the mid 1800s, the region and its residents have been subject to the annual threat of wildfire. This is in large part due to the environmental conditions, namely low annual precipitation and high amount of public lands. Lightning is the primary cause of wildfire in the county. However, the potential risk for human caused fires increases as more people move into the wildland urban interface.

Many of Utah's wildland urban interface areas are located in our most fire prone wildland fuels. Generally, these fuels are found on drier, lower elevation sites which are often very desirable for real estate development. To address these issues, a multi-jurisdictional group of agencies, organizations, and individuals collaborated to develop the *Southwest Utah Regional Wildfire Protection Plan* (October 2007). The purpose of this plan is to be a tool in the effort to protect human life and reduce property loss due to catastrophic wildland fires in the communities and surrounding areas located in the southwest Utah counties of Beaver, Garfield, Iron, Kane and Washington.

Garfield County is almost exclusively covered in Forest and Shrub/Rangelands. Shrub/Rangelands accounts for 65.7% of the land area (2,139,677 acres). Forest area accounts for 31.8% of the County (1,036,581 acres). Grass/Pasture/Haylands make up 0.6% of the County's land area (20,300 acres). Water/Wetlands (32,150 acres) comprise 1% of the County's land area while Urban/Developed (27,000 acres) comprises only 0.8% of the County's land area. Only 4% of Garfield County land area is in private ownership. 96% of Garfield County land area is non-private land.

Using National Fire Plan guidelines, the Utah Division of Forestry, Fire, and State Lands (UDFFSL) has worked with national and local wildland fire officials to create a statewide list of Communities at Risk (CARs). As of 2005, there were over 600 communities listed statewide and 148 are located in the southwestern Utah region. Beginning in 2000, the Color Country Fuels Committee (CCFC) undertook an intensive assessment of the 148 identified CARs in the Color Country fire management response area. These assessments have been the foundation for prioritizing fuels treatments, determining focus areas, and targeting the development of Community Wildfire Protection Plans within the Color Country Interagency Fire Management area.

PROBLEM SOILS

There are six types of problem soils and rocks that are found in southwestern Utah; namely, Expansive Soil, Collapsible Soil, Limestone (Karsts Terrain), Gypsiferous Soil/Rock, Soils subject to Piping, and Sand Dunes.

Expansive soil and rock is the most common type of problem deposit in southwestern Utah. In particular, the Jurassic-age Arapien and Cretaceous-age Tropic Shale's, and the Triassic-age Chinle and Moenkopi Formations are sources for expansive materials. Expansive deposits contain clay minerals that expand and contract with changes in moisture content. Clays absorb water when wetted, causing the soil or rock to expand. Conversely, as the material dries, the loss of water between clay crystals or grains causes the deposit to shrink. Expansive deposits are extensive around St. George, Washington, and Santa Clara. In these areas expansive clays in the Chinle Formation have been most damaging to structures. Common problems are cracked formations, heaving and cracking of floor slabs and walls, and failure of wastewater disposal systems. Sidewalks and roads are particularly susceptible to damage.

Collapsible Soil- Subsidence of the ground surface due to collapsible soil has caused extensive damage in and around Cedar City and the Hurricane cliffs, where it is most prevalent. Collapsible soil is common in Holocene alluvial-fan and debris-flow deposits in southwestern Utah. Soil and rock containing gypsum are also susceptible to subsidence. Collapse occurs when susceptible soils are wetted to a depth below that normally reached by rainfall, destroying the clay-bonds between bands. Collapsible soil is present in geologically young materials such as Holocene-age alluvial-fan and debris-flow sediments, and in some wind-blown silts.

Limestone (Karst Terrains) susceptible to dissolution and subsidence occurs throughout mountains west of Sevier Lake, west of Richfield, and south of St. George. Karsts terrain is characterized by closed depressions (sinkholes), caverns, and streams that abruptly disappear underground. Most karsts terrain in southwestern Utah is relict and relates to moisture climates during the Pleistocene, or may have been created by ground water prior to the rock being uplifted and tilted during basin and range faulting. No known damage has occurred to structures from ground collapsing or subsidence related to limestone karsts, but because karsts ground-water systems have little filtering capacity, contamination of ground water is a major concern.

Gypsiferous Soil/ Rock deposits are subject to settlement caused by the dissolution of gypsum, which creates a loss of internal structure and volume within the deposit. Gypsiferous soil and rock deposits are common in southwestern Utah, particularly along the base of the Hurricane cliffs. Gypsum in these deposits can cause damage to foundations, and induce land subsidence and sinkholes similar to those seen in limestone terrain.

Soils subject to Piping- Piping is subsurface erosion by ground water that moves along permeable, non-cohesive layers in unconsolidated materials and exists at a free face, usually along a stream bank or cliff that intersects the layer. Deposits susceptible to piping are common in the southwestern part of the state. Holocene-age alluvial fill in canyon bottoms is the most common material susceptible to piping in Utah. Collapse of soil pipes and subsequent erosion has damaged roads and agricultural land. Piping can cause damage to roads, bridges, culverts, and any structure built over soils subject to piping. Earth-fill structures such as dams may also be susceptible to piping.

Sand Dunes- are common surficial deposits in arid areas where sand derived from weathering of rock or unconsolidated deposits is blown by the wind into mounds or ridges. In areas where development encroaches on dunes, inactive or vegetated dunes may be reactivated, allowing them to migrate over roads and bury structures. Sand Dunes occur in the Escalante Desert and west of Kanab. Migration of dunes across roads and burial structures are common problems in areas where active dunes are present. Avoidance of dunes is the best way to prevent damage to structures. However, active dunes usually are a maintenance problem only and do not preclude development.

SEVERE WEATHER

The term severe weather, as it pertains to this plan, is used to represent a broad range of weather phenomena which affect southwestern Utah, namely; downburst, lightning, heavy snowstorms, avalanches, and tornados. Severe weather events are the most deadly type of natural hazard in

Utah. Interestingly, more people have died in avalanches in Utah than by any other natural hazard. Between 1958 and 2006 avalanches killed 85 people.

Since 1950, lightning has killed 60 people statewide and injured another 144. In southwestern Utah the most common type of severe weather activity is related to lightning. Since 1950 a total of 5 lightning deaths and 10 lightning injuries have been recorded within the region.

A tornado is a violently rotating column of air extending from a thunderstorm to the ground. Most tornados have winds less than 112 miles per hour and zones of damage less than 100 feet wide. According to the National Weather Service, a total of 12 tornados have been observed in southwestern Utah. Of this amount, Iron and Beaver counties contain the highest amounts at 5 and 4 respectively.

Climate- Most of the moisture in the winter comes from fronts that develop in the Gulf of Alaska and move from west to east across the State. Tropical air from the Gulf of Mexico enters the state from the south and west during July through September and is the source of severe thunderstorms. Tropical Pacific air masses from the southwest at times have caused extreme floods in the southwest part of the State. The mountains form barriers to the flow of moisture-laden air, and orographic precipitation may occur any time during the year. Rain shadows, which are areas of reduced precipitation, on the leeward side of the mountains account for the low normal annual rainfall in many of the interior valleys in the region.

Cloudburst storms and resultant floods occur principally during the summer. All parts of the State are subject to these storms, even the flat desert areas of the western portion. However, they occur more frequently along the west slope of the Wasatch Range, the Colorado Plateaus, and the southwest part of the State.

Tornados- Generally speaking, atmospheric conditions are rarely favorable for the development of tornadoes in Utah due to its dry climate and mountainous terrain. In fact, Utah ranks as having one of the lowest incidences of tornadoes in the nation, averaging only about two tornadoes per year, with only one F2 or stronger tornado once every seven years.

In the central U.S., tornadoes are commonly one-fourth of a mile wide and often cause considerable destruction and death. However, Utah tornadoes are usually smaller in size, often no more than 60 feet wide (at the base), with a path length usually less than a mile and a life span of only a few seconds to a few minutes. They normally follow a path from a southwesterly to a northeasterly direction and usually precede the passage of a cold front. About 73% of all Utah tornadoes have occurred in May, June, July and August, when severe thunderstorms occasionally frequent Utah.

Avalanches occur when a cohesive slab of snow fractures as a unit and slides on top of weaker snow, breaking apart as it slides. Slab avalanches occur when additional weight is added quickly to the snow pack, overloading a buried weaker layer. Dry snow avalanches usually travel between 60-80 miles per hour, reaching this speed within 5 seconds of the fracture, resulting in the deadliest form of snow avalanche.

Wet avalanches occur when percolating water dissolves the bonds between the snow grains in a pre-existing snow pack, this decreases the strength of the buried weak layer. Strong sun or warm temperatures can melt the snow and create wet avalanches. Wet avalanches usually travel about 20 miles per hour.

According to the Colorado Avalanche Information Center (CAIC), over the last 10 winters in the United States an average of 25 people died in avalanches every year. In Utah, this translates to approximately 4 avalanche related fatalities every year. Generally speaking, the lion share of avalanche fatalities have occurred in northern Utah. Since every fatal accident is investigated and reported, the numbers can be reported with some certainty. However, there is no way to determine the number of people caught or buried in avalanches each year, because non-fatal avalanche incidents are increasingly under reported. Unfortunately, statistical data pertaining to avalanche related fatalities in southern Utah is underprovided.

VULNERABILITY ASSESSMENT

Requirement §201.6(c)(2)(ii): [The risk assessment **shall** include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description **shall** include an overall summary of each hazard and its impact on the community.

Requirement §201.6(c)(2)(ii)(A): The plan **should** describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area.

Requirement §201.6(c)(2)(ii)(B): [The plan **should** describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph *(c)(2)(ii)(A)* of this section and a description of the methodology used to prepare the estimate.

FLOOD

The Army Corps of Engineers conducted a *Flood Hazard Identification Study* for the Five County region in August, 2003. The intent of this study is to aid in detailing natural hazards associated with fluvial process for entities within the region. The study evaluates and identifies areas with a high flood hazard and identifies potential mitigation solutions. Municipalities within the region were studied if they met the following criteria: 1) Jurisdiction has not been mapped by FEMA; and 2) Jurisdiction mapped by FEMA as a Zone D, area of undetermined flood hazard. The following information is provided from the Study.

Dams are a critical support function for water managers in the State, and also can act as a flood control measure. If a dam remains stable, does not get overtopped, or is not impaired as the

result of an earthquake, then at a minimum, they do provide incidental flood control. If not then they can add to the flood threat. There are 145 dams within the Five County region, of those 33 have received a high hazard rating by Utah Division of Water Right Dam Safety Section. The State Dam Safety Section has developed a hazard rating system for all non-federal dams in Utah. Downstream uses, size height, volume, and incremental risk/damage assessments are a variable used to assign dam safety classification. High hazard dams would cause a possible loss of life in the event of a rupture. The following are high hazard dams in Garfield County: Tropic, Oak Creek Upper Bowns, Wide Hollow, and Panguitch Lake.

Only a little over 20% of Garfield County residents live in the unincorporated county. The County does participate in the National Flood Insurance Program (NFIP). Most development in the unincorporated county is located near Panguitch and Escalante. No major rivers threaten extensive developments in the unincorporated county; therefore, no structural flood control projects are warranted at this time. Potential flood sources include the Sevier and Escalante Rivers and their tributaries, as well as the Colorado River and tributaries, which forms the eastern boundary of the county. There appears to be little development in the unincorporated county that is at risk of serious flooding. The only two identified developments in the unincorporated county are Osiris, adjacent to the East Fork Sevier River (flood threat west of highway) and Ticaboo, adjacent to two unnamed tributaries upstream of Hansen Creek (relatively minor flood threat).

In addition to the above analysis, the vulnerability assessment was conducted using GIS software to join: 1) County Property Tax data as it relates to 2) buildings located with a respective hazard area. This analysis was based upon the most recent County Property Tax data provided by each County Assessor's office. The values shown are based upon utilizing the ***market value*** for structures in each defined hazard area. The GIS software then quantified the number of units and total market value for all structures located within each defined hazard area.

Garfield County - Flood		
Type of Structure	Market Value of Structures	Number of Structures
Residential	$13,872,146	269
Commercial	$32,045,365	40
Total	**$45,917,511**	**309**

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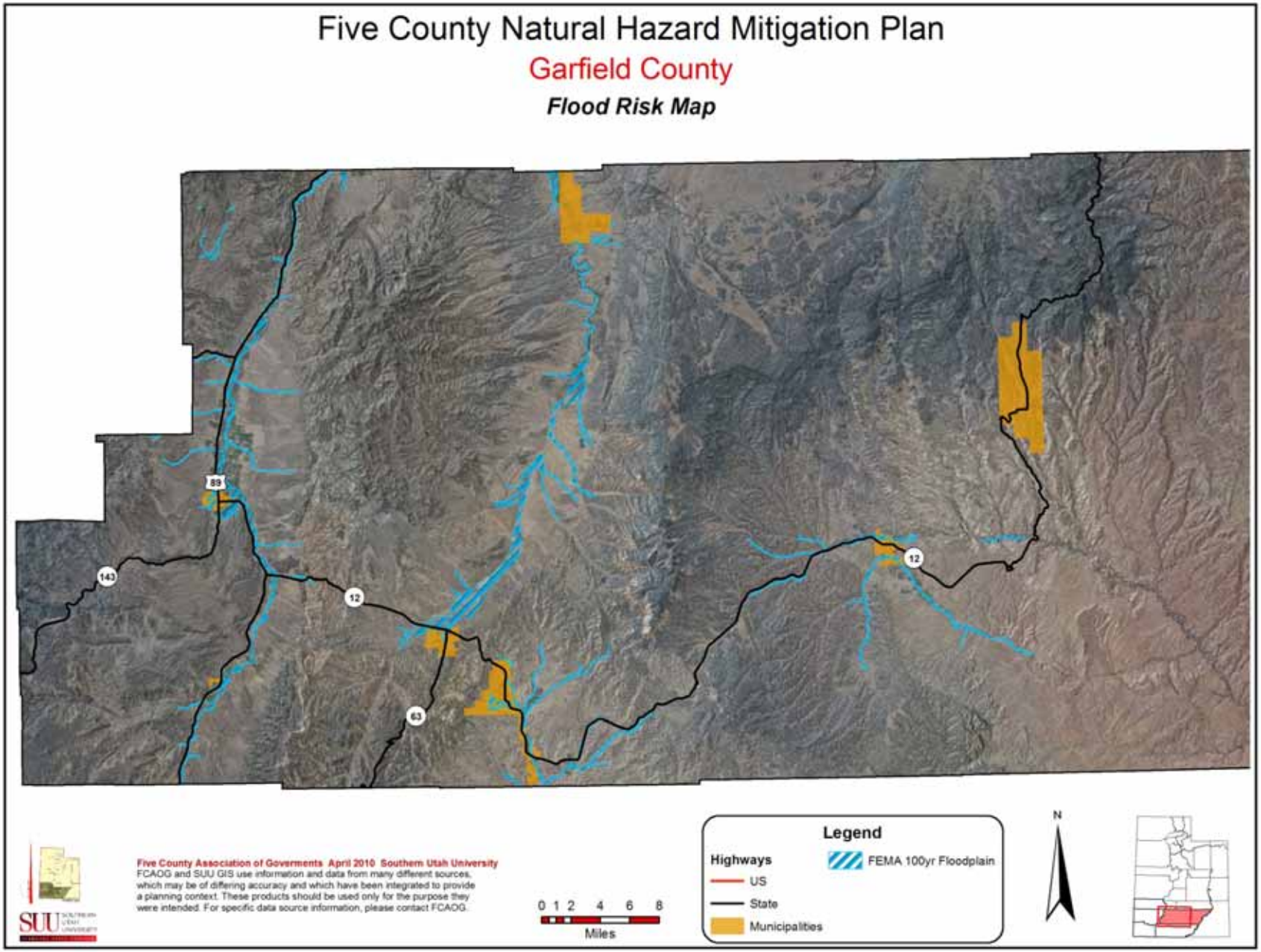
Five County Natural Hazard Mitigation Plan
Garfield County
Flood Risk Map
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Five County Association of Governments April 2010 Southern Utah University
FCAOG and SUU GIS use information and data from many different sources, which may be of differing accuracy and which have been integrated to provide a planning context. These products should be used only for the purpose they were intended. For specific data source information, please contact FCAOG.
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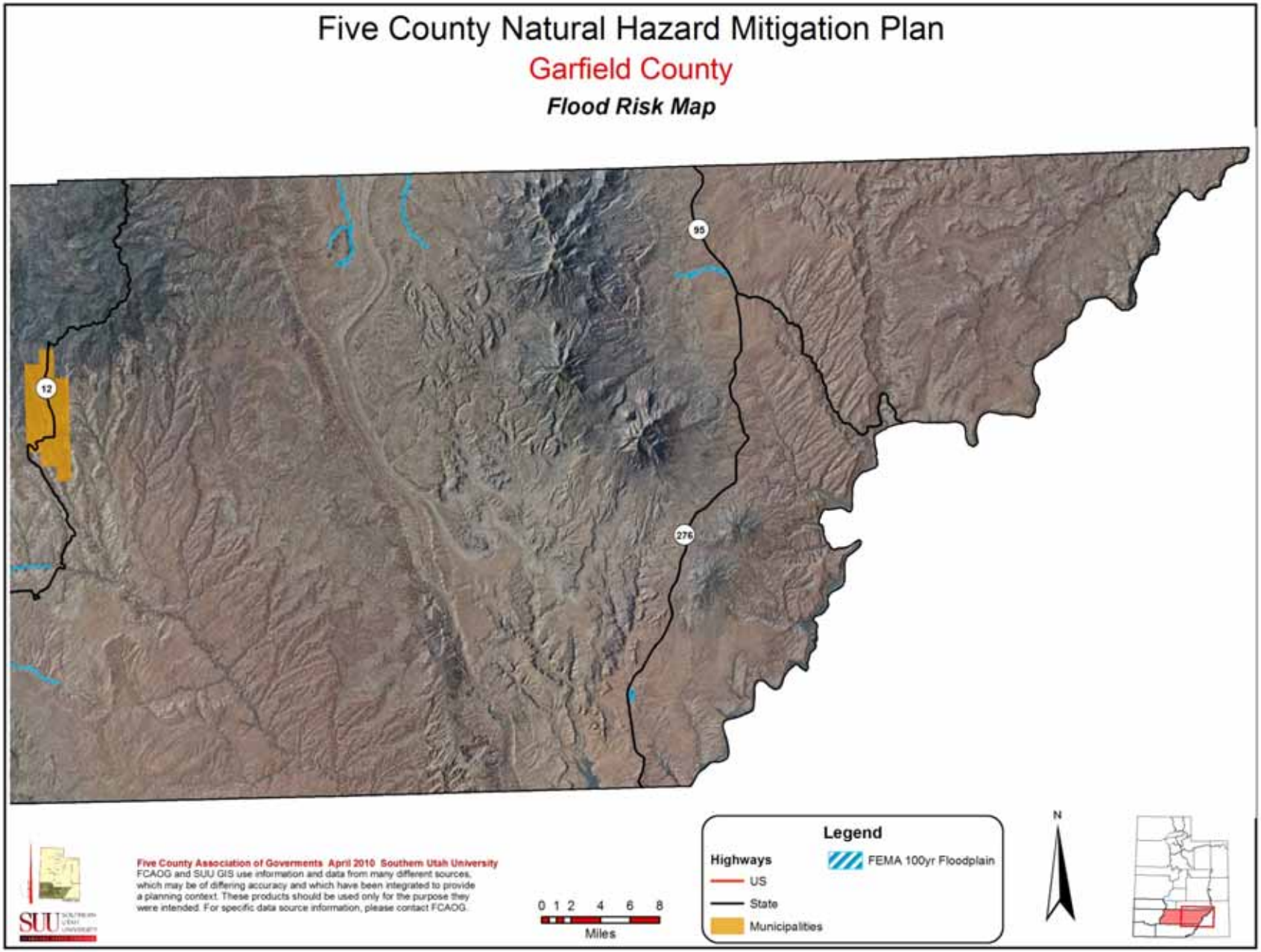
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Garfield County
Flood Risk Map
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LANDSLIDE

According to the USGS, landslides are a widespread geologic hazard that can occur in all 50 states. On average, landslides cause $1-2 billion annually in damages and claim 25 lives per year. Urban development in and along hillside areas increase the number of people threatened by landslide events each year (USGS, 2007). Many factors contribute to overall landslide vulnerability; including local weather, soil moisture, duration and intensity of precipitation, wildfire history, and development pressure. Typically, landslides result from other natural disasters such as earthquakes, volcanoes, wildfires and floods (USGS, 2007). The table below illustrates landslide susceptibility by hazard category.

Landslide susceptibility by hazard category				
County	High Hazard (square miles)	Moderate Hazard (square miles)	Low Hazard (square miles)	**Total (square miles)**
Garfield	3.7	193.8	223.5	**421.0**
Beaver	46.6	579	236.1	**861.7**
Iron	20.5	738.2	333	**1,091.7**
Washington	28.1	1,079.9	423.2	**1,531.2**
Kane	42	1,638.5	672.9	**2,353.4**
Source: State of Utah, Natural Hazard Mitigation Plan, November 2007.				

In addition to the above analysis, the vulnerability assessment was conducted using GIS software to join: 1) County Property Tax data as it relates to 2) buildings located with a respective hazard area. This analysis was based upon the most recent County Property Tax data provided by each County Assessor's office. The values shown are based upon utilizing the ***market value*** for structures in each defined hazard area. The GIS software then quantified the number of units and total market value for all structures located within each defined hazard area.

Garfield County - Landslide			
Type of Structure	Market Value of Structures		Number of Structures
	Landslide Risk Area- High	Landslide Risk Area- Medium	
Residential			
Commercial			
Residential		$9,405,546	157
Commercial		$33,553,685	25
Total		**$42,959,231**	**182**
Overall Total		**$42,959,231**	**182**

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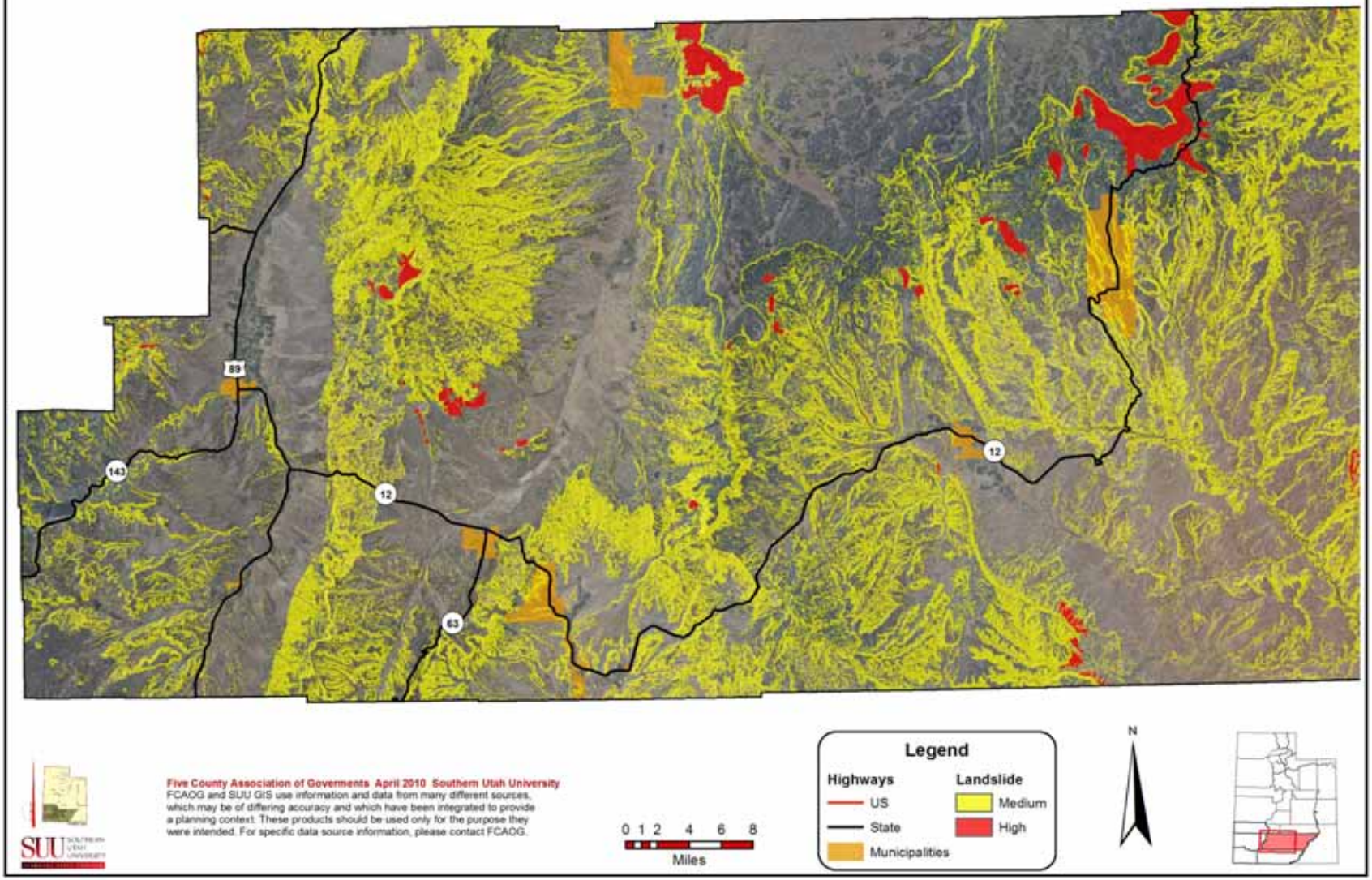
Five County Natural Hazard Mitigation Plan

Garfield County

Landslide Risk Map



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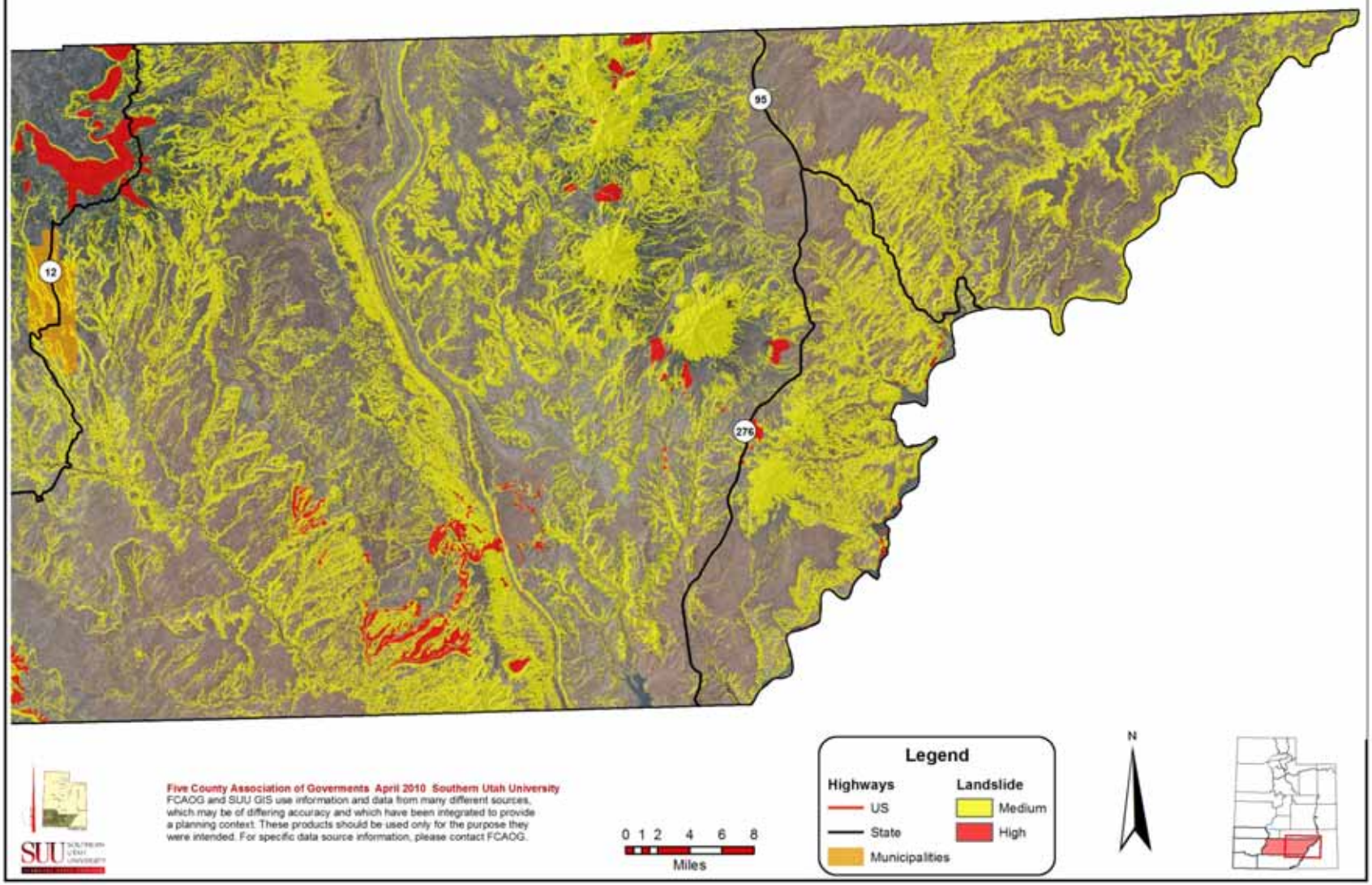
Five County Natural Hazard Mitigation Plan

Garfield County

Landslide Risk Map



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EARTHQUAKE

When assessing the vulnerability of structures as a result of an earthquake, an understanding of the building code, to which the structure was designed, is of extreme importance. Utah building codes began to address seismic design as early as 1976; although, the state did not adopt building codes fully addressing seismic safety until 1989. It is fairly safe to assume that structures constructed prior to 1976 will not perform in an earthquake as well as structures built following 1976. This is to say that an increased understanding of seismic events coupled with advances in building design has greatly increased our ability to design and construct buildings which perform better in earthquakes.

Earthquakes are regional hazards affecting multi-county areas, and because almost the entire state could experience a seismic event, all communities contain some degree of risk. The degree of risk is determined by several factors; however, the paramount factor is naturally the likelihood and magnitude of the earthquake. This being said, building design is a key factor when discussing potential structural damage. Vulnerability of structures was determined through age of construction with those structures built before 1976 considered possessing a higher risk.

Age of Housing Stock			
County	Structures built before 1976	Total Structures	**% of Structures built before 1976**
Beaver	1,559	2,660	**59%**
Garfield	1,497	2,767	**54%**
Iron	5,336	13,618	**39%**
Kane	1,398	3,767	**37%**
Washington	6,777	36,478	**19%**
Source: U.S. Census, November 2000.			

In addition to the above analysis, the vulnerability assessment was conducted using GIS software to join: 1) County Property Tax data as it relates to 2) buildings located with a respective hazard area. This analysis was based upon the most recent County Property Tax data provided by each County Assessor's office. The values shown are based upon utilizing the *market value* for structures in each defined hazard area. The GIS software then quantified the number of units and total market value for all structures located within each defined hazard area. The quantitative earthquake data provided below includes all structures which are: 1) on a fault line, or 2) within a 500' to 1,000' fault line buffer area. The range provided for the fault line buffer area is a determination made by Utah Geological Survey as it relates to the fault being studied or unstudied.

Garfield County - Earthquake		
Type of Structure	Market Value of Structures	Number of Structures
Residential	$2,540,580	19
Commercial	$26,463,675	5
Total	**$29,004,255**	**24**

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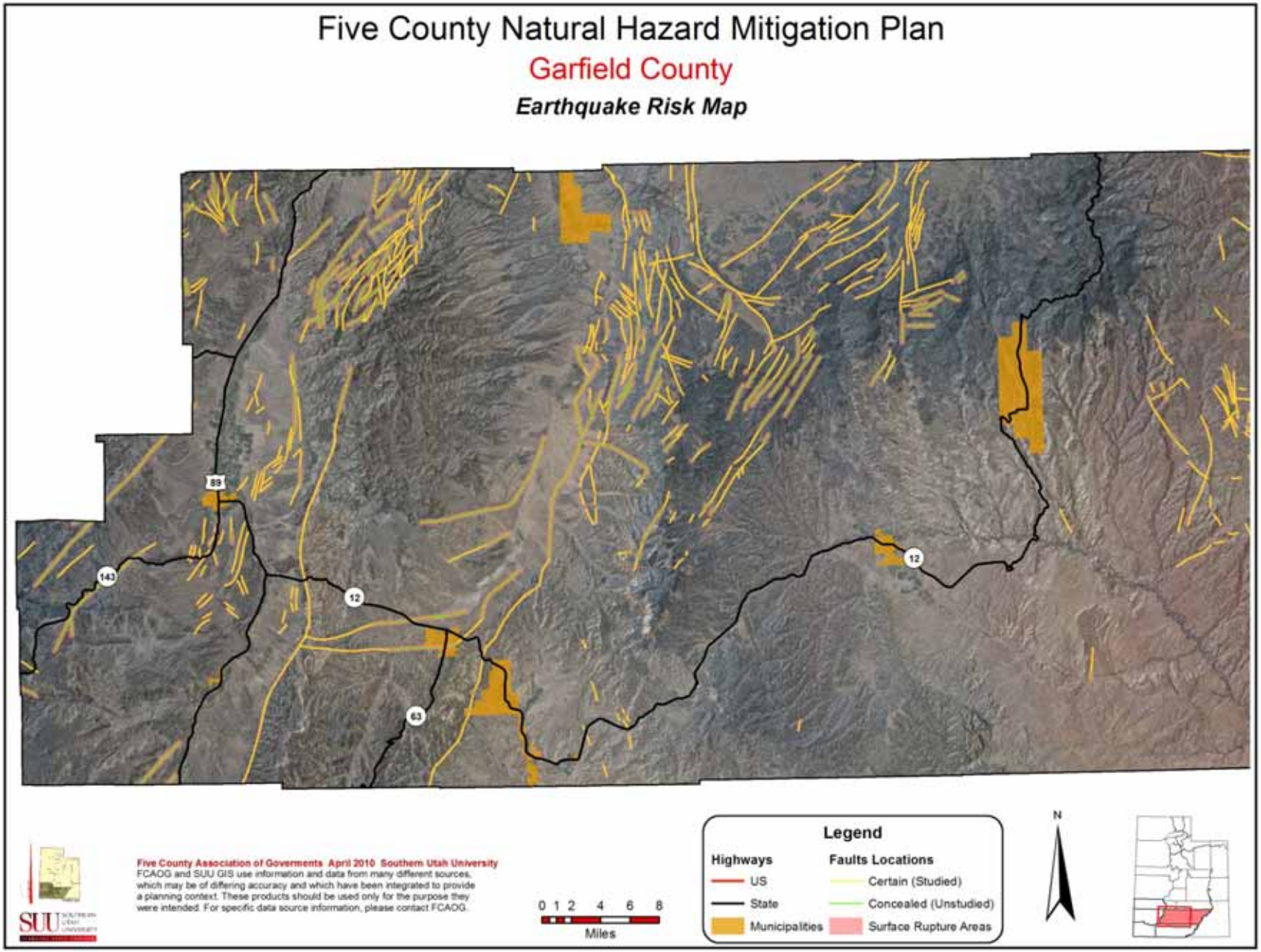
Five County Natural Hazard Mitigation Plan

Garfield County

Earthquake Risk Map



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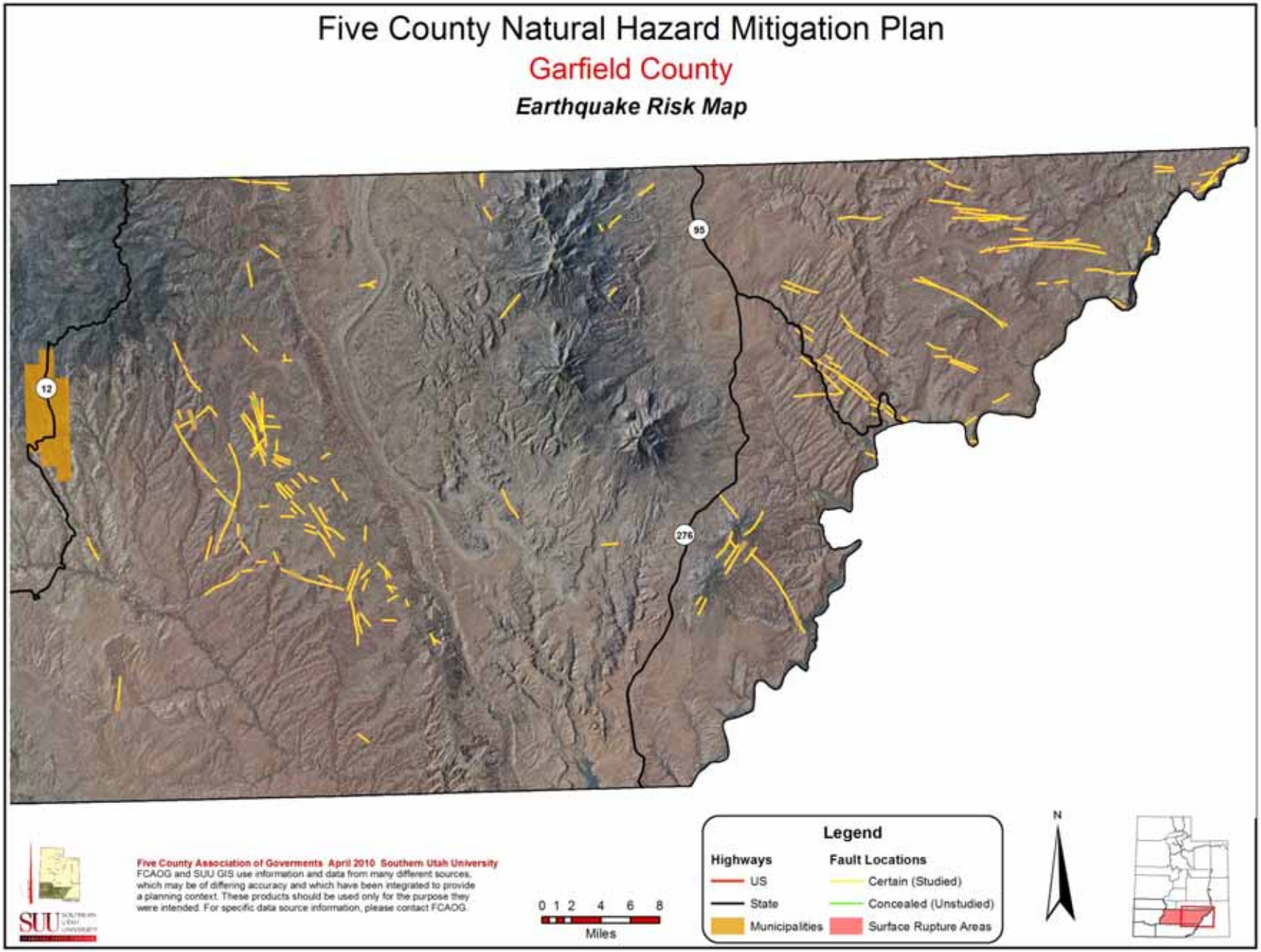
Five County Natural Hazard Mitigation Plan
Garfield County
Earthquake Risk Map
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Five County Association of Governments April 2010 Southern Utah University
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0 1 2 4 6 8
Miles
Legend
Highways
US
State
Municipalities
Fault Locations
Certain (Studied)
Concealed (Unstudied)
Surface Rupture Areas
N

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WILDFIRE

As illustrated in the *Southwest Utah Regional Wildfire Protection Plan* (October 2007), the Color Country Fuels Committee (CCFC) compiled data that included standardized internal and external risk assessments, digital photos, maps, and other information to prioritize hazardous fuels target areas and to aid in suppression efforts. Each CARs was given a score ranging from 0 (no risk) to 12 (extreme risk) based on the sum of multiple risk factors (e.g., fire history, local vegetation, firefighting capabilities) analyzed in every area. The scoring system allows Utah's fire prevention program officials to assess the relative risk in a given area of the state and open communication channels with these communities to help them better prepare for wildfire.

Garfield County- Communities at Risk and Risk Score (2005)	
Mammoth Creek	12
Panguitch Lake/Beaver Dam/Clear Creek	10
Blue Spring	10
Tropic	10
Boulder	9
Main Canyon	9
Red Canyon	9
Ruby's Inn	9
Escalante	8
Hatch	8
Antimony	8
Upper Valley	8
Widtsoe Jct.	8
Aspen Academy	8
Panguitch	8
Boulder Mtn.	7
Cannonville	7
Haycock	7
Henrieville	7
Salt Gulch Ranch	7
Forest Gardens	6
Source: Southwest Utah Regional Wildfire Protection Plan (October 2007)	

In addition to the above analysis, the vulnerability assessment was conducted using GIS software to join: 1) County Property Tax data as it relates to 2) structures located within a respective hazard area. This analysis was based upon the most recent (2009) County Property Tax data provided by each County Assessor's office. The values shown are based upon utilizing the market value for structures in each defined hazard area. Where applicable, if a critical facility was located within a defined hazard area, this valuation was included within the commercial structure category. The GIS software then quantified the number of units and total market value for all structures located within each defined hazard area.

Garfield County - Wildfire			
Type of Structure	Market Value of Structures		Number of Structures
	Wildfire Risk Area-High	Wildfire Risk Area-Medium	
Residential	$377,110		8
Commercial	$79,940		2
Residential		$13,347,121	245
Commercial		$6,172,580	35
Total	**$457,050.00**	**$19,519,701.00**	**290**
Overall Total		**$19,976,751**	**290**

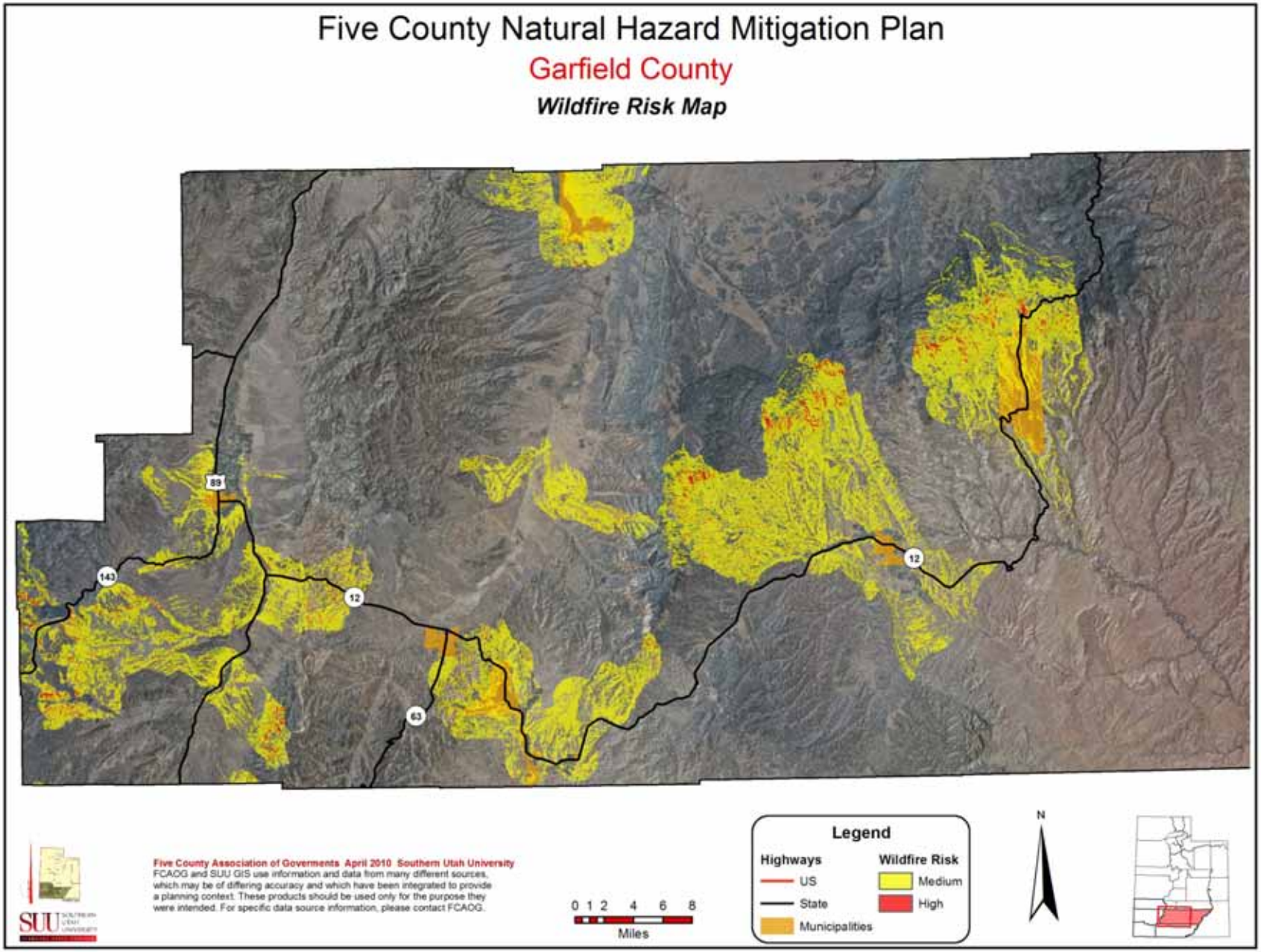
In addition to structures located within a defined hazard area, there is also an overwhelming amount (in terms of quantity and value) of infrastructure that is not captured by the GIS analysis. This is in large part due to the fact that compilation of this data would be exhaustive; nevertheless, the following provides a summarization of infrastructure at risk from wildfire.

Infrastructure at Risk from Wildfire			
Location	Miles of Major Roadways	Miles of Railroad Track	Miles of Utility Powerlines
Beaver County	60	5	87
Garfield County	104	0	154
Iron County	110	117	180
Kane County	59	0	50
Washington County	80	0	155
Paiute Indian Lands	10	0	0
Region Totals	**423**	**122**	**626**

Five County Natural Hazard Mitigation Plan

Garfield County

Wildfire Risk Map



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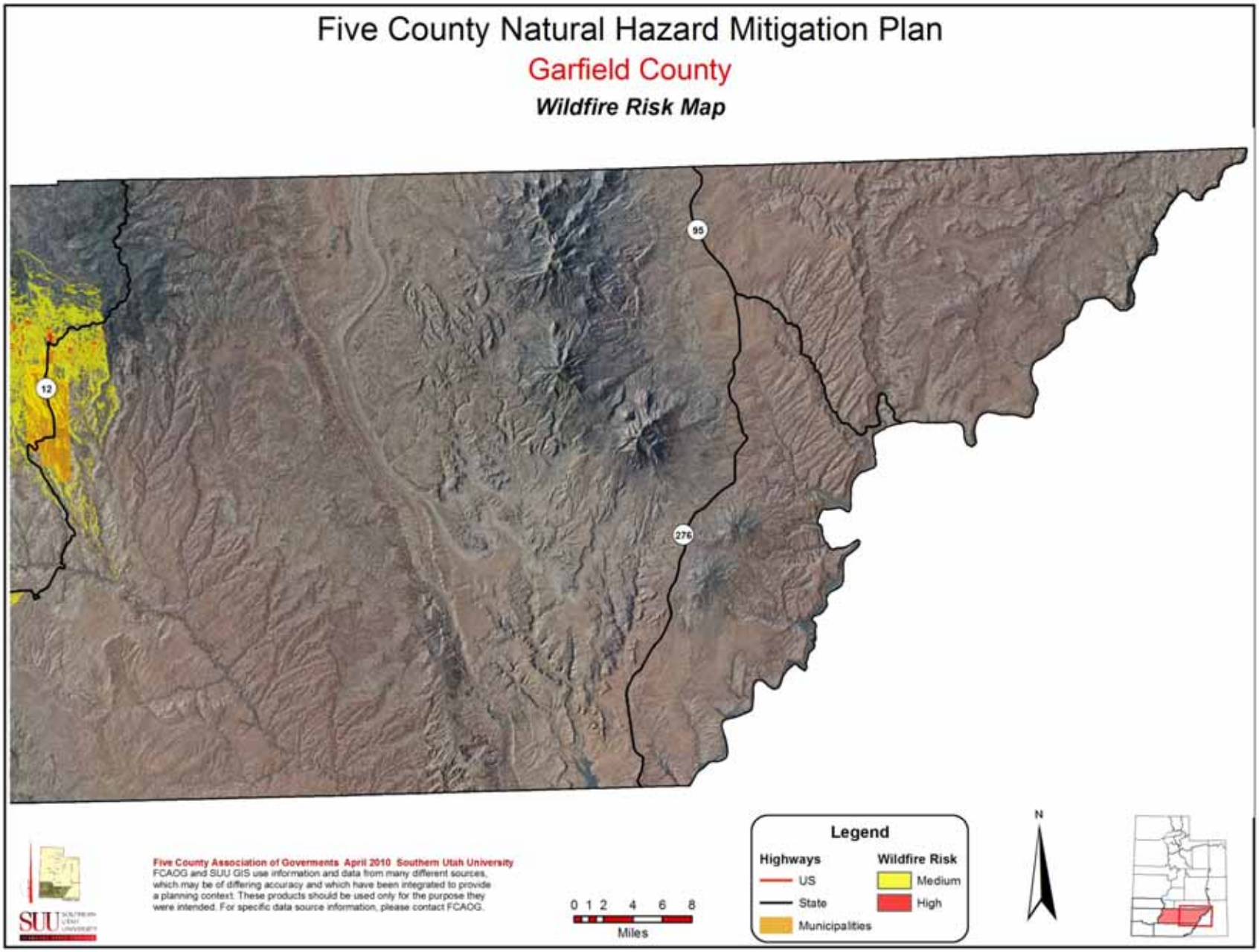
Five County Natural Hazard Mitigation Plan
Garfield County
Wildfire Risk Map
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SUU
0 1 2 4 6 8
Miles
Legend
Highways
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State
Municipalities
Wildfire Risk
Medium
High
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PROBLEM SOILS

Geologic materials with characteristics that make them susceptible to volumetric changes, collapse, subsidence, or other engineering-geologic problems are referred to as problem soils. Geologic and climatic conditions in southwestern Utah provide a variety of both localized and widespread occurrences of these materials. Soil and rock related geologic problems occur in a variety of geologic settings and are some of the most widespread and costly geologic hazards. Six types of problem soil and rock are present in southwestern Utah. Six types of problem soil and rock are found in southwestern Utah: (1) expansive soil and rock with high shrink/swell potential, (2) collapsible soil, (3) limestone (Karsts Terrain) susceptible to dissolution under some hydro geologic conditions, (4) gypsiferous soil/rock susceptible to dissolution, (5) soil subject to piping (localized subsurface erosion), and (6) active dunes. Some materials, such as expansive soil and limestone, cover large areas, whereas others, like active dunes, are of limited extent. The most extensive problem soils found in the region are expansive soil and rock.

Expansive Soils and rock are the most common type of problem soils in southwestern Utah. Expansive deposits contain clay minerals that expand and contract with changes in moisture content. Clays absorb water when wetted, causing the soil or rock to expand. Conversely, as the material dries, the loss of water between clay crystals or grains causes the deposit to shrink.

Expansive deposits are extensive around St. George, Washington, and Santa Clara in Washington County. In these areas expansive clays in the Chinle Formation have been most damaging to structures. In Santa Clara, many homes and a church were damaged by expansive clays in the Chinle Formation. Common problems are cracked foundations, heaving and cracking of floor slabs and walls, and failure of wastewater disposal systems. Sidewalks and roads are particularly susceptible to damage. The majority of expansive soil problems are found in Washington and Iron Counties.

Collapsible Soil- The phenomenon of hydrocompaction, which causes subsidence in collapse prone soil, occurs in loose, dry, low density deposits that decrease in volume or collapse when saturated for the first time following deposition. Collapse occurs when susceptible soils are wetted to a depth below that normally reached by rainfall, destroying the clay bonds between grains. Collapsible soil is present in geologically young materials such as Holocene age alluvial fan and debris flow sediments. When saturated, the soil collapses and the ground surface subsides, damaging property and structures. Human activities that involve some form of water application such as irrigation, water impoundment, lawn watering, and alterations to natural drainage or wastewater disposal commonly initiate hydrocompaction.

Collapsible soil is present particularly near Cedar City (Iron County) and the Hurricane Cliffs (Washington County). In Cedar City approximately $3 million in damage to public and private structures has been attributed to collapsible soil. Other areas in southwestern Utah with a potential collapsible soil problem are along mountain fronts where young alluvial fan deposits containing fine-grained sediments are present. Climate also plays a role in the distribution of collapsible soils. Drier areas, such as the Basin and Range and Colorado Plateau provinces, provide the best conditions for development of collapsible soil. Soil and rock containing gypsum

are also susceptible to subsidence. Ground water and introduced waters from irrigation dissolve gypsum causing subsidence.

Limestone (Karsts Terrain) is characterized by sinkholes, caverns, and streams that abruptly disappear underground. Karsts features are caused by ground and surface water dissolution of calcareous rocks, such as limestone. Cavernous subterranean openings in karst terrain often collapse, leaving sinkholes at the surface.

Limestone susceptible to dissolution and subsidence occurs throughout mountains west of Sevier Lake, west of Richfield, and south of St. George. No known damage to structures has occurred from ground collapse or subsidence related to limestone karsts; however, the potential for damage exists where susceptible units are present. In addition, because karsts ground-water systems have little filtering capacity, contamination of ground water is a major concern.

Gypsiferous soil/rock are subject to settlement caused by the dissolution of gypsum, which creates a loss of internal structure and volume within the deposit. Gypsum in soil can also form in other ways - including as a secondary mineral deposit leached from surficial layers and concentrated lower in the soil profile or wind-blown dust, and in the St. George area (Washington County) by the evaporation of ground water.

Gypsiferous soil and rock deposits are common in southwestern Utah, particularly along the base of the Hurricane Cliffs. Much of the gypsum is derived from erosion of gypsum rich rock units. Gypsum in these deposits can cause damage to foundations, and induce land subsidence and sinkholes similar to those seen in limestone terrain. Water introduced into the subsurface for irrigation and landscaping or into wastewater disposal systems, can cause underground solution cavities to develop, which may ultimately cause surface collapse. Gypsum is also a weak material with low bearing strength, which can cause problems when loaded with the weight of a structure. In addition, gypsum dissolved in water forms sulfuric acid and sulphate, which react with certain types of cement and weaken foundations.

Soils Subject to Piping- Piping is subsurface erosion by ground water that moves along permeable, non-cohesive layers in unconsolidated materials and exits at a free face, usually along a stream bank or cliff that intersects the layer. Removal of fine-grained particles by this process creates voids within the material that act as minute channels which direct the movement of water. As channels enlarge, water moving through the conduit increases velocity and removes more material, forming a "pipe." The pipe becomes a preferred avenue for ground-water drainage and enlarges as more water is intercepted. Increasing the size of the pipe removes support from the walls and roof, causing eventual collapse.

Deposits susceptible to piping are common in southwestern Utah. Piping can cause damage to roads, bridges, culverts, and any structure built over soils subject to piping. In areas where piping is common, roads are frequently damaged where they parallel stream drainages and cross-cut pipes. Road construction can contribute to the piping problem by disturbing natural runoff and concentrating water along paved surfaces, allowing greater infiltration and potential for pipes to develop.

Sand Dunes are common surficial deposits in arid areas where sand derived from weathering of rock or unconsolidated deposits is blown by the wind into mounds or ridges. In areas where development encroaches on dunes, inactive or vegetated dunes may be reactivated, allowing them to migrate over roads and bury structures. Another problem is the contamination of local ground water from wastewater disposal in dunes. The uniform size of the sand grains comprising dunes makes them highly permeable. Dunes are present in many areas of southwestern Utah, especially in the Escalante Desert (Iron County) and west of Kanab (Kane County). Avoidance of dunes is the best way to prevent damage to structures. (Excerpted from Lund, UGS unpublished information).

Conclusions- In addition to the above analysis, the vulnerability assessment was conducted using GIS software to join: 1) County Property Tax data as it relates to 2) buildings located with a respective hazard area. This analysis was based upon the most recent County Property Tax data provided by each County Assessor's office. The values shown are based upon utilizing the ***market value*** for structures in each defined hazard area. The GIS software then quantified the number of units and total market value for all structures located within each defined hazard area.

Garfield County – Problem Soils		
Type of Structure	Market Value of Structures	Number of Structures
Residential	$9,742,490	210
Commercial	$4,262,680	28
Total	**$14,005,170**	**238**

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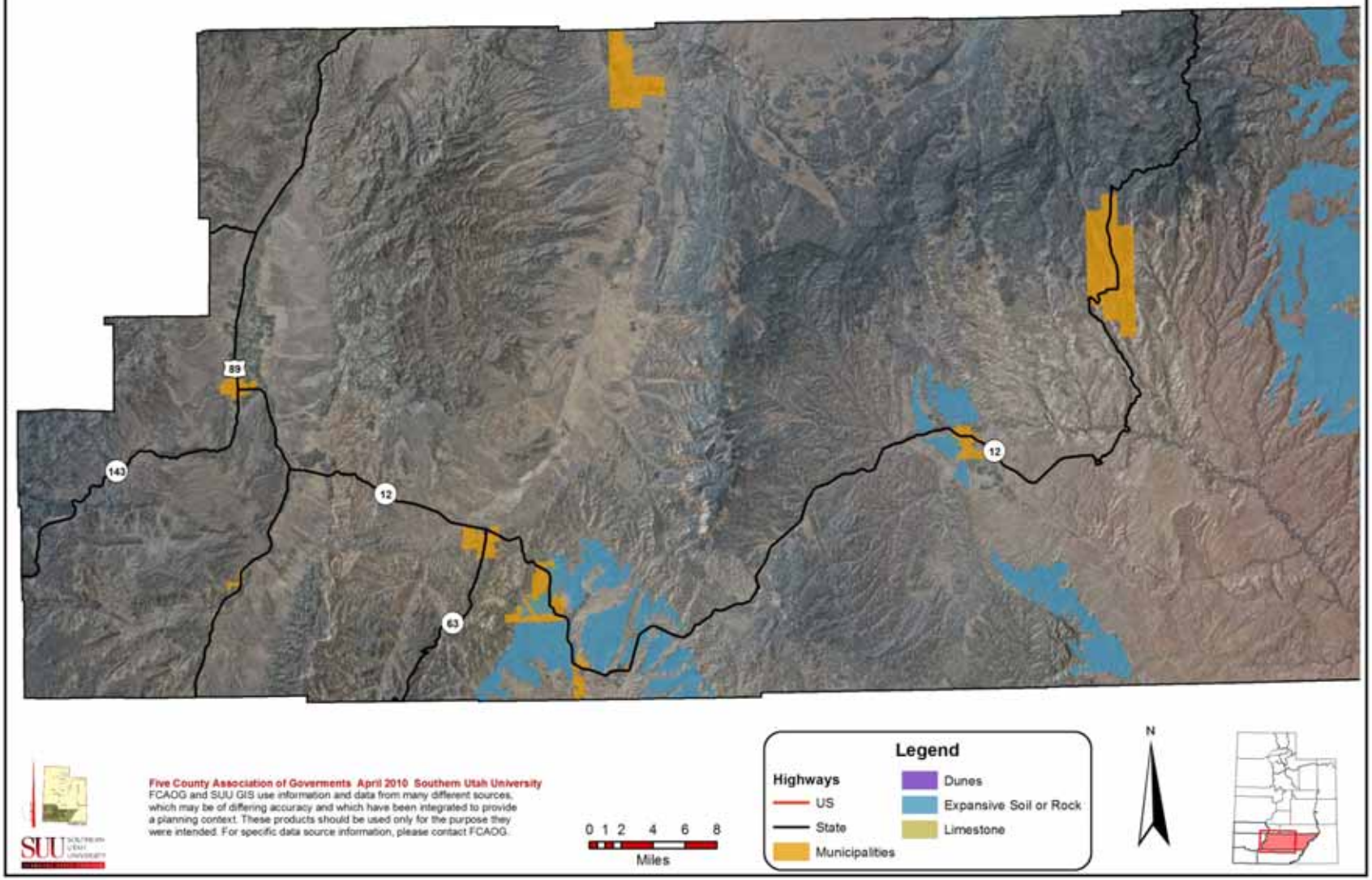
Five County Natural Hazard Mitigation Plan

Garfield County

Problem Soils Risk Map



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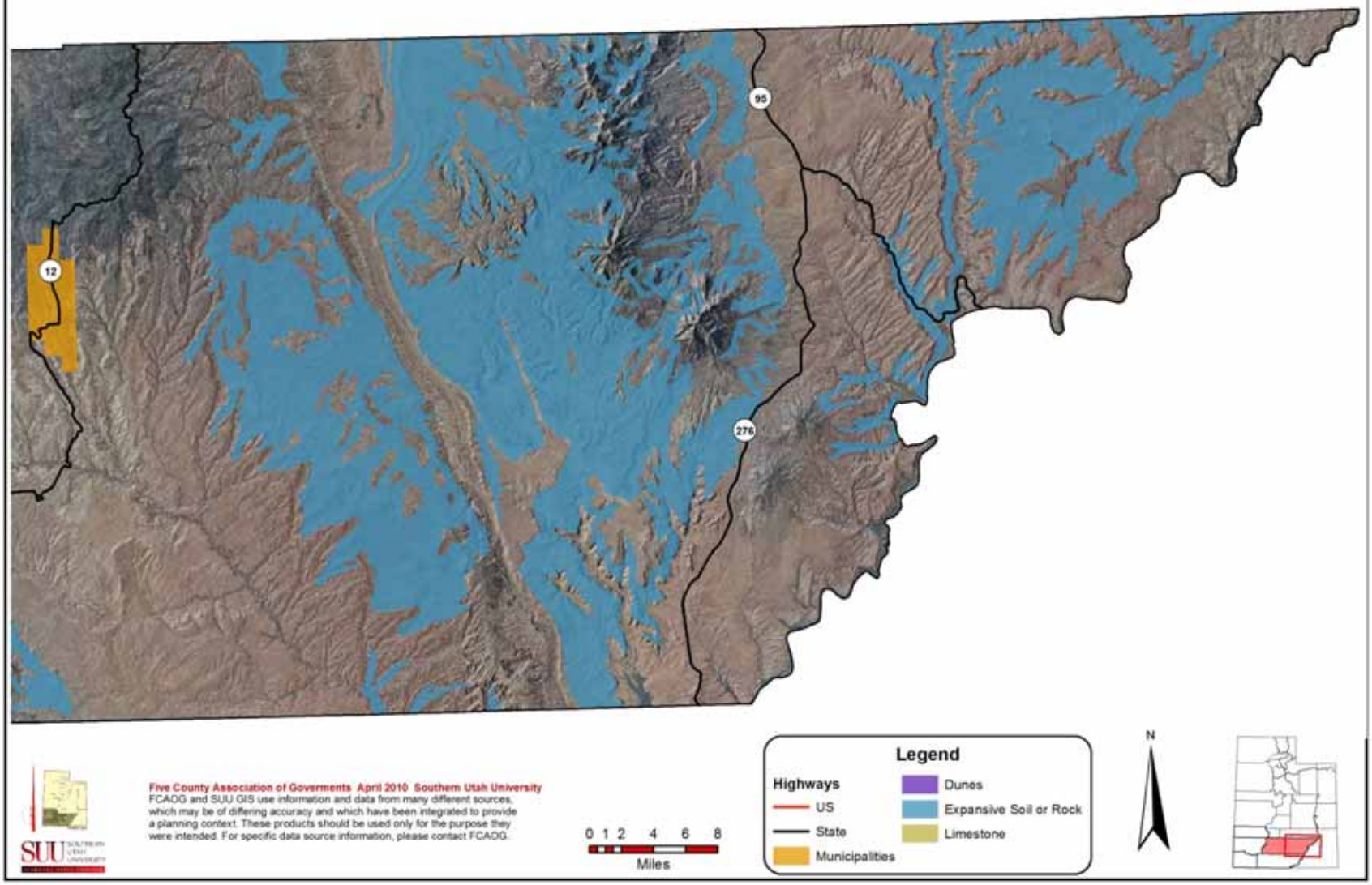
Five County Natural Hazard Mitigation Plan

Garfield County

Problem Soils Risk Map



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SEVERE WEATHER

There are many qualitative factors that point to potential vulnerability. Severe weather can cause power outages, transportation and economic disruptions, significant property damage, and pose a high risk for injuries and loss of life. The event can also be typified by a need to shelter and care for individuals impacted by the event. On numerous occasions, severe weather have brought economic hardship and affected the life of the residents of southwestern Utah. Higher elevations in The Five County region have greater exposure to snow and ice, but may be less economically vulnerable because they are sparsely populated. Quantitative assessment of severe weather vulnerability and determining which counties are more vulnerable is very challenging. However, using the principle of the past being the key to the future is effective. For example, one would assume that an area that has exhibited a high number of occurrences would continue to exhibit the same.

A quantitative vulnerability assessment is difficult based upon the simple fact that severe weather occurrences are random and difficult to predict. Several factors limit a determination of potential losses, they include:

- Limited GIS data availability;
- Lack of research on site-specific location;
- The entire state of Utah shares similar, if not identical risks; and
- Most hazards are tied to weather and cannot be predicted with location.

The vulnerability assessment was conducted using GIS software to join: 1) County Property Tax data as it relates to 2) buildings located with an area that has exhibited severe weather occurrences. This analysis was based upon the most recent County Property Tax data provided by each County Assessor's office. The values shown are based upon utilizing the ***market value*** for structures in each defined severe weather hazard area. The GIS software then quantified the number of units and total market value for all structures located within each defined severe weather hazard area.

Garfield County – Severe Weather		
Type of Structure	Market Value of Structures	Number of Structures
Residential	$1,628,790	23
Commercial	$681,210	4
Total	**$2,310,000**	**27**

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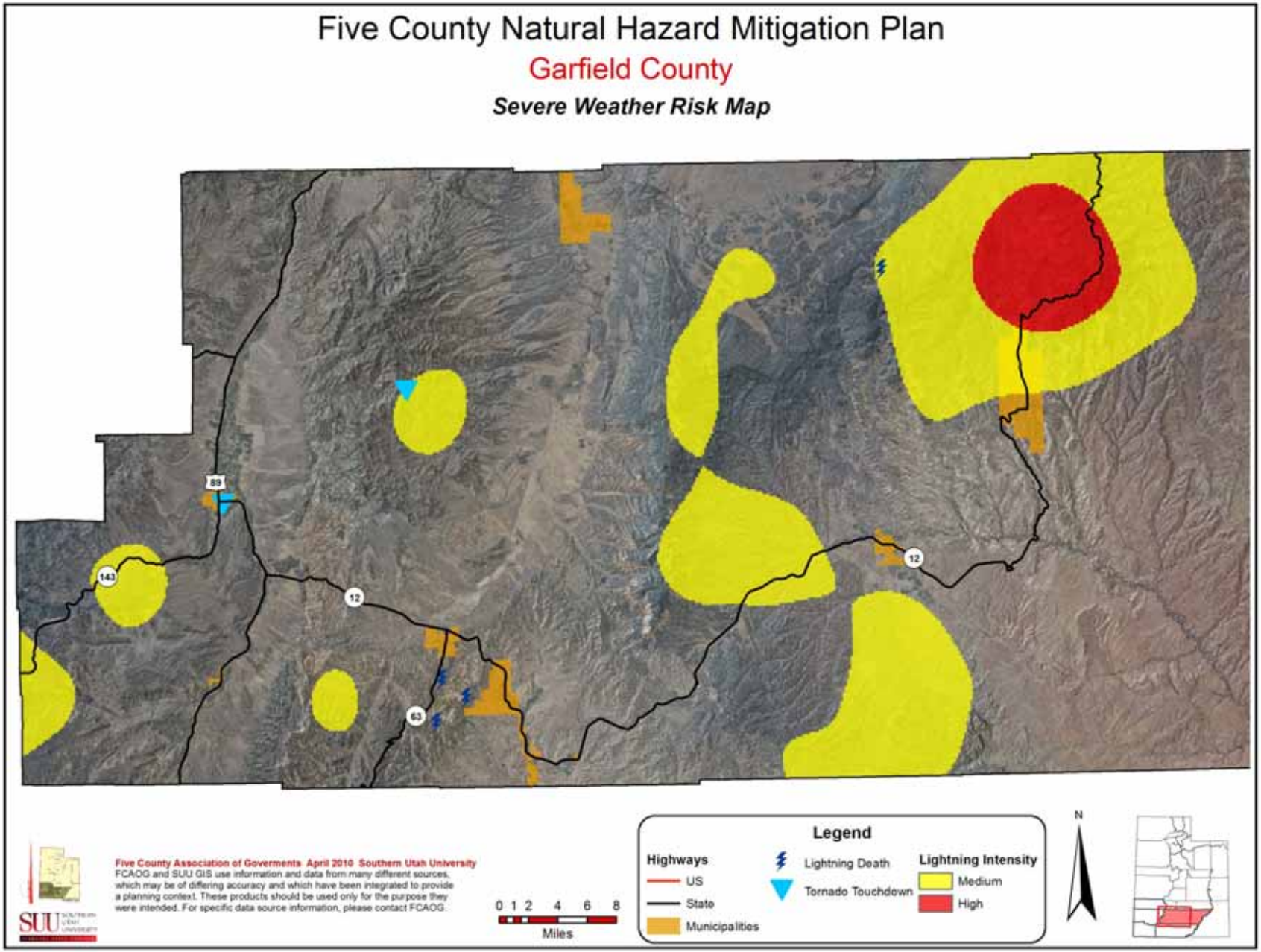
Five County Natural Hazard Mitigation Plan
Garfield County
Severe Weather Risk Map
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143
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63
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0 1 2 4 6 8
Miles
Legend
Highways
US
State
Municipalities
Lightning Death
Tornado Touchdown
Lightning Intensity
Medium
High
N

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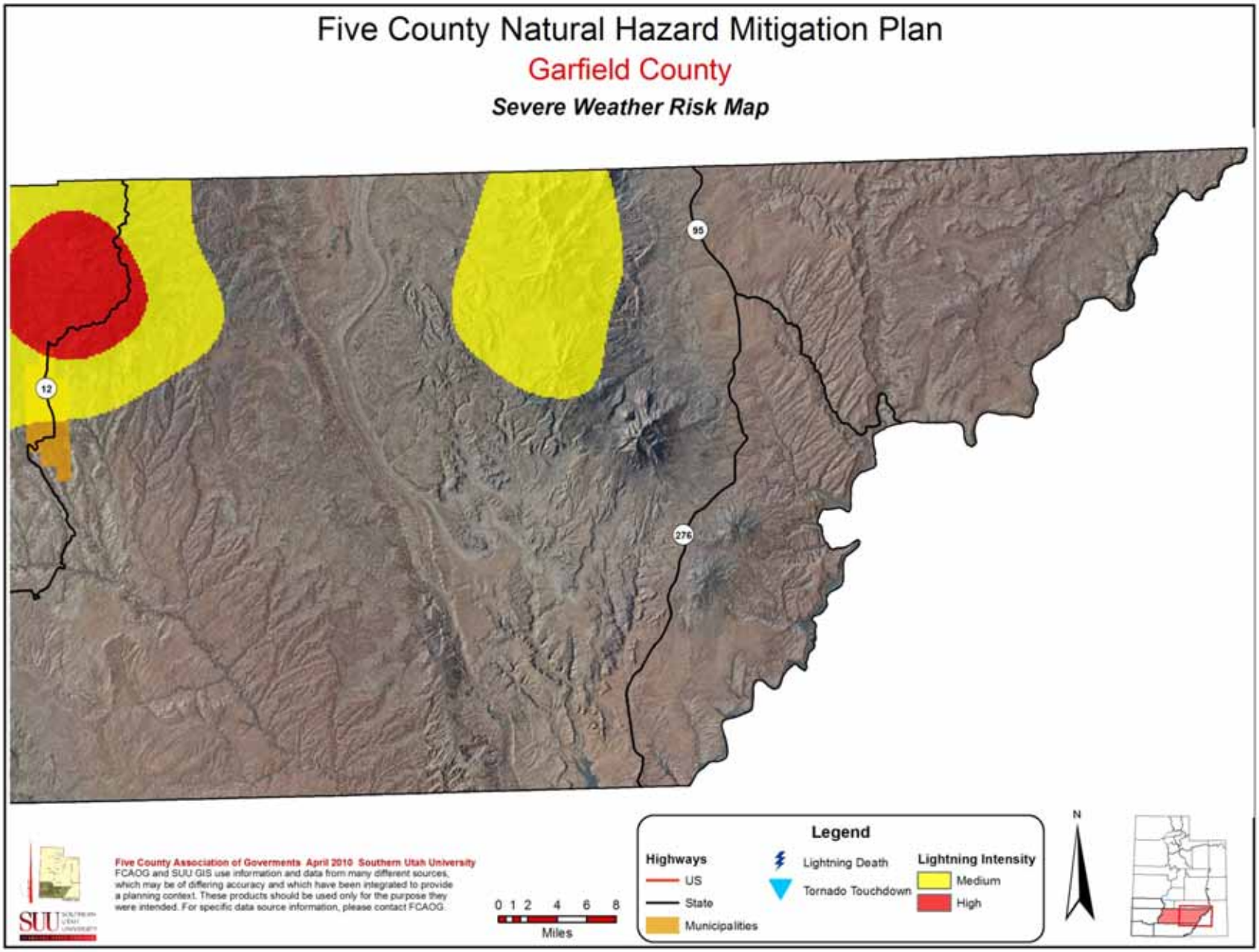
Five County Natural Hazard Mitigation Plan
Garfield County
Severe Weather Risk Map
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MITIGATION STRATEGY

The following table provides a brief synopsis of the Garfield County mitigation strategies. Additional information for each specific hazard, including specific mitigation strategies and associated information, are found following this table.

Garfield County- Mitigation Strategies									
Mitigation Strategy	**Action**	**Timeline**	**Estimated Cost**	**Plan Goals Addressed**					
				Education/ Outreach	**Emergency Services**	**Environmental Protection**	**Partnership/ Coordination**	**Prevention**	**Property Protection**
Flood-Mitigation Strategy #1	Nonstructural measures appear to be the most prudent option for the county to implement. Zoning to prevent development of structures near all rivers, creeks, and lakes (100' min. setback).	Ongoing	Minimal		●		●		●
Flood-Mitigation Strategy #2	Address flood control at the building/construction level by requiring all subdivision proposals to have a storm water drainage system.	Ongoing	Minimal			●		●	●
Flood-Mitigation Strategy #3	Clear debris and other material from all waterways	Ongoing	Minimal			●		●	●
Flood-Mitigation Strategy #4	Create outreach document promoting flood insurance and include in local newspaper(s), libraries, and other public buildings.	1 year	Minimal	●			●	●	●

Flood-Mitigation Strategy #5	A potentially viable alternative would be to flood proof those relatively few existing low-lying structures that are subject to flooding. (Boulder & Cannonville)	Unknown	$10,000 to $30,000 per structure.			●		●	●
Flood-Mitigation Strategy #6	The potential structural solution consisted of raising existing levees and constructing a new one. (Panguitch)	5 years	About $3.5 million				●	●	●
Landslide-Mitigation Strategy #1	Increase public education related to landslide hazards by distributing UGS landslide informational brochures to local municipality level emergency mgmt., engineering, and planning departments.	Ongoing	Very minimal	●	●		●	●	
Landslide-Mitigation Strategy #2	Drafting/updating zoning and/or landslide ordinances to prevent development of structures near debris flows, landslides, and rock fall areas.	Ongoing	Minimal					●	●
Landslide-Mitigation Strategy #3	1-Address landslide risk at the building/construction level by requiring all subdivision proposals to have a geotechnical report.	Ongoing	Minimal					●	●
	2-If jurisdiction does not have trained staff to review the geotechnical report, the jurisdiction can, upon request, have UGS perform a review of the report.	Ongoing	Minimal				●	●	●

Earthquake-Mitigation Strategy #1	Increase public education related to earthquake hazards by distributing Utah Seismic Safety Commission informational brochures to County and City emergency management agencies.	Ongoing	Very minimal	●			●		
Earthquake-Mitigation Strategy #2	Continued dedication/vigilance in enforcing the seismic standards established in the International Building Code.	Ongoing	Minimal					●	●
Earthquake-Mitigation Strategy #3	1-Utilize the Earthquake Risk Map provided in this plan as a tool to assess earthquake risks as it relates to any building/subdivision proposals. If deemed necessary, jurisdiction should require the builder/developer to conduct a site-specific earthquake hazard identification/mappin g study.	Ongoing	$1,000-$5,000					●	●
	2- At the County level, contract with UGS to formally study/map earthquake hazard areas.	3-5 years	$7,109-$14,218 per jurisdiction				●	●	●
Wildfire-Mitigation Strategy #1	Promote public awareness campaign for property owners living in wildland urban interface areas.	Ongoing	Unknown	●			●	●	●
Wildfire-Mitigation Strategy #2	1-Complement fuels reduction work being done by the Park Service and Forest Service onto private lands.	Ongoing	Unknown		●		●	●	●
	2-Prevent fires on private lands which may spread onto federal lands.	Ongoing	Unknown		●		●	●	●

Wildfire-Mitigation Strategy #3	1-Continue to place strategic fuel breaks throughout the focus area.	Ongoing	Unknown		●	●		●	●
	2-Encourage landowner mitigation and defensible space work.	Ongoing	Unknown	●	●		●	●	●
Wildfire-Mitigation Strategy #4	Enhance existing wildfire training programs, equipment procurement, and fire fighting resources for wildfire suppression.	Ongoing	Unknown		●		●	●	●
Problem Soils-Mitigation Strategy #1	1-Address problem soils at the building/construction level by requiring all subdivision proposals to have a geotechnical report.	Ongoing	$1,000-$5,000					●	●
	2- If jurisdiction does not have trained staff to review the geotechnical report, the jurisdiction can, upon request, have UGS perform a review of the report.	Ongoing	Minimal				●	●	●
Problem Soils-Mitigation Strategy #2	Utilize the Problem Soils Risk Map provided in this plan as a tool to assess problem soils risks as it relates to any building/subdivision proposals. If deemed necessary, jurisdiction should require the builder/developer to conduct a site-specific geotechnical (soils) report.	Ongoing	$1,000-$5,000					●	●

Problem Soils-Mitigation Strategy #3	Through mapping, identify areas which contain collapsible and expansive soils. Require soils testing at the building/construction level and ensure that engineer's recommendations are followed.	Ongoing	$1,000-$5,000					●	●
Severe Weather-Mitigation Strategy #1	Continued dedication/vigilance in enforcing the standards established in the International Building Code as it relates to wind-loading, electrical grounding, snow-loading, and other weather-related hazards.	Ongoing	Minimal					●	●
Severe Weather-Mitigation Strategy #2	1-Enhance the Emergency Alert System (tv & radio)	Ongoing	Unknown	●	●		●		
	2-Enhance NOAA Weather Radio All Hazard coverage.	Ongoing	Unknown	●	●		●		
Severe Weather-Mitigation Strategy #3	At the county Local Emergency Planning Committee (LEPC) level, meet the program guidelines then apply to the National Weather Service StormReady Program.	3-5 years	Minimal		●		●	●	●
Drought-Mitigation Strategy #1	1-County-level distribution of water conservation information via newsletter and/or website to affiliated constituents.	Ongoing	Minimal	●		●	●	●	
	2- Water purveyors distribute water conservation information to affiliated constituents.	Ongoing	Minimal	●		●	●	●	

Drought-Mitigation Strategy #2	Develop/demonstrate water conservation practices for agricultural use.	Ongoing	Minimal	●		●	●	●	●
Drought-Mitigation Strategy #3	County-level implementation of mitigation strategies identified in *"Drought in Utah-Learning from the Past-Preparing for the Future."*	3-5 years	Unknown			●	●	●	●
Radon Gas-Mitigation Strategy #1	Increase public education related to radon gas hazards by distributing Utah Dept. of Environmental Quality informational brochures to County and City planning and engineering departments.	Ongoing	Very minimal	●		●	●	●	●
Radon Gas-Mitigation Strategy #2	Utilize the Radon Risk Map provided in this plan as a tool to assess radon gas risks as it relates to any building/ subdivision proposals. If deemed necessary, jurisdiction should require the builder/ developer to conduct a site-specific radon hazard identification study and implement applicable control techniques.	Ongoing	$25- $1,200	●		●		●	●

Requirement §201.6(c)(3): The plan shall include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.

The following mitigation strategies, listed in accordance to their respective natural hazard, are presented in an effort to provide macro-level risk reduction. Although each mitigation measure is important and achievable, they have been prioritized and listed in order of:

1) Respective amount of potential loss of life/property value as a result of a natural hazard occurrence (as quantified through GIS analysis) ; and
2) Implementation priority through utilization of the STAPLEE process (as explained in Chapter 3 of this Plan and in FEMA 386-3).

FLOOD

The Army Corps of Engineers *Flood Hazard Identification Study* (August, 2003), identifies areas with a high flood hazard and identifies potential mitigation solutions. The following prioritized mitigation strategies are provided from this Study as well as from the Five County *Natural Hazard Mitigation Plan (2004).*

Most development in the unincorporated county is located near Panguitch and Escalante. No major rivers threaten extensive developments in the unincorporated county; therefore, no structural flood control projects are warranted at this time. There appears to be little development in the unincorporated county that is at risk of serious flooding.

Flood Mitigation Strategy #1	
Objective:	Minimize future flood damage in the unincorporated County.
Action:	Nonstructural measures appear to be the most prudent option for the county to implement. Zoning to prevent development of structures near all rivers, creeks, and lakes (100' min. setback).
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	Local government operating budget; State and Federal flood and planning grant programs
Responsible Agencies:	Local government

Flood Mitigation Strategy #2	
Objective:	To reduce flooding risk as it relates to the built environment.
Action:	Address flood control at the building/construction level by requiring all subdivision proposals to have a storm water drainage system.
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	Private funds/ developer.
Responsible Agencies:	Local, jurisdictional level.

Flood Mitigation Strategy #3	
Objective:	To reduce flooding risk at the community level.
Action:	Clear debris and other material from all waterways.
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	Related public/private property owners.
Responsible Agencies:	Private property owners, irrigation companies, local jurisdictions.

Flood insurance is not promoted actively in the County. Further, three communities: Antimony, Boulder and Cannonville are not active participants in the National Flood Insurance Program (NFIP).

Flood Mitigation Strategy #4	
Objective:	Promote participation in the National Flood Insurance Program (NFIP) throughout the county.
Action:	Create outreach document promoting flood insurance and include in local newspaper(s), libraries, and other public buildings.
Timeline:	1 year
Estimated Cost:	Minimal
Possible Funding:	Local government operating budget; State and Federal flood grant programs
Responsible Agencies:	County Floodplain Administrator, State Floodplain Manager, Department of Homeland Security.

Boulder Town has a relatively large incorporated area. Only a moderate flood threat appears to exist from unnamed drainages to the north. In addition, the county floodplain map shows the Paria River flowing just east of Cannonville poses a relatively minor threat to the east side of town. An unnamed tributary wash on the north end of town poses a moderate risk. The Army Corps of Engineers *Flood Hazard Identification Study* (August, 2003), provides the following mitigation strategy.

Flood Mitigation Strategy #5	
Objective:	Minimize future flood damage in Boulder and Cannonville.
Action:	A potentially viable alternative would be to flood proof those relatively few existing low-lying structures that are subject to flooding.
Timeline:	Unknown
Estimated Cost:	$10,000 to $30,000 per structure
Possible Funding:	Local government operating budget; State and Federal flood programs; private property owner.
Responsible Agencies:	Community & local government entities; private property owner.

Although, the FIRM floodplain map for Panguitch is relatively small, a study completed by the Corps of Engineers in 1994 showed a substantial threat to the community. For additional information see Figure 9 of the US Army Corps of Engineers *Flood Damage Preventions Study Sevier River Basin Investigation.*

Flood Mitigation Strategy #6	
Objective:	Minimize future flood damage in Panguitch.
Action:	The potential structural solution consisted of raising existing levees and constructing a new one. Mitigating for the 50-year event consists of 4,820 l.f. of levee enlargement and 4,080 l.f. of new setback levees

	for a total of 8,900 l.f.
Timeline:	5 years
Estimated Cost:	About $3.5 million
Possible Funding:	Local government operating budget; State and Federal flood grant programs
Responsible Agencies:	Local and Federal government

LANDSLIDE

Factors included in assessing landslide risk include built property distribution in the hazard area, the frequency of landslide or debris flow occurrences, slope steepness, and soil characteristics. This type of analysis generates estimates of the damages to the county due to a landslide or debris flow event on the current built environment. The mitigation strategies listed below identify cost effective measures that will yield measurable benefits toward reducing the risk of landslide hazards.

Landslide Mitigation Strategy #1	
Objective:	Increase the level of knowledge related to landslides.
Action:	Increase public education related to landslide hazards by distributing Utah Geological Survey (UGS) landslide informational brochures to local municipality level emergency management, engineering and planning departments.
Timeline:	Ongoing
Estimated Cost:	Very Minimal: request UGS to deliver brochures; and/or download brochures directly from: http://geology.utah.gov
Possible Funding:	Local, jurisdictional level.
Responsible Agencies:	Local, jurisdictional level.

Landslide Mitigation Strategy #2	
Objective:	Minimize future landslide damage in the unincorporated County.
Action:	Drafting/updating zoning and/or landslide ordinances to prevent development of structures near debris flows, landslides, and rock fall areas.
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	Local government operating budget; State and Federal planning grant programs.
Responsible Agencies:	Local government

As part of this NHMP Update process, Five County Association of Governments developed a *Natural Hazards Questionnaire* in an effort to solicit information from a sampling of citizens. Of the responses obtained through this questionnaire, 75% of the respondents indicated they would

be willing to spend more money on a home/business that had features that made it more disaster resistant.

Landslide Mitigation Strategy #3	
Objective:	To reduce landslide risk as it relates to the built environment.
Action:	1-Address landslide risk at the building/construction level by requiring all subdivision proposals to have a geotechnical report. 2-If jurisdiction does not have trained staff to review the geotechnical report, the jurisdiction can, upon request, have Utah Geological Survey (UGS) perform a review of the report.
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	Private funds/ developer; Local government operating budget; Utah Geologic Survey operating budget.
Responsible Agencies:	Local, jurisdictional level; Utah Geological Survey

EARTHQUAKE

Earthquake mitigation strategies include general mitigation actions that agencies are capable of implementing during the next five years, given their existing resources and authorities. In addition to the earthquake mitigation strategies provided herewith, this Natural Hazard Mitigation Plan endorses any seismic mitigation proffered by the Utah Seismic Safety Commission. In particular, numerous and varied earthquake mitigation strategies are provided in *A Strategic Plan for Earthquake Safety in Utah (January, 1995)* completed by the Utah Seismic Safety Commission. It is highly recommended that jurisdictions whom desire to provide more specific earthquake mitigation strategies consult the aforementioned plan, which can be accessed at: http://ussc.utah.gov/.

Earthquake Mitigation Strategy #1	
Objective:	Promote building safety through non-structural improvements.
Action:	Increase public education related to earthquake hazards by distributing Utah Seismic Safety Commission informational brochures to County and City emergency management agencies.
Timeline:	Ongoing
Estimated Cost:	Very Minimal: request Utah Seismic Safety Commission to deliver brochures; and/or download brochures directly from: http://ussc.utah.gov/
Possible Funding:	County and City operating budget; Utah Seismic Safety Commission operating budget.
Responsible Agencies:	Local, jurisdictional level.

As part of this NHMP Update process, Five County Association of Governments developed a *Natural Hazards Questionnaire* in an effort to solicit information from a sampling of citizens. Of

the responses obtained through this questionnaire, 75% of the respondents indicated they would be willing to spend more money on a home/business that had features that made it more disaster resistant. Further, 75% of the respondents indicated that their household/business does not have insurance coverage for earthquake events.

Earthquake Mitigation Strategy #2	
Objective:	To reduce earthquake risk as it relates to the built environment.
Action:	Continued dedication/vigilance in enforcing the seismic standards established in the International Building Code (IBC).
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	County or City government operating budget (where applicable).
Responsible Agencies:	County or City government (where applicable).

Earthquake Mitigation Strategy #3	
Objective:	To reduce earthquake losses by mapping and identifying earthquake hazard areas.
Action:	1-Utilize the Earthquake Risk Map provided in this plan as a tool to assess earthquake risks as it relates to any building/subdivision proposals. If deemed necessary, jurisdiction should require the builder/developer to conduct a site-specific earthquake hazard identification/mapping study. 2-At the County level, contract with Utah Geological Survey (UGS) to formally study/map earthquake hazard areas.
Timeline:	Action 1-Ongoing Action 2- 3 to 5 years
Estimated Cost:	Action 1-$1,000 to $5,000 Action 2- $7,109 to $14,218 per jurisdiction (1995 cost as reflected in *A Strategic Plan for Earthquake Safety in Utah* adjusted for inflation)
Possible Funding:	Action 1-Private funds/ developer. Action 2- Local government operating budget; Utah Geologic Survey operating budget.
Responsible Agencies:	Local, jurisdictional level; Private property owner; Utah Geological Survey

WILDFIRE

The Color Country Interagency Fire Center Fuels Committee has identified the general location of ten "Focus Areas" within the southwest Utah region. The selection of these specific areas was based on the need for fuels reductions as understood by fuels specialists and fire wardens, risk levels in the Regional Wildfire Protection Plan risk assessment, values at risk in the area, firefighting concerns including access and evacuation routes, the presence of Communities At

Risk (CARs), and local interest in the community documented by having a Community Wildfire Protection Plan in place.

The Color Country Interagency Fire Center Fuels Committee has not prioritized these ten focus areas. The Committee determined that to do so would have the effect of minimizing the fact that every one of these areas is in need of treatment and all are of concern. Each focus area also includes a list of general goals resulting from activities and treatments for the area.

Goals common to all treatment areas include fuels reduction, public education, and increases in equipment and training available to firefighting personnel. Goals that are generally applicable to all of the focus areas include the following:

- Protection of human life, firefighter and public safety as the highest priority.
- Public education and partnerships with citizens or community-centered approaches to manage fire risks and hazards in WUI areas located in the focus area, including effort aimed towards the implementation and maintenance of defensible space projects to reduce risk to homes and personal property.
- Protection of high value resources and watersheds through fuels reduction treatments as determined locally.
- Restoration and maintenance of ecosystems consistent with land uses and historic fire regimes. Restoration of vegetation to the appropriate Condition Classes and Fire Regimes.
- Maintenance and/or improvement of fire prevention and road/structure identification signage. Dissemination of fire restriction information through appropriate signage and/or visitor contacts when necessary.
- Improvement of wildland firefighting equipment, training and information for volunteer fire departments located in the focus area, including the improvement of GIS and road data.

The ten Focus Areas, as they pertain to Garfield County, developed by the Color Country Interagency Fire Center Fuels Committee include the 1) Ruby's/Bryce and the 2)Mammoth Creek Focus Areas. This being said, the Communities at Risk within Garfield County (from high to medium risk) include: Mammoth Creek, Panguitch Lake/Beaver Dam/Clear Creek, Blue Spring, Tropic, Boulder, Main Canyon, Red Canyon, Ruby's Inn, Escalante, Hatch, Antimony, Upper Valley, Widtsoe Jct., Aspen Academy, Panguitch, Boulder Mtn., Cannonville, Haycock, Henrieville, Salt Gulch Ranch, and Forest Gardens.

The following mitigation strategies are provided in an effort to provide macro-level risk reduction. Although each mitigation measure is important and achievable, they have been prioritized and listed in order of implementation priority through utilization of the STAPLEE.

As part of this NHMP Update process, Five County Association of Governments developed a *Natural Hazards Questionnaire* in an effort to solicit information from a sampling of citizens. Of the responses obtained through this questionnaire, 100% of the respondents indicated they are concerned (25% extremely concerned, 50% concerned, and 25% somewhat concerned), about

the wildfire risks in the county. In an effort to ameliorate these concerns the following is provided.

Wildfire Mitigation Strategy #1	
Objective:	Promote public awareness campaign for property owners living in wildland urban interface areas.
Action:	Mailings; Printed Information; Public Service Announcements;
Timeline:	Ongoing
Estimated Cost:	Unknown
Possible Funding:	State and Federal wildfire grant programs
Responsible Agencies:	State and Federal government

The primary concern within the Ruby's/Bryce Focus Area is located within the east-central portion of the watershed, located along Highway 12 and Highway 63 toward Bryce Canyon National Park. The Communities at Risk within this focus area are: Ruby's Inn, Bryce Canyon, Pines, and Fosters.

Wildfire Mitigation Strategy #2	
Objective:	Ameliorate firefighting and access concerns related to heavy seasonal tourist traffic.
Action:	1-Compliment fuels reduction work being done by the Park Service and Forest Service onto private lands. 2-Prevent fires on private lands which may spread onto federal lands.
Timeline:	Ongoing
Estimated Cost:	Unknown
Possible Funding:	Local government operating budget; Special Service District operating budget; private property owner
Responsible Agencies:	Community & local government entities; private property owner

The primary concern within the Mammoth Creek Focus Area is the area has recently experienced a wide-spread spruce beetle outbreak. The high number of dead spruce increases fire severity, spotting and high fire intensity. The Communities at Risk within this focus area are: Mammoth Creek, Ireland Meadow, Castle Valley, Rainbow Meadow, and Meadow Lakes.

Wildfire Mitigation Strategy #3	
Objective:	Fuels reduction and defensible space tactics.
Action:	1-Continue to place strategic fuel breaks throughout the focus area. 2-Encourage landowner mitigation and defensible space work.
Timeline:	Ongoing

Estimated Cost:	Unknown
Possible Funding:	Local government operating budget; Special Service District operating budget
Responsible Agencies:	Community & local government entities; private property owner

Wildfire Mitigation Strategy #4	
Objective:	Provide training, equipment, and resources for fire departments to fight wildfires.
Action:	Enhance existing wildfire training programs, equipment procurement, and fire fighting resources for wildfire suppression.
Timeline:	Ongoing
Estimated Cost:	Unknown
Possible Funding:	State CIB funding; Federal wildfire grant programs
Responsible Agencies:	Federal Government

PROBLEM SOILS

Problem soils pose a significant hazard to the current/future built environment. This being said, many of these problems can be dramatically reduced through proper assessment of the risk and adherence to applicable mitigation measures. Factors included in assessing problem soils risk include built property distribution in the hazard area. This type of analysis generates estimates of the damages in the county due to problem soils occurrences in the current built environment. The mitigation strategies listed below identify cost effective measures that will yield measurable benefits toward reducing the risk of problem soils as they relate to the built environment. Further, these mitigation strategies include general actions that agencies are capable of implementing during the next five years, given their existing resources and authorities.

Problem Soils Mitigation Strategy #1	
Objective:	Lessen the risk to buildings from problem soils.
Action:	1-Address problem soils at the building/construction level by requiring all subdivision proposals to have a geotechnical report. 2-If jurisdiction does not have trained staff to review the geotechnical report, the jurisdiction can, upon request, have Utah Geological Survey (UGS) perform a review of the report.
Timeline:	Ongoing
Estimated Cost:	$1,000 to $5,000
Possible Funding:	Private funds/ developer; Local government operating budget; Utah Geologic Survey operating budget.
Responsible Agencies:	Local, jurisdictional level; Utah Geological Survey

As part of this NHMP Update process, Five County Association of Governments developed a *Natural Hazards Questionnaire* in an effort to solicit information from a sampling of citizens. Of the responses obtained through this questionnaire, 75% of the respondents indicated they would

be willing to spend more money on a home/business that had features that made it more disaster resistant.

Problem Soils Mitigation Strategy #2	
Objective:	To reduce problem soils related losses by mapping and identifying problem soils hazard areas.
Action:	Utilize the Problem Soils Risk Map provided in this plan as a tool to assess problem soils risks as it relates to any building/subdivision proposals. If deemed necessary, jurisdiction should require the builder/developer to conduct a site-specific geotechnical (soils) report.
Timeline:	Ongoing
Estimated Cost:	$1,000 to $5,000
Possible Funding:	Private funds/ developer; Local government operating budget
Responsible Agencies:	Local, jurisdictional level; Private property owner.

Problem Soils Mitigation Strategy #3	
Objective:	Lessen the risk to buildings from collapsible and expansive soils.
Action:	Through mapping, identify areas which contain collapsible and expansive soils. Require soils testing at the building/construction level and ensure that engineer's recommendations are followed.
Timeline:	Ongoing
Estimated Cost:	$1,000 to $5,000
Possible Funding:	Private funds/ developer; Local government operating budget.
Responsible Agencies:	Local, jurisdictional level.

SEVERE WEATHER

Quantitative assessment of severe weather vulnerability and determining which specific areas of the county are more vulnerable is very challenging. This being said, the vulnerability assessment quantified the number of units and total market value for all structures located within a defined severe weather hazard area; said area includes: known lightning deaths, lightning intensity (based upon actual lighting strike data), and tornado touchdowns. The following severe weather hazard mitigation strategies are specific to the aforementioned severe weather hazards.

As part of this NHMP Update process, Five County Association of Governments developed a *Natural Hazards Questionnaire* in an effort to solicit information from a sampling of citizens. Of the responses obtained through this questionnaire, 75% of the respondents indicated they would be willing to spend more money on a home/business that had features that made it more disaster resistant. Further, 100% indicated their preference for receiving severe weather information would be through television and internet sources.

Severe Weather Mitigation Strategy #1	
Objective:	To reduce severe weather risk as it relates to the built environment.
Action:	Continued dedication/vigilance in enforcing the standards established in the International Building Code (IBC) as it relates to wind-loading, electrical grounding, snow-loading, and other weather-related hazards.
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	County or City government operating budget (where applicable).
Responsible Agencies:	County or City government (where applicable).

Severe Weather Mitigation Strategy #2	
Objective:	Ensure that the general public is warned of severe weather occurrences via broadcast media.
Action:	1-Enhance the Emergency Alert System (television and radio). 2-Enhance NOAA Weather Radio All Hazard coverage.
Timeline:	Ongoing
Estimated Cost:	Unknown
Possible Funding:	Federal and State government operating budget.
Responsible Agencies:	Federal and State government.

Nearly 90% of all presidentially declared disasters are weather related. In an effort to guard against the negative effects of severe weather, the National Weather Service has designed the StormReady program. This program is a nationwide community preparedness program that uses an approach which helps communities develop plans to handle all types of severe weather. To be classified as a StormReady community several criteria must be met; however, the county Local Emergency Planning Committee (LEPC) is positioned well to satisfy the StormReady application/program guidelines. Ultimately the benefit of becoming formally recognized as a StormReady community lies in the additional planning/preparation/preparedness for severe weather occurrences; however, some grant opportunities are available through the National Weather Service as well as possible adjustment to insurance rates through the Insurance Services Organization (ISO).

Severe Weather Mitigation Strategy #3	
Objective:	Guard against the negative effects of severe weather by becoming a StormReady community.
Action:	At the county Local Emergency Planning Committee (LEPC) level, meet the program guidelines then apply to the National Weather Service StormReady program.
Timeline:	3 to 5 years
Estimated Cost:	Minimal
Possible Funding:	County and City operating budget.
Responsible Agencies:	County and City government.

Chapter 8 **IRON COUNTY**

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A PICTURE OF IRON COUNTY

DEMOGRAPHICS

Iron County is located in the southwestern quarter of Utah bounded by Nevada on the west, Beaver County on the north, Washington County on the south, and Garfield County on the east. Interstate 15 bisects the eastern part of the county in a north-south direction. I-15 places Las Vegas within a three-hour travel time and Salt Lake City lies four hours to the north on I-15. State highways 56 from the west, 14 and 20 from the east, and 130 from the north provide excellent access into the surrounding areas. Iron County is strategically located to service the recreation visitor that comes to visit southern Utah and to service the visitor passing through to points beyond.

Historically, Cedar City has been a popular transportation hub for access to some of the National Parks; namely, Zion National Park, Bryce Canyon National Park, and Cedar Breaks National Monument. The center block of the Dixie National Forest lies in eastern Iron County and is easily accessed through Cedar City and Parowan. Vast expanses of public lands managed by the Bureau of Land Management occupy the northern and western parts of the county.

The County includes 6 incorporated areas: Cedar City, Enoch, Brian Head, Parowan, Paragonah, and Kanarraville. Additional areas of residential development are Summit and the Beryl-Newcastle area. According to population studies conducted by the Governor's Office of Planning and Budget, the unincorporated area of the county is expected to grow faster than the incorporated areas.

Coal in the canyons east of Cedar City and iron ore in the mountains to the west brought mining and smelting to Iron County in the 19th century. However, smelting efforts failed because of the lack of economical transportation to large markets. Despite this change, the county has transitioned well into other economic sectors and has become a very strong economic player in the region. Iron County is well known for its Utah Shakespearean Festival, the Utah Summer Games, Southern Utah University, and a distinct manufacturing sector. Manufacturing plays a strong role in this nonurban county. However, trade and services provide the most employment.

DEVELOPMENT TRENDS

Generally speaking, population growth in Iron County has mirrored state expansion rates. That trend ended in the 1990s when the population of Iron County exploded. During the1990's population grew by 63 percent. Growth in the County continued at a rate of 44% from 2000 to 2009. According to growth projections provided by the Governor's Office of Planning and Budget, Iron County can expect noteworthy increases in population over the next 20 years. The projected population increase from 2010 to 2020 is 35% and 28.3% from 2020 to 2030. Overall this translates to 73% growth projected over the next 20 years. This growth projection is much higher than the State of Utah growth projection of 49.9% over the same period.

Despite the dramatic growth projections, Iron County officials diligently worked on ensuring the ratio of land designated for residential, and other uses, will be balanced to meet growth

projections. Such planning has enabled the creation/implementation of growth boundary designations to allow for appropriate growth while directing that growth into areas where services are available. The growth boundaries will accommodate the anticipated 20 year population projected for the county in locations which maximize the value, and minimize the effects, of growth on the county's environment and quality of life. In an effort to ensure that growth is minimized and/or eliminated in environmentally sensitive areas, the Iron County General Plan establishes through policy, "The County shall also designate a tier for the preservation of rural/environmentally sensitive land outside of the Urban Growth Boundary." This policy has been implemented through adoption (September 2006), of the *Iron County Tier Growth Map*. In general, this map and implementing ordinance limit the amount of growth in rural/ environmentally sensitive areas which ultimately affords increased safety in relation to natural hazards and the built environment.

IRON COUNTY LANDSCAPE

Iron County lies almost entirely within the Great Basin except for some acreage along the south central county line that drains into the Virgin River. Elevations range from the high point of 11,307 feet at Brian Head to the low point of 5,050 feet northeast of Lund on the county line. The elevations extremes provide for a variety of landscapes, vegetative types, recreational choices and year-round livestock grazing opportunities. Mountain streams flow from the mountain ranges out onto the valley bottoms where the waters drain in the valley alluvium through free flow or are spread over the land through irrigation.

The county area contains a variety of soil types and conditions. The soils in the county are primarily igneous and sedimentary rocks. Many of the soils on mountain and foothill slopes are shallow or moderately deep and are gravelly, cobbly or stony. In the alluvium valleys, soils are very deep and tend to have finer textures. Some timber and woodland products are harvested. The high mountain forests and the pinyon juniper forests of the lowlands also provide recreational and aesthetic values important to the diversity found in Iron County.

Public land ownership in Iron County accounts for approximately 71% of the total land area. The largest category of land ownership, totaling 51%, is the national resource lands managed by the Bureau of Land Management.

Agricultural land uses are a long standing tradition in Iron County. The agricultural nature of the area has been a large factor in supporting residents of the area. In addition, the open space and rural qualities of the county are attractions for people wishing to leave the congestion of more urbanized areas of the country. This being said, the agricultural make-up of the county is rapidly being replaced by urban expansion. Approximately 95% of the Iron County population is located in the eastern third of the county along I-15. For

this reason, Iron County officials have endeavored to comprehensively plan growth which can be a protection from the deterioration of rural communities.

HAZARD IDENTIFICATION

Requirement §201.6(c)(2): The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.

Requirement §201.6(c)(2)(i): [The risk assessment **shall** include a] description of the…location and extent of all natural hazards that can affect the jurisdiction. The plan **shall** include information on previous occurrences of hazard events and on the probability of future hazard events.

Requirement §201.6(c)(2)(ii)(C): [The plan **should** describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

Requirement §201.6(c)(2)(iii): For multi-jurisdictional plans, the risk assessment must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.

PROBLEM SOILS

There are six types of problem soils and rocks that are found in southwestern Utah; namely, Expansive Soil, Collapsible Soil, Limestone (Karsts Terrain), Gypsiferous Soil/Rock, Soils subject to Piping, and Sand Dunes.

Expansive soil and rock is the most common type of problem deposit in southwestern Utah. In particular, the Jurassic-age Arapien and Cretaceous-age Tropic Shale's, and the Triassic-age Chinle and Moenkopi Formations are sources for expansive materials. Expansive deposits contain clay minerals that expand and contract with changes in moisture content. Clays absorb water when wetted, causing the soil or rock to expand. Conversely, as the material dries, the loss of water between clay crystals or grains causes the deposit to shrink. Expansive deposits are extensive around St. George, Washington, and Santa Clara. In these areas expansive clays in the Chinle Formation have been most damaging to structures. Common problems are cracked formations, heaving and cracking of floor slabs and walls, and failure of wastewater disposal systems. Sidewalks and roads are particularly susceptible to damage.

Collapsible Soil- Subsidence of the ground surface due to collapsible soil has caused extensive damage in and around Cedar City and the Hurricane cliffs, where it is most prevalent. Collapsible soil is common in Holocene alluvial-fan and debris-flow deposits in southwestern Utah. Soil and rock containing gypsum are also susceptible to subsidence. Collapse occurs when susceptible soils are wetted to a depth below that normally reached by rainfall, destroying the clay-bonds between bands. Collapsible soil is present in geologically young materials such as Holocene-age alluvial-fan and debris-flow sediments, and in some wind-blown silts.

Limestone (Karst Terrains) susceptible to dissolution and subsidence occurs throughout mountains west of Sevier Lake, west of Richfield, and south of St. George. Karsts terrain is characterized by closed depressions (sinkholes), caverns, and streams that abruptly disappear underground. Most karsts terrain in southwestern Utah is relict and relates to moisture climates during the Pleistocene, or may have been created by ground water prior to the rock being uplifted and tilted during basin and range faulting. No known damage has occurred to structures from ground collapsing or subsidence related to limestone karsts, but because karsts ground-water systems have little filtering capacity, contamination of ground water is a major concern.

Gypsiferous Soil/ Rock deposits are subject to settlement caused by the dissolution of gypsum, which creates a loss of internal structure and volume within the deposit. Gypsiferous soil and rock deposits are common in southwestern Utah, particularly along the base of the Hurricane cliffs. Gypsum in these deposits can cause damage to foundations, and induce land subsidence and sinkholes similar to those seen in limestone terrain.

Soils subject to Piping- Piping is subsurface erosion by ground water that moves along permeable, non-cohesive layers in unconsolidated materials and exists at a free face, usually along a stream bank or cliff that intersects the layer. Deposits susceptible to piping are common in the southwestern part of the state. Holocene-age alluvial fill in canyon bottoms is the most common material susceptible to piping in Utah. Collapse of soil pipes and subsequent erosion has damaged roads and agricultural land. Piping can cause damage to roads, bridges, culverts, and any structure built over soils subject to piping. Earth-fill structures such as dams may also be susceptible to piping.

Sand Dunes- are common surficial deposits in arid areas where sand derived from weathering of rock or unconsolidated deposits is blown by the wind into mounds or ridges. In areas where development encroaches on dunes, inactive or vegetated dunes may be reactivated, allowing them to migrate over roads and bury structures. Sand Dunes occur in the Escalante Desert and west of Kanab. Migration of dunes across roads and burial structures are common problems in areas where active dunes are present. Avoidance of dunes is the best way to prevent damage to structures. However, active dunes usually are a maintenance problem only and do not preclude development.

WILDFIRE

When discussing wildfires it is important to remember that fires are part of a natural process and are needed to maintain a healthy ecosystem. Since its settlement in the mid 1800s, the region and its residents have been subject to the annual threat of wildfire. This is in large part due to the environmental conditions, namely low annual precipitation and high amount of public lands. Lightning is the primary cause of wildfire in the county. However, the potential risk for human caused fires increases as more people move into the wildland urban interface.

Many of Utah's wildland urban interface areas are located in our most fire prone wildland fuels. Generally, these fuels are found on drier, lower elevation sites which are often very desirable for real estate development. To address these issues, a multi-jurisdictional group of agencies, organizations, and individuals collaborated to develop the *Southwest Utah Regional Wildfire Protection Plan* (October 2007). The purpose of this plan is to be a tool in the effort to protect human life and reduce property loss due to catastrophic wildland fires in the communities and surrounding areas located in the southwest Utah counties of Beaver, Garfield, Iron, Kane and Washington.

Iron County is primarily covered in Forest and Shrub/Rangelands, accounting for 93% of the area. Shrub/rangelands accounts for 50% of the land area (1,064,773 acres). Forest area accounts for 43% of the County (907,610 acres). Grass/Pasture/Haylands/Croplands makes up 4% of the County's land area (75,000 acres). Urban/Developed (42,214 acres) comprises 2% of the County's land area. Water/Wetlands (21,107 acres) comprise 1% of Iron County's land area. Shrub/Rangelands consist of oak savannahs and pinion/juniper areas. Grass/Pasture/Haylands includes approximately 71,900 acres of Hayland/Cropland, 3,100 acres of Hayland/Cropland.

Using National Fire Plan guidelines, the Utah Division of Forestry, Fire, and State Lands (UDFFSL) has worked with national and local wildland fire officials to create a statewide list of Communities at Risk (CARs). As of 2005, there were over 600 communities listed statewide and 148 are located in the southwestern Utah region. Beginning in 2000, the Color Country Fuels Committee (CCFC) undertook an intensive assessment of the 148 identified CARs in the Color Country fire management response area. These assessments have been the foundation for prioritizing fuels treatments, determining focus areas, and targeting the development of Community Wildfire Protection Plans within the Color Country Interagency Fire Management area.

FLOOD

In the southwest, as elsewhere, flooding, erosion, and sediment discharge are responsible for loss of life, land, and infrastructure, along with damage to reservoirs and natural habitats. Stream flooding is the most prevalent and destructive (annually) of the geologic hazards that affect Utah. This destructive trend is nowhere more evident than in the southwest part of the state.

The two types of stream flooding events which typically occur in southwestern Utah are riverine floods and flash floods. Riverine floods are usually regional in nature, last for several hours or days, and have recurrence intervals of 25 to more than 100 years. They commonly result from the rapid melt of a winter snow pack or from periods of prolonged heavy rainfall. Flash floods result from thunderstorm cloudbursts. They are localized, quickly reach a maximum flow, and then quickly diminish. Recurrence intervals for flash floods are erratic, ranging from a few hours to decades or longer for a given drainage. Both types of flooding have caused extensive damage in southwestern Utah.

Four major riverine floods have affected southwestern Utah since the area was settled. They occurred in 1966, 1983, 1984 and 2005. The 1966 flood on the Santa Clara River near Pine Valley resulted from an intense three-day rainstorm that produced record peak flows on the Virgin River. This three-day storm produced between 1 and 12 inches of rain and resulted in total damage of approximately $1.4 billion (Butler and Mundorff, 1970). The 1983 and 1984 floods occurred in response to the rapid melting of maximum-of-record and greater-than-average snow packs respectively. The 1983 and 1984 floods caused several landslides and a dam failure. Total damage was in excess of $640 million and the President issued a disaster declaration for 22 Utah counties. Lastly, a stalled storm-system containing abundant moisture caused significant flooding in Washington and Kane Counties between January 8-12, 2005. It is estimated that $300 million dollars in damages was sustained along the Santa Clara and Virgin Rivers in Washington County. 30 homes were destroyed in the flood and another 20 homes were significantly damaged (NCDC, 2005). A Presidential Disaster Declaration was declared February 1, 2005.

According to statistics provided by SHELDUS, Iron County has experienced a total of 10 major flooding events; the first event occurring December 4, 1966 and the most recent occurring October 21, 2004. The total property damage (not adjusted for inflation) for these flood events was $ 3,924,550.

By nature flash floods are sudden, intense, and localized. Many undoubtedly occur every summer along isolated drainages in southwestern Utah and are never recorded. Flash floods have damaged every major town in southwestern Utah. Many communities have implemented flood-control measures to reduce flash flood hazard; however, as communities expand into unprotected areas, new development is again subject to flash flooding. As a whole, any new development in southwestern Utah must consider the potential for stream flooding, and mitigate any flood hazard that may exist.

EARTHQUAKE

In Utah most earthquakes are associated with the Intermountain seismic belt (Smith and Sbar, 1974; Smith and Arabasz, 1991), an approximately 160-kilometer-wide (100 miles), north-south trending zone of earthquake activity that extends from northern Montana to northwestern Arizona. Since 1850, there have been at least 16 earthquakes of magnitude 6.0 or greater within this belt (Eldredge and Christenson, 1992). Included among those 16 events are Utah's two largest historical earthquakes, the 1901 Richfield earthquake with an estimated magnitude of 6.5,

and the 1934 Hansel Valley magnitude 6.6 earthquake, which produced Utah's only historical surface fault rupture. In an average year Utah experiences more than 700 earthquakes, but most are too small to be felt. Moderate magnitude (5.5 – 6.5) earthquakes happen every several years on average, the most recent being the magnitude 5.8 St. George earthquake on September 2, 1992. Large magnitude earthquakes (6.5 – 7.5) occur much less frequently in Utah, but geologic evidence shows that most areas of the state within the Intermountain seismic belt, including southwestern Utah, have experienced large surface-faulting earthquakes in the recent geologic past.

Fault-related surface rupture has not occurred in southwestern Utah historically, but the area does have a pronounced record of seismicity. At least 20 earthquakes greater than magnitude 4 have occurred in southwestern Utah over the past century (Christenson and Nava, 1992); the largest events were the estimated magnitude 6 Pine Valley earthquake in 1902 (Williams and Trapper, 1953) and the magnitude 5.8 St. George earthquakes in 1992 (Christenson, 1995). The Pine Valley earthquake is pre-instrumental and poorly located, and therefore, is not associated with a recognized fault. However, the epicenter is west of the surface trace of the Hurricane fault, so the event may have occurred on that structure. Pechmann and others (1995) have tentatively assigned the St. George earthquake to the Hurricane fault. The largest historical earthquake in nearby northwestern Arizona is the 1959 Fredonia, Arizona, earthquake (approximate magnitude 5.7; DuBois and others, 1982). Since 1987 the northwest part of Arizona has been quite seismically active (Pearthree and others, 1998), experiencing more than 40 events with magnitudes >2.5.

Despite the lack of an historical surface-faulting earthquake in southern Utah, available geologic data for faults in the region indicate a moderate rate of long-term Quaternary activity. Mid-Quaternary basalt flows are displaced hundreds of meters at several locations and alluvial and colluvial deposits are displaced meters to tens of meters in late Quaternary time.

Because earthquakes result from slippage on faults, from an earthquake-hazard standpoint, faults are commonly classified as active, capable of generating damaging earthquakes, or inactive, not capable of generating earthquakes. The term "active fault" is frequently incorporated into regulations pertaining to earthquake hazards, and over time the term has been defined differently for different regulatory and legal purposes. In fact, faults possess a wide range of activity levels. Some, such as the San Andreas fault in California, produce repeated large earthquakes and associated surface faulting every few hundred years, while others, like Utah's Wasatch fault and many of the faults in the Basin and Range Province, generate large earthquakes and surface faulting every few thousand to tens of thousands of years. Therefore, depending on the area of

interest or the intended purpose, the definition of "active fault" may change. The time period over which faulting activity is assessed is critical because it determines which faults are ultimately classified as hazardous and therefore in need of regulatory mitigation (National Research Council, 1986).

LANDSLIDE

Nationwide, estimated losses from damaging landslides equal $3.5 billion annually (USGS, 2005). In Utah, documented losses from damaging landslides in 2001 exceeded $3 million, including the costs to repair and stabilize hillsides along state and federal highway (Ashland, 2003). Total landslide dollar losses are hard to determine from past events because a standard for documenting them do not exist. Several state and local agencies track landslide losses with inconsistent formats often resulting in several different totals for a single event.

SEVERE WEATHER

The term severe weather, as it pertains to this plan, is used to represent a broad range of weather phenomena which affect southwestern Utah, namely; downburst, lightning, heavy snowstorms, avalanches, and tornados. Severe weather events are the most deadly type of natural hazard in Utah. Interestingly, more people have died in avalanches in Utah than by any other natural hazard. Between 1958 and 2006 avalanches killed 85 people.

Since 1950, lightning has killed 60 people statewide and injured another 144. In southwestern Utah the most common type of severe weather activity is related to lightning. Since 1950 a total of 5 lightning deaths and 10 lightning injuries have been recorded within the region.

A tornado is a violently rotating column of air extending from a thunderstorm to the ground. Most tornados have winds less than 112 miles per hour and zones of damage less than 100 feet wide. According to the National Weather Service, a total of 12 tornados have been observed in southwestern Utah. Of this amount, Iron and Beaver counties contain the highest amounts at 5 and 4 respectively.

A stalled storm system containing abundant moisture caused significant flooding in Washington and Kane Counties between January 8-12, 2005. Higher snowfall and water equivalent totals equaled 70" at Cedar Breaks, and 60" at Kolob-Zion National Park. It is estimated that $300 million dollars in damages was sustained along the Santa Clara and Virgin Rivers. 30 homes were destroyed in the flood and another 20 homes were significantly damaged. One fatality associated with this event resulted when a man and his wife in their vehicle were caught in floodwaters in

the Red Cliff Recreation Area near the Quail Creek Reservoir. Six other injuries were reported. A Presidential Disaster Declaration was declared on February 1, 2005. .

Climate- Most of the moisture in the winter comes from fronts that develop in the Gulf of Alaska and move from west to east across the State. Tropical air from the Gulf of Mexico enters the state from the south and west during July through September and is the source of severe thunderstorms. Tropical Pacific air masses from the southwest at times have caused extreme floods in the southwest part of the State. The mountains form barriers to the flow of moisture-laden air, and orographic precipitation may occur any time during the year. Rain shadows, which are areas of reduced precipitation, on the leeward side of the mountains account for the low normal annual rainfall in many of the interior valleys in the region.

Cloudburst storms and resultant floods occur principally during the summer. All parts of the State are subject to these storms, even the flat desert areas of the western portion. However, they occur more frequently along the west slope of the Wasatch Range, the Colorado Plateaus, and the southwest part of the State.

Tornados- Generally speaking, atmospheric conditions are rarely favorable for the development of tornadoes in Utah due to its dry climate and mountainous terrain. In fact, Utah ranks as having one of the lowest incidences of tornadoes in the nation, averaging only about two tornadoes per year, with only one F2 or stronger tornado once every seven years.

In the central U.S., tornadoes are commonly one-fourth of a mile wide and often cause considerable destruction and death. However, Utah tornadoes are usually smaller in size, often no more than 60 feet wide (at the base), with a path length usually less than a mile and a life span of only a few seconds to a few minutes. They normally follow a path from a southwesterly to a northeasterly direction and usually precede the passage of a cold front. About 73% of all Utah tornadoes have occurred in May, June, July and August, when severe thunderstorms occasionally frequent Utah.

Avalanches occur when a cohesive slab of snow fractures as a unit and slides on top of weaker snow, breaking apart as it slides. Slab avalanches occur when additional weight is added quickly to the snow pack, overloading a buried weaker layer. Dry snow avalanches usually travel between 60-80 miles per hour, reaching this speed within 5 seconds of the fracture, resulting in the deadliest form of snow avalanche.

Wet avalanches occur when percolating water dissolves the bonds between the snow grains in a pre-existing snow pack, this decreases the strength of the buried weak layer. Strong sun or warm

temperatures can melt the snow and create wet avalanches. Wet avalanches usually travel about 20 miles per hour.

According to the Colorado Avalanche Information Center (CAIC), over the last 10 winters in the United States an average of 25 people died in avalanches every year. In Utah, this translates to approximately 4 avalanche related fatalities every year. Generally speaking, the lion share of avalanche fatalities have occurred in northern Utah. Since every fatal accident is investigated and reported, the numbers can be reported with some certainty. However, there is no way to determine the number of people caught or buried in avalanches each year, because non-fatal avalanche incidents are increasingly under reported. Unfortunately, statistical data pertaining to avalanche related fatalities in southern Utah is underprovided.

VULNERABILITY ASSESSMENT

Requirement §201.6(c)(2)(ii): [The risk assessment **shall** include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description **shall** include an overall summary of each hazard and its impact on the community.

Requirement §201.6(c)(2)(ii)(A): The plan **should** describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area.

Requirement §201.6(c)(2)(ii)(B): [The plan **should** describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph *(c)(2)(ii)(A)* of this section and a description of the methodology used to prepare the estimate.

PROBLEM SOILS

Geologic materials with characteristics that make them susceptible to volumetric changes, collapse, subsidence, or other engineering-geologic problems are referred to as problem soils. Geologic and climatic conditions in southwestern Utah provide a variety of both localized and widespread occurrences of these materials. Soil and rock related geologic problems occur in a variety of geologic settings and are some of the most widespread and costly geologic hazards. Six types of problem soil and rock are present in southwestern Utah. Six types of problem soil and rock are found in southwestern Utah: (1) expansive soil and rock with high shrink/swell potential, (2) collapsible soil, (3) limestone (Karsts Terrain) susceptible to dissolution under some hydro geologic conditions, (4) gypsiferous soil/rock susceptible to dissolution, (5) soil subject to piping (localized subsurface erosion), and (6) active dunes. Some materials, such as expansive soil and limestone, cover large areas, whereas others, like active dunes, are of limited extent. The most extensive problem soils found in the region are expansive soil and rock.

Expansive Soils and rock are the most common type of problem soils in southwestern Utah. Expansive deposits contain clay minerals that expand and contract with changes in moisture content. Clays absorb water when wetted, causing the soil or rock to expand. Conversely, as the material dries, the loss of water between clay crystals or grains causes the deposit to shrink.

Expansive deposits are extensive around St. George, Washington, and Santa Clara in Washington County. In these areas expansive clays in the Chinle Formation have been most damaging to structures. In Santa Clara, many homes and a church were damaged by expansive clays in the Chinle Formation. Common problems are cracked foundations, heaving and cracking of floor slabs and walls, and failure of wastewater disposal systems. Sidewalks and roads are particularly susceptible to damage. The majority of expansive soil problems are found in Washington and Iron Counties.

Collapsible Soil- The phenomenon of hydrocompaction, which causes subsidence in collapse prone soil, occurs in loose, dry, low density deposits that decrease in volume or collapse when saturated for the first time following deposition. Collapse occurs when susceptible soils are wetted to a depth below that normally reached by rainfall, destroying the clay bonds between grains. Collapsible soil is present in geologically young materials such as Holocene age alluvial fan and debris flow sediments. When saturated, the soil collapses and the ground surface subsides, damaging property and structures. Human activities that involve some form of water application such as irrigation, water impoundment, lawn watering, and alterations to natural drainage or wastewater disposal commonly initiate hydrocompaction.

Collapsible soil is present particularly near Cedar City (Iron County) and the Hurricane Cliffs (Washington County). In Cedar City approximately $3 million in damage to public and private structures has been attributed to collapsible soil. Other areas in southwestern Utah with a potential collapsible soil problem are along mountain fronts where young alluvial fan deposits containing fine-grained sediments are present. Climate also plays a role in the distribution of collapsible soils. Drier areas, such as the Basin and Range and Colorado Plateau provinces, provide the best conditions for development of collapsible soil. Soil and rock containing gypsum are also susceptible to subsidence. Ground water and introduced waters from irrigation dissolve gypsum causing subsidence.

Limestone (Karsts Terrain) is characterized by sinkholes, caverns, and streams that abruptly disappear underground. Karsts features are caused by ground and surface water dissolution of calcareous rocks, such as limestone. Cavernous subterranean openings in karst terrain often collapse, leaving sinkholes at the surface.

Limestone susceptible to dissolution and subsidence occurs throughout mountains west of Sevier Lake, west of Richfield, and south of St. George. No known damage to structures has occurred from ground collapse or subsidence related to limestone karsts; however, the potential for damage exists where susceptible units are present. In addition, because karsts ground-water systems have little filtering capacity, contamination of ground water is a major concern.

Gypsiferous soil/rock are subject to settlement caused by the dissolution of gypsum, which creates a loss of internal structure and volume within the deposit. Gypsum in soil can also form in other ways - including as a secondary mineral deposit leached from surficial layers and concentrated lower in the soil profile or wind-blown dust, and in the St. George area (Washington County) by the evaporation of ground water.

Gypsiferous soil and rock deposits are common in southwestern Utah, particularly along the base of the Hurricane Cliffs. Much of the gypsum is derived from erosion of gypsum rich rock units. Gypsum in these deposits can cause damage to foundations, and induce land subsidence and sinkholes similar to those seen in limestone terrain. Water introduced into the subsurface for irrigation and landscaping or into wastewater disposal systems, can cause underground solution cavities to develop, which may ultimately cause surface collapse. Gypsum is also a weak material with low bearing strength, which can cause problems when loaded with the weight of a structure. In addition, gypsum dissolved in water forms sulfuric acid and sulphate, which react with certain types of cement and weaken foundations.

Soils Subject to Piping- Piping is subsurface erosion by ground water that moves along permeable, non-cohesive layers in unconsolidated materials and exits at a free face, usually along a stream bank or cliff that intersects the layer. Removal of fine-grained particles by this process creates voids within the material that act as minute channels which direct the movement of water. As channels enlarge, water moving through the conduit increases velocity and removes more material, forming a "pipe." The pipe becomes a preferred avenue for ground-water drainage and enlarges as more water is intercepted. Increasing the size of the pipe removes support from the walls and roof, causing eventual collapse.

Deposits susceptible to piping are common in southwestern Utah. Piping can cause damage to roads, bridges, culverts, and any structure built over soils subject to piping. In areas where piping is common, roads are frequently damaged where they parallel stream drainages and cross-cut pipes. Road construction can contribute to the piping problem by disturbing natural runoff and concentrating water along paved surfaces, allowing greater infiltration and potential for pipes to develop.

Sand Dunes are common surficial deposits in arid areas where sand derived from weathering of rock or unconsolidated deposits is blown by the wind into mounds or ridges. In areas where development encroaches on dunes, inactive or vegetated dunes may be reactivated, allowing them to migrate over roads and bury structures. Another problem is the contamination of local ground water from wastewater disposal in dunes. The uniform size of the sand grains comprising dunes makes them highly permeable. Dunes are present in many areas of southwestern Utah, especially in the Escalante Desert (Iron County) and west of Kanab (Kane County). Avoidance of dunes is the best way to prevent damage to structures. (Excerpted from Lund, UGS unpublished information).

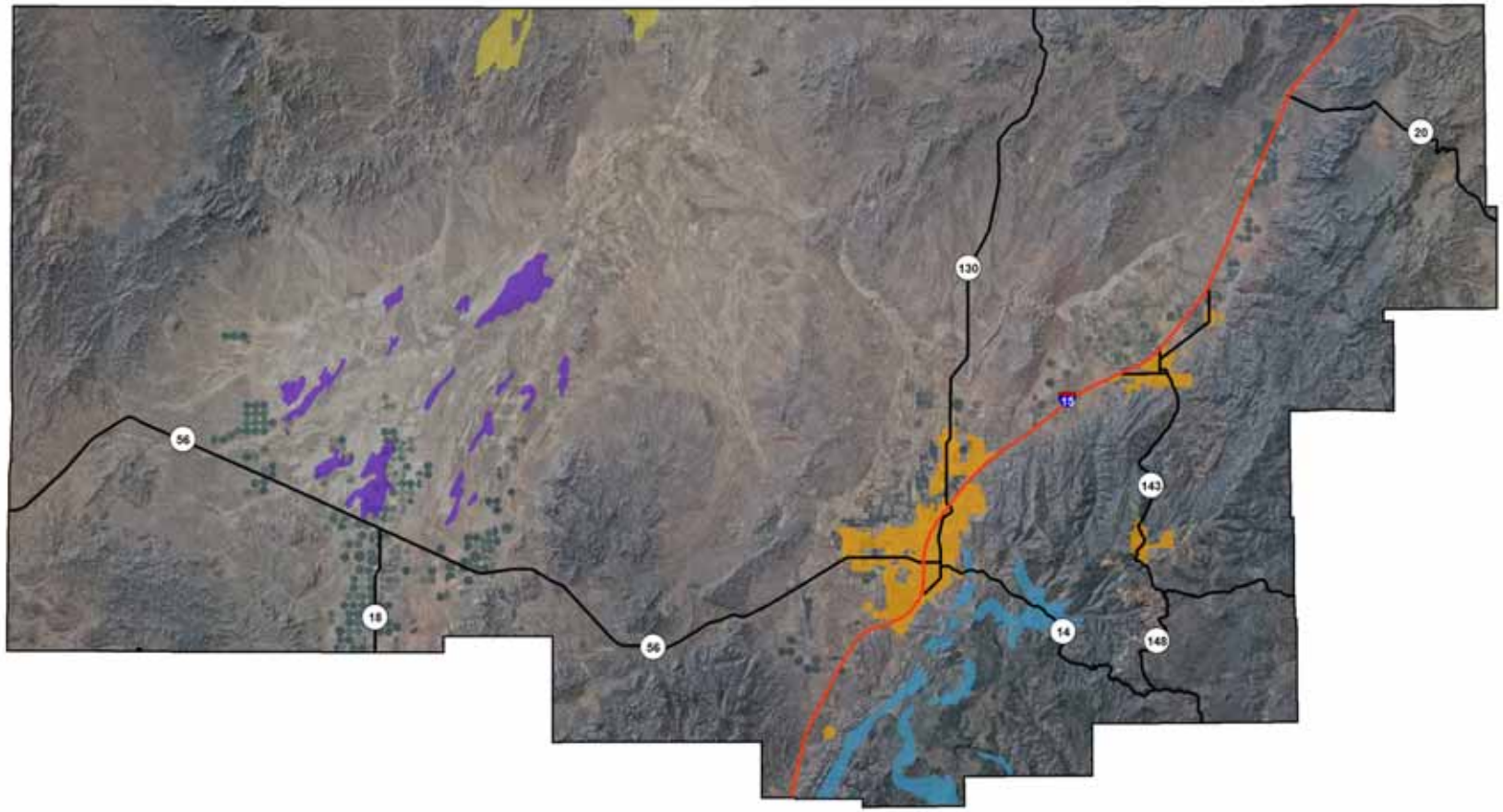
Conclusions- In addition to the above analysis, the vulnerability assessment was conducted using GIS software to join: 1) County Property Tax data as it relates to 2) buildings located with a respective hazard area. This analysis was based upon the most recent County Property Tax data provided by each County Assessor's office. The values shown are based upon utilizing the *market value* for structures in each defined hazard area. The GIS software then quantified the number of units and total market value for all structures located within each defined hazard area.

Iron County – Problem Soils		
Type of Structure	Market Value of Structures	Number of Structures
Residential	$654,504,256	4,741
Commercial	$194,842,459	436
Total	**$849,346,715**	**5,177**

Five County Natural Hazard Mitigation Plan

Iron County

Problem Soils Risk Map



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0 1 2 4 6 8
Miles

Legend

Highways
- US
- State
- Municipalities

- Dunes
- Expansive Soil or Rock
- Limestone

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WILDFIRE

As illustrated in the *Southwest Utah Regional Wildfire Protection Plan* (October 2007), the Color Country Fuels Committee (CCFC) compiled data that included standardized internal and external risk assessments, digital photos, maps, and other information to prioritize hazardous fuels target areas and to aid in suppression efforts. Each CARs was given a score ranging from 0 (no risk) to 12 (extreme risk) based on the sum of multiple risk factors (e.g., fire history, local vegetation, firefighting capabilities) analyzed in every area. The scoring system allows Utah's fire prevention program officials to assess the relative risk in a given area of the state and open communication channels with these communities to help them better prepare for wildfire.

Iron County- Communities at Risk and Risk Score (2005)	
Quichapa	12
Brian Head	11
Comstock	11
Far West	11
Iron Springs	11
Old Iron Town	11
Bumblebee Ridge	10
Castle Valley	10
Cedar Highlands	10
Chekshani	10
Ireland Meadow	10
Rainbow Meadow	10
Kanarraville	9
Summit	9
Braffits Creek/Red Canyon	8
Hamblin Valley	8
Meadow Lake	8
New Castle	8
Paragonah	8
Parowan	8
Cedar Valley Estates	7
Cedar City	6
Source: Southwest Utah Regional Wildfire Protection Plan (October 2007)	

In addition to the above analysis, the vulnerability assessment was conducted using GIS software to join: 1) County Property Tax data as it relates to 2) structures located within a respective hazard area. This analysis was based upon the most recent (2009) County Property Tax data provided by each County Assessor's office. The values shown are based upon utilizing the market value for structures in each defined hazard area. Where applicable, if a critical facility was located within a defined hazard area, this valuation was included within the commercial structure category. The GIS software then quantified the number of units and total market value for all structures located within each defined hazard area.

Iron County - Wildfire			
Type of Structure	Market Value of Structures		Number of Structures
	Wildfire Risk Area-High	Wildfire Risk Area-Medium	
Residential	$8,352,302		48
Commercial			
Residential		$397,524,458	2198
Commercial		$124,400,827	124
Total	**$8,352,302**	**$521,925,285**	**2322**
Overall Total		**$530,277,587**	**2322**

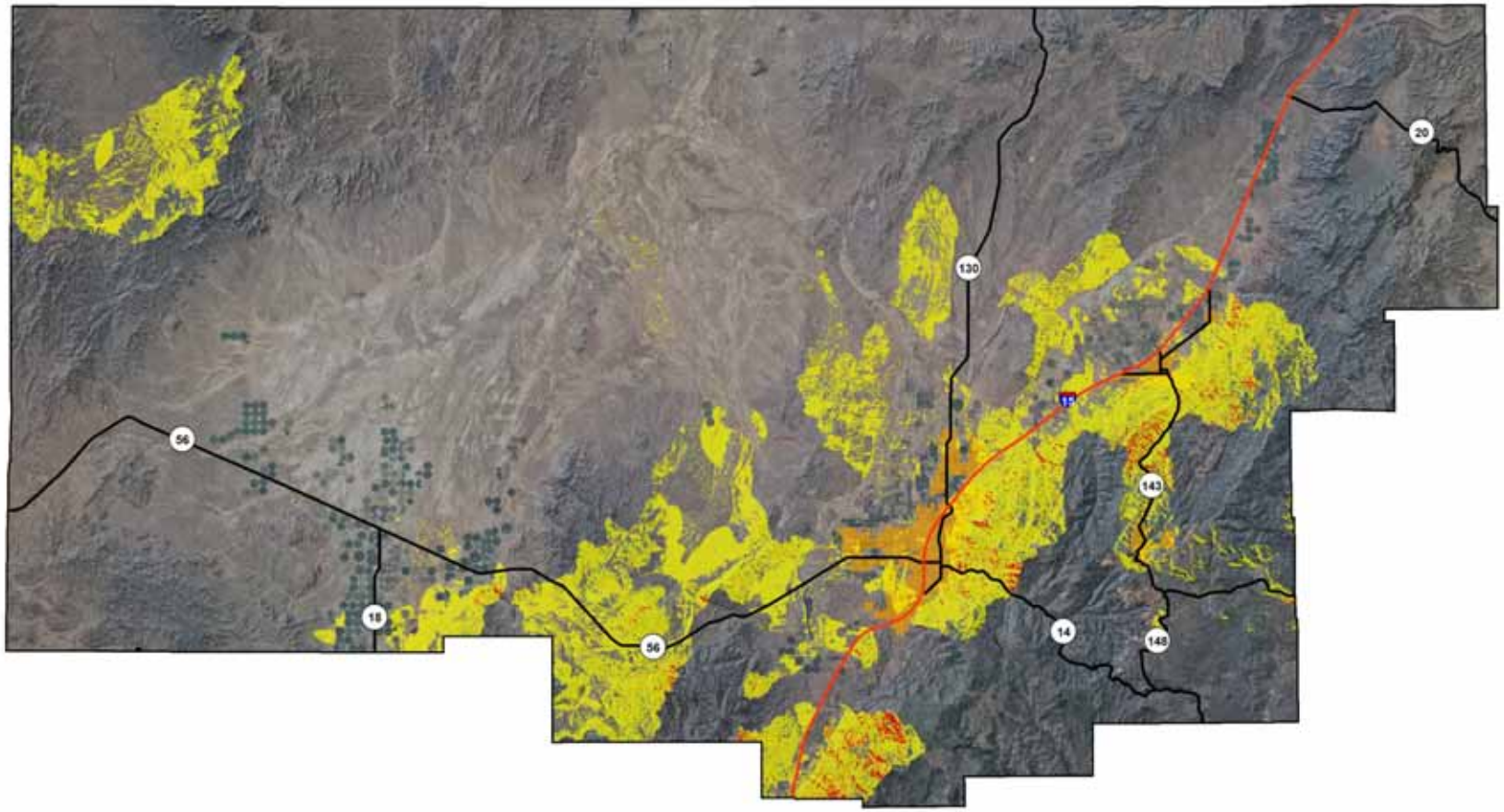
In addition to structures located within a defined hazard area, there is also an overwhelming amount (in terms of quantity and value) of infrastructure that is not captured by the GIS analysis. This is in large part due to the fact that compilation of this data would be exhaustive; nevertheless, the following provides a summarization of infrastructure at risk from wildfire.

Infrastructure at Risk from Wildfire			
Location	Miles of Major Roadways	Miles of Railroad Track	Miles of Utility Powerlines
Beaver County	60	5	87
Garfield County	104	0	154
Iron County	110	117	180
Kane County	59	0	50
Washington County	80	0	155
Paiute Indian Lands	10	0	0
Region Totals	**423**	**122**	**626**

Five County Natural Hazard Mitigation Plan

Iron County

Wildfire Risk Map



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0 1 2 4 6 8
Miles

Legend

Highways	Wildfire Risk
US	Medium
State	High
Municipalities	

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FLOOD

The Army Corps of Engineers conducted a *Flood Hazard Identification Study* for the Five County region in August, 2003. The intent of this study is to aid in detailing natural hazards associated with fluvial process for entities within the region. The study evaluates and identifies areas with a high flood hazard and identifies potential mitigation solutions. Municipalities within the region were studied if they met the following criteria: 1) Jurisdiction has not been mapped by FEMA; and 2) Jurisdiction mapped by FEMA as a Zone D, area of undetermined flood hazard. The following information is provided from the Study.

Dams are a critical support function for water managers in the State, and also can act as a flood control measure. If a dam remains stable, does not get overtopped, or is not impaired as the result of an earthquake, then at a minimum, they do provide incidental flood control. If not then they can add to the flood threat. There are 145 dams within the Five County region, of those 33 have received a high hazard rating by Utah Division of Water Right Dam Safety Section. The State Dam Safety Section has developed a hazard rating system for all non-federal dams in Utah. Downstream uses, size height, volume, and incremental risk/damage assessments are a variable used to assign dam safety classification. High hazard dams would cause a possible loss of life in the event of a rupture. The following are high hazard dams in Iron County: Yankee Meadow, Red Creek, Fiddler Canyon Debris Basin #2, Newcastle, Stephens Canyon Debris Basin North, Stephens Canyon Debris Basin South, Dry Canyon Debris Basin, and Leigh Hill Reservoir.

About 20% of Iron County residents live in the unincorporated county. The County does participate in the National Flood Insurance Program (NFIP). No major rivers threaten existing urban development; therefore, no structural flood control projects are warranted at this time. Flood sources include Coal and other creeks, their tributaries, and other potential flood sources such as lakes and reservoirs.

In addition to the above analysis, the vulnerability assessment was conducted using GIS software to join: 1) County Property Tax data as it relates to 2) buildings located with a respective hazard area. This analysis was based upon the most recent County Property Tax data provided by each County Assessor's office. The values shown are based upon utilizing the ***market value*** for structures in each defined hazard area. The GIS software then quantified the number of units and total market value for all structures located within each defined hazard area.

Iron County - Flood		
Type of Structure	Market Value of Structures	Number of Structures
Residential	$280,180,241	1,968
Commercial	$141,443,627	295
Total	**$421,623,868**	**2,263**

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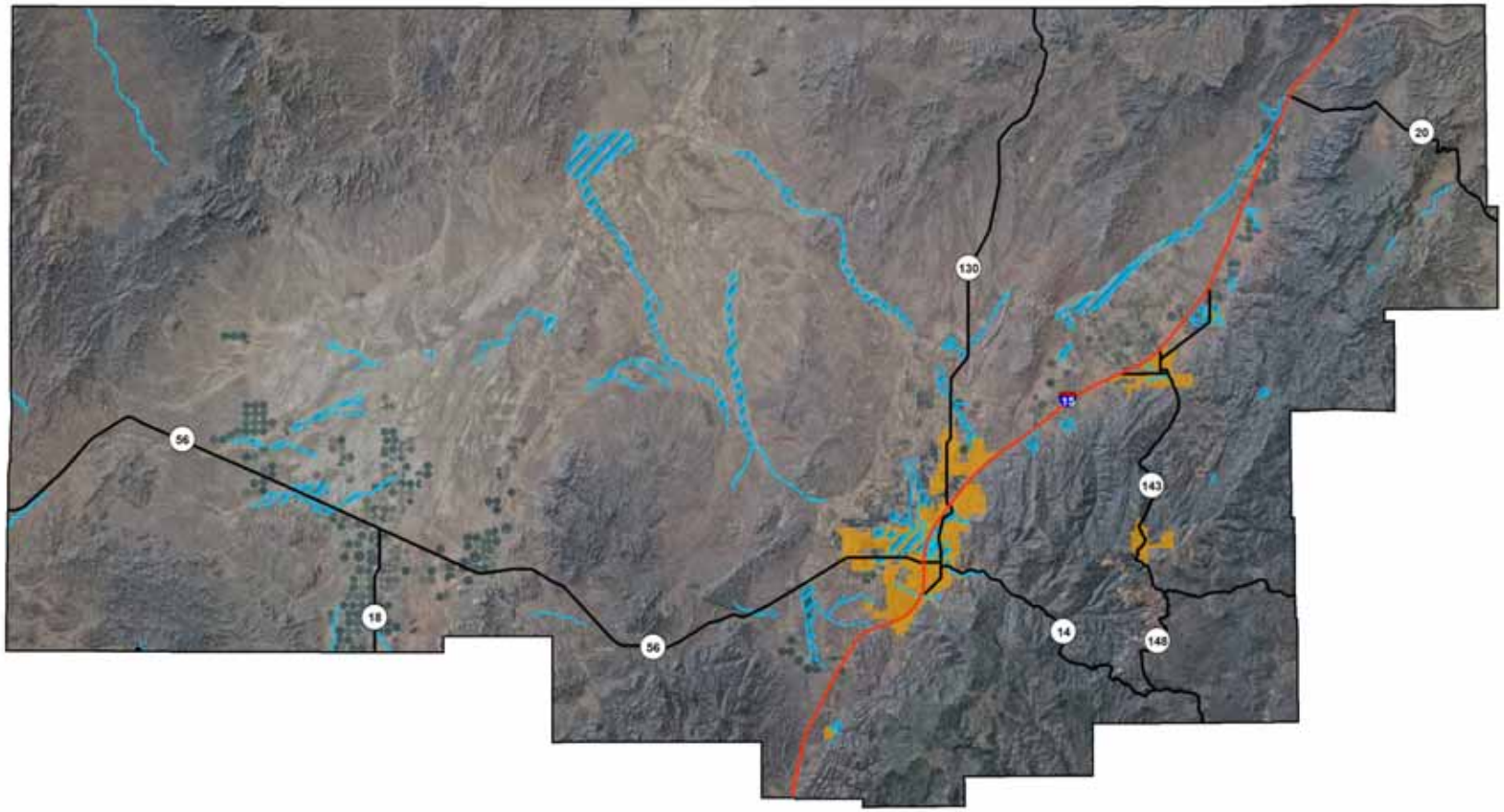
Five County Natural Hazard Mitigation Plan

Iron County

Flood Risk Map



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0 1 2 4 6 8
Miles

Legend

Highways
- US
- State
- Municipalities

FEMA 100yr Floodplain

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EARTHQUAKE

When assessing the vulnerability of structures as a result of an earthquake, an understanding of the building code, to which the structure was designed, is of extreme importance. Utah building codes began to address seismic design as early as 1976; although, the state did not adopt building codes fully addressing seismic safety until 1989. It is fairly safe to assume that structures constructed prior to 1976 will not perform in an earthquake as well as structures built following 1976. This is to say that an increased understanding of seismic events coupled with advances in building design has greatly increased our ability to design and construct buildings which perform better in earthquakes.

Earthquakes are regional hazards affecting multi-county areas, and because almost the entire state could experience a seismic event, all communities contain some degree of risk. The degree of risk is determined by several factors; however, the paramount factor is naturally the likelihood and magnitude of the earthquake. This being said, building design is a key factor when discussing potential structural damage. Vulnerability of structures was determined through age of construction with those structures built before 1976 considered possessing a higher risk.

Age of Housing Stock			
County	Structures built before 1976	Total Structures	**% of Structures built before 1976**
Beaver	1,559	2,660	**59%**
Garfield	1,497	2,767	**54%**
Iron	5,336	13,618	**39%**
Kane	1,398	3,767	**37%**
Washington	6,777	36,478	**19%**
Source: U.S. Census, November 2000.			

In addition to the above analysis, the vulnerability assessment was conducted using GIS software to join: 1) County Property Tax data as it relates to 2) buildings located with a respective hazard area. This analysis was based upon the most recent County Property Tax data provided by each County Assessor's office. The values shown are based upon utilizing the *market value* for structures in each defined hazard area. The GIS software then quantified the number of units and total market value for all structures located within each defined hazard area. The quantitative earthquake data provided below includes all structures which are: 1) on a fault line, or 2) within a 500' to 1,000' fault line buffer area. The range provided for the fault line buffer area is a determination made by Utah Geological Survey as it relates to the fault being studied or unstudied.

Iron County - Earthquake		
Type of Structure	Market Value of Structures	Number of Structures
Residential	$227,736,939	1,605
Commercial	$2,543,181	16
Total	**$230,280,120.00**	**1,621**

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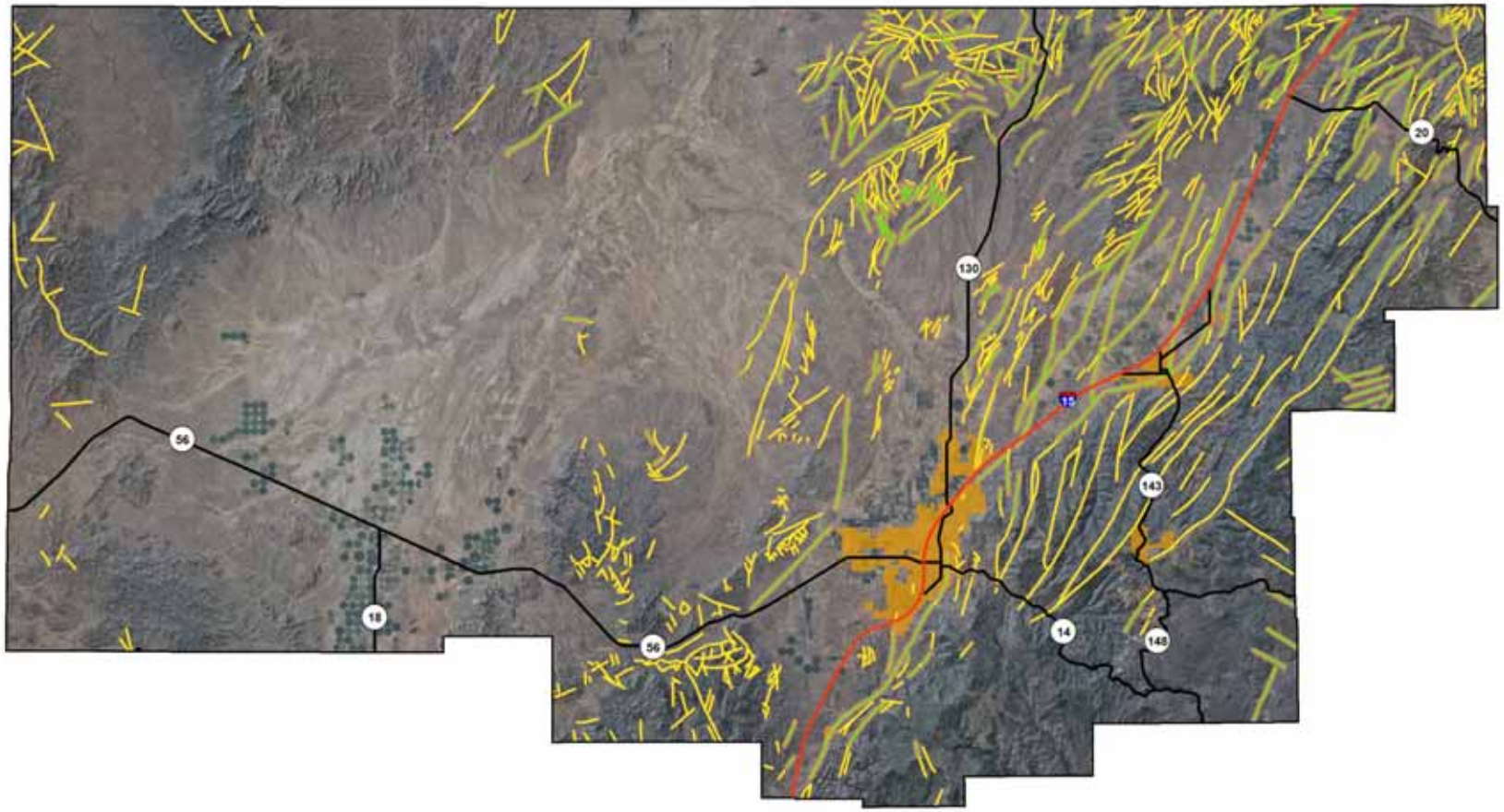
Five County Natural Hazard Mitigation Plan

Iron County

Earthquake Risk Map



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0 1 2 4 6 8
Miles

Legend

Highways
- US
- State
- Municipalities

Fault Locations
- Certain (Studied)
- Concealed (Unstudied)
- Surface Rupture Areas

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LANDSLIDE

According to the USGS, landslides are a widespread geologic hazard that can occur in all 50 states. On average, landslides cause $1-2 billion annually in damages and claim 25 lives per year. Urban development in and along hillside areas increase the number of people threatened by landslide events each year (USGS, 2007). Many factors contribute to overall landslide vulnerability; including local weather, soil moisture, duration and intensity of precipitation, wildfire history, and development pressure. Typically, landslides result from other natural disasters such as earthquakes, volcanoes, wildfires and floods (USGS, 2007). The table below illustrates landslide susceptibility by hazard category.

Landslide susceptibility by hazard category				
County	High Hazard (square miles)	Moderate Hazard (square miles)	Low Hazard (square miles)	**Total (square miles)**
Garfield	3.7	193.8	223.5	**421.0**
Beaver	46.6	579	236.1	**861.7**
Iron	20.5	738.2	333	**1,091.7**
Washington	28.1	1,079.9	423.2	**1,531.2**
Kane	42	1,638.5	672.9	**2,353.4**
Source: State of Utah, Natural Hazard Mitigation Plan, November 2007.				

In addition to the above analysis, the vulnerability assessment was conducted using GIS software to join: 1) County Property Tax data as it relates to 2) buildings located with a respective hazard area. This analysis was based upon the most recent County Property Tax data provided by each County Assessor's office. The values shown are based upon utilizing the *market value* for structures in each defined hazard area. The GIS software then quantified the number of units and total market value for all structures located within each defined hazard area.

Iron County - Landslide			
Type of Structure	Market Value of Structures		Number of Structures
	Landslide Risk Area- High	Landslide Risk Area- Medium	
Residential	$23,031,563		103
Commercial			
Residential		$154,713,353	764
Commercial		$16,429,624	14
Total	**$23,031,563**	**$171,142,977**	**881**
Overall Total		**$194,175,540**	**881**

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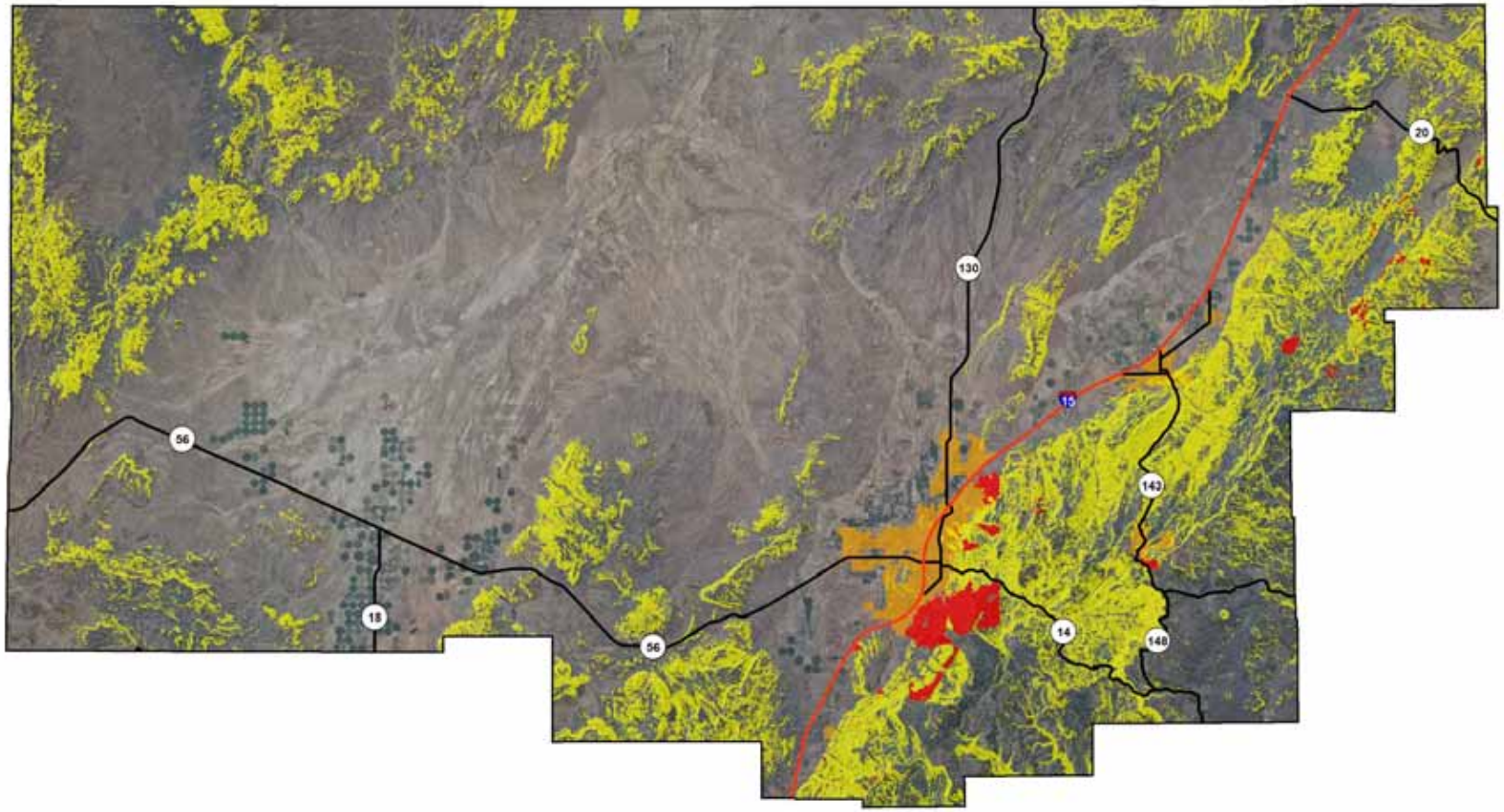
Five County Natural Hazard Mitigation Plan

Iron County

Landslide Risk Map



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0 1 2 4 6 8
Miles

Legend

Highways	Landslide
US	Medium
State	High
Municipalities	

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SEVERE WEATHER

There are many qualitative factors that point to potential vulnerability. Severe weather can cause power outages, transportation and economic disruptions, significant property damage, and pose a high risk for injuries and loss of life. The event can also be typified by a need to shelter and care for individuals impacted by the event. On numerous occasions, severe weather have brought economic hardship and affected the life of the residents of southwestern Utah. Higher elevations in The Five County region have greater exposure to snow and ice, but may be less economically vulnerable because they are sparsely populated. Quantitative assessment of severe weather vulnerability and determining which counties are more vulnerable is very challenging. However, using the principle of the past being the key to the future is effective. For example, one would assume that an area that has exhibited a high number of occurrences would continue to exhibit the same.

A quantitative vulnerability assessment is difficult based upon the simple fact that severe weather occurrences are random and difficult to predict. Several factors limit a determination of potential losses, they include:

- Limited GIS data availability;
- Lack of research on site-specific location;
- The entire state of Utah shares similar, if not identical risks; and
- Most hazards are tied to weather and cannot be predicted with location.

The vulnerability assessment was conducted using GIS software to join: 1) County Property Tax data as it relates to 2) buildings located with an area that has exhibited severe weather occurrences. This analysis was based upon the most recent County Property Tax data provided by each County Assessor's office. The values shown are based upon utilizing the ***market value*** for structures in each defined severe weather hazard area. The GIS software then quantified the number of units and total market value for all structures located within each defined severe weather hazard area.

Iron County – Severe Weather		
Type of Structure	Market Value of Structures	Number of Structures
Residential	$155,957,542	824
Commercial	$4,591,936	16
Total	**$160,549,478**	**840**

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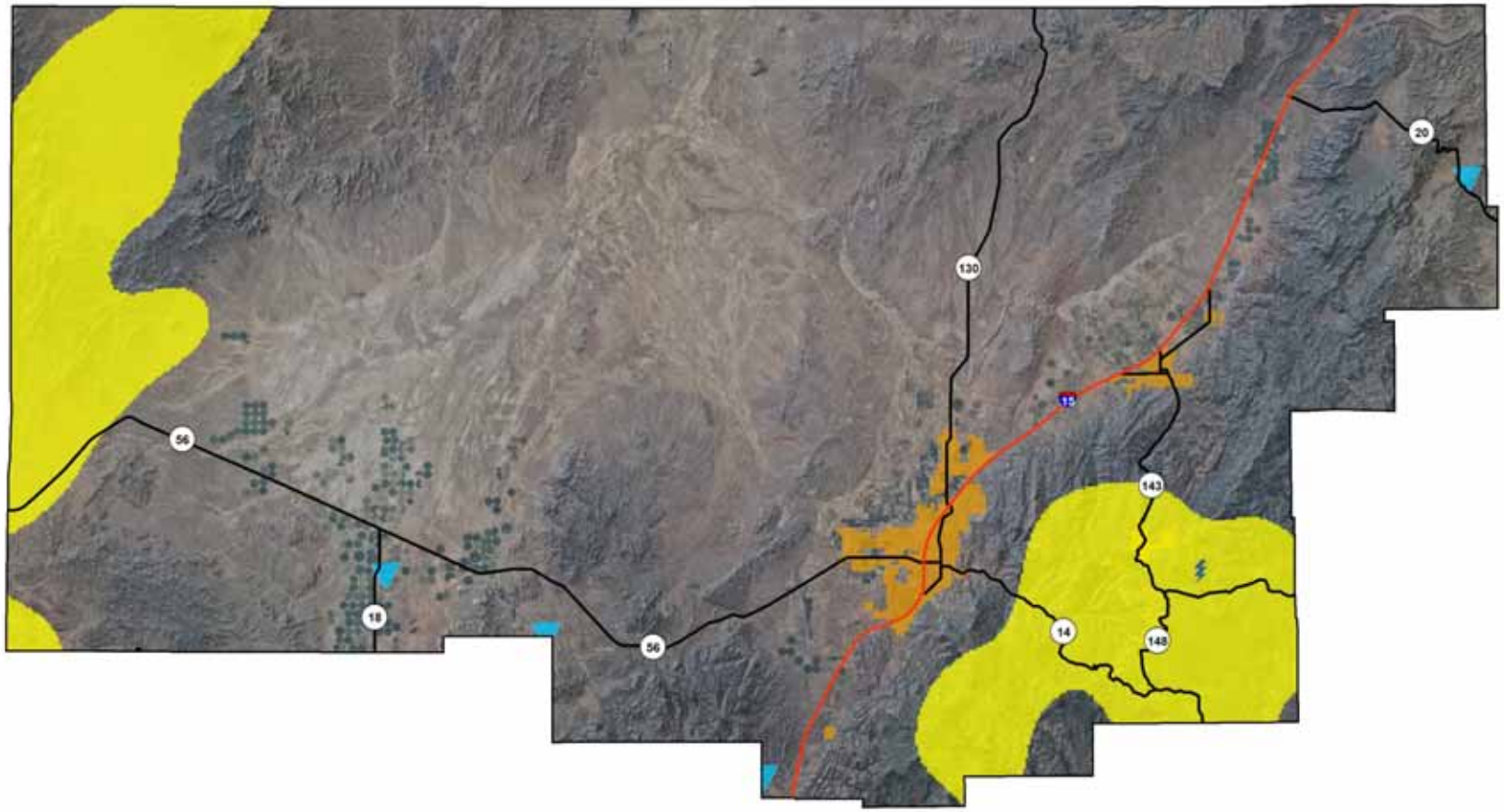
Five County Natural Hazard Mitigation Plan

Iron County

Severe Weather Risk Map



Five County Association of Goverments April 2010 Southern Utah University
FCAOG and SUU GIS use information and data from many different sources, which may be of differing accuracy and which have been integrated to provide a planning context. These products should be used only for the purpose they were intended. For specific data source information, please contact FCAOG.

0 1 2 4 6 8
Miles

Legend

Highways
- US
- State
- Municipalities

Tornado Touchdown
Lightning Death

Lightning Intensity
- Medium
- High

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MITIGATION STRATEGY

The following table provides a brief synopsis of the Iron County mitigation strategies. Additional information for each specific hazard, including specific mitigation strategies and associated information, are found following this table.

Iron County- Mitigation Strategies									
Mitigation Strategy	**Action**	**Timeline**	**Estimated Cost**	**Plan Goals Addressed**					
				Education/ Outreach	**Emergency Services**	**Environmental Protection**	**Partnership/ Coordination**	**Prevention**	**Property Protection**
Flood-Mitigation Strategy #1	Nonstructural measures appear to be the most prudent option for the county to implement. Zoning to prevent development of structures near all rivers, creeks, and lakes (100' min. setback).	Ongoing	Minimal		●		●		●
Flood-Mitigation Strategy #2	Address flood control at the building/construction level by requiring all subdivision proposals to have a storm water drainage system.	Ongoing	Minimal			●		●	●
Flood-Mitigation Strategy #3	Clear debris and other material from all waterways	Ongoing	Minimal			●		●	●
Flood-Mitigation Strategy #4	Create outreach document promoting flood insurance and include in local newspaper(s), libraries, and other public buildings.	1 year	Minimal	●			●	●	●
Flood-Mitigation Strategy #5	A potentially viable alternative would be to flood proof those relatively few existing low-lying structures that are subject to flooding. (Boulder & Cannonville)	Unknown	$10,000 to $30,000 per structure.			●		●	●

Flood-Mitigation Strategy #6	The potential structural solution consisted of raising existing levees and constructing a new one. (Panguitch)	5 years	About $3.5 million				●	●	●
Landslide-Mitigation Strategy #1	Increase public education related to landslide hazards by distributing UGS landslide informational brochures to local municipality level emergency mgmt., engineering, and planning departments.	Ongoing	Very minimal	●	●		●	●	
Landslide-Mitigation Strategy #2	Drafting/updating zoning and/or landslide ordinances to prevent development of structures near debris flows, landslides, and rock fall areas.	Ongoing	Minimal					●	●
Landslide-Mitigation Strategy #3	1-Address landslide risk at the building/construction level by requiring all subdivision proposals to have a geotechnical report.	Ongoing	Minimal					●	●
	2-If jurisdiction does not have trained staff to review the geotechnical report, the jurisdiction can, upon request, have UGS perform a review of the report.	Ongoing	Minimal				●	●	●
Earthquake-Mitigation Strategy #1	Increase public education related to earthquake hazards by distributing Utah Seismic Safety Commission informational brochures to County and City emergency management agencies.	Ongoing	Very minimal	●			●		
Earthquake-Mitigation Strategy #2	Continued dedication/vigilance in enforcing the seismic standards established in the International Building Code.	Ongoing	Minimal					●	●

Earthquake-Mitigation Strategy #3	1-Utilize the Earthquake Risk Map provided in this plan as a tool to assess earthquake risks as it relates to any building/subdivision proposals. If deemed necessary, jurisdiction should require the builder/developer to conduct a site-specific earthquake hazard identification/mapping study.	Ongoing	$1,000-$5,000					●	●
	2- At the County level, contract with UGS to formally study/map earthquake hazard areas.	3-5 years	$7,109-$14,218 per jurisdiction				●	●	●
Wildfire-Mitigation Strategy #1	Promote public awareness campaign for property owners living in wildland urban interface areas.	Ongoing	Unknown	●			●	●	●
Wildfire-Mitigation Strategy #2	1-Complement fuels reduction work being done by the Park Service and Forest Service onto private lands.	Ongoing	Unknown		●		●	●	●
	2-Prevent fires on private lands which may spread onto federal lands.	Ongoing	Unknown		●		●	●	●
Wildfire-Mitigation Strategy #3	1-Continue to place strategic fuel breaks throughout the focus area.	Ongoing	Unknown		●	●		●	●
	2-Encourage landowner mitigation and defensible space work.	Ongoing	Unknown	●	●		●	●	●
Wildfire-Mitigation Strategy #4	Enhance existing wildfire training programs, equipment procurement, and fire fighting resources for wildfire suppression.	Ongoing	Unknown		●		●	●	●

Problem Soils-Mitigation Strategy #1	1-Address problem soils at the building/construction level by requiring all subdivision proposals to have a geotechnical report.	Ongoing	$1,000-$5,000					●	●
	2- If jurisdiction does not have trained staff to review the geotechnical report, the jurisdiction can, upon request, have UGS perform a review of the report.	Ongoing	Minimal				●	●	●
Problem Soils-Mitigation Strategy #2	Utilize the Problem Soils Risk Map provided in this plan as a tool to assess problem soils risks as it relates to any building/subdivision proposals. If deemed necessary, jurisdiction should require the builder/developer to conduct a site-specific geotechnical (soils) report.	Ongoing	$1,000-$5,000					●	●
Problem Soils-Mitigation Strategy #3	Through mapping, identify areas which contain collapsible and expansive soils. Require soils testing at the building/construction level and ensure that engineer's recommendations are followed.	Ongoing	$1,000-$5,000					●	●
Severe Weather-Mitigation Strategy #1	Continued dedication/vigilance in enforcing the standards established in the International Building Code as it relates to wind-loading, electrical grounding, snow-loading, and other weather-related hazards.	Ongoing	Minimal					●	●
Severe Weather-Mitigation	1-Enhance the Emergency Alert System (tv & radio)	Ongoing	Unknown	●	●		●		

Strategy #2	2-Enhance NOAA Weather Radio All Hazard coverage.	Ongoing	Unknown	●	●		●		
Severe Weather-Mitigation Strategy #3	At the county Local Emergency Planning Committee (LEPC) level, meet the program guidelines then apply to the National Weather Service StormReady Program.	3-5 years	Minimal		●		●	●	●
Drought-Mitigation Strategy #1	1-County-level distribution of water conservation information via newsletter and/or website to affiliated constituents.	Ongoing	Minimal	●		●	●	●	
	2- Water purveyors distribute water conservation information to affiliated constituents.	Ongoing	Minimal	●		●	●	●	
Drought-Mitigation Strategy #2	Develop/demonstrate water conservation practices for agricultural use.	Ongoing	Minimal	●		●	●	●	●
Drought-Mitigation Strategy #3	County-level implementation of mitigation strategies identified in "*Drought in Utah-Learning from the Past-Preparing for the Future.*"	3-5 years	Unknown			●	●	●	●
Radon Gas-Mitigation Strategy #1	Increase public education related to radon gas hazards by distributing Utah Dept. of Environmental Quality informational brochures to County and City planning and engineering departments.	Ongoing	Very minimal	●		●	●	●	●

Radon Gas-Mitigation Strategy #2	Utilize the Radon Risk Map provided in this plan as a tool to assess radon gas risks as it relates to any building/ subdivision proposals. If deemed necessary, jurisdiction should require the builder/ developer to conduct a site-specific radon hazard identification study and implement applicable control techniques.	Ongoing	$25- $1,200	●		●		●	●

Requirement §201.6(c)(3): The plan shall include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.

The following mitigation strategies, listed in accordance to their respective natural hazard, are presented in an effort to provide macro-level risk reduction. Although each mitigation measure is important and achievable, they have been prioritized and listed in order of:

1) Respective amount of potential loss of life/property value as a result of a natural hazard occurrence (as quantified through GIS analysis) ; and
2) Implementation priority through utilization of the STAPLEE process (as explained in Chapter 3 of this Plan and in FEMA 386-3).

PROBLEM SOILS

Problem soils pose a significant hazard to the current/future built environment. This being said, many of these problems can be dramatically reduced through proper assessment of the risk and adherence to applicable mitigation measures. Factors included in assessing problem soils risk include built property distribution in the hazard area. This type of analysis generates estimates of the damages in the county due to problem soils occurrences in the current built environment. The mitigation strategies listed below identify cost effective measures that will yield measurable benefits toward reducing the risk of problem soils as they relate to the built environment. Further, these mitigation strategies include general actions that agencies are capable of implementing during the next five years, given their existing resources and authorities.

As part of this NHMP Update process, Five County Association of Governments developed a *Natural Hazards Questionnaire* in an effort to solicit information from a sampling of citizens. Of the responses obtained through this questionnaire, 71% of the respondents indicated they would be willing to spend more money on a home/business that had features that made it more disaster resistant.

Problem Soils Mitigation Strategy #1	
Objective:	Lessen the risk to buildings from problem soils.
Action:	1-Address problem soils at the building/construction level by requiring all subdivision proposals to have a geotechnical report. 2-If jurisdiction does not have trained staff to review the geotechnical report, the jurisdiction can, upon request, have Utah Geological Survey (UGS) perform a review of the report.
Timeline:	Ongoing
Estimated Cost:	$1,000 to $5,000
Possible Funding:	Private funds/ developer; Local government operating budget; Utah Geologic Survey operating budget.
Responsible Agencies:	Local, jurisdictional level; Utah Geological Survey

Problem Soils Mitigation Strategy #2	
Objective:	To reduce problem soils related losses by mapping and identifying problem soils hazard areas.
Action:	Utilize the Problem Soils Risk Map provided in this plan as a tool to assess problem soils risks as it relates to any building/subdivision proposals. If deemed necessary, jurisdiction should require the builder/developer to conduct a site-specific geotechnical (soils) report.
Timeline:	Ongoing
Estimated Cost:	$1,000 to $5,000
Possible Funding:	Private funds/ developer; Local government operating budget
Responsible Agencies:	Local, jurisdictional level; Private property owner.

Problem Soils Mitigation Strategy #3	
Objective:	Lessen the risk to buildings from collapsible and expansive soils.
Action:	Through mapping, identify areas which contain collapsible and expansive soils. Require soils testing at the building/construction level and ensure that engineer's recommendations are followed.
Timeline:	Ongoing
Estimated Cost:	$1,000 to $5,000
Possible Funding:	Private funds/ developer; Local government operating budget.
Responsible Agencies:	Local, jurisdictional level.

WILDFIRE

The Color Country Interagency Fire Center Fuels Committee has identified the general location of ten "Focus Areas" within the southwest Utah region. The selection of these specific areas was based on the need for fuels reductions as understood by fuels specialists and fire wardens, risk levels in the Regional Wildfire Protection Plan risk assessment, values at risk in the area,

firefighting concerns including access and evacuation routes, the presence of Communities At Risk (CARs), and local interest in the community documented by having a Community Wildfire Protection Plan in place.

The Color Country Interagency Fire Center Fuels Committee has not prioritized these ten focus areas. The Committee determined that to do so would have the effect of minimizing the fact that every one of these areas is in need of treatment and all are of concern. Each focus area also includes a list of general goals resulting from activities and treatments for the area.

Goals common to all treatment areas include fuels reduction, public education, and increases in equipment and training available to firefighting personnel. Goals that are generally applicable to all of the focus areas include the following:

- Protection of human life, firefighter and public safety as the highest priority.
- Public education and partnerships with citizens or community-centered approaches to manage fire risks and hazards in WUI areas located in the focus area, including effort aimed towards the implementation and maintenance of defensible space projects to reduce risk to homes and personal property.
- Protection of high value resources and watersheds through fuels reduction treatments as determined locally.
- Restoration and maintenance of ecosystems consistent with land uses and historic fire regimes. Restoration of vegetation to the appropriate Condition Classes and Fire Regimes.
- Maintenance and/or improvement of fire prevention and road/structure identification signage. Dissemination of fire restriction information through appropriate signage and/or visitor contacts when necessary.
- Improvement of wildland firefighting equipment, training and information for volunteer fire departments located in the focus area, including the improvement of GIS and road data.

The ten Focus Areas, as they pertain to Iron County, developed by the Color Country Interagency Fire Center Fuels Committee include the 1) Comstock/Farwest, 2) Cedar/Parowan Front, and the 3)Mammoth Creek Focus Areas. This being said, the Communities at Risk within Iron County (from high to medium risk) include: Quichapa, Brian Head, Comstock, Farwest, Iron Springs, Old Iron Town, Bumblebee Ridge, Castle Valley, Cedar Highlands, Chekshani Ireland Meadow, Rainbow Meadow, Kanarraville, Summit, Braffits Creek/Red Canyon, Hamblin Valley, Meadow Lake, New Castle, Paragonah, Parowan, Cedar Valley Estates, and Cedar City.

As part of this NHMP Update process, Five County Association of Governments developed a *Natural Hazards Questionnaire* in an effort to solicit information from a sampling of citizens. Of the responses obtained through this questionnaire, 100% of the respondents indicated they are concerned (12% extremely concerned, 65% concerned), about the wildfire risks in the county. In an effort to ameliorate these concerns the following is provided.

Wildfire Mitigation Strategy #1	
Objective:	Promote public awareness campaign for property owners living in wildland urban interface areas.
Action:	Mailings; Printed Information; Public Service Announcements;
Timeline:	Ongoing
Estimated Cost:	Unknown
Possible Funding:	State and Federal wildfire grant programs
Responsible Agencies:	State and Federal government

The primary concern within the Ruby's/Bryce Focus Area is located within the east-central portion of the watershed, located along Highway 12 and Highway 63 toward Bryce Canyon National Park. The Communities at Risk within this focus area are: Ruby's Inn, Bryce Canyon, Pines, and Fosters.

Wildfire Mitigation Strategy #2	
Objective:	Ameliorate firefighting and access concerns related to heavy seasonal tourist traffic.
Action:	1-Compliment fuels reduction work being done by the Park Service and Forest Service onto private lands. 2-Prevent fires on private lands which may spread onto federal lands.
Timeline:	Ongoing
Estimated Cost:	Unknown
Possible Funding:	Local government operating budget; Special Service District operating budget; private property owner
Responsible Agencies:	Community & local government entities; private property owner

The primary concern within the Mammoth Creek Focus Area is the area has recently experienced a wide-spread spruce beetle outbreak. The high number of dead spruce increases fire severity, spotting and high fire intensity. The Communities at Risk within this focus area are: Mammoth Creek, Ireland Meadow, Castle Valley, Rainbow Meadow, and Meadow Lakes.

Wildfire Mitigation Strategy #3	
Objective:	Fuels reduction and defensible space tactics.
Action:	1-Continue to place strategic fuel breaks throughout the focus area. 2-Encourage landowner mitigation and defensible space work.
Timeline:	Ongoing
Estimated Cost:	Unknown
Possible Funding:	Local government operating budget; Special Service District operating budget
Responsible Agencies:	Community & local government entities; private property owner

Wildfire Mitigation Strategy #4	
Objective:	Provide training, equipment, and resources for fire departments to fight wildfires.
Action:	Enhance existing wildfire training programs, equipment procurement, and fire fighting resources for wildfire suppression.
Timeline:	Ongoing
Estimated Cost:	Unknown
Possible Funding:	State CIB funding; Federal wildfire grant programs
Responsible Agencies:	Federal Government

FLOOD

The Army Corps of Engineers *Flood Hazard Identification Study* (August, 2003), identifies areas with a high flood hazard and identifies potential mitigation solutions. The following prioritized mitigation strategies are provided from this Study as well as from the Five County *Natural Hazard Mitigation Plan (2004).*

As part of this NHMP Update process, Five County Association of Governments developed a *Natural Hazards Questionnaire* in an effort to solicit information from a sampling of citizens. Of the responses obtained through this questionnaire, 94% of the respondents indicated they are concerned (18% extremely/very concerned) about the flood hazards affecting the county. Further, 76% indicated that their household and/or business does not have insurance coverage for flood events.

Flood Mitigation Strategy #1	
Objective:	Minimize future flood damage in the unincorporated County.
Action:	Nonstructural measures appear to be the most prudent option for the county to implement. Zoning to prevent development of structures near all rivers, creeks, and lakes (100' min. setback).
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	Local government operating budget; State and Federal flood and planning grant programs
Responsible Agencies:	Local government

As part of this NHMP Update process, Five County Association of Governments developed a *Natural Hazards Questionnaire* in an effort to solicit information from a sampling of citizens. Of the responses obtained through this questionnaire, 71% of the respondents indicated they would be willing to spend more money on a home/business that had features that made it more disaster resistant.

Flood Mitigation Strategy #2	
Objective:	To reduce flooding risk as it relates to the built environment.
Action:	Address flood control at the building/construction level by requiring all subdivision proposals to have a storm water drainage system.
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	Private funds/ developer.
Responsible Agencies:	Local, jurisdictional level.

Flood Mitigation Strategy #3	
Objective:	To reduce flooding risk at the community level.
Action:	Clear debris and other material from all waterways.
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	Related public/private property owners.
Responsible Agencies:	Private property owners, irrigation companies, local jurisdictions.

Flood Mitigation Strategy #4	
Objective:	Correct the inaccuracies related to the current FEMA 100-yr. floodplain along Coal Creek.
Action:	Obtain a Letter of Map Revision (LOMR) from FEMA that will remove the flood zone designation from the property adjacent to Coal Creek.
Timeline:	Within the next 3-5 years
Estimated Cost:	Minimal (CLOMR already obtained).
Possible Funding:	Cedar City operating budget; Federal grant programs
Responsible Agencies:	Cedar City Engineering Staff; Consultant

The following mitigation strategies are based upon mitigation strategies proposed in the Five County *Natural Hazard Mitigation Plan (2004),* and through consultation with the Iron County Engineer.

Flood Mitigation Strategy #5	
Objective:	Prevent Fiddlers Canyon flood waters from doing damage to homes and/or farmlands.
Action:	Construct a channel from the west side of the freeway (I-15) to the north route of the Coal Creek flood channel.
Timeline:	Within the next 5 years
Estimated Cost:	$2 million
Possible Funding:	Local government operating budget; State and Federal flood programs
Responsible Agencies:	Local government

Paragonah town has been frequently flooded by waters from Red Creek. This occurs mostly from July, August, and September thundershowers. Occasionally, excess spring runoff may pose significant threats.

Flood Mitigation Strategy #6	
Objective:	Prevent Red Creek flood waters from going through residential areas. Iron County is responsible from the mouth of the canyon to the town boundary and again after it leaves the town boundary to west of I-15. Paragonah is responsible within the town boundary.
Action:	Construct and/or widen and deepen the existing Red Creek flood way from the mouth of the canyon to west of I-15.
Timeline:	Within the next 5 years
Estimated Cost:	$2 million
Possible Funding:	Utah Army National Guard 115th Engineer Battalion, 348 East Main Street, Lehi, UT 84043 will contribute equipment and personnel but no cash outlay; Iron County and Paragonah town will purchase necessary materials.
Responsible Agencies:	Utah Army National Guard, Iron County and Paragon town.

Coal Creek is the main drainage through Cedar City from Cedar Mountain. Flooding through the city along Coal Creek would damage homes, business, and infrastructure if the projected flows of 6,600 cfs were realized.

Flood Mitigation Strategy #7	
Objective:	Install flood control improvements along Coal Creek that would contain the design flood and protect the adjacent homes, businesses, and city infrastructure.
Action:	Construct berms, levees, and other channel improvements that will contain the 100-yr. flood within the channel.
Timeline:	Within the next 3-5 years
Estimated Cost:	$2.8 million
Possible Funding:	Cedar City operating budget; Federal grant programs
Responsible Agencies:	Cedar City Engineering Staff; Federal Agency and Contractor.

Excess spring runoff or thundershower waters from Summit Canyon cause flooding in Summit all too frequently. Over the years the channel has become obstructed and is not functionally obsolete. Unfortunately, the main historic and natural flood channel is only discernible through old aerial photographs.

Flood Mitigation Strategy #8	
Objective:	Maintain spring runoff or thundershower waters in the natural and historic Summit Canyon flood channel.
Action:	By survey, mark upon the ground the natural channel. Then construct and/or open it up so when necessary it will convey flood waters. Rip-rap may be necessary at some locations. Some easements may be necessary.
Timeline:	Within the next 10 years
Estimated Cost:	$3 million
Possible Funding:	County Public Works and Engineer's budget.
Responsible Agencies:	County Engineer and Public Works personnel.

Excess spring runoff or thundershower waters from Parowan Canyon cause flooding in Parowan all too frequently. Over the years the channel has become obstructed and is not functionally obsolete. Unfortunately, the main historic and natural flood channel is only discernible through old aerial photographs.

Flood Mitigation Strategy #9	
Objective:	Maintain spring runoff or thundershower waters in the natural and historic flood channel.
Action:	By survey, mark upon the ground the natural channel. Then construct and/or open it up so when necessary it will convey flood waters. Rip-rap may be necessary at some locations. Some easements may be necessary.
Timeline:	Within the next 5 years
Estimated Cost:	$5 million
Possible Funding:	County Public Works and Engineer's budget.
Responsible Agencies:	County Engineer and Public Works personnel.

EARTHQUAKE

Earthquake mitigation strategies include general mitigation actions that agencies are capable of implementing during the next five years, given their existing resources and authorities. In addition to the earthquake mitigation strategies provided herewith, this Natural Hazard Mitigation Plan endorses any seismic mitigation proffered by the Utah Seismic Safety Commission. In particular, numerous and varied earthquake mitigation strategies are provided in *A Strategic Plan for Earthquake Safety in Utah (January, 1995)* completed by the Utah Seismic Safety Commission. It is highly recommended that jurisdictions whom desire to provide more specific earthquake mitigation strategies consult the aforementioned plan, which can be accessed at: http://ussc.utah.gov/.

Earthquake Mitigation Strategy #1	
Objective:	Promote building safety through non-structural improvements.
Action:	Increase public education related to earthquake hazards by distributing Utah Seismic Safety Commission informational brochures to County and City emergency management agencies.
Timeline:	Ongoing
Estimated Cost:	Very Minimal: request Utah Seismic Safety Commission to deliver brochures; and/or download brochures directly from: http://ussc.utah.gov/
Possible Funding:	County and City operating budget; Utah Seismic Safety Commission operating budget.
Responsible Agencies:	Local, jurisdictional level.

As part of this NHMP Update process, Five County Association of Governments developed a *Natural Hazards Questionnaire* in an effort to solicit information from a sampling of citizens. Of the responses obtained through this questionnaire, 71% of the respondents indicated they would be willing to spend more money on a home/business that had features that made it more disaster resistant. Further, 63% of the respondents indicated that their household/business does not have insurance coverage for earthquake events.

Earthquake Mitigation Strategy #2	
Objective:	To reduce earthquake risk as it relates to the built environment.
Action:	Continued dedication/vigilance in enforcing the seismic standards established in the International Building Code (IBC).
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	County or City government operating budget (where applicable).
Responsible Agencies:	County or City government (where applicable).

Earthquake Mitigation Strategy #3	
Objective:	To reduce earthquake losses by mapping and identifying earthquake hazard areas.
Action:	1-Utilize the Earthquake Risk Map provided in this plan as a tool to assess earthquake risks as it relates to any building/subdivision proposals. If deemed necessary, jurisdiction should require the builder/developer to conduct a site-specific earthquake hazard identification/mapping study. 2-At the County level, contract with Utah Geological Survey (UGS) to formally study/map earthquake hazard areas.
Timeline:	Action 1-Ongoing Action 2- 3 to 5 years
Estimated Cost:	Action 1-$1,000 to $5,000 Action 2- $7,109 to $14,218 per jurisdiction (1995 cost as reflected in

	A Strategic Plan for Earthquake Safety in Utah adjusted for inflation)
Possible Funding:	Action 1-Private funds/ developer. Action 2- Local government operating budget; Utah Geologic Survey operating budget.
Responsible Agencies:	Local, jurisdictional level; Private property owner; Utah Geological Survey

LANDSLIDE

Factors included in assessing landslide risk include built property distribution in the hazard area, the frequency of landslide or debris flow occurrences, slope steepness, and soil characteristics. This type of analysis generates estimates of the damages to the county due to a landslide or debris flow event on the current built environment. The mitigation strategies listed below identify cost effective measures that will yield measurable benefits toward reducing the risk of landslide hazards.

Landslide Mitigation Strategy #1	
Objective:	Increase the level of knowledge related to landslides.
Action:	Increase public education related to landslide hazards by distributing Utah Geological Survey (UGS) landslide informational brochures to local municipality level emergency management, engineering and planning departments.
Timeline:	Ongoing
Estimated Cost:	Very Minimal: request UGS to deliver brochures; and/or download brochures directly from: http://geology.utah.gov
Possible Funding:	Local, jurisdictional level.
Responsible Agencies:	Local, jurisdictional level.

Landslide Mitigation Strategy #2	
Objective:	Minimize future landslide damage in the unincorporated County.
Action:	Drafting/updating zoning and/or landslide ordinances to prevent development of structures near debris flows, landslides, and rock fall areas.
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	Local government operating budget; State and Federal planning grant programs.
Responsible Agencies:	Local government

As part of this NHMP Update process, Five County Association of Governments developed a *Natural Hazards Questionnaire* in an effort to solicit information from a sampling of citizens. Of the responses obtained through this questionnaire, 71% of the respondents indicated they would

be willing to spend more money on a home/business that had features that made it more disaster resistant.

Landslide Mitigation Strategy #3	
Objective:	To reduce landslide risk as it relates to the built environment.
Action:	1-Address landslide risk at the building/construction level by requiring all subdivision proposals to have a geotechnical report. 2-If jurisdiction does not have trained staff to review the geotechnical report, the jurisdiction can, upon request, have Utah Geological Survey (UGS) perform a review of the report.
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	Private funds/ developer; Local government operating budget; Utah Geologic Survey operating budget.
Responsible Agencies:	Local, jurisdictional level; Utah Geological Survey

SEVERE WEATHER

Quantitative assessment of severe weather vulnerability and determining which specific areas of the county are more vulnerable is very challenging. This being said, the vulnerability assessment quantified the number of units and total market value for all structures located within a defined severe weather hazard area; said area includes: known lightning deaths, lightning intensity (based upon actual lighting strike data), and tornado touchdowns. The following severe weather hazard mitigation strategies are specific to the aforementioned severe weather hazards.

As part of this NHMP Update process, Five County Association of Governments developed a *Natural Hazards Questionnaire* in an effort to solicit information from a sampling of citizens. Of the responses obtained through this questionnaire, 71% of the respondents indicated they would be willing to spend more money on a home/business that had features that made it more disaster resistant. Further, 76% indicated their preference for receiving severe weather information would be through the internet; 41% through television, 24% through radio sources.

Severe Weather Mitigation Strategy #1	
Objective:	To reduce severe weather risk as it relates to the built environment.
Action:	Continued dedication/vigilance in enforcing the standards established in the International Building Code (IBC) as it relates to wind-loading, electrical grounding, snow-loading, and other weather-related hazards.
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	County or City government operating budget (where applicable).
Responsible Agencies:	County or City government (where applicable).

Severe Weather Mitigation Strategy #2	
Objective:	Ensure that the general public is warned of severe weather occurrences via broadcast media.
Action:	1-Enhance the Emergency Alert System (television and radio). 2-Enhance NOAA Weather Radio All Hazard coverage.
Timeline:	Ongoing
Estimated Cost:	Unknown
Possible Funding:	Federal and State government operating budget.
Responsible Agencies:	Federal and State government.

Nearly 90% of all presidentially declared disasters are weather related. In an effort to guard against the negative effects of severe weather, the National Weather Service has designed the StormReady program. This program is a nationwide community preparedness program that uses an approach which helps communities develop plans to handle all types of severe weather. To be classified as a StormReady community several criteria must be met; however, the county Local Emergency Planning Committee (LEPC) is positioned well to satisfy the StormReady application/program guidelines. Ultimately the benefit of becoming formally recognized as a StormReady community lies in the additional planning/preparation/preparedness for severe weather occurrences; however, some grant opportunities are available through the National Weather Service as well as possible adjustment to insurance rates through the Insurance Services Organization (ISO).

Severe Weather Mitigation Strategy #3	
Objective:	Guard against the negative effects of severe weather by becoming a StormReady community.
Action:	At the county Local Emergency Planning Committee (LEPC) level, meet the program guidelines then apply to the National Weather Service StormReady program.
Timeline:	3 to 5 years
Estimated Cost:	Minimal
Possible Funding:	County and City operating budget.
Responsible Agencies:	County and City government.

Chapter 9 **KANE COUNTY**

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A PICTURE OF KANE COUNTY

DEMOGRAPHICS

According to the U.S. Census Bureau, the county has a total area of 4,108 square miles of which. The Colorado River, reformed as Lake Powell, forms its eastern boundary. Arizona lies on the southern boundary. Kane County is bordered on the west by Washington County and on the north by Garfield County. Grand Staircase-Escalante National Monument covers much of the county. A rugged and inhospitable country of deserts, mountains and cliffs makes up the terrain, with breath-taking scenery in every area. Parts of Bryce Canyon National Park and Zion National Park extend into the northern and western portions of the county. The eastern part of the county is part of the Glen Canyon National Recreation Area. One defining feature of Kane County is its remote character. Much of the county roadway system is included in the major state highways (89, 89A, 9, 14, and the Bryce Canyon Road). Despite the relative remoteness, millions of visitors visit the county as they make their way to the myriad natural resource attractions found therein.

The economy of Kane County has historically been based upon livestock grazing. However, the establishment of Grand Canyon National Park and the Kaibab Game Reserve began a demon for tourist services. The canyon country of eastern Kane County remained a sparsely settled area until the construction of Glen Canyon Dam on the Colorado River in the late 1950's. The resulting reservoir, Lake Powell, created the impetus for the establishment of several communities surrounding the lake. Lake Powell is a world class attraction which draws millions of visitors each year. Most of these visitors travel through the county to reach the lake. Presently, Kane County is heavily influenced by three major economic sectors: Trade, Services and Government. With Lake Powell and the Grand Staircase Escalante National Monument partially within its border, Kane County relies heavily on tourism. The county is experiencing moderate growth by attracting additional trade and service sector activity to support growing tourist activity. In addition, more and more people are relocating to the county for retirement living.

DEVELOPMENT TRENDS

After suffering from out-migration in the 1960's, Kane County has typically experienced faster than average population expansion. However, in the 1990s, Kane County's growth slowed. Between 1990 and 2000 the population grew by 17.2 percent, placing it in the bottom third of Utah's counties. Kane County growth during the 2000s didn't fare much better at only 11%; State of Utah growth for the same time period totaled 27%. However, according to growth projections provided by the Governor's Office of Planning and Budget, Kane County can expect noteworthy increases in population over the next 20 years. The projected population increase from 2010 to 2020 is 26.9% and 18.8% from 2020 to 2030. Overall this translates to 50.8% growth projected over the next 20 years. This growth projection is roughly equivalent the State of Utah growth projection of 53.6% over the same period. The projected increase in population is not expected to change the rural nature of the County. If the present population pattern continues, most of the population increase is expected to occur in established developed areas of the County.

The Kane County General Plan (Adopted 1998) stipulates, "Intensive, urban-scale uses will be directed to municipalities where basic services can be accommodated. Land use policies and regulations will recognize and respect the constraints which natural hazards present to human use." Growth as it relates to natural hazard conflicts is further managed through implementation of policy statements which stipulate "The County will address erosion control, salinity control, water quality impacts, and associated concerns when land use proposal are reviewed." Additionally, the county endeavors to implement "conservation efforts (which) will focus on the rehabilitation of the land base in order to improve the functioning of natural systems for the benefit of residents and visitors."

KANE COUNTY LANDSCAPE

Kane County, located on the western side of the Colorado Plateau, encompasses approximately 3 million acres of some of the most remote and rugged lands in the United States. The county is a land of extremes in elevation, vegetation, precipitation and landscapes. The county is divided into four broad landscapes known from northwest to southeast as the High Southern Plateaus, the Grand Staircase, the Kaiparowits Plateau, and the Colorado River Canyons. Kane County lies across four broad watersheds, all part of the Colorado River system. Less than ten percent of the waterways found within the county are perennial streams.

Steep canyons, limited water, unique and isolated geologic substrates, and large fluctuations in climatic conditions have all influenced the composition, structure, and diversity within the county. Elevations in Garfield County range from less than 5,000 feet to over 9,000 feet. This wide range of elevation has marked influence on the climate of the County. Precipitation within the county varies from 7 to 18 inches annually. Winter-time precipitation varies from 4 to 12 inches and is the primary source of recharge of ground water systems. Winter precipitation is the greatest along the northwest border of the county in the higher elevations of the Pansugant Plateau.

Climate, elevation, and the presence of adequate water have determined the present day land ownership and land use patterns of Kane County. Almost 90 percent of the county land base remains in federal ownership. The land base which is privately owned is located along perennial water courses and at the base of high elevation forests. While agriculture has been an important base of economic activity in Kane County, the total amount of land devoted to agricultural pursuits is relatively minor. However, the majority of BLM and National Forest public lands have been included in livestock grazing allotments.

Kane County is a land of contrasts. Its 4,100 square miles of territory extend from the sandstone deserts of Glen Canyon and Lake Powell to the 10,000 foot high alpine meadows of the Pansugant Plateau. Less than one percent of the county land

base is located inside incorporated communities. The lack of precipitation and difficulty of access has resulted in a land use pattern which is dominated by public lands surrounding a small base of private lands. A substantial amount of lands in the higher elevations forest lands have been developed for recreation homes and cabins. Extensive deposits of coal and other natural resources have been the subject of numerous explorations and feasibility studies. Each of these land uses presents different challenges and opportunities.

HAZARD IDENTIFICATION

Requirement §201.6(c)(2): The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.

Requirement §201.6(c)(2)(i): [The risk assessment **shall** include a] description of the…location and extent of all natural hazards that can affect the jurisdiction. The plan **shall** include information on previous occurrences of hazard events and on the probability of future hazard events.

Requirement §201.6(c)(2)(ii)(C): [The plan **should** describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

Requirement §201.6(c)(2)(iii): For multi-jurisdictional plans, the risk assessment must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.

WILDFIRE

When discussing wildfires it is important to remember that fires are part of a natural process and are needed to maintain a healthy ecosystem. Since its settlement in the mid 1800s, the region and its residents have been subject to the annual threat of wildfire. This is in large part due to the environmental conditions, namely low annual precipitation and high amount of public lands. Lightning is the primary cause of wildfire in the county. However, the potential risk for human caused fires increases as more people move into the wildland urban interface.

Many of Utah's wildland urban interface areas are located in our most fire prone wildland fuels. Generally, these fuels are found on drier, lower elevation sites which are often very desirable for real estate development. To address these issues, a multi-jurisdictional group of agencies, organizations, and individuals collaborated to develop the *Southwest Utah Regional Wildfire Protection Plan* (October 2007). The purpose of this plan is to be a tool in the effort to protect human life and reduce property loss due to catastrophic wildland fires in the communities and surrounding areas located in the southwest Utah counties of Beaver, Garfield, Iron, Kane and Washington.

Kane County is almost exclusively covered in Forest and Shrub/Rangelands accounting for 97% of the area. Shrub/rangelands accounts for 75% of the land area (1,890,058 acres).
Forest area accounts for 22% of the County (548,016 acres). Water/Wetlands (32,049 acres) and Developed (22,510 acres) each comprise about 1% of the County's land area.

Grass/Pasture/Haylands/Croplands make up less than 1% of the County's land area (11,817 acres). Shrub/Rangelands consists of oak savannahs and sagebrush flats. 85% of Kane County land area is federally owned and 10% is state owned. Only 5% of Kane County land area is privately owned.

Using National Fire Plan guidelines, the Utah Division of Forestry, Fire, and State Lands (UDFFSL) has worked with national and local wildland fire officials to create a statewide list of Communities at Risk (CARs). As of 2005, there were over 600 communities listed statewide and 148 are located in the southwestern Utah region. Beginning in 2000, the Color Country Fuels Committee (CCFC) undertook an intensive assessment of the 148 identified CARs in the Color Country fire management response area. These assessments have been the foundation for prioritizing fuels treatments, determining focus areas, and targeting the development of Community Wildfire Protection Plans within the Color Country Interagency Fire Management area.

LANDSLIDE

Nationwide, estimated losses from damaging landslides equal $3.5 billion annually (USGS, 2005). In Utah, documented losses from damaging landslides in 2001 exceeded $3 million, including the costs to repair and stabilize hillsides along state and federal highway (Ashland, 2003). Total landslide dollar losses are hard to determine from past events because a standard for documenting them do not exist. Several state and local agencies track landslide losses with inconsistent formats often resulting in several different totals for a single event.

On March 12, 2005 a 100 ft. long by 60 ft. high vertical stream-cut along Kanab Creek failed. This rock fall occurred within the city limits of Kanab, killing one boy and partially burying tow children. This earth-fall type landslide was most likely the result of long-term gravitational effects on over-steepened, unconsolidated material in the arroyo walls (Lund, 2005).

FLOOD

In the southwest, as elsewhere, flooding, erosion, and sediment discharge are responsible for loss of life, land, and infrastructure, along with damage to reservoirs and natural habitats. Stream flooding is the most prevalent and destructive (annually) of the geologic hazards that affect Utah. This destructive trend is nowhere more evident than in the southwest part of the state.

The two types of stream flooding events which typically occur in southwestern Utah are riverine floods and flash floods. Riverine floods are usually regional in nature, last for several hours or days, and have recurrence intervals of 25 to more than 100 years. They commonly result from the rapid melt of a winter snow pack or from periods of prolonged heavy rainfall. Flash floods result from thunderstorm cloudbursts. They are localized, quickly reach a maximum flow, and then quickly diminish. Recurrence intervals for flash floods are erratic, ranging from a few hours

to decades or longer for a given drainage. Both types of flooding have caused extensive damage in southwestern Utah.

Four major riverine floods have affected southwestern Utah since the area was settled. They occurred in 1966, 1983, 1984 and 2005. The 1966 flood on the Santa Clara River near Pine Valley resulted from an intense three-day rainstorm that produced record peak flows on the Virgin River. This three-day storm produced between 1 and 12 inches of rain and resulted in total damage of approximately $1.4 billion (Butler and Mundorff, 1970). The 1983 and 1984 floods occurred in response to the rapid melting of maximum-of-record and greater-than-average snow packs respectively. The 1983 and 1984 floods caused several landslides and a dam failure. Total damage was in excess of $640 million and the President issued a disaster declaration for 22 Utah counties. Lastly, a stalled storm-system containing abundant moisture caused significant flooding in Washington and Kane Counties between January 8-12, 2005. It is estimated that $300 million dollars in damages was sustained along the Santa Clara and Virgin Rivers in Washington County. 30 homes were destroyed in the flood and another 20 homes were significantly damaged (NCDC, 2005). A Presidential Disaster Declaration was declared February 1, 2005.

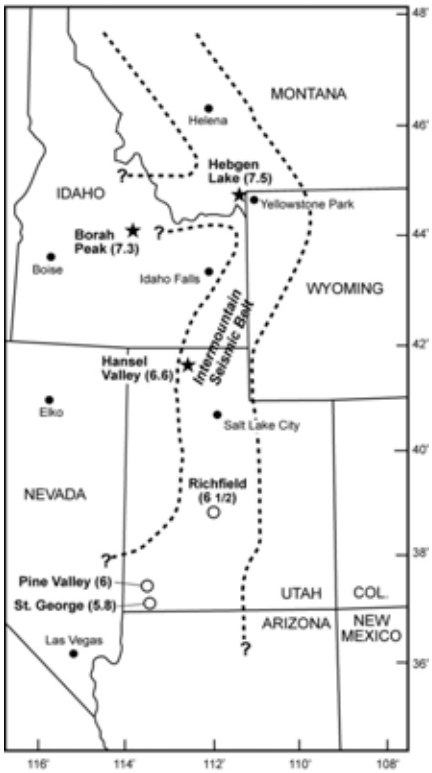
According to statistics provided by SHELDUS, Kane County has experienced a total of 10 major flooding events; the first event occurring December 4, 1966 and the most recent occurring October 5, 2006. The total property damage (not adjusted for inflation) for these flood events was $ 323,935.

By nature flash floods are sudden, intense, and localized. Many undoubtedly occur every summer along isolated drainages in southwestern Utah and are never recorded. Flash floods have damaged every major town in southwestern Utah. Many communities have implemented flood-control measures to reduce flash flood hazard; however, as communities expand into unprotected areas, new development is again subject to flash flooding. As a whole, any new development in southwestern Utah must consider the potential for stream flooding, and mitigate any flood hazard that may exist.

EARTHQUAKE

In Utah most earthquakes are associated with the Intermountain seismic belt (Smith and Sbar, 1974; Smith and Arabasz, 1991), an approximately 160-kilometer-wide (100 miles), north-south trending zone of earthquake activity that extends from northern Montana to northwestern Arizona. Since 1850, there have been at least 16 earthquakes of magnitude 6.0 or greater within this belt (Eldredge and Christenson, 1992). Included among those 16 events are Utah's two largest historical earthquakes, the 1901 Richfield earthquake with an estimated magnitude of 6.5, and the 1934 Hansel Valley magnitude 6.6 earthquake, which produced Utah's only historical surface fault rupture. In an average year Utah experiences more than 700 earthquakes, but most are too small to be felt. Moderate magnitude (5.5 – 6.5) earthquakes happen every several years on average, the most recent being the magnitude 5.8 St. George earthquake on September 2, 1992. Large magnitude earthquakes (6.5 – 7.5) occur much less frequently in Utah, but geologic

evidence shows that most areas of the state within the Intermountain seismic belt, including southwestern Utah, have experienced large surface-faulting earthquakes in the recent geologic past.



Fault-related surface rupture has not occurred in southwestern Utah historically, but the area does have a pronounced record of seismicity. At least 20 earthquakes greater than magnitude 4 have occurred in southwestern Utah over the past century (Christenson and Nava, 1992); the largest events were the estimated magnitude 6 Pine Valley earthquake in 1902 (Williams and Trapper, 1953) and the magnitude 5.8 St. George earthquakes in 1992 (Christenson, 1995). The Pine Valley earthquake is pre-instrumental and poorly located, and therefore, is not associated with a recognized fault. However, the epicenter is west of the surface trace of the Hurricane fault, so the event may have occurred on that structure. Pechmann and others (1995) have tentatively assigned the St. George earthquake to the Hurricane fault. The largest historical earthquake in nearby northwestern Arizona is the 1959 Fredonia, Arizona, earthquake (approximate magnitude 5.7; DuBois and others, 1982). Since 1987 the northwest part of Arizona has been quite seismically active (Pearthree and others, 1998), experiencing more than 40 events with magnitudes >2.5.

Despite the lack of an historical surface-faulting earthquake in southern Utah, available geologic data for faults in the region indicate a moderate rate of long-term Quaternary activity. Mid-Quaternary basalt flows are displaced hundreds of meters at several locations and alluvial and colluvial deposits are displaced meters to tens of meters in late Quaternary time.

Because earthquakes result from slippage on faults, from an earthquake-hazard standpoint, faults are commonly classified as active, capable of generating damaging earthquakes, or inactive, not capable of generating earthquakes. The term "active fault" is frequently incorporated into regulations pertaining to earthquake hazards, and over time the term has been defined differently for different regulatory and legal purposes. In fact, faults possess a wide range of activity levels. Some, such as the San Andreas Fault in California, produce repeated large earthquakes and associated surface faulting every few hundred years, while others, like Utah's Wasatch fault and many of the faults in the Basin and Range Province, generate large earthquakes and surface faulting every few thousand to tens of thousands of years. Therefore, depending on the area of interest or the intended purpose, the definition of "active fault" may change. The time period over which faulting activity is assessed is critical because it determines which faults are ultimately classified as hazardous and therefore in need of regulatory mitigation (National Research Council, 1986).

PROBLEM SOILS

There are six types of problem soils and rocks that are found in southwestern Utah; namely, Expansive Soil, Collapsible Soil, Limestone (Karsts Terrain), Gypsiferous Soil/Rock, Soils subject to Piping, and Sand Dunes.

Expansive soil and rock is the most common type of problem deposit in southwestern Utah. In particular, the Jurassic-age Arapien and Cretaceous-age Tropic Shale's, and the Triassic-age Chinle and Moenkopi Formations are sources for expansive materials. Expansive deposits contain clay minerals that expand and contract with changes in moisture content. Clays absorb water when wetted, causing the soil or rock to expand. Conversely, as the material dries, the loss of water between clay crystals or grains causes the deposit to shrink. Expansive deposits are extensive around St. George, Washington, and Santa Clara. In these areas expansive clays in the Chinle Formation have been most damaging to structures. Common problems are cracked formations, heaving and cracking of floor slabs and walls, and failure of wastewater disposal systems. Sidewalks and roads are particularly susceptible to damage.

Collapsible Soil- Subsidence of the ground surface due to collapsible soil has caused extensive damage in and around Cedar City and the Hurricane cliffs, where it is most prevalent. Collapsible soil is common in Holocene alluvial-fan and debris-flow deposits in southwestern Utah. Soil and rock containing gypsum are also susceptible to subsidence. Collapse occurs when susceptible soils are wetted to a depth below that normally reached by rainfall, destroying the clay-bonds between bands. Collapsible soil is present in geologically young materials such as Holocene-age alluvial-fan and debris-flow sediments, and in some wind-blown silts.

Limestone (Karst Terrains) susceptible to dissolution and subsidence occurs throughout mountains west of Sevier Lake, west of Richfield, and south of St. George. Karsts terrain is characterized by closed depressions (sinkholes), caverns, and streams that abruptly disappear underground. Most karsts terrain in southwestern Utah is relict and relates to moisture climates during the Pleistocene, or may have been created by ground water prior to the rock being uplifted and tilted during basin and range faulting. No known damage has occurred to structures from ground collapsing or subsidence related to limestone karsts, but because karsts ground-water systems have little filtering capacity, contamination of ground water is a major concern.

Gypsiferous Soil/ Rock deposits are subject to settlement caused by the dissolution of gypsum, which creates a loss of internal structure and volume within the deposit. Gypsiferous soil and rock deposits are common in southwestern Utah, particularly along the base of the Hurricane cliffs. Gypsum in these deposits can cause damage to foundations, and induce land subsidence and sinkholes similar to those seen in limestone terrain.

Soils subject to Piping- Piping is subsurface erosion by ground water that moves along permeable, non-cohesive layers in unconsolidated materials and exists at a free face, usually along a stream bank or cliff that intersects the layer. Deposits susceptible to piping are common in the southwestern part of the state. Holocene-age alluvial fill in canyon bottoms is the most common material susceptible to piping in Utah. Collapse of soil pipes and subsequent erosion has damaged roads and agricultural land. Piping can cause damage to roads, bridges, culverts,

and any structure built over soils subject to piping. Earth-fill structures such as dams may also be susceptible to piping.

Sand Dunes- are common surficial deposits in arid areas where sand derived from weathering of rock or unconsolidated deposits is blown by the wind into mounds or ridges. In areas where development encroaches on dunes, inactive or vegetated dunes may be reactivated, allowing them to migrate over roads and bury structures. Sand Dunes occur in the Escalante Desert and west of Kanab. Migration of dunes across roads and burial structures are common problems in areas where active dunes are present. Avoidance of dunes is the best way to prevent damage to structures. However, active dunes usually are a maintenance problem only and do not preclude development.

SEVERE WEATHER

The term severe weather, as it pertains to this plan, is used to represent a broad range of weather phenomena which affect southwestern Utah, namely; downburst, lightning, heavy snowstorms, avalanches, and tornados. Severe weather events are the most deadly type of natural hazard in Utah. Interestingly, more people have died in avalanches in Utah than by any other natural hazard. Between 1958 and 2006 avalanches killed 85 people.

Since 1950, lightning has killed 60 people statewide and injured another 144. In southwestern Utah the most common type of severe weather activity is related to lightning. Since 1950 a total of 5 lightning deaths and 10 lightning injuries have been recorded within the region.

A tornado is a violently rotating column of air extending from a thunderstorm to the ground. Most tornados have winds less than 112 miles per hour and zones of damage less than 100 feet wide. According to the National Weather Service, a total of 12 tornados have been observed in southwestern Utah. Of this amount, Iron and Beaver counties contain the highest amounts at 5 and 4 respectively.

A stalled storm system containing abundant moisture caused significant flooding in Washington and Kane Counties between January 8-12, 2005. Higher snowfall and water equivalent totals equaled 70" at Cedar Breaks, and 60" at Kolob-Zion National Park. It is estimated that $300 million dollars in damages was sustained along the Santa Clara and Virgin Rivers. 30 homes were destroyed in the flood and another 20 homes were significantly damaged. One fatality associated with this event resulted when a man and his wife in their vehicle were caught in floodwaters in the Red Cliff Recreation Area near the Quail Creek Reservoir. Six other injuries were reported. A Presidential Disaster Declaration was declared on February 1, 2005. .

Climate- Most of the moisture in the winter comes from fronts that develop in the Gulf of Alaska and move from west to east across the State. Tropical air from the Gulf of Mexico enters the state from the south and west during July through September and is the source of severe thunderstorms. Tropical Pacific air masses from the southwest at times have caused extreme floods in the southwest part of the State. The mountains form barriers to the flow of moisture-laden air, and orographic precipitation may occur any time during the year. Rain shadows, which are areas of reduced precipitation, on the leeward side of the mountains account for the low normal annual rainfall in many of the interior valleys in the region.

Cloudburst storms and resultant floods occur principally during the summer. All parts of the State are subject to these storms, even the flat desert areas of the western portion. However, they occur more frequently along the west slope of the Wasatch Range, the Colorado Plateaus, and the southwest part of the State.

Tornados- Generally speaking, atmospheric conditions are rarely favorable for the development of tornadoes in Utah due to its dry climate and mountainous terrain. In fact, Utah ranks as having one of the lowest incidences of tornadoes in the nation, averaging only about two tornadoes per year, with only one F2 or stronger tornado once every seven years.

In the central U.S., tornadoes are commonly one-fourth of a mile wide and often cause considerable destruction and death. However, Utah tornadoes are usually smaller in size, often no more than 60 feet wide (at the base), with a path length usually less than a mile and a life span of only a few seconds to a few minutes. They normally follow a path from a southwesterly to a northeasterly direction and usually precede the passage of a cold front. About 73% of all Utah tornadoes have occurred in May, June, July and August, when severe thunderstorms occasionally frequent Utah.

Avalanches occur when a cohesive slab of snow fractures as a unit and slides on top of weaker snow, breaking apart as it slides. Slab avalanches occur when additional weight is added quickly to the snow pack, overloading a buried weaker layer. Dry snow avalanches usually travel between 60-80 miles per hour, reaching this speed within 5 seconds of the fracture, resulting in the deadliest form of snow avalanche.

Wet avalanches occur when percolating water dissolves the bonds between the snow grains in a pre-existing snow pack; this decreases the strength of the buried weak layer. Strong sun or warm temperatures can melt the snow and create wet avalanches. Wet avalanches usually travel about 20 miles per hour.

According to the Colorado Avalanche Information Center (CAIC), over the last 10 winters in the United States an average of 25 people died in avalanches every year. In Utah, this translates to approximately 4 avalanche related fatalities every year. Generally speaking, the lion share of avalanche fatalities have occurred in northern Utah. Since every fatal accident is investigated and reported, the numbers can be reported with some certainty. However, there is no way to determine the number of people caught or buried in avalanches each year, because non-fatal

avalanche incidents are increasingly under reported. Unfortunately, statistical data pertaining to avalanche related fatalities in southern Utah is underprovided.

VULNERABILITY ASSESSMENT

Requirement §201.6(c)(2)(ii): [The risk assessment **shall** include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description **shall** include an overall summary of each hazard and its impact on the community.

Requirement §201.6(c)(2)(ii)(A): The plan **should** describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area.

Requirement §201.6(c)(2)(ii)(B): [The plan **should** describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph *(c)(2)(ii)(A)* of this section and a description of the methodology used to prepare the estimate.

WILDFIRE

As illustrated in the *Southwest Utah Regional Wildfire Protection Plan* (October 2007), the Color Country Fuels Committee (CCFC) compiled data that included standardized internal and external risk assessments, digital photos, maps, and other information to prioritize hazardous fuels target areas and to aid in suppression efforts. Each CARs was given a score ranging from 0 (no risk) to 12 (extreme risk) based on the sum of multiple risk factors (e.g., fire history, local vegetation, firefighting capabilities) analyzed in every area. The scoring system allows Utah's fire prevention program officials to assess the relative risk in a given area of the state and open communication channels with these communities to help them better prepare for wildfire.

Kane County- Communities at Risk and Risk Score (2005)	
Duck Creek Area	11
East Zion Estates	11
Elk Ridge	11
North Fork Drainage	11
Stout Canyon	11
Zion View	11
Best Friends	10
Bryce Woodlands	10
Glendale	10
Little Ponderosa	10
Sky Haven	10
Spencer Bench	10
Spencer Cliff Estates	10
Sylvin Canyon	10
Deer Springs	9

Mineral Wash	9
Johnson Canyon	8
Orderville	8
Kanab	7
Source: Southwest Utah Regional Wildfire Protection Plan (October 2007)	

In addition to the above analysis, the vulnerability assessment was conducted using GIS software to join: 1) County Property Tax data as it relates to 2) structures located within a respective hazard area. This analysis was based upon the most recent (2009) County Property Tax data provided by each County Assessor's office. The values shown are based upon utilizing the market value for structures in each defined hazard area. Where applicable, if a critical facility was located within a defined hazard area, this valuation was included within the commercial structure category. The GIS software then quantified the number of units and total market value for all structures located within each defined hazard area.

Kane County - Wildfire			
Type of Structure	Market Value of Structures		Number of Structures
	Wildfire Risk Area-High	Wildfire Risk Area-Medium	
Residential	$40,767,408		265
Commercial	$11,218,991		24
Residential		$241,108,433	1,450
Commercial		$33,180,453	38
Total	**$51,986,399**	**$274,288,886**	**1,777**
Overall Total		**$326,275,285**	**1,777**

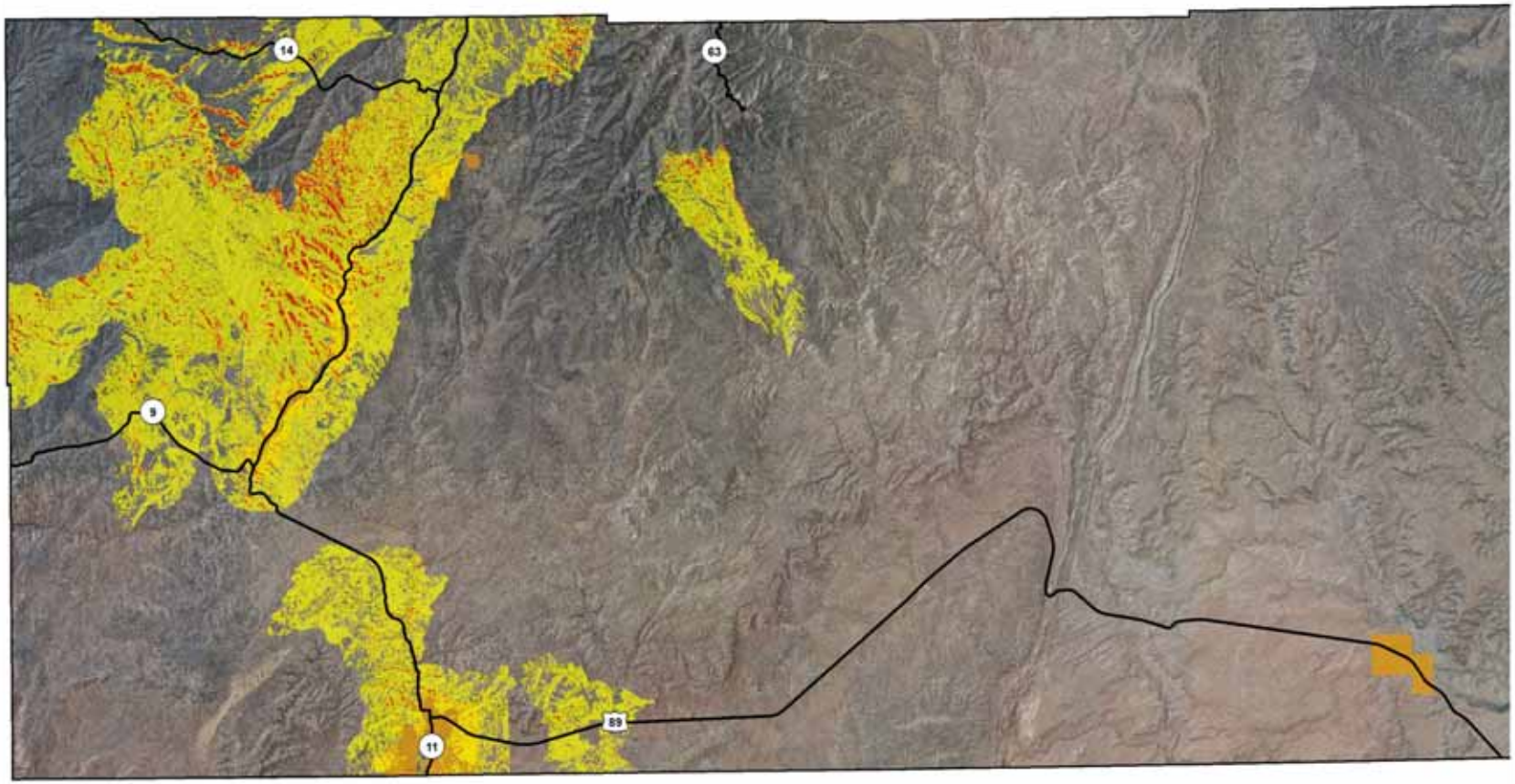
In addition to structures located within a defined hazard area, there is also an overwhelming amount (in terms of quantity and value) of infrastructure that is not captured by the GIS analysis. This is in large part due to the fact that compilation of this data would be exhaustive; nevertheless, the following provides a summarization of infrastructure at risk from wildfire.

Infrastructure at Risk from Wildfire			
Location	Miles of Major Roadways	Miles of Railroad Track	Miles of Utility Powerlines
Beaver County	60	5	87
Garfield County	104	0	154
Iron County	110	117	180
Kane County	59	0	50
Washington County	80	0	155
Paiute Indian Lands	10	0	0
Region Totals	**423**	**122**	**626**

Five County Natural Hazard Mitigation Plan

Kane County

Wildfire Risk Map



Five County Association of Goverments April 2010 Southern Utah University
FCAOG and SUU GIS use information and data from many different sources, which may be of differing accuracy and which have been integrated to provide a planning context. These products should be used only for the purpose they were intended. For specific data source information, please contact FCAOG.

0 1 2 4 6 8
Miles

Legend

Highways	Wildfire
US	Medium
State	High
Municipalities	

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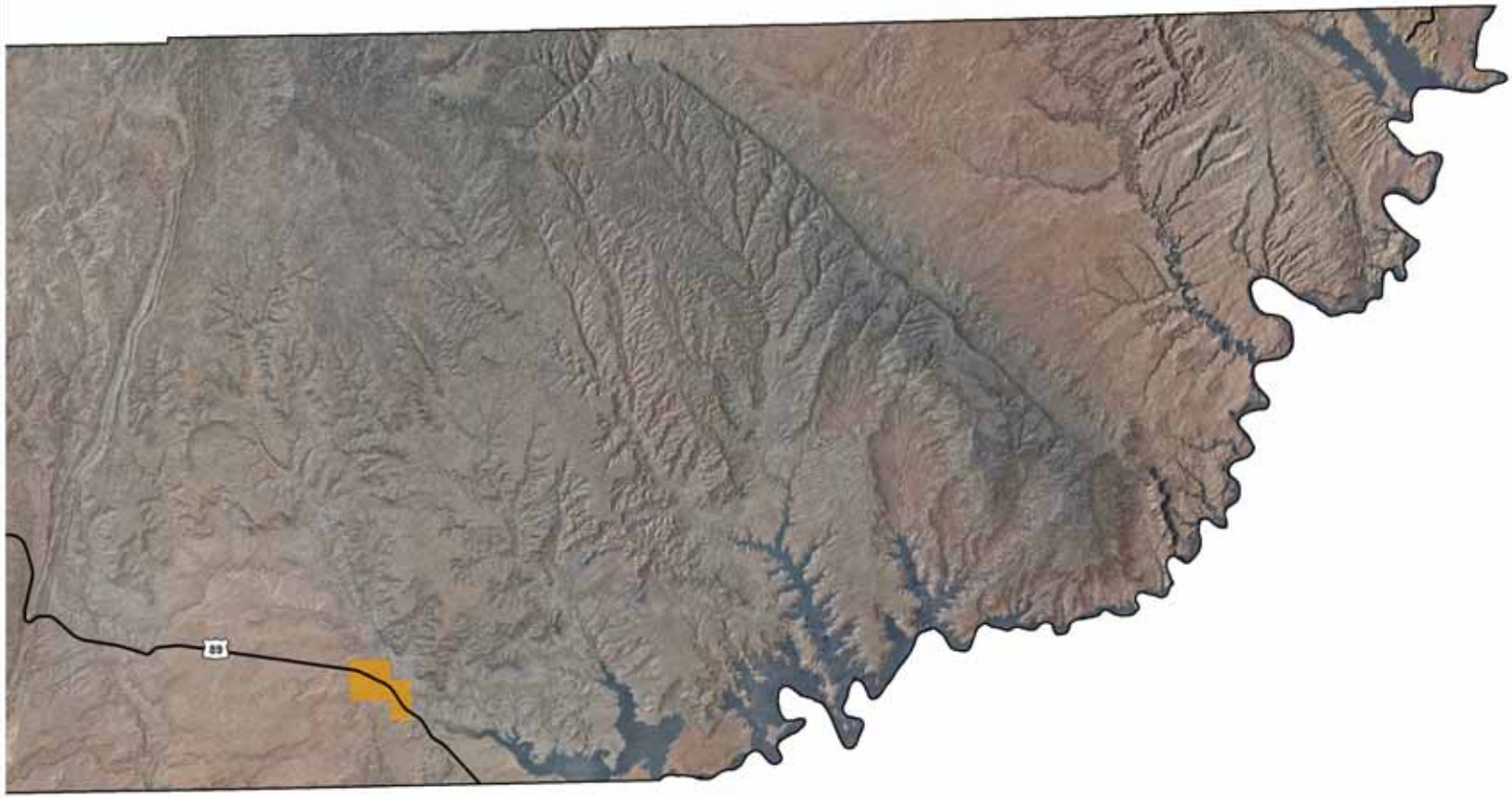
Five County Natural Hazard Mitigation Plan

Kane County

Wildfire Risk Map



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0 1 2 4 6 8
Miles

Legend

Highways	Wildfire
US	Medium
State	High
Municipalities	

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LANDSLIDE

According to the USGS, landslides are a widespread geologic hazard that can occur in all 50 states. On average, landslides cause $1-2 billion annually in damages and claim 25 lives per year. Urban development in and along hillside areas increase the number of people threatened by landslide events each year (USGS, 2007). Many factors contribute to overall landslide vulnerability; including local weather, soil moisture, duration and intensity of precipitation, wildfire history, and development pressure. Typically, landslides result from other natural disasters such as earthquakes, volcanoes, wildfires and floods (USGS, 2007). The table below illustrates landslide susceptibility by hazard category.

Landslide susceptibility by hazard category				
County	High Hazard (square miles)	Moderate Hazard (square miles)	Low Hazard (square miles)	**Total (square miles)**
Garfield	3.7	193.8	223.5	**421.0**
Beaver	46.6	579	236.1	**861.7**
Iron	20.5	738.2	333	**1,091.7**
Washington	28.1	1,079.9	423.2	**1,531.2**
Kane	42	1,638.5	672.9	**2,353.4**
Source: State of Utah, Natural Hazard Mitigation Plan, November 2007.				

In addition to the above analysis, the vulnerability assessment was conducted using GIS software to join: 1) County Property Tax data as it relates to 2) buildings located with a respective hazard area. This analysis was based upon the most recent County Property Tax data provided by each County Assessor's office. The values shown are based upon utilizing the *market value* for structures in each defined hazard area. The GIS software then quantified the number of units and total market value for all structures located within each defined hazard area.

Kane County - Landslide			
Type of Structure	Market Value of Structures		Number of Structures
	Landslide Risk Area- High	Landslide Risk Area- Medium	
Residential	$5,797,452		35
Commercial			
Residential		$190,871,389	1,463
Commercial		$16,632,898	38
Total	**$5,797,452**	**$207,504,287**	**1,536**
Overall Total		**$213,301,739**	**881**

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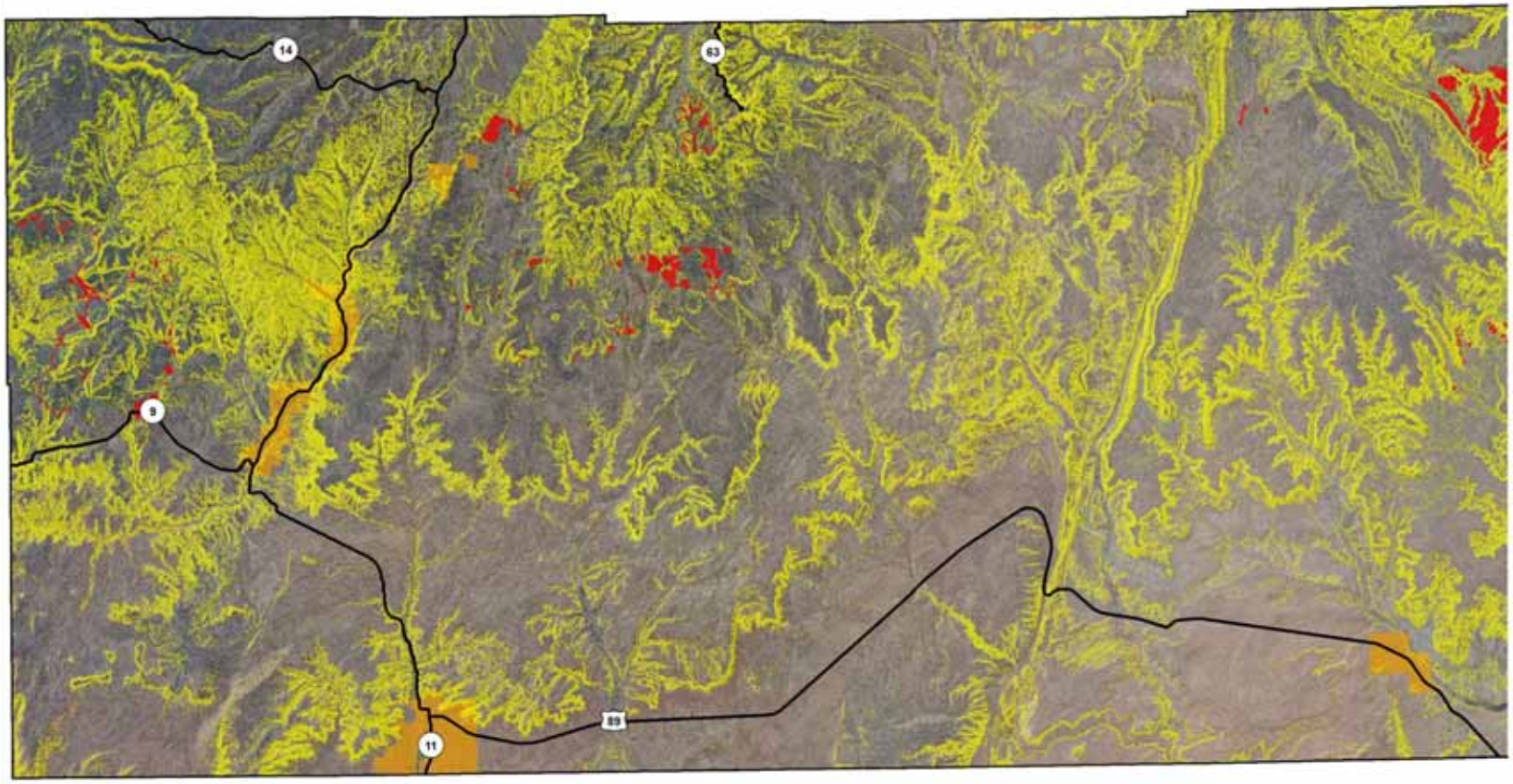
Five County Natural Hazard Mitigation Plan

Kane County

Landslide Risk Map



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Miles

Legend

Highways	Landslide
US	Medium
State	High
Municipalities	

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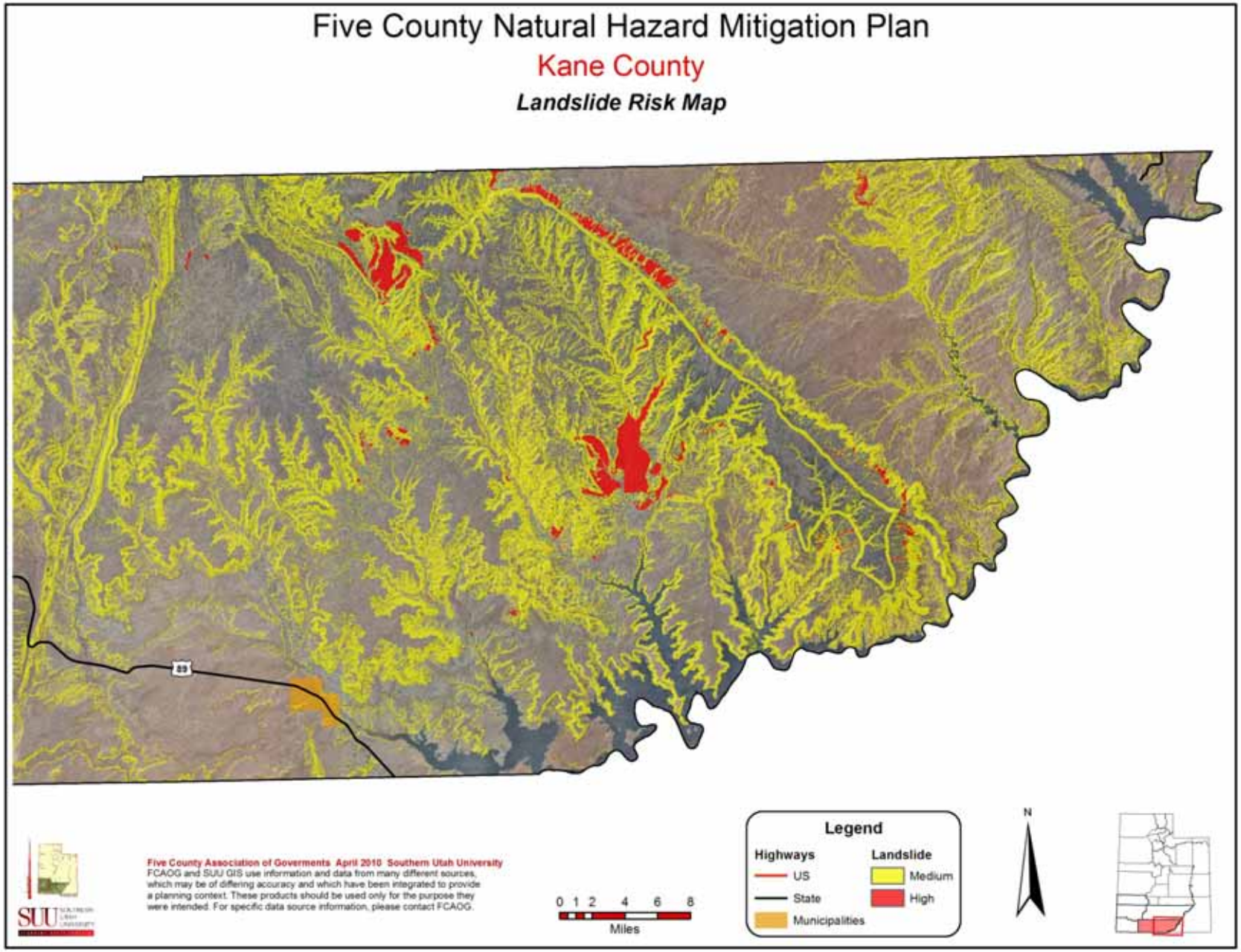
Five County Natural Hazard Mitigation Plan
Kane County
Landslide Risk Map
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Highways
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Municipalities
Landslide
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FLOOD

The Army Corps of Engineers conducted a *Flood Hazard Identification Study* for the Five County region in August, 2003. The intent of this study is to aid in detailing natural hazards associated with fluvial process for entities within the region. The study evaluates and identifies areas with a high flood hazard and identifies potential mitigation solutions. Municipalities within the region were studied if they met the following criteria: 1) Jurisdiction has not been mapped by FEMA; and 2) Jurisdiction mapped by FEMA as a Zone D, area of undetermined flood hazard. The following information is provided from the Study.

Dams are a critical support function for water managers in the State, and also can act as a flood control measure. If a dam remains stable, does not get overtopped, or is not impaired as the result of an earthquake, then at a minimum, they do provide incidental flood control. If not then they can add to the flood threat. There are 145 dams within the Five County region, of those 33 have received a high hazard rating by Utah Division of Water Right Dam Safety Section. The State Dam Safety Section has developed a hazard rating system for all non-federal dams in Utah. Downstream uses, size height, volume, and incremental risk/damage assessments are a variable used to assign dam safety classification. High hazard dams would cause a possible loss of life in the event of a rupture. According to information provided by the Utah Division of Water Right Dam Safety Section, there are no high hazard dams in Kane County.

Kane County is one of the smallest counties in the state in terms of population. About 16% of its residents live in the unincorporated county. There is little development in the unincorporated county with the exception of the Kanab area. The County does participate in the National Flood Insurance Program (NFIP). No major rivers threaten existing urban development; therefore, no structural flood control projects are warranted at this time. Potential future flood sources include the Virgin and Colorado Rivers and their tributaries, and other potential flood sources such as existing reservoirs.

In addition to the above analysis, the vulnerability assessment was conducted using GIS software to join: 1) County Property Tax data as it relates to 2) buildings located with a respective hazard area. This analysis was based upon the most recent County Property Tax data provided by each County Assessor's office. The values shown are based upon utilizing the ***market value*** for structures in each defined hazard area. The GIS software then quantified the number of units and total market value for all structures located within each defined hazard area.

Kane County - Flood		
Type of Structure	Market Value of Structures	Number of Structures
Residential	$58,507,118	384
Commercial	$10,428,001	38
Total	**$68,935,119**	**422**

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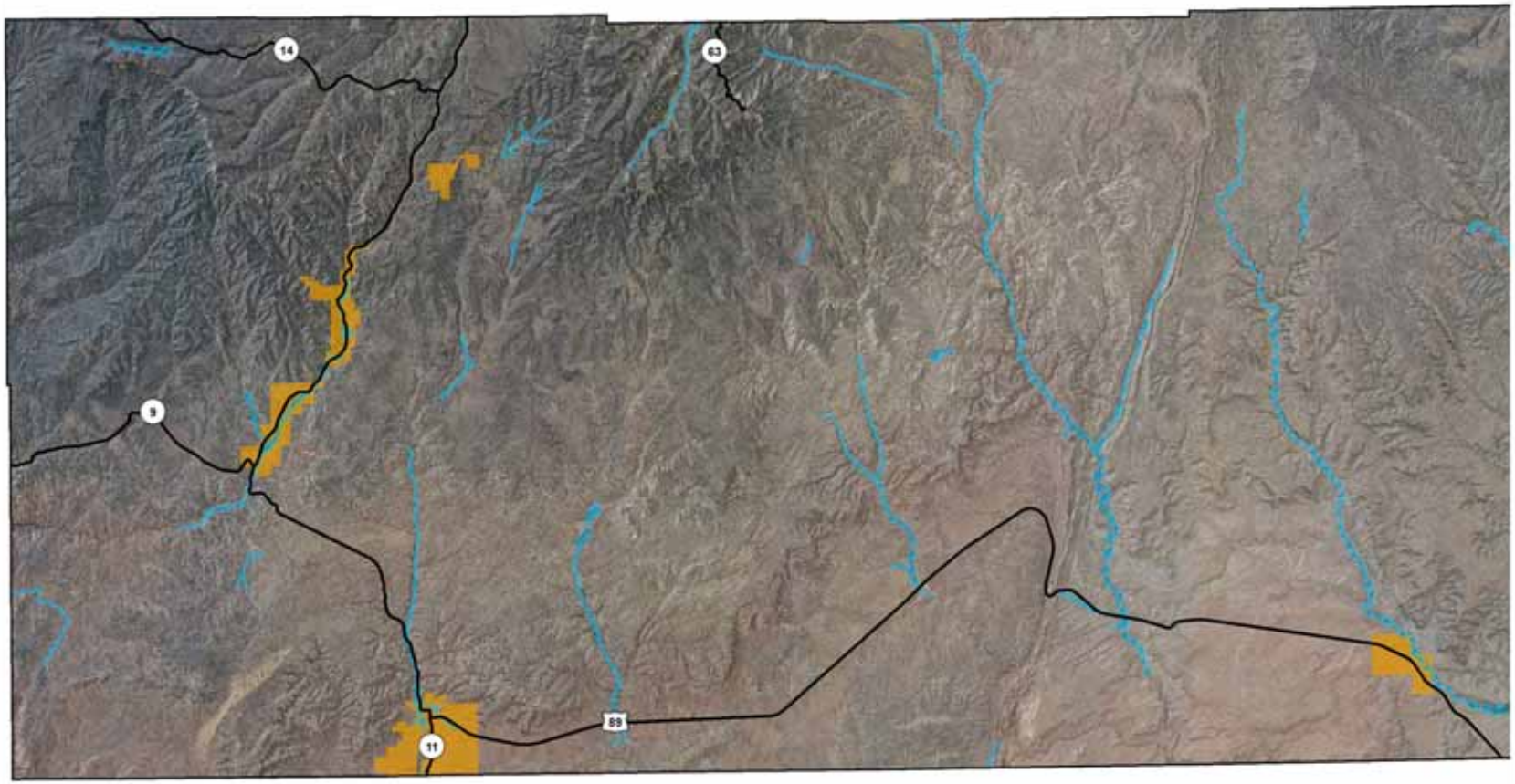
Five County Natural Hazard Mitigation Plan

Kane County

Flood Risk Map



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Miles

Legend

Highways
- US
- State
- Municipalities

FEMA 100yr Floodplain

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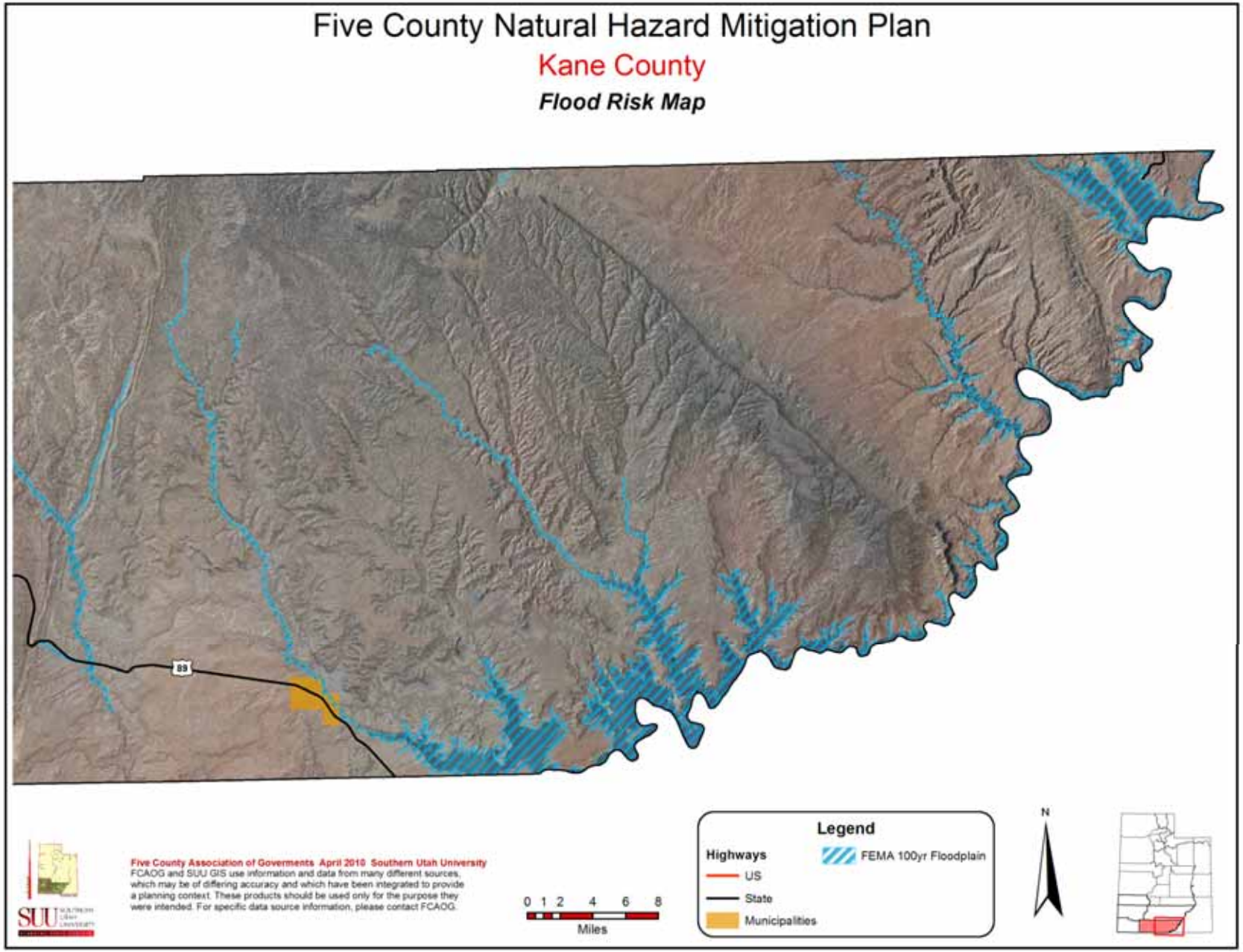
Five County Natural Hazard Mitigation Plan
Kane County
Flood Risk Map
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Miles
Legend
Highways
US
State
Municipalities
FEMA 100yr Floodplain
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EARTHQUAKE

When assessing the vulnerability of structures as a result of an earthquake, an understanding of the building code, to which the structure was designed, is of extreme importance. Utah building codes began to address seismic design as early as 1976; although, the state did not adopt building codes fully addressing seismic safety until 1989. It is fairly safe to assume that structures constructed prior to 1976 will not perform in an earthquake as well as structures built following 1976. This is to say that an increased understanding of seismic events coupled with advances in building design has greatly increased our ability to design and construct buildings which perform better in earthquakes.

Earthquakes are regional hazards affecting multi-county areas, and because almost the entire state could experience a seismic event, all communities contain some degree of risk. The degree of risk is determined by several factors; however, the paramount factor is naturally the likelihood and magnitude of the earthquake. This being said, building design is a key factor when discussing potential structural damage. Vulnerability of structures was determined through age of construction with those structures built before 1976 considered possessing a higher risk.

Age of Housing Stock			
County	Structures built before 1976	Total Structures	**% of Structures built before 1976**
Beaver	1,559	2,660	**59%**
Garfield	1,497	2,767	**54%**
Iron	5,336	13,618	**39%**
Kane	1,398	3,767	**37%**
Washington	6,777	36,478	**19%**
Source: U.S. Census, November 2000.			

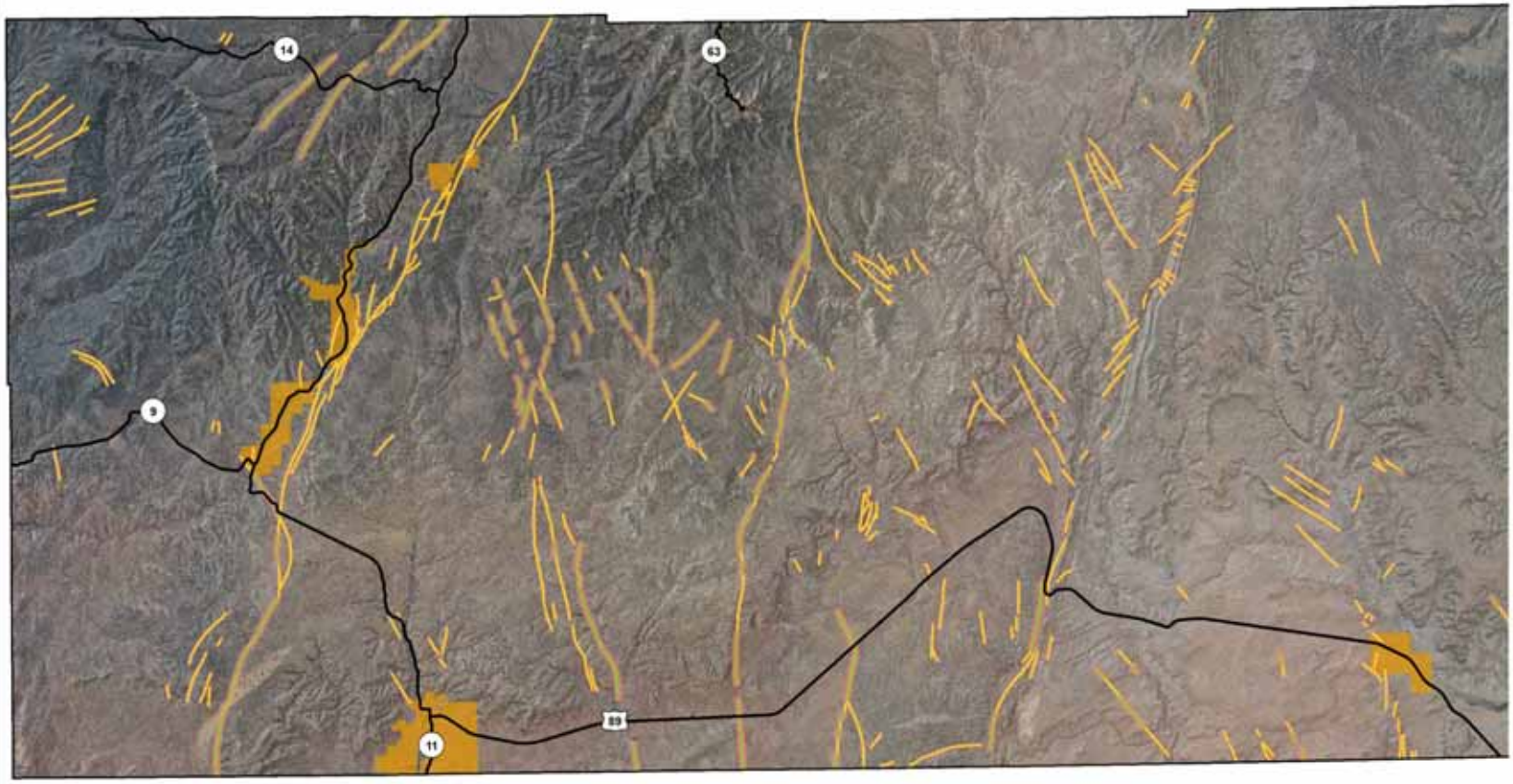
In addition to the above analysis, the vulnerability assessment was conducted using GIS software to join: 1) County Property Tax data as it relates to 2) buildings located with a respective hazard area. This analysis was based upon the most recent County Property Tax data provided by each County Assessor's office. The values shown are based upon utilizing the ***market value*** for structures in each defined hazard area. The GIS software then quantified the number of units and total market value for all structures located within each defined hazard area. The quantitative earthquake data provided below includes all structures which are: 1) on a fault line, or 2) within a 500' to 1,000' fault line buffer area. The range provided for the fault line buffer area is a determination made by Utah Geological Survey as it relates to the fault being studied or unstudied.

Kane County - Earthquake		
Type of Structure	Market Value of Structures	Number of Structures
Residential	$61,673,777	482
Commercial	$5,446,870	14
Total	**$67,120,647**	**496**

Five County Natural Hazard Mitigation Plan

Kane County

Earthquake Risk Map



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Miles

Legend

Highways	Fault Locations
US	Certain (Studied)
State	Concealed (Unstudied)
Municipalities	Surface Rupture Areas

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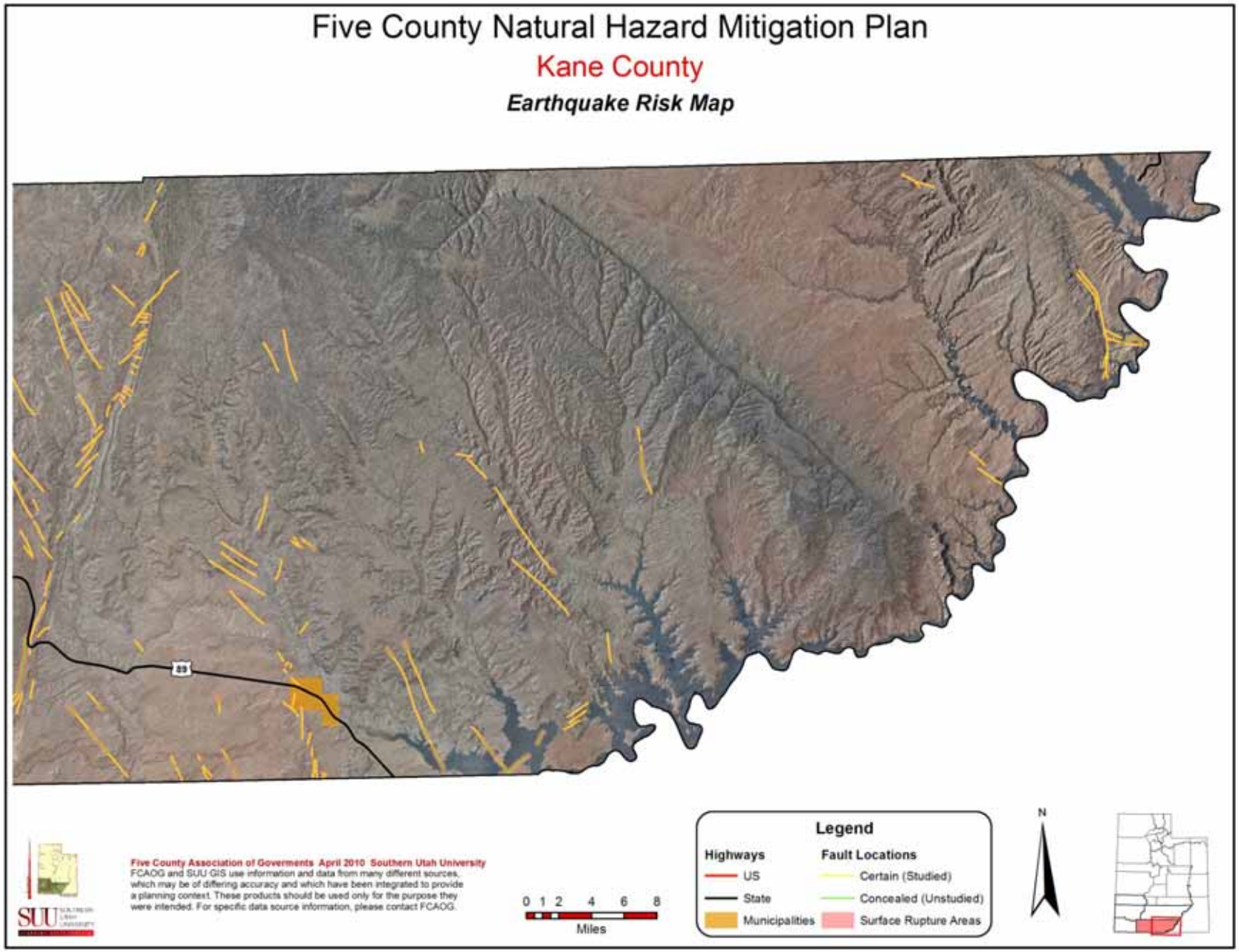
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Kane County
Earthquake Risk Map
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SUU
0 1 2 4 6 8
Miles
Legend
Highways
US
State
Municipalities
Fault Locations
Certain (Studied)
Concealed (Unstudied)
Surface Rupture Areas
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PROBLEM SOILS

Geologic materials with characteristics that make them susceptible to volumetric changes, collapse, subsidence, or other engineering-geologic problems are referred to as problem soils. Geologic and climatic conditions in southwestern Utah provide a variety of both localized and widespread occurrences of these materials. Soil and rock related geologic problems occur in a variety of geologic settings and are some of the most widespread and costly geologic hazards. Six types of problem soil and rock are present in southwestern Utah. Six types of problem soil and rock are found in southwestern Utah: (1) expansive soil and rock with high shrink/swell potential, (2) collapsible soil, (3) limestone (Karsts Terrain) susceptible to dissolution under some hydro geologic conditions, (4) gypsiferous soil/rock susceptible to dissolution, (5) soil subject to piping (localized subsurface erosion), and (6) active dunes. Some materials, such as expansive soil and limestone, cover large areas, whereas others, like active dunes, are of limited extent. The most extensive problem soils found in the region are expansive soil and rock.

Expansive Soils and rock are the most common type of problem soils in southwestern Utah. Expansive deposits contain clay minerals that expand and contract with changes in moisture content. Clays absorb water when wetted, causing the soil or rock to expand. Conversely, as the material dries, the loss of water between clay crystals or grains causes the deposit to shrink.

Expansive deposits are extensive around St. George, Washington, and Santa Clara in Washington County. In these areas expansive clays in the Chinle Formation have been most damaging to structures. In Santa Clara, many homes and a church were damaged by expansive clays in the Chinle Formation. Common problems are cracked foundations, heaving and cracking of floor slabs and walls, and failure of wastewater disposal systems. Sidewalks and roads are particularly susceptible to damage. The majority of expansive soil problems are found in Washington and Iron Counties.

Collapsible Soil- The phenomenon of hydrocompaction, which causes subsidence in collapse prone soil, occurs in loose, dry, low density deposits that decrease in volume or collapse when saturated for the first time following deposition. Collapse occurs when susceptible soils are wetted to a depth below that normally reached by rainfall, destroying the clay bonds between grains. Collapsible soil is present in geologically young materials such as Holocene age alluvial fan and debris flow sediments. When saturated, the soil collapses and the ground surface subsides, damaging property and structures. Human activities that involve some form of water application such as irrigation, water impoundment, lawn watering, and alterations to natural drainage or wastewater disposal commonly initiate hydrocompaction.

Collapsible soil is present particularly near Cedar City (Iron County) and the Hurricane Cliffs (Washington County). In Cedar City approximately $3 million in damage to public and private structures has been attributed to collapsible soil. Other areas in southwestern Utah with a potential collapsible soil problem are along mountain fronts where young alluvial fan deposits containing fine-grained sediments are present. Climate also plays a role in the distribution of collapsible soils. Drier areas, such as the Basin and Range and Colorado Plateau provinces, provide the best conditions for development of collapsible soil. Soil and rock containing gypsum

are also susceptible to subsidence. Ground water and introduced waters from irrigation dissolve gypsum causing subsidence.

Limestone (Karsts Terrain) is characterized by sinkholes, caverns, and streams that abruptly disappear underground. Karsts features are caused by ground and surface water dissolution of calcareous rocks, such as limestone. Cavernous subterranean openings in karst terrain often collapse, leaving sinkholes at the surface.

Limestone susceptible to dissolution and subsidence occurs throughout mountains west of Sevier Lake, west of Richfield, and south of St. George. No known damage to structures has occurred from ground collapse or subsidence related to limestone karsts; however, the potential for damage exists where susceptible units are present. In addition, because karsts ground-water systems have little filtering capacity, contamination of ground water is a major concern.

Gypsiferous soil/rock are subject to settlement caused by the dissolution of gypsum, which creates a loss of internal structure and volume within the deposit. Gypsum in soil can also form in other ways - including as a secondary mineral deposit leached from surficial layers and concentrated lower in the soil profile or wind-blown dust, and in the St. George area (Washington County) by the evaporation of ground water.

Gypsiferous soil and rock deposits are common in southwestern Utah, particularly along the base of the Hurricane Cliffs. Much of the gypsum is derived from erosion of gypsum rich rock units. Gypsum in these deposits can cause damage to foundations, and induce land subsidence and sinkholes similar to those seen in limestone terrain. Water introduced into the subsurface for irrigation and landscaping or into wastewater disposal systems, can cause underground solution cavities to develop, which may ultimately cause surface collapse. Gypsum is also a weak material with low bearing strength, which can cause problems when loaded with the weight of a structure. In addition, gypsum dissolved in water forms sulfuric acid and sulphate, which react with certain types of cement and weaken foundations.

Soils Subject to Piping- Piping is subsurface erosion by ground water that moves along permeable, non-cohesive layers in unconsolidated materials and exits at a free face, usually along a stream bank or cliff that intersects the layer. Removal of fine-grained particles by this process creates voids within the material that act as minute channels which direct the movement of water. As channels enlarge, water moving through the conduit increases velocity and removes more material, forming a "pipe." The pipe becomes a preferred avenue for ground-water drainage and enlarges as more water is intercepted. Increasing the size of the pipe removes support from the walls and roof, causing eventual collapse.

Deposits susceptible to piping are common in southwestern Utah. Piping can cause damage to roads, bridges, culverts, and any structure built over soils subject to piping. In areas where piping is common, roads are frequently damaged where they parallel stream drainages and cross-cut pipes. Road construction can contribute to the piping problem by disturbing natural runoff and concentrating water along paved surfaces, allowing greater infiltration and potential for pipes to develop.

Sand Dunes are common surficial deposits in arid areas where sand derived from weathering of rock or unconsolidated deposits is blown by the wind into mounds or ridges. In areas where development encroaches on dunes, inactive or vegetated dunes may be reactivated, allowing them to migrate over roads and bury structures. Another problem is the contamination of local ground water from wastewater disposal in dunes. The uniform size of the sand grains comprising dunes makes them highly permeable. Dunes are present in many areas of southwestern Utah, especially in the Escalante Desert (Iron County) and west of Kanab (Kane County). Avoidance of dunes is the best way to prevent damage to structures. (Excerpted from Lund, UGS unpublished information).

Conclusions- In addition to the above analysis, the vulnerability assessment was conducted using GIS software to join: 1) County Property Tax data as it relates to 2) buildings located with a respective hazard area. This analysis was based upon the most recent County Property Tax data provided by each County Assessor's office. The values shown are based upon utilizing the ***market value*** for structures in each defined hazard area. The GIS software then quantified the number of units and total market value for all structures located within each defined hazard area.

Kane County – Problem Soils		
Type of Structure	Market Value of Structures	Number of Structures
Residential	$14,209,947	136
Commercial	$851,752	6
Total	**$15,061,699**	**142**

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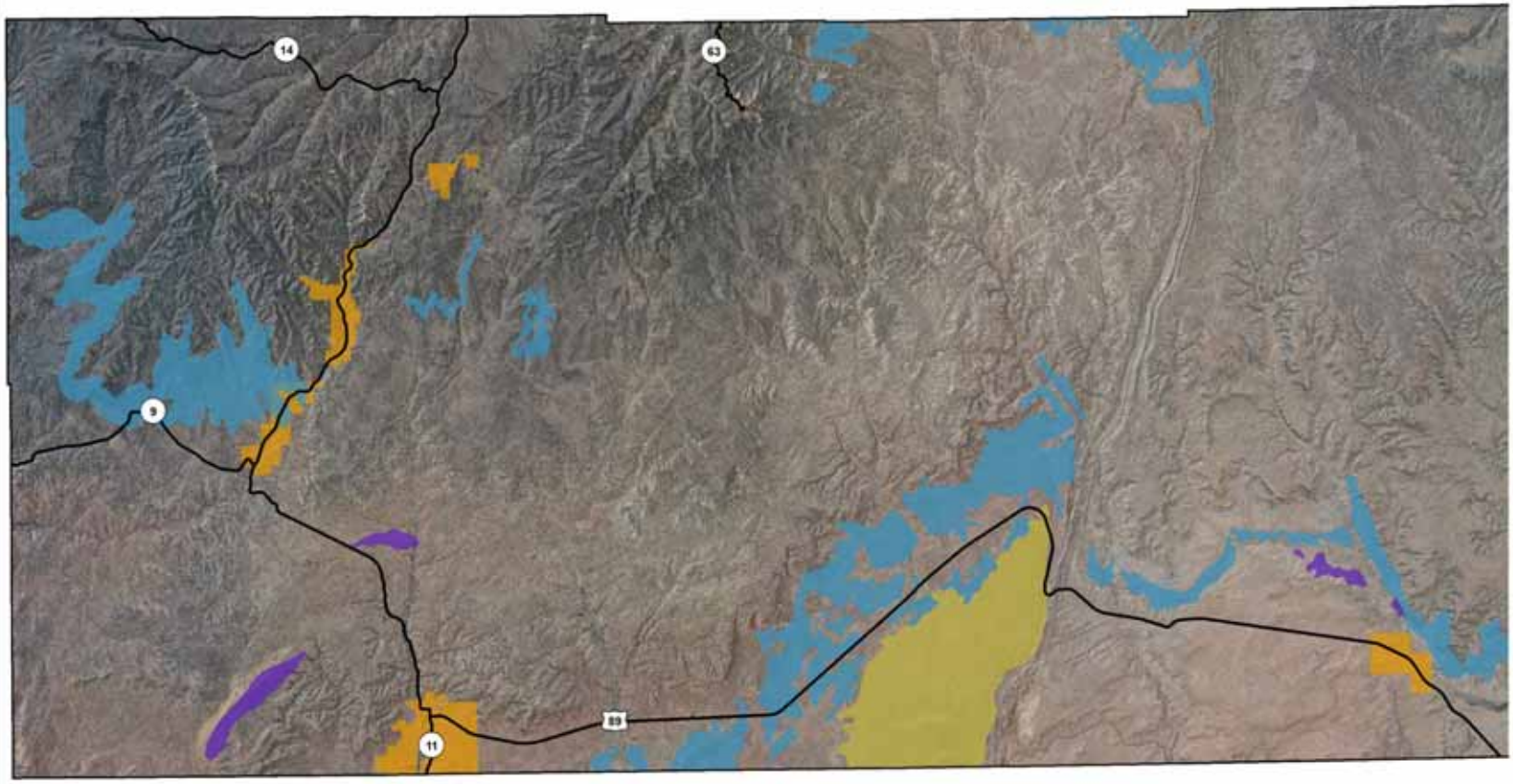
Five County Natural Hazard Mitigation Plan

Kane County

Problem Soils Risk Map



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Miles

Legend

Highways
- US
- State
- Municipalities

- Dunes
- Expansive Soil or Rock
- Limestone

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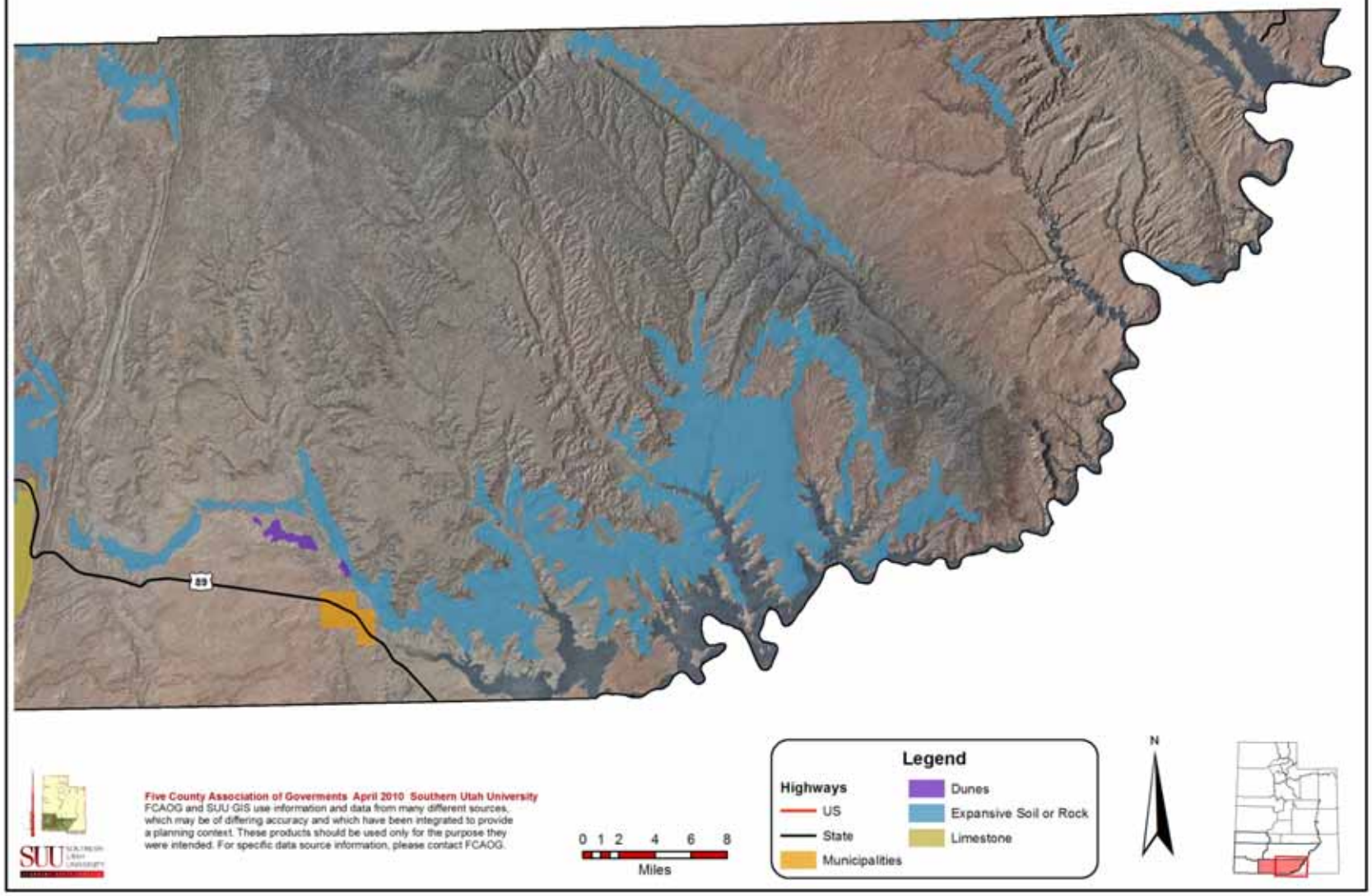
Five County Natural Hazard Mitigation Plan

Kane County

Problem Soils Risk Map



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SEVERE WEATHER

There are many qualitative factors that point to potential vulnerability. Severe weather can cause power outages, transportation and economic disruptions, significant property damage, and pose a high risk for injuries and loss of life. The event can also be typified by a need to shelter and care for individuals impacted by the event. On numerous occasions, severe weather have brought economic hardship and affected the life of the residents of southwestern Utah. Higher elevations in The Five County region have greater exposure to snow and ice, but may be less economically vulnerable because they are sparsely populated. Quantitative assessment of severe weather vulnerability and determining which counties are more vulnerable is very challenging. However, using the principle of the past being the key to the future is effective. For example, one would assume that an area that has exhibited a high number of occurrences would continue to exhibit the same.

A quantitative vulnerability assessment is difficult based upon the simple fact that severe weather occurrences are random and difficult to predict. Several factors limit a determination of potential losses, they include:

- Limited GIS data availability;
- Lack of research on site-specific location;
- The entire state of Utah shares similar, if not identical risks; and
- Most hazards are tied to weather and cannot be predicted with location.

The vulnerability assessment was conducted using GIS software to join: 1) County Property Tax data as it relates to 2) buildings located with an area that has exhibited severe weather occurrences. This analysis was based upon the most recent County Property Tax data provided by each County Assessor's office. The values shown are based upon utilizing the ***market value*** for structures in each defined severe weather hazard area. The GIS software then quantified the number of units and total market value for all structures located within each defined severe weather hazard area.

Kane County – Severe Weather		
Type of Structure	Market Value of Structures	Number of Structures
Residential	$6,084,548	166
Commercial		
Total	**$6,084,548**	**166**

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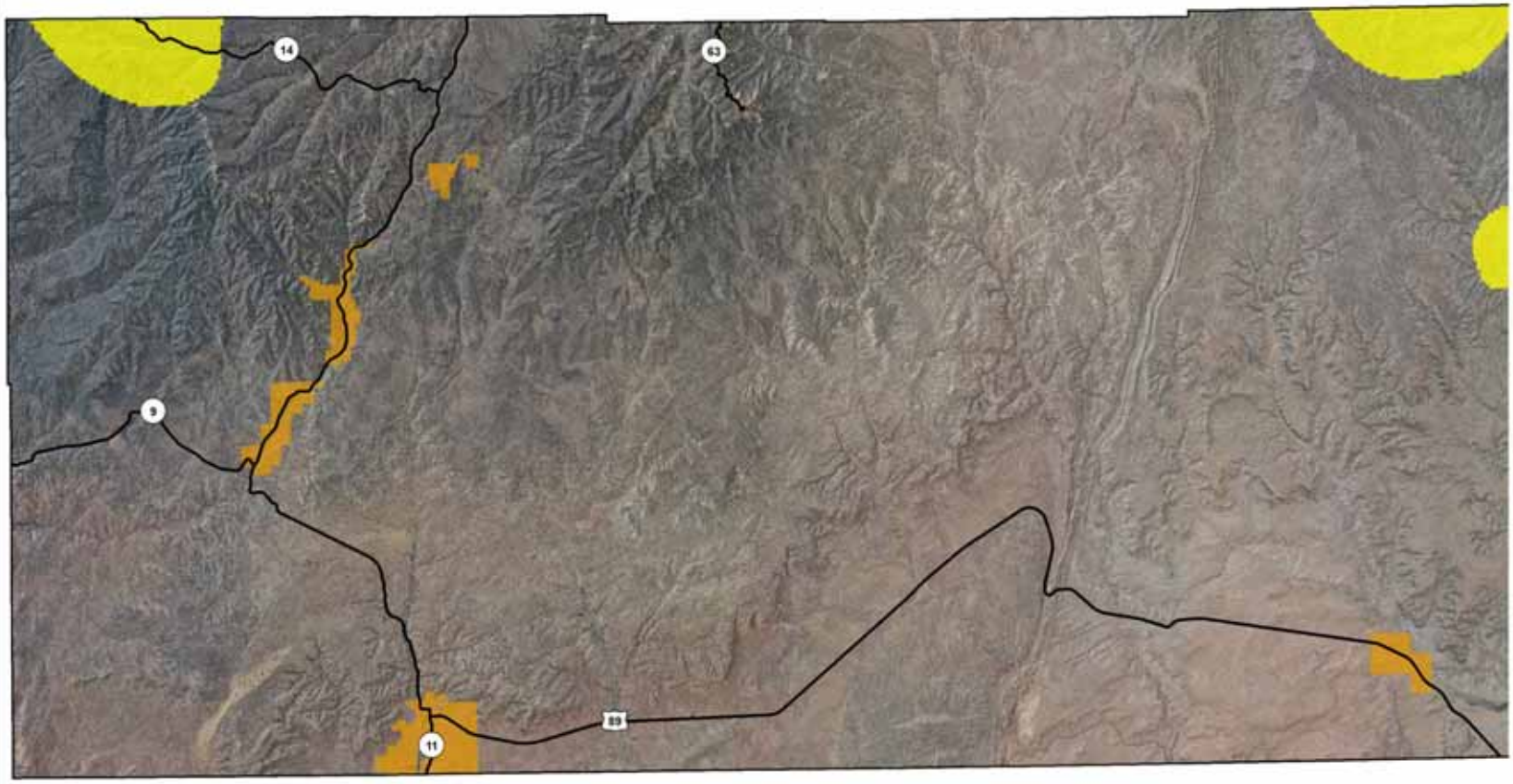
Five County Natural Hazard Mitigation Plan

Kane County

Severe Weather Risk Map



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0 1 2 4 6 8
Miles

Legend

Highways
- US
- State
- Municipalities

Lightning Death
Tornado Touchdown

Lightning Intensity
- Medium
- High

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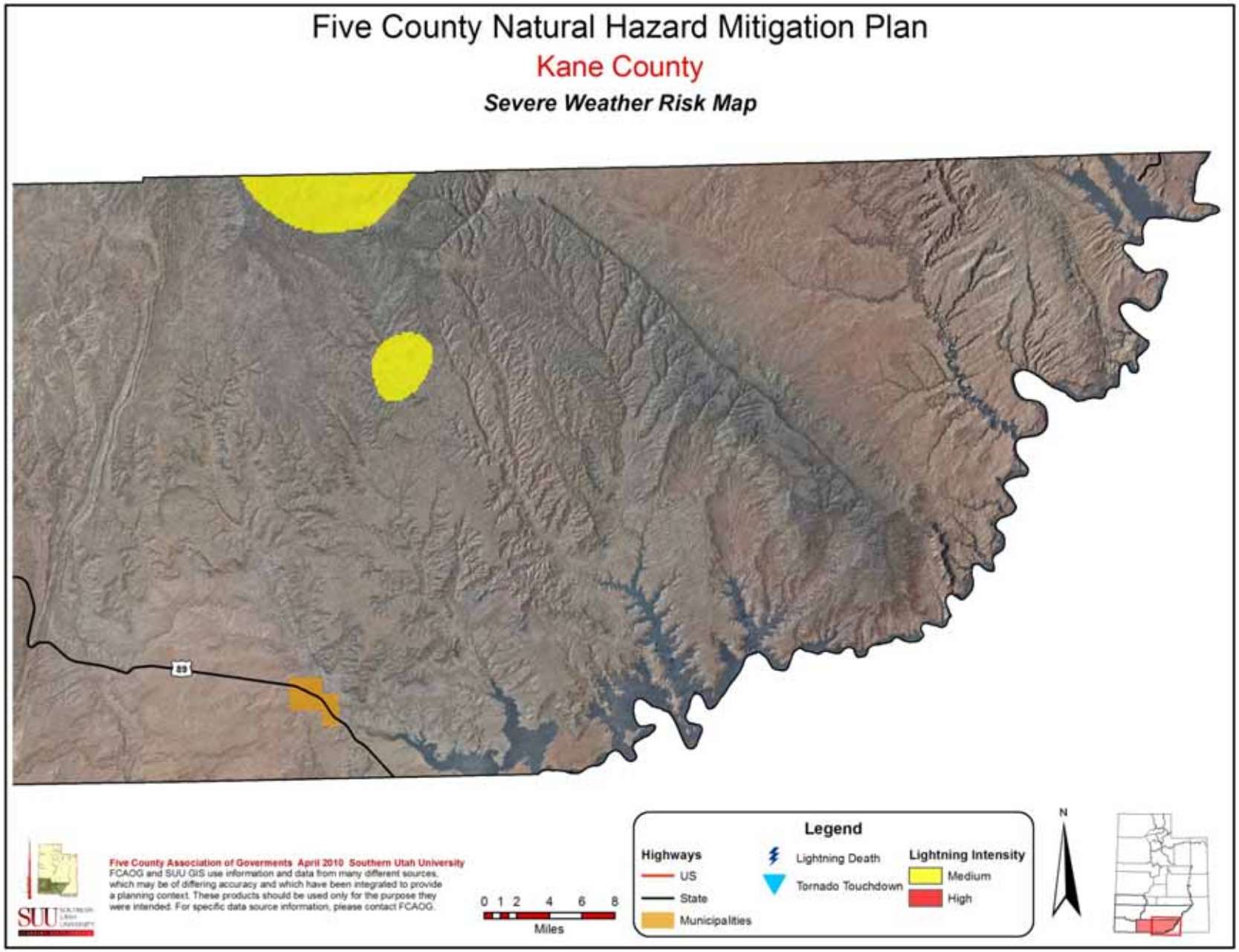
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Kane County
Severe Weather Risk Map
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Miles
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Highways
US
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Municipalities
Lightning Death
Tornado Touchdown
Lightning Intensity
Medium
High
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MITIGATION STRATEGY

The following table provides a brief synopsis of the Kane County mitigation strategies. Additional information for each specific hazard, including specific mitigation strategies and associated information, are found following this table.

Kane County- Mitigation Strategies									
Mitigation Strategy	**Action**	**Timeline**	**Estimated Cost**	**Plan Goals Addressed**					
				Education/ Outreach	**Emergency Services**	**Environmental Protection**	**Partnership/ Coordination**	**Prevention**	**Property Protection**
Wildfire-Mitigation Strategy #1	Promote public awareness campaign for property owners living in wildland urban interface areas.	Ongoing	Unknown	●			●	●	●
Wildfire-Mitigation Strategy #2	Continue interagency fuels projects, education, and mitigation throughout the focus area.	Ongoing	Unknown	●			●	●	●
Wildfire-Mitigation Strategy #3	1-Increase ingress/egress into private property/subdivisions.	Unknown	Unknown		●		●	●	●
	2-Coordinate the roadwork being done by private land owners with the work being done by the National Park Service and the Bureau of Land Mgmt.	Unknown	Unknown		●		●	●	●
Landslide-Mitigation Strategy #1	Increase public education related to landslide hazards by distributing UGS landslide informational brochures to local municipality level emergency mgmt., engineering, and planning departments.	Ongoing	Very minimal	●	●		●	●	

Landslide-Mitigation Strategy #2	Drafting/updating zoning and/or landslide ordinances to prevent development of structures near debris flows, landslides, and rock fall areas.	Ongoing	Minimal					●	●
Landslide-Mitigation Strategy #3	1-Address landslide risk at the building/construction level by requiring all subdivision proposals to have a geotechnical report.	Ongoing	Minimal					●	●
	2-If jurisdiction does not have trained staff to review the geotechnical report, the jurisdiction can, upon request, have UGS perform a review of the report.	Ongoing	Minimal				●	●	●
Flood-Mitigation Strategy #1	Nonstructural measures appear to be the most prudent option for the county to implement. Zoning to prevent development of structures near all rivers, creeks, and lakes (100' min. setback).	Ongoing	Minimal		●		●		●
Flood-Mitigation Strategy #2	Address flood control at the building/construction level by requiring all subdivision proposals to have a storm water drainage system.	Ongoing	Minimal			●		●	●
Flood-Mitigation Strategy #3	Clear debris and other material from all waterways	Ongoing	Minimal			●		●	●
Flood-Mitigation Strategy #4	Create outreach document promoting flood insurance and include in local newspaper(s), libraries, and other public buildings.	1 year	Minimal	●			●	●	●

Flood-Mitigation Strategy #5	A structural alternative would be to construct a levee along the creek through the north and east part of town, a distance of about 8,000ft. (Kanab)	Unknown	$465,430					●	●
Flood-Mitigation Strategy #6	Install adequate storm drainage for excess flows. (Kanab)	Unknown	$1,147,242					●	●
Earthquake-Mitigation Strategy #1	Increase public education related to earthquake hazards by distributing Utah Seismic Safety Commission informational brochures to County and City emergency management agencies.	Ongoing	Very minimal	●			●		
Earthquake-Mitigation Strategy #2	Continued dedication/vigilance in enforcing the seismic standards established in the International Building Code.	Ongoing	Minimal					●	●
Earthquake-Mitigation Strategy #3	1-Utilize the Earthquake Risk Map provided in this plan as a tool to assess earthquake risks as it relates to any building/subdivision proposals. If deemed necessary, jurisdiction should require the builder/developer to conduct a site-specific earthquake hazard identification/mapping study.	Ongoing	$1,000-$5,000					●	●
	2- At the County level, contract with UGS to formally study/map earthquake hazard areas.	3-5 years	$7,109-$14,218 per jurisdiction				●	●	●

Problem Soils-Mitigation Strategy #1	1-Address problem soils at the building/construction level by requiring all subdivision proposals to have a geotechnical report.	Ongoing	$1,000-$5,000					●	●
	2- If jurisdiction does not have trained staff to review the geotechnical report, the jurisdiction can, upon request, have UGS perform a review of the report.	Ongoing	Minimal				●	●	●
Problem Soils-Mitigation Strategy #2	Utilize the Problem Soils Risk Map provided in this plan as a tool to assess problem soils risks as it relates to any building/subdivision proposals. If deemed necessary, jurisdiction should require the builder/developer to conduct a site-specific geotechnical (soils) report.	Ongoing	$1,000-$5,000					●	●
Problem Soils-Mitigation Strategy #3	Through mapping, identify areas which contain collapsible and expansive soils. Require soils testing at the building/construction level and ensure that engineer's recommendations are followed.	Ongoing	$1,000-$5,000					●	●
Severe Weather-Mitigation Strategy #1	Continued dedication/vigilance in enforcing the standards established in the International Building Code as it relates to wind-loading, electrical grounding, snow-loading, and other weather-related hazards.	Ongoing	Minimal					●	●
Severe Weather-Mitigation	1-Enhance the Emergency Alert System (tv & radio)	Ongoing	Unknown	●	●		●		

Strategy #2	2-Enhance NOAA Weather Radio All Hazard coverage.	Ongoing	Unknown	●	●		●		
Severe Weather-Mitigation Strategy #3	At the county Local Emergency Planning Committee (LEPC) level, meet the program guidelines then apply to the National Weather Service StormReady Program.	3-5 years	Minimal		●		●	●	●
Drought-Mitigation Strategy #1	1-County-level distribution of water conservation information via newsletter and/or website to affiliated constituents.	Ongoing	Minimal	●		●	●	●	
	2- Water purveyors distribute water conservation information to affiliated constituents.	Ongoing	Minimal	●		●	●	●	
Drought-Mitigation Strategy #2	Develop/demonstrate water conservation practices for agricultural use.	Ongoing	Minimal	●		●	●	●	●
Drought-Mitigation Strategy #3	County-level implementation of mitigation strategies identified in *"Drought in Utah-Learning from the Past-Preparing for the Future."*	3-5 years	Unknown			●	●	●	●
Radon Gas-Mitigation Strategy #1	Increase public education related to radon gas hazards by distributing Utah Dept. of Environmental Quality informational brochures to County and City planning and engineering departments.	Ongoing	Very minimal	●		●	●	●	●

Radon Gas-Mitigation Strategy #2	Utilize the Radon Risk Map provided in this plan as a tool to assess radon gas risks as it relates to any building/ subdivision proposals. If deemed necessary, jurisdiction should require the builder/ developer to conduct a site-specific radon hazard identification study and implement applicable control techniques.	Ongoing	$25- $1,200	●		●		●	●

Requirement §201.6(c)(3): The plan shall include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.

The following mitigation strategies, listed in accordance to their respective natural hazard, are presented in an effort to provide macro-level risk reduction. Although each mitigation measure is important and achievable, they have been prioritized and listed in order of:

3) Respective amount of potential loss of life/property value as a result of a natural hazard occurrence (as quantified through GIS analysis) ; and
4) Implementation priority through utilization of the STAPLEE process (as explained in Chapter 3 of this Plan and in FEMA 386-3).

WILDFIRE

The Color Country Interagency Fire Center Fuels Committee has identified the general location of ten "Focus Areas" within the southwest Utah region. The selection of these specific areas was based on the need for fuels reductions as understood by fuels specialists and fire wardens, risk levels in the Regional Wildfire Protection Plan risk assessment, values at risk in the area, firefighting concerns including access and evacuation routes, the presence of Communities At Risk (CARs), and local interest in the community documented by having a Community Wildfire Protection Plan in place.

The Color Country Interagency Fire Center Fuels Committee has not prioritized these ten focus areas. The Committee determined that to do so would have the effect of minimizing the fact that every one of these areas is in need of treatment and all are of concern. Each focus area also includes a list of general goals resulting from activities and treatments for the area.

Goals common to all treatment areas include fuels reduction, public education, and increases in equipment and training available to firefighting personnel. Goals that are generally applicable to all of the focus areas include the following:

- Protection of human life, firefighter and public safety as the highest priority.
- Public education and partnerships with citizens or community-centered approaches to manage fire risks and hazards in WUI areas located in the focus area, including effort aimed towards the implementation and maintenance of defensible space projects to reduce risk to homes and personal property.
- Protection of high value resources and watersheds through fuels reduction treatments as determined locally.
- Restoration and maintenance of ecosystems consistent with land uses and historic fire regimes. Restoration of vegetation to the appropriate Condition Classes and Fire Regimes.
- Maintenance and/or improvement of fire prevention and road/structure identification signage. Dissemination of fire restriction information through appropriate signage and/or visitor contacts when necessary.
- Improvement of wildland firefighting equipment, training and information for volunteer fire departments located in the focus area, including the improvement of GIS and road data.

The ten Focus Areas, as they pertain to Kane County, developed by the Color Country Interagency Fire Center Fuels Committee include the 1) Duck Creek, 2) East Zion, and the 3)Bryce Woodlands/Sunset Cliffs Focus Areas. This being said, the Communities at Risk within Kane County (from high to medium risk) include: Duck Creek Area, East Zion Estates, Elk Ridge, North Fork Drainage, Stout Canyon, Zion View, Best Friends, Bryce Woodlands, Glendale, Little Ponderosa, Sky Haven, Spencer Bench, Spencer Cliff Estates, Sylvin Canyon, Deer Springs, Mineral Wash, Johnson Canyon, Orderville, and Kanab.

As part of this NHMP Update process, Five County Association of Governments developed a *Natural Hazards Questionnaire* in an effort to solicit information from a sampling of citizens. Of the responses obtained through this questionnaire, 100% of the respondents indicated they would be willing to spend more money on a home/business that had features that made it more disaster resistant. Further, 75% of the respondents indicated they were concerned about the wildfire risks within the county.

Wildfire Mitigation Strategy #1	
Objective:	Promote public awareness campaign for property owners living in wildland urban interface areas.
Action:	Mailings; Printed Information; Public Service Announcements;
Timeline:	Ongoing
Estimated Cost:	Unknown
Possible Funding:	State and Federal wildfire grant programs
Responsible Agencies:	State and Federal government

The primary concern within the Duck Creek Focus Area is the potential for long-range spotting due to downed and standing dead fuels. Such fuels result in long duration fires, extensive fire

crew needs, and long-term evacuation needs within communities. The Communities at Risk within this focus area are: Duck Creek Area, Ponderosa Estates, Ponderosa Village, Swains Creek, Zion View, and Strawberry Valley.

Wildfire Mitigation Strategy #2	
Objective:	Fuels reduction and defensible space tactics.
Action:	Continue interagency fuels projects, education, and mitigation throughout the focus area.
Timeline:	Ongoing
Estimated Cost:	Unknown
Possible Funding:	Local government operating budget; Special Service District operating budget
Responsible Agencies:	Community & local government entities; private property owner

The primary concern within the East Zion Focus Area is the distance to incorporated subdivisions is remote, with access off Highway 9 along dirt roads. There are narrow one-way roads into most residences; additionally, access to this area when wet makes travel almost impossible. The Communities at Risk within this focus area are: East Zion Estates, and Little Ponderosa.

The primary concern within the Bryce Woodlands/Sunset Cliffs Focus Area is that single residences have limited access with one-way, dead-end ingress/egress and there is greater firefighter response time due to the proximity of established fire districts. The Communities at Risk within this focus area are: Bryce Woodlands, and Long Valley/Canyon.

Wildfire Mitigation Strategy #3	
Objective:	Ameliorate access concerns.
Action:	1-Increase ingress/egress into private property/subdivisions. 2-Coordinate the roadwork being done by private land owners with the work being done by the National Park Service and the Bureau of Land Management.
Timeline:	Unknown (dependent upon available funding)
Estimated Cost:	Unknown
Possible Funding:	Local government operating budget; Special Service District operating budget; private property owner; Federal Government
Responsible Agencies:	Community & Local, and Federal government entities; private property owner

LANDSLIDE

Factors included in assessing landslide risk include built property distribution in the hazard area, the frequency of landslide or debris flow occurrences, slope steepness, and soil characteristics.

This type of analysis generates estimates of the damages to the county due to a landslide or debris flow event on the current built environment. The mitigation strategies listed below identify cost effective measures that will yield measurable benefits toward reducing the risk of landslide hazards.

Landslide Mitigation Strategy #1	
Objective:	Increase the level of knowledge related to landslides.
Action:	Increase public education related to landslide hazards by distributing Utah Geological Survey (UGS) landslide informational brochures to local municipality level emergency management, engineering and planning departments.
Timeline:	Ongoing
Estimated Cost:	Very Minimal: request UGS to deliver brochures; and/or download brochures directly from: http://geology.utah.gov
Possible Funding:	Local, jurisdictional level.
Responsible Agencies:	Local, jurisdictional level.

Landslide Mitigation Strategy #2	
Objective:	Minimize future landslide damage in the unincorporated County.
Action:	Drafting/updating zoning and/or landslide ordinances to prevent development of structures near debris flows, landslides, and rock fall areas.
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	Local government operating budget; State and Federal planning grant programs.
Responsible Agencies:	Local government

As part of this NHMP Update process, Five County Association of Governments developed a *Natural Hazards Questionnaire* in an effort to solicit information from a sampling of citizens. Of the responses obtained through this questionnaire, 100% of the respondents indicated they would be willing to spend more money on a home/business that had features that made it more disaster resistant.

Landslide Mitigation Strategy #3	
Objective:	To reduce landslide risk as it relates to the built environment.
Action:	1-Address landslide risk at the building/construction level by requiring all subdivision proposals to have a geotechnical report. 2-If jurisdiction does not have trained staff to review the geotechnical report, the jurisdiction can, upon request, have Utah Geological Survey (UGS) perform a review of the report.
Timeline:	Ongoing

Estimated Cost:	Minimal
Possible Funding:	Private funds/ developer; Local government operating budget; Utah Geologic Survey operating budget.
Responsible Agencies:	Local, jurisdictional level; Utah Geological Survey

FLOOD

The Army Corps of Engineers *Flood Hazard Identification Study* (August, 2003), identifies areas with a high flood hazard and identifies potential mitigation solutions. The following prioritized mitigation strategies are provided from this Study as well as from the Five County *Natural Hazard Mitigation Plan (2004).*

As part of this NHMP Update process, Five County Association of Governments developed a *Natural Hazards Questionnaire* in an effort to solicit information from a sampling of citizens. Of the responses obtained through this questionnaire, 100% of the respondents indicated they would be willing to spend more money on a home/business that had features that made it more disaster resistant.

Flood Mitigation Strategy #1	
Objective:	Minimize future flood damage in the unincorporated County.
Action:	Nonstructural measures appear to be the most prudent option for the county to implement. Zoning to prevent development of structures near all rivers, creeks, and lakes (100' min. setback).
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	Local government operating budget; State and Federal flood and planning grant programs
Responsible Agencies:	Local government

Flood Mitigation Strategy #2	
Objective:	To reduce flooding risk as it relates to the built environment.
Action:	Address flood control at the building/construction level by requiring all subdivision proposals to have a storm water drainage system.
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	Private funds/ developer.
Responsible Agencies:	Local, jurisdictional level.

Flood Mitigation Strategy #3	
Objective:	To reduce flooding risk at the community level.
Action:	Clear debris and other material from all waterways.
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	Related public/private property owners.

Responsible Agencies:	Private property owners, irrigation companies, local jurisdictions.

Flood insurance is not promoted actively in the County. Further, the community of Big Water is not an active participant in the National Flood Insurance Program (NFIP). The responses provided in the *Natural Hazards Questionnaire* indicate that 75% of the county households and/or businesses do not have insurance coverage for flood events.

Flood Mitigation Strategy #4	
Objective:	Promote participation in the National Flood Insurance Program (NFIP) throughout the county.
Action:	Create outreach document promoting flood insurance and include in local newspaper(s), libraries, and other public buildings.
Timeline:	1 year
Estimated Cost:	Minimal
Possible Funding:	Local government operating budget; State and Federal flood grant programs
Responsible Agencies:	County Floodplain Administrator, State Floodplain Manager, Department of Homeland Security.

Kanab City, with approximately 60% of the total county population, appears to have a significant flood threat through much of the city. On the north side is an unnamed creek that comes to a confluence on the northeast side of town with Toms Canyon and other adjacent drainages also pose significant flood threats. Kanab Creek itself appears to cause little flood threat due to its incised channel. Southwest of Kanab, just west of Kanab Creek lies a large development (Ranchos) that is moderately flood prone due to the numerous drainages that run through it. The following mitigation strategies are based upon mitigation strategies proposed in the Five County *Natural Hazard Mitigation Plan (2004),* the Army Corps of Engineers *Flood Hazard Identification Study* (August, 2003), and through consultation with the Kane County Public Works director.

Flood Mitigation Strategy #5	
Objective:	Minimize future flood damage in Kanab and the surrounding developed areas.
Action:	A structural alternative would be to construct a levee along the creek through the north and east part of town, a distance of about 8,000ft.
Timeline:	Unknown (contingent on funding)
Estimated Cost:	$465,430 (2003 cost, inflation adjusted)
Possible Funding:	Local government operating budget; State and Federal flood programs
Responsible Agencies:	Local government

Flood Mitigation Strategy #6	
Objective:	Minimize future flood damage in Kanab and the surrounding developed areas.
Action:	Install adequate storm drainage for excess flows.
Timeline:	Unknown (contingent on funding)
Estimated Cost:	$1,147,242 (2004 cost, inflation adjusted)
Possible Funding:	Local government operating budget; State and Federal flood programs
Responsible Agencies:	Local government

EARTHQUAKE

Earthquake mitigation strategies include general mitigation actions that agencies are capable of implementing during the next five years, given their existing resources and authorities. In addition to the earthquake mitigation strategies provided herewith, this Natural Hazard Mitigation Plan endorses any seismic mitigation proffered by the Utah Seismic Safety Commission. In particular, numerous and varied earthquake mitigation strategies are provided in *A Strategic Plan for Earthquake Safety in Utah (January, 1995)* completed by the Utah Seismic Safety Commission. It is highly recommended that jurisdictions whom desire to provide more specific earthquake mitigation strategies consult the aforementioned plan, which can be accessed at: http://ussc.utah.gov/.

Earthquake Mitigation Strategy #1	
Objective:	Promote building safety through non-structural improvements.
Action:	Increase public education related to earthquake hazards by distributing Utah Seismic Safety Commission informational brochures to County and City emergency management agencies.
Timeline:	Ongoing
Estimated Cost:	Very Minimal: request Utah Seismic Safety Commission to deliver brochures; and/or download brochures directly from: http://ussc.utah.gov/
Possible Funding:	County and City operating budget; Utah Seismic Safety Commission operating budget.
Responsible Agencies:	Local, jurisdictional level.

As part of this NHMP Update process, Five County Association of Governments developed a *Natural Hazards Questionnaire* in an effort to solicit information from a sampling of citizens. Of the responses obtained through this questionnaire, 100% of the respondents indicated they would be willing to spend more money on a home/business that had features that made it more disaster resistant. Further, 75% of the respondents indicated that their household/business does not have insurance coverage for earthquake events.

Earthquake Mitigation Strategy #2	
Objective:	To reduce earthquake risk as it relates to the built environment.

Action:	Continued dedication/vigilance in enforcing the seismic standards established in the International Building Code (IBC).
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	County or City government operating budget (where applicable).
Responsible Agencies:	County or City government (where applicable).

Earthquake Mitigation Strategy #3	
Objective:	To reduce earthquake losses by mapping and identifying earthquake hazard areas.
Action:	1-Utilize the Earthquake Risk Map provided in this plan as a tool to assess earthquake risks as it relates to any building/subdivision proposals. If deemed necessary, jurisdiction should require the builder/developer to conduct a site-specific earthquake hazard identification/mapping study. 2-At the County level, contract with Utah Geological Survey (UGS) to formally study/map earthquake hazard areas.
Timeline:	Action 1-Ongoing Action 2- 3 to 5 years
Estimated Cost:	Action 1-$1,000 to $5,000 Action 2- $7,109 to $14,218 per jurisdiction (1995 cost as reflected in *A Strategic Plan for Earthquake Safety in Utah* adjusted for inflation)
Possible Funding:	Action 1-Private funds/ developer. Action 2- Local government operating budget; Utah Geologic Survey operating budget.
Responsible Agencies:	Local, jurisdictional level; Private property owner; Utah Geological Survey

PROBLEM SOILS

Problem soils pose a significant hazard to the current/future built environment. This being said, many of these problems can be dramatically reduced through proper assessment of the risk and adherence to applicable mitigation measures. Factors included in assessing problem soils risk include built property distribution in the hazard area. This type of analysis generates estimates of the damages in the county due to problem soils occurrences in the current built environment. The mitigation strategies listed below identify cost effective measures that will yield measurable benefits toward reducing the risk of problem soils as they relate to the built environment. Further, these mitigation strategies include general actions that agencies are capable of implementing during the next five years, given their existing resources and authorities.

As part of this NHMP Update process, Five County Association of Governments developed a *Natural Hazards Questionnaire* in an effort to solicit information from a sampling of citizens. Of

the responses obtained through this questionnaire, 100% of the respondents indicated they would be willing to spend more money on a home/business that had features that made it more disaster resistant.

Problem Soils Mitigation Strategy #1	
Objective:	Lessen the risk to buildings from problem soils.
Action:	1-Address problem soils at the building/construction level by requiring all subdivision proposals to have a geotechnical report. 2-If jurisdiction does not have trained staff to review the geotechnical report, the jurisdiction can, upon request, have Utah Geological Survey (UGS) perform a review of the report.
Timeline:	Ongoing
Estimated Cost:	$1,000 to $5,000
Possible Funding:	Private funds/ developer; Local government operating budget; Utah Geologic Survey operating budget.
Responsible Agencies:	Local, jurisdictional level; Utah Geological Survey

Problem Soils Mitigation Strategy #2	
Objective:	To reduce problem soils related losses by mapping and identifying problem soils hazard areas.
Action:	Utilize the Problem Soils Risk Map provided in this plan as a tool to assess problem soils risks as it relates to any building/subdivision proposals. If deemed necessary, jurisdiction should require the builder/developer to conduct a site-specific geotechnical (soils) report.
Timeline:	Ongoing
Estimated Cost:	$1,000 to $5,000
Possible Funding:	Private funds/ developer; Local government operating budget
Responsible Agencies:	Local, jurisdictional level; Private property owner.

Problem Soils Mitigation Strategy #3	
Objective:	Lessen the risk to buildings from collapsible and expansive soils.
Action:	Through mapping, identify areas which contain collapsible and expansive soils. Require soils testing at the building/construction level and ensure that engineer's recommendations are followed.
Timeline:	Ongoing
Estimated Cost:	$1,000 to $5,000
Possible Funding:	Private funds/ developer; Local government operating budget.
Responsible Agencies:	Local, jurisdictional level.

SEVERE WEATHER

Quantitative assessment of severe weather vulnerability and determining which specific areas of the county are more vulnerable is very challenging. This being said, the vulnerability assessment quantified the number of units and total market value for all structures located within a defined severe weather hazard area; said area includes: known lightning deaths, lightning intensity (based upon actual lighting strike data), and tornado touchdowns. The following severe weather hazard mitigation strategies are specific to the aforementioned severe weather hazards.

As part of this NHMP Update process, Five County Association of Governments developed a *Natural Hazards Questionnaire* in an effort to solicit information from a sampling of citizens. Of the responses obtained through this questionnaire, 100% of the respondents indicated they would be willing to spend more money on a home/business that had features that made it more disaster resistant. Further, 50% indicated their preference for receiving severe weather information would be through the internet and/or television sources.

Severe Weather Mitigation Strategy #1	
Objective:	To reduce severe weather risk as it relates to the built environment.
Action:	Continued dedication/vigilance in enforcing the standards established in the International Building Code (IBC) as it relates to wind-loading, electrical grounding, snow-loading, and other weather-related hazards.
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	County or City government operating budget (where applicable).
Responsible Agencies:	County or City government (where applicable).

Severe Weather Mitigation Strategy #2	
Objective:	Ensure that the general public is warned of severe weather occurrences via broadcast media.
Action:	1-Enhance the Emergency Alert System (television and radio). 2-Enhance NOAA Weather Radio All Hazard coverage.
Timeline:	Ongoing
Estimated Cost:	Unknown
Possible Funding:	Federal and State government operating budget.
Responsible Agencies:	Federal and State government.

Nearly 90% of all presidentially declared disasters are weather related. In an effort to guard against the negative effects of severe weather, the National Weather Service has designed the StormReady program. This program is a nationwide community preparedness program that uses an approach which helps communities develop plans to handle all types of severe weather. To be classified as a StormReady community several criteria must be met; however, the county Local Emergency Planning Committee (LEPC) is positioned well to satisfy the StormReady

application/program guidelines. Ultimately the benefit of becoming formally recognized as a StormReady community lies in the additional planning/preparation/preparedness for severe weather occurrences; however, some grant opportunities are available through the National Weather Service as well as possible adjustment to insurance rates through the Insurance Services Organization (ISO).

Severe Weather Mitigation Strategy #3	
Objective:	Guard against the negative effects of severe weather by becoming a StormReady community.
Action:	At the county Local Emergency Planning Committee (LEPC) level, meet the program guidelines then apply to the National Weather Service StormReady program.
Timeline:	3 to 5 years
Estimated Cost:	Minimal
Possible Funding:	County and City operating budget.
Responsible Agencies:	County and City government.

Chapter 10 **WASHINGTON COUNTY**

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A PICTURE OF WASHINGTON COUNTY

DEMOGRAPHICS

Washington County is bordered on the north by Iron County, on the east by Kane County, on the south by Mohave County Arizona, and on the west by Lincoln County Nevada. According to the U.S. Census Bureau, the county has a total area of 2,430 square miles. Within Washington County there are several federal and state highways, the most prominent being Interstate 15 (I-15) and State Routes 9, 17, 18, and 59. St. George, the Washington County seat, is the southernmost city in Utah along the I-15 corridor. I-15 runs diagonal in nature through the county, generally in a southwest-northeast direction and provides direct access to the prominent metropolitan regions of Las Vegas to the south and Salt Lake City to the north.

Washington County is known as "Utah's Dixie" because of its temperate climate. The county, particularly the St. George Metropolitan Statistical Area, is the business and cultural center for southwestern Utah. Washington County is a major gateway to nearby Zion National Park which is located in the eastern part of the county. The trademark of Washington County is its geology. Within the St. George Metropolitan Statistical Area, red bluffs make up the northern part of the area. The northeastern edges of the Mojave Desert are visible to the south. Zion National Park can be seen to the east, and the Pine Valley Mountains loom over the area to the north and northwest. The climate has more in common with the Desert Southwest than the rest of the state, with scorching hot summers and mild, mostly snowless winters.

Washington County is the most urban county in southwestern Utah, and most closely resembles the economies of northern Utah. While it started as an agricultural region, tourism and winter residences began to change the character of the region beginning in the 1960s. Visitation to National Parks further spurred growth as Zion National Park became an international destination and a part of the National Parks "Grand Circle." As Washington County grew into an urban area, trade, transportation, and utilities became the largest sectors of the county economy. The services sector has had the most significant increases since 1980 and the growth in student population at Dixie State College is viewed as a significant contributor to the tourism related workforce. Because the county's economy is already diverse, the balance of industry sectors is expected to remain relatively stable, but services are expected to continue growing and county leaders believe that the manufacturing sector will increase as well.

DEVELOPMENT TRENDS

Washington County has been the fastest growing county in the state for the past decade, and is projected to continue to be so. County population increased 503% between 1980 and 2009, and 75% over the past decade. In comparison, State of Utah growth during the 2000s totaled 27%. The Governor's Office of Planning and Budget predicts continued growth in Utah's Dixie over the next 20 years. The projected population increase from 2010 to 2020 is 66.5% and 48.5% from 2020 to 2030. Overall this translates to 147% growth projected over the next 20 years. This growth projection is dramatically higher than the State of Utah growth projection of 54% over

the same period. If the population projections for the county are in fact realized, the area will transform into a densely populated urban area which will sprawl into outlying communities.

The Washington County General Plan (Amended May 1999) classifies open space areas, which include: public lands, drainage channels and washes, unstable soils, reservoirs, steep slopes, etc. In terms of open space land preservation, the County General Plan provides as a goal, "Identify open space areas…and provide protection from development in the areas identifies. Areas that may be hazardous in nature and are of an open space character should be maintained as open space in order to protect the health, safety, and welfare of the present and future residents..." Growth as it relates to natural hazard conflicts is further managed through implementation of policy statements which: disallow development within identified FEMA 100-year floodplains; implementing greater setbacks from major washes, streams, and drainage channels; encourage public lands to incorporate a buffer zone between private and public lands; and, incorporation of wildfire protection measures.

WASHINGTON COUNTY LANDSCAPE

Washington County is at the intersection of three distinct landscapes; namely, the Great Basin, the Colorado Plateau, and the Mohave Desert. While the geography of these three differ, they have one thing in common, aridity. The County, known as "Utah's Dixie" was originally settled as an agricultural region for its favorable warm climate. Three major rivers, the Virgin, Santa Clara, and Ash Creek fed from precipitation and snowmelt at higher elevations, are the lifeblood of this region.

Elevations in Washington County range from 2,178 to 10,194 feet in elevation. The lowest point in the state of Utah is located in the Beaver Dam Wash in Washington County, where it (seasonally) flows out of Utah and into Arizona. Average annual precipitation in the county totals a sparse 8". The average Washington County temperature in January is 40 degrees and the average July temperature is 86 degrees. The majority of the County population base, located in the St. George Metropolitan Statistical Area, experiences summers characterized by hot, dry weather with average maximum temperatures of 100 degrees at lower elevations and relatively mild winters.

There are many identifiable communities in Washington County. Most of these are incorporated and urban in their character. In addition, there are a number of other communities that are unincorporated and are still quite rural in character. Residential development in the county is strong and primarily within incorporated communities. A majority of the industrial and commercial activities in the county are found in the St. George Metropolitan Statistical Area. The

neighboring communities are experiencing some of this commercial development, especially Washington City and Hurricane City.

While many people are relocating to the area for the wealth of public lands and recreation offerings, the limited quantity of private land is a constraint to growth. In addition to the National Parks, recreation on BLM and US Forest Service lands are a major draw for new residents and visitors alike. There is a substantial amount of private land that are near, adjacent to, or within the forest lands and managing the urban-forest interface is becoming a critical issue. The current water supply will prove to be a limit to growth unless new water sources, such as Lake Powell or converting agriculture water to municipal and industrial use, are developed. The County Water Conservation District supports the opportunity for improved management and development to increase water quantity, which will undoubtedly permit continued growth.

HAZARD IDENTIFICATION

Requirement §201.6(c)(2): The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.

Requirement §201.6(c)(2)(i): [The risk assessment **shall** include a] description of the…location and extent of all natural hazards that can affect the jurisdiction. The plan **shall** include information on previous occurrences of hazard events and on the probability of future hazard events.

Requirement §201.6(c)(2)(ii)(C): [The plan **should** describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

Requirement §201.6(c)(2)(iii): For multi-jurisdictional plans, the risk assessment must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.

PROBLEM SOILS

There are six types of problem soils and rocks that are found in southwestern Utah; namely, Expansive Soil, Collapsible Soil, Limestone (Karsts Terrain), Gypsiferous Soil/Rock, Soils subject to Piping, and Sand Dunes.

Expansive soil and rock is the most common type of problem deposit in southwestern Utah. In particular, the Jurassic-age Arapien and Cretaceous-age Tropic Shale's, and the Triassic-age Chinle and Moenkopi Formations are sources for expansive materials. Expansive deposits contain clay minerals that expand and contract with changes in moisture content. Clays absorb water when wetted, causing the soil or rock to expand. Conversely, as the material dries, the loss of water between clay crystals or grains causes the deposit to shrink. Expansive deposits are extensive around St. George, Washington, and Santa Clara. In these areas expansive clays in the Chinle Formation have been most damaging to structures. Common problems are cracked formations, heaving and cracking of floor slabs and walls, and failure of wastewater disposal systems. Sidewalks and roads are particularly susceptible to damage.

Collapsible Soil- Subsidence of the ground surface due to collapsible soil has caused extensive damage in and around Cedar City and the Hurricane cliffs, where it is most prevalent.

Collapsible soil is common in Holocene alluvial-fan and debris-flow deposits in southwestern Utah. Soil and rock containing gypsum are also susceptible to subsidence. Collapse occurs when susceptible soils are wetted to a depth below that normally reached by rainfall, destroying the clay-bonds between bands. Collapsible soil is present in geologically young materials such as Holocene-age alluvial-fan and debris-flow sediments, and in some wind-blown silts.

Limestone (Karst Terrains) susceptible to dissolution and subsidence occurs throughout mountains west of Sevier Lake, west of Richfield, and south of St. George. Karsts terrain is characterized by closed depressions (sinkholes), caverns, and streams that abruptly disappear underground. Most karsts terrain in southwestern Utah is relict and relates to moisture climates during the Pleistocene, or may have been created by ground water prior to the rock being uplifted and tilted during basin and range faulting. No known damage has occurred to structures from ground collapsing or subsidence related to limestone karsts, but because karsts ground-water systems have little filtering capacity, contamination of ground water is a major concern.

Gypsiferous Soil/ Rock deposits are subject to settlement caused by the dissolution of gypsum, which creates a loss of internal structure and volume within the deposit. Gypsiferous soil and rock deposits are common in southwestern Utah, particularly along the base of the Hurricane cliffs. Gypsum in these deposits can cause damage to foundations, and induce land subsidence and sinkholes similar to those seen in limestone terrain.

Soils subject to Piping- Piping is subsurface erosion by ground water that moves along permeable, non-cohesive layers in unconsolidated materials and exists at a free face, usually along a stream bank or cliff that intersects the layer. Deposits susceptible to piping are common in the southwestern part of the state. Holocene-age alluvial fill in canyon bottoms is the most common material susceptible to piping in Utah. Collapse of soil pipes and subsequent erosion has damaged roads and agricultural land. Piping can cause damage to roads, bridges, culverts, and any structure built over soils subject to piping. Earth-fill structures such as dams may also be susceptible to piping.

Sand Dunes are common surficial deposits in arid areas where sand derived from weathering of rock or unconsolidated deposits is blown by the wind into mounds or ridges. In areas where development encroaches on dunes, inactive or vegetated dunes may be reactivated, allowing them to migrate over roads and bury structures. Sand Dunes occur in the Escalante Desert and west of Kanab. Migration of dunes across roads and burial structures are common problems in areas where active dunes are present. Avoidance of dunes is the best way to prevent damage to structures. However,

active dunes usually are a maintenance problem only and do not preclude development.

LANDSLIDE

Nationwide, estimated losses from damaging landslides equal $3.5 billion annually (USGS, 2005). In Utah, documented losses from damaging landslides in 2001 exceeded $3 million, including the costs to repair and stabilize hillsides along state and federal highway (Ashland, 2003). Total landslide dollar losses are hard to determine from past events because a standard for documenting them do not exist. Several state and local agencies track landslide losses with inconsistent formats often resulting in several different totals for a single event.

WILDFIRE

When discussing wildfires it is important to remember that fires are part of a natural process and are needed to maintain a healthy ecosystem. Since its settlement in the mid 1800s, the region and its residents have been subject to the annual threat of wildfire. This is in large part due to the environmental conditions, namely low annual precipitation and high amount of public lands. Lightning is the primary cause of wildfire in the county. However, the potential risk for human caused fires increases as more people move into the wildland urban interface.

Many of Utah's wildland urban interface areas are located in our most fire prone wildland fuels. Generally, these fuels are found on drier, lower elevation sites which are often very desirable for real estate development. To address these issues, a multi-jurisdictional group of agencies, organizations, and individuals collaborated to develop the *Southwest Utah Regional Wildfire Protection Plan* (October 2007). The purpose of this plan is to be a tool in the effort to protect human life and reduce property loss due to catastrophic wildland fires in the communities and surrounding areas located in the southwest Utah counties of Beaver, Garfield, Iron, Kane and Washington.

Washington County is primarily covered in Forest and Shrub/Rangelands, accounting for 84% of the area. Shrub/Rangelands accounts for 74% of the land area (1,149,428 acres). Forest area accounts for 10% of the County (155,328). Zion National Park accounts for 8.2% (126,720 acres) of the County. Urban/Developed (69,120 acres) comprises 4.5% of the County's land area. Grass/Pasture/Haylands makes up 2.3% of the County's land area (35,900 acres). Water/Wetlands (15,533 acres) comprise 1% of Washington County's land area. Shrub/rangelands consist primarily of oak savannahs and pinion/juniper, mesquite and blackbrush areas. Much of the county consists of federal National Park Service, U.S. Forest Service and Bureau of Land Management owned lands.

Using National Fire Plan guidelines, the Utah Division of Forestry, Fire, and State Lands (UDFFSL) has worked with national and local wildland fire officials to create a statewide list of Communities at Risk (CARs). As of 2005, there were over 600 communities listed statewide and 148 are located in the southwestern Utah region. Beginning in 2000, the Color Country Fuels Committee (CCFC) undertook an intensive assessment of the 148 identified CARs in the Color Country fire management response area. These assessments have been the foundation for prioritizing fuels treatments, determining focus areas, and targeting the development of

Community Wildfire Protection Plans within the Color Country Interagency Fire Management area.

FLOOD

In the southwest, as elsewhere, flooding, erosion, and sediment discharge are responsible for loss of life, land, and infrastructure, along with damage to reservoirs and natural habitats. Stream flooding is the most prevalent and destructive (annually) of the geologic hazards that affect Utah. This destructive trend is nowhere more evident than in the southwest part of the state.

The two types of stream flooding events which typically occur in southwestern Utah are riverine floods and flash floods. Riverine floods are usually regional in nature, last for several hours or days, and have recurrence intervals of 25 to more than 100 years. They commonly result from the rapid melt of a winter snow pack or from periods of prolonged heavy rainfall. Flash floods result from thunderstorm cloudbursts. They are localized, quickly reach a maximum flow, and then quickly diminish. Recurrence intervals for flash floods are erratic, ranging from a few hours to decades or longer for a given drainage. Both types of flooding have caused extensive damage in southwestern Utah.

Four major riverine floods have affected southwestern Utah since the area was settled. They occurred in 1966, 1983, 1984 and 2005. The 1966 flood on the Santa Clara River near Pine Valley resulted from an intense three-day rainstorm that produced record peak flows on the Virgin River. This three-day storm produced between 1 and 12 inches of rain and resulted in total damage of approximately $1.4 billion (Butler and Mundorff, 1970). The 1983 and 1984 floods occurred in response to the rapid melting of maximum-of-record and greater-than-average snow packs respectively. The 1983 and 1984 floods caused several landslides and a dam failure. Total damage was in excess of $640 million and the President issued a disaster declaration for 22 Utah counties. Lastly, a stalled storm-system containing abundant moisture caused significant flooding in Washington and Kane Counties between January 8-12, 2005. It is estimated that $300 million dollars in damages was sustained along the Santa Clara and Virgin Rivers in Washington County. 30 homes were destroyed in the flood and another 20 homes were significantly damaged (NCDC, 2005). A Presidential Disaster Declaration was declared February 1, 2005.

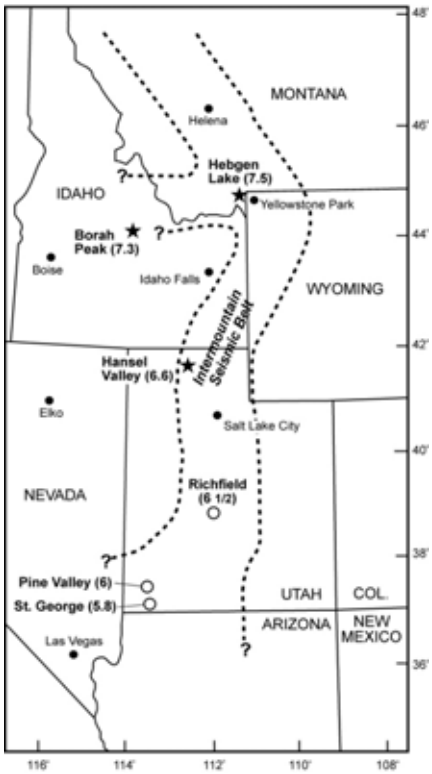
According to statistics provided by SHELDUS, Washington County has experienced a total of 10 major flooding events; the first event occurring February 14, 1980 and the most recent occurring August 1, 2007. The total property damage (not adjusted for inflation) for these flood events was $ 317,838,221.

By nature flash floods are sudden, intense, and localized. Many undoubtedly occur every summer along isolated drainages in southwestern Utah and are never recorded. Flash floods have damaged every major town in southwestern Utah. Many communities have implemented flood-control measures to reduce flash flood hazard; however, as communities expand into unprotected areas, new development is again subject to flash flooding. As a whole, any new

development in southwestern Utah must consider the potential for stream flooding, and mitigate any flood hazard that may exist.

EARTHQUAKE

In Utah most earthquakes are associated with the Intermountain seismic belt (Smith and Sbar, 1974; Smith and Arabasz, 1991), an approximately 160-kilometer-wide (100 miles), north-south trending zone of earthquake activity that extends from northern Montana to northwestern Arizona. Since 1850, there have been at least 16 earthquakes of magnitude 6.0 or greater within this belt (Eldredge and Christenson, 1992). Included among those 16 events are Utah's two largest historical earthquakes, the 1901 Richfield earthquake with an estimated magnitude of 6.5, and the 1934 Hansel Valley magnitude 6.6 earthquake, which produced Utah's only historical surface fault rupture. In an average year Utah experiences more than 700 earthquakes, but most are too small to be felt. Moderate magnitude (5.5 – 6.5) earthquakes happen every several years on average, the most recent being the magnitude 5.8 St. George earthquake on September 2, 1992. Large magnitude earthquakes (6.5 – 7.5) occur much less frequently in Utah, but geologic evidence shows that most areas of the state within the Intermountain seismic belt, including southwestern Utah, have experienced large surface-faulting earthquakes in the recent geologic past.



Fault-related surface rupture has not occurred in southwestern Utah historically, but the area does have a pronounced record of seismicity. At least 20 earthquakes greater than magnitude 4 have occurred in southwestern Utah over the past century (Christenson and Nava, 1992); the largest events were the estimated magnitude 6 Pine Valley earthquake in 1902 (Williams and Trapper, 1953) and the magnitude 5.8 St. George earthquakes in 1992 (Christenson, 1995). The Pine Valley earthquake is pre-instrumental and poorly located, and therefore, is not associated with a recognized fault. However, the epicenter is west of the surface trace of the Hurricane fault, so the event may have occurred on that structure. Pechmann and others (1995) have tentatively assigned the St. George earthquake to the Hurricane fault. The largest historical earthquake in nearby northwestern Arizona is the 1959 Fredonia, Arizona, earthquake (approximate magnitude 5.7; DuBois and others, 1982). Since 1987 the northwest part of Arizona has been quite seismically active (Pearthree and others, 1998), experiencing more than 40 events with magnitudes >2.5.

Despite the lack of an historical surface-faulting earthquake in southern Utah, available geologic data for faults in the region indicate a moderate rate of long-term Quaternary activity. Mid-Quaternary basalt flows are displaced hundreds of meters at several locations and alluvial and colluvial deposits are displaced meters to tens of meters in late Quaternary time.

Because earthquakes result from slippage on faults, from an earthquake-hazard standpoint, faults are commonly classified as active, capable of generating damaging earthquakes, or inactive, not capable of generating earthquakes. The term "active fault" is frequently incorporated into regulations pertaining to earthquake hazards, and over time the term has been defined differently for different regulatory and legal purposes. In fact, faults possess a wide range of activity levels. Some, such as the San Andreas Fault in California, produce repeated large earthquakes and associated surface faulting every few hundred years, while others, like Utah's Wasatch fault and many of the faults in the Basin and Range Province, generate large earthquakes and surface faulting every few thousand to tens of thousands of years. Therefore, depending on the area of interest or the intended purpose, the definition of "active fault" may change. The time period over which faulting activity is assessed is critical because it determines which faults are ultimately classified as hazardous and therefore in need of regulatory mitigation (National Research Council, 1986).

SEVERE WEATHER

The term severe weather, as it pertains to this plan, is used to represent a broad range of weather phenomena which affect southwestern Utah, namely; downburst, lightning, heavy snowstorms, avalanches, and tornados. Severe weather events are the most deadly type of natural hazard in Utah. Interestingly, more people have died in avalanches in Utah than by any other natural hazard. Between 1958 and 2006 avalanches killed 85 people.

Since 1950, lightning has killed 60 people statewide and injured another 144. In southwestern Utah the most common type of severe weather activity is related to lightning. Since 1950 a total of 5 lightning deaths and 10 lightning injuries have been recorded within the region.

A tornado is a violently rotating column of air extending from a thunderstorm to the ground. Most tornados have winds less than 112 miles per hour and zones of damage less than 100 feet wide. According to the National Weather Service, a total of 12 tornados have been observed in southwestern Utah. Of this amount, Iron and Beaver counties contain the highest amounts at 5 and 4 respectively.

A stalled storm system containing abundant moisture caused significant flooding in Washington and Kane Counties between January 8-12, 2005. Higher snowfall and water equivalent totals equaled 70" at Cedar Breaks, and 60" at Kolob-Zion National Park. It is estimated that $300 million dollars in damages was sustained along the Santa Clara and Virgin Rivers. 30 homes were destroyed in the flood and another 20 homes were significantly damaged. One fatality associated with this event resulted when a man and his wife in their vehicle were caught in floodwaters in the Red Cliff

Recreation Area near the Quail Creek Reservoir. Six other injuries were reported. A Presidential Disaster Declaration was declared on February 1, 2005.

Climate- Most of the moisture in the winter comes from fronts that develop in the Gulf of Alaska and move from west to east across the State. Tropical air from the Gulf of Mexico enters the state from the south and west during July through September and is the source of severe thunderstorms. Tropical Pacific air masses from the southwest at times have caused extreme floods in the southwest part of the State. The mountains form barriers to the flow of moisture-laden air, and orographic precipitation may occur any time during the year. Rain shadows, which are areas of reduced precipitation, on the leeward side of the mountains account for the low normal annual rainfall in many of the interior valleys in the region.

Cloudburst storms and resultant floods occur principally during the summer. All parts of the State are subject to these storms, even the flat desert areas of the western portion. However, they occur more frequently along the west slope of the Wasatch Range, the Colorado Plateaus, and the southwest part of the State.

Tornados- Generally speaking, atmospheric conditions are rarely favorable for the development of tornadoes in Utah due to its dry climate and mountainous terrain. In fact, Utah ranks as having one of the lowest incidences of tornadoes in the nation, averaging only about two tornadoes per year, with only one F2 or stronger tornado once every seven years.

In the central U.S., tornadoes are commonly one-fourth of a mile wide and often cause considerable destruction and death. However, Utah tornadoes are usually smaller in size, often no more than 60 feet wide (at the base), with a path length usually less than a mile and a life span of only a few seconds to a few minutes. They normally follow a path from a southwesterly to a northeasterly direction and usually precede the passage of a cold front. About 73% of all Utah tornadoes have occurred in May, June, July and August, when severe thunderstorms occasionally frequent Utah.

Avalanches occur when a cohesive slab of snow fractures as a unit and slides on top of weaker snow, breaking apart as it slides. Slab avalanches occur when additional weight is added quickly to the snow pack, overloading a buried weaker layer. Dry snow avalanches usually travel between 60-80 miles per hour, reaching this speed within 5 seconds of the fracture, resulting in the deadliest form of snow avalanche.

Wet avalanches occur when percolating water dissolves the bonds between the snow grains in a pre-existing snow pack; this decreases the strength of the buried weak layer. Strong sun or warm temperatures can melt the snow and create wet avalanches. Wet avalanches usually travel about 20 miles per hour.

According to the Colorado Avalanche Information Center (CAIC), over the last 10 winters in the United States an average of 25 people died in avalanches every year. In Utah, this translates to approximately 4 avalanche related fatalities every year. Generally speaking, the lion share of avalanche fatalities have occurred in northern Utah. Since every fatal accident is investigated and

reported, the numbers can be reported with some certainty. However, there is no way to determine the number of people caught or buried in avalanches each year, because non-fatal avalanche incidents are increasingly under reported. Unfortunately, statistical data pertaining to avalanche related fatalities in southern Utah is underprovided.

VULNERABILITY ASSESSMENT

Requirement §201.6(c)(2)(ii): [The risk assessment **shall** include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description **shall** include an overall summary of each hazard and its impact on the community.

Requirement §201.6(c)(2)(ii)(A): The plan **should** describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area.

Requirement §201.6(c)(2)(ii)(B): [The plan **should** describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph *(c)(2)(ii)(A)* of this section and a description of the methodology used to prepare the estimate.

PROBLEM SOILS

Geologic materials with characteristics that make them susceptible to volumetric changes, collapse, subsidence, or other engineering-geologic problems are referred to as problem soils. Geologic and climatic conditions in southwestern Utah provide a variety of both localized and widespread occurrences of these materials. Soil and rock related geologic problems occur in a variety of geologic settings and are some of the most widespread and costly geologic hazards. Six types of problem soil and rock are present in southwestern Utah. Six types of problem soil and rock are found in southwestern Utah: (1) expansive soil and rock with high shrink/swell potential, (2) collapsible soil, (3) limestone (Karsts Terrain) susceptible to dissolution under some hydro geologic conditions, (4) gypsiferous soil/rock susceptible to dissolution, (5) soil subject to piping (localized subsurface erosion), and (6) active dunes. Some materials, such as expansive soil and limestone, cover large areas, whereas others, like active dunes, are of limited extent. The most extensive problem soils found in the region are expansive soil and rock.

Expansive Soils and rock are the most common type of problem soils in southwestern Utah. Expansive deposits contain clay minerals that expand and contract with changes in moisture content. Clays absorb water when wetted, causing the soil or rock to expand. Conversely, as the material dries, the loss of water between clay crystals or grains causes the deposit to shrink.

Expansive deposits are extensive around St. George, Washington, and Santa Clara in Washington County. In these areas expansive clays in the Chinle Formation have been most damaging to structures. In Santa Clara, many homes and a church were damaged by expansive clays in the Chinle Formation. Common problems are cracked foundations, heaving and cracking of floor slabs and walls, and failure of wastewater disposal systems. Sidewalks and roads are particularly susceptible to damage. The majority of expansive soil problems are found in Washington and Iron Counties.

Collapsible Soil- The phenomenon of hydrocompaction, which causes subsidence in collapse prone soil, occurs in loose, dry, low density deposits that decrease in volume or collapse when saturated for the first time following deposition. Collapse occurs when susceptible soils are wetted to a depth below that normally reached by rainfall, destroying the clay bonds between grains. Collapsible soil is present in geologically young materials such as Holocene age alluvial fan and debris flow sediments. When saturated, the soil collapses and the ground surface subsides, damaging property and structures. Human activities that involve some form of water application such as irrigation, water impoundment, lawn watering, and alterations to natural drainage or wastewater disposal commonly initiate hydrocompaction.

Collapsible soil is present particularly near Cedar City (Iron County) and the Hurricane Cliffs (Washington County). In Cedar City approximately $3 million in damage to public and private structures has been attributed to collapsible soil. Other areas in southwestern Utah with a potential collapsible soil problem are along mountain fronts where young alluvial fan deposits containing fine-grained sediments are present. Climate also plays a role in the distribution of collapsible soils. Drier areas, such as the Basin and Range and Colorado Plateau provinces, provide the best conditions for development of collapsible soil. Soil and rock containing gypsum are also susceptible to subsidence. Ground water and introduced waters from irrigation dissolve gypsum causing subsidence.

Limestone (Karsts Terrain) is characterized by sinkholes, caverns, and streams that abruptly disappear underground. Karsts features are caused by ground and surface water dissolution of calcareous rocks, such as limestone. Cavernous subterranean openings in karst terrain often collapse, leaving sinkholes at the surface.

Limestone susceptible to dissolution and subsidence occurs throughout mountains west of Sevier Lake, west of Richfield, and south of St. George. No known damage to structures has occurred from ground collapse or subsidence related to limestone karsts; however, the potential for damage exists where susceptible units are present. In addition, because karsts ground-water systems have little filtering capacity, contamination of ground water is a major concern.

Gypsiferous soil/rock are subject to settlement caused by the dissolution of gypsum, which creates a loss of internal structure and volume within the deposit. Gypsum in soil can also form in other ways - including as a secondary mineral deposit leached from surficial layers and concentrated lower in the soil profile or wind-blown dust, and in the St. George area (Washington County) by the evaporation of ground water.

Gypsiferous soil and rock deposits are common in southwestern Utah, particularly along the base of the Hurricane Cliffs. Much of the gypsum is derived from erosion of gypsum rich rock units. Gypsum in these deposits can cause damage to foundations, and induce land subsidence and sinkholes similar to those seen in limestone terrain. Water introduced into the subsurface for irrigation and landscaping or into wastewater disposal systems, can cause underground solution cavities to develop, which may ultimately cause surface collapse. Gypsum is also a weak material with low bearing strength, which can cause problems when loaded with the weight of a

structure. In addition, gypsum dissolved in water forms sulfuric acid and sulphate, which react with certain types of cement and weaken foundations.

Soils Subject to Piping- Piping is subsurface erosion by ground water that moves along permeable, non-cohesive layers in unconsolidated materials and exits at a free face, usually along a stream bank or cliff that intersects the layer. Removal of fine-grained particles by this process creates voids within the material that act as minute channels which direct the movement of water. As channels enlarge, water moving through the conduit increases velocity and removes more material, forming a "pipe." The pipe becomes a preferred avenue for ground-water drainage and enlarges as more water is intercepted. Increasing the size of the pipe removes support from the walls and roof, causing eventual collapse.

Deposits susceptible to piping are common in southwestern Utah. Piping can cause damage to roads, bridges, culverts, and any structure built over soils subject to piping. In areas where piping is common, roads are frequently damaged where they parallel stream drainages and cross-cut pipes. Road construction can contribute to the piping problem by disturbing natural runoff and concentrating water along paved surfaces, allowing greater infiltration and potential for pipes to develop.

Sand Dunes are common surficial deposits in arid areas where sand derived from weathering of rock or unconsolidated deposits is blown by the wind into mounds or ridges. In areas where development encroaches on dunes, inactive or vegetated dunes may be reactivated, allowing them to migrate over roads and bury structures. Another problem is the contamination of local ground water from wastewater disposal in dunes. The uniform size of the sand grains comprising dunes makes them highly permeable. Dunes are present in many areas of southwestern Utah, especially in the Escalante Desert (Iron County) and west of Kanab (Kane County). Avoidance of dunes is the best way to prevent damage to structures. (Excerpted from Lund, UGS unpublished information).

Conclusions- In addition to the above analysis, the vulnerability assessment was conducted using GIS software to join: 1) County Property Tax data as it relates to 2) buildings located with a respective hazard area. This analysis was based upon the most recent County Property Tax data provided by each County Assessor's office. The values shown are based upon utilizing the ***market value*** for structures in each defined hazard area. The GIS software then quantified the number of units and total market value for all structures located within each defined hazard area.

Washington County – Problem Soils		
Type of Structure	Market Value of Structures	Number of Structures
Residential	$876,704,195	5,272
Commercial	$82,111,024	156
Total	**$958,815,219**	**5,428**

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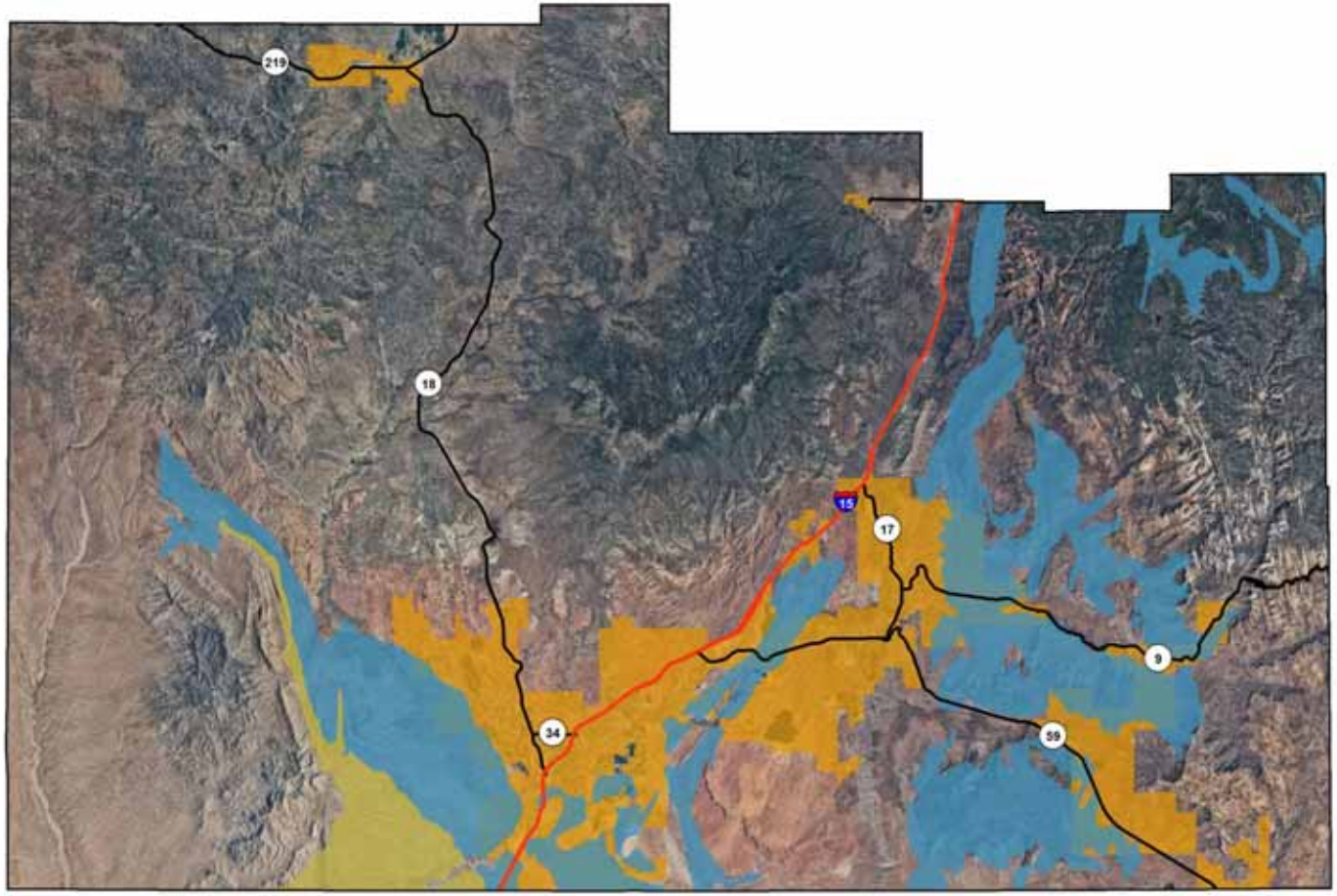
Five County Natural Hazard Mitigation Plan

Washington County

Problem Soils Risk Map



Five County Association of Goverments April 2010 Southern Utah University
FCAOG and SUU GIS use information and data from many different sources, which may be of differing accuracy and which have been integrated to provide a planning context. These products should be used only for the purpose they were intended. For specific data source information, please contact FCAOG.

0 1 2 4 6 8
Miles

Legend

Highways
- US
- State
- Municipalities

- Dunes
- Expansive Soil or Rock
- Limestone

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LANDSLIDE

According to the USGS, landslides are a widespread geologic hazard that can occur in all 50 states. On average, landslides cause $1-2 billion annually in damages and claim 25 lives per year. Urban development in and along hillside areas increase the number of people threatened by landslide events each year (USGS, 2007). Many factors contribute to overall landslide vulnerability; including local weather, soil moisture, duration and intensity of precipitation, wildfire history, and development pressure. Typically, landslides result from other natural disasters such as earthquakes, volcanoes, wildfires and floods (USGS, 2007). The table below illustrates landslide susceptibility by hazard category.

Landslide susceptibility by hazard category				
County	High Hazard (square miles)	Moderate Hazard (square miles)	Low Hazard (square miles)	**Total (square miles)**
Garfield	3.7	193.8	223.5	**421.0**
Beaver	46.6	579	236.1	**861.7**
Iron	20.5	738.2	333	**1,091.7**
Washington	28.1	1,079.9	423.2	**1,531.2**
Kane	42	1,638.5	672.9	**2,353.4**
Source: State of Utah, Natural Hazard Mitigation Plan, November 2007.				

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Washington County - Landslide			
Type of Structure	Market Value of Structures		Number of Structures
	Landslide Risk Area- High	Landslide Risk Area- Medium	
Residential	$27,792,060		211
Commercial	$42,575,847		97
Residential		$652,416,977	2,298
Commercial		$182,494,518	217
Total	**$70,367,907**	**$834,911,495**	**2,823**
Overall Total		**$905,279,402**	**2,823**

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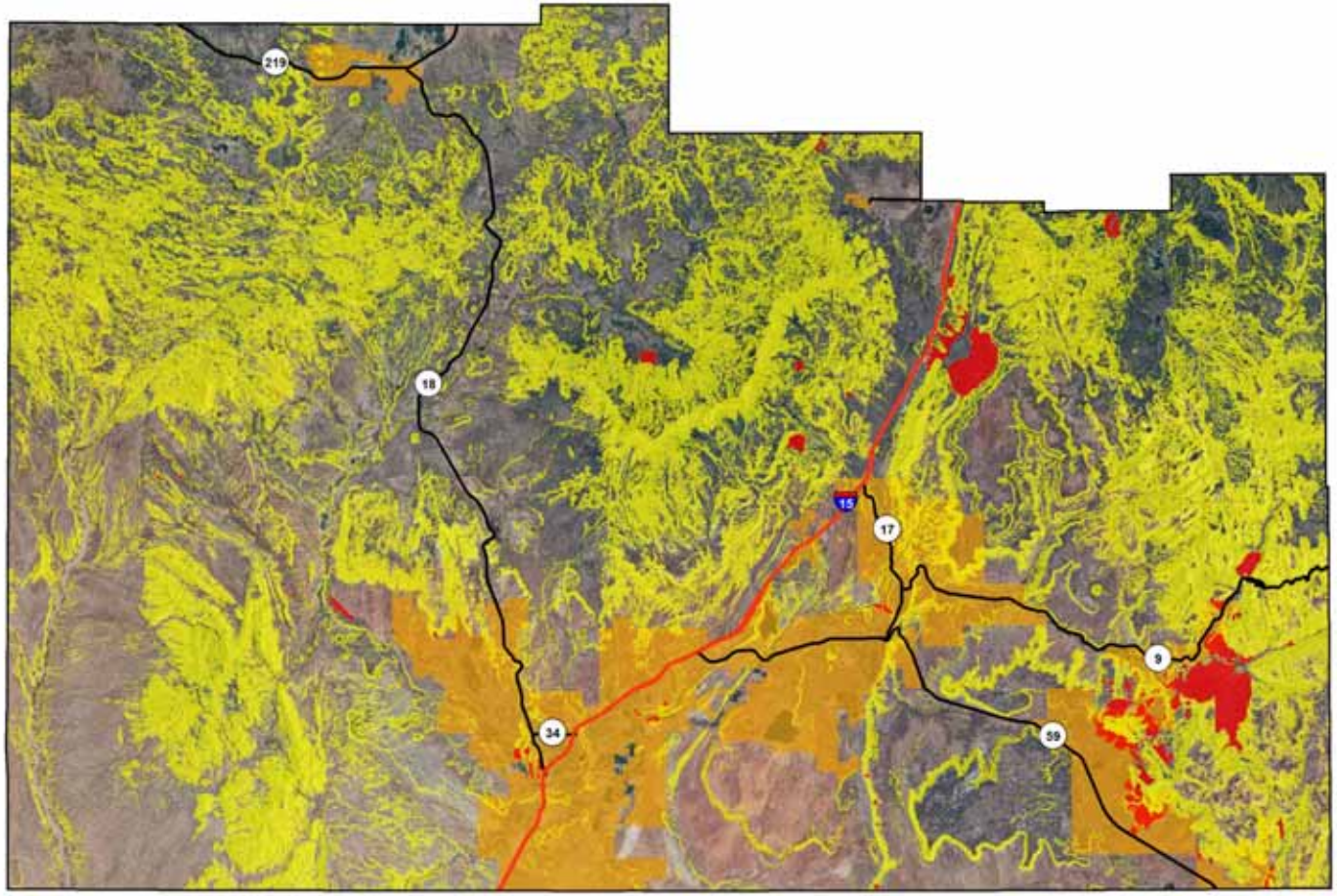
Five County Natural Hazard Mitigation Plan

Washington County

Landslide Risk Map



Five County Association of Goverments April 2010 Southern Utah University
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0 1 2 4 6 8
Miles

Legend

Highways
- US
- State
- Municipalities

Landslide
- Medium
- High

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WILDFIRE

As illustrated in the *Southwest Utah Regional Wildfire Protection Plan* (October 2007), the Color Country Fuels Committee (CCFC) compiled data that included standardized internal and external risk assessments, digital photos, maps, and other information to prioritize hazardous fuels target areas and to aid in suppression efforts. Each CARs was given a score ranging from 0 (no risk) to 12 (extreme risk) based on the sum of multiple risk factors (e.g., fire history, local vegetation, firefighting capabilities) analyzed in every area. The scoring system allows Utah's fire prevention program officials to assess the relative risk in a given area of the state and open communication channels with these communities to help them better prepare for wildfire.

Washington County- Communities at Risk and Risk Score (2005)	
Brookside	11
Central	11
Pine Valley	11
Pintura	11
Zion Panorama	11
Black Ridge Ranches	10
Blue Springs	10
Dammeron Valley	10
Diamond Valley	10
Kolob Terrace	10
Motoqua	10
Mountain Meadow	10
New Harmony	10
Pinto	10
Shivwits	10
Veyo	10
Anderson Jct.	9
Bloomington	9
Gunlock	9
Rockville	9
Santa Clara	9
Silver Reef	9
Springdale	9
Toquerville	9
Virgin	9
Winchester Hills	9
Enterprise	8
LaVerkin	8
Leeds	8
Washington	8
Apple Valley	7
Grass Valley	7

Harrisburg	7
Hilldale	7
Hurricane	7
St. George	7
Ivins	6
Source: Southwest Utah Regional Wildfire Protection Plan (October 2007)	

In addition to the above analysis, the vulnerability assessment was conducted using GIS software to join: 1) County Property Tax data as it relates to 2) structures located within a respective hazard area. This analysis was based upon the most recent (2009) County Property Tax data provided by each County Assessor's office. The values shown are based upon utilizing the market value for structures in each defined hazard area. Where applicable, if a critical facility was located within a defined hazard area, this valuation was included within the commercial structure category. The GIS software then quantified the number of units and total market value for all structures located within each defined hazard area.

Washington County - Wildfire			
Type of Structure	Market Value of Structures		Number of Structures
	Wildfire Risk Area-High	Wildfire Risk Area-Medium	
Residential	$6,420,407		44
Commercial			
Residential		$745,360,101	3,005
Commercial		$149,849,862	245
Total	**$6,420,407**	**$895,209,963**	**3,250**
Overall Total		**$901,630,370**	**3,250**

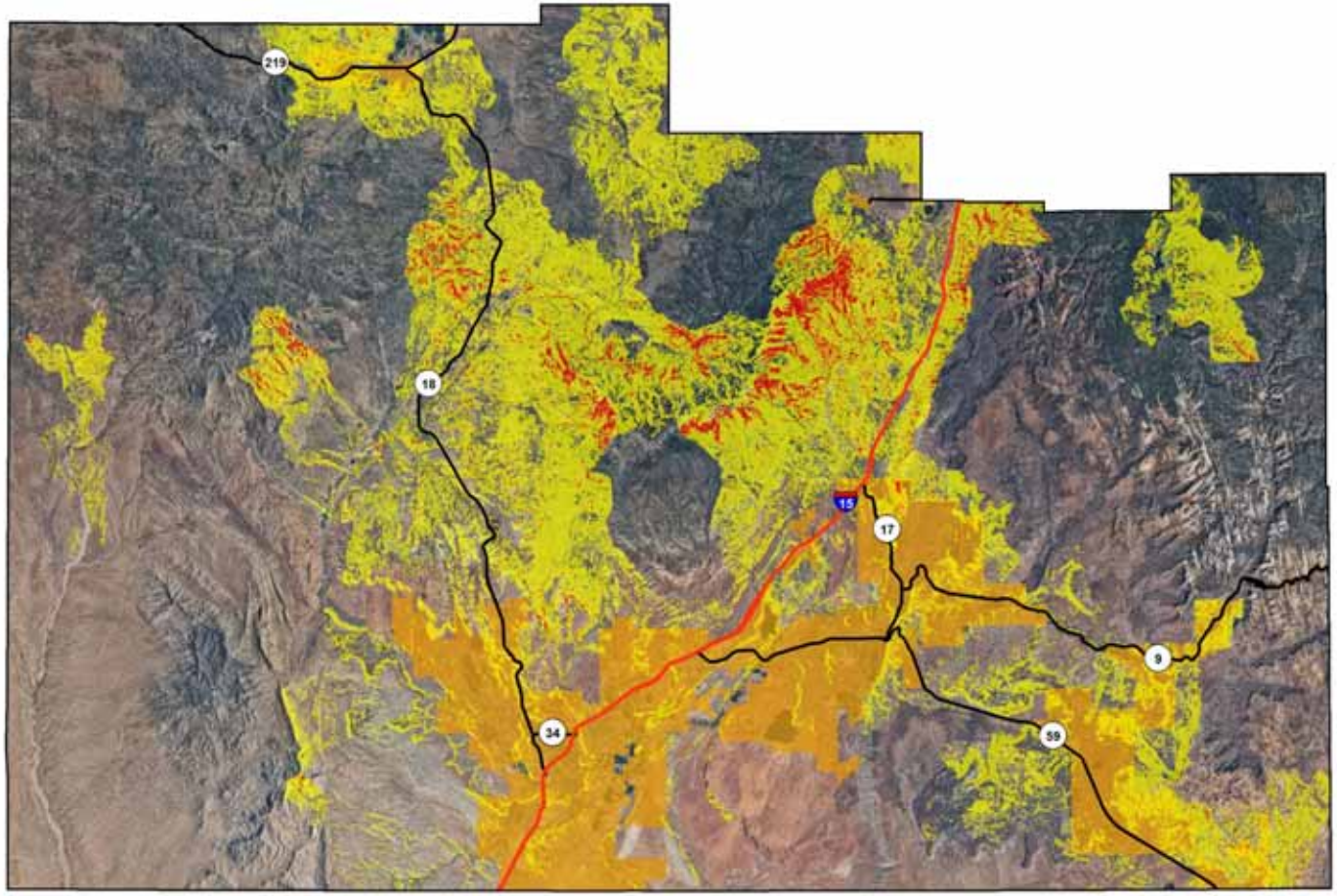
In addition to structures located within a defined hazard area, there is also an overwhelming amount (in terms of quantity and value) of infrastructure that is not captured by the GIS analysis. This is in large part due to the fact that compilation of this data would be exhaustive; nevertheless, the following provides a summarization of infrastructure at risk from wildfire.

Infrastructure at Risk from Wildfire			
Location	Miles of Major Roadways	Miles of Railroad Track	Miles of Utility Powerlines
Beaver County	60	5	87
Garfield County	104	0	154
Iron County	110	117	180
Kane County	59	0	50
Washington County	80	0	155
Paiute Indian Lands	10	0	0
Region Totals	**423**	**122**	**626**

Five County Natural Hazard Mitigation Plan

Washington County

Wildfire Risk Map



Five County Association of Goverments April 2010 Southern Utah University
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0 1 2 4 6 8
Miles

Legend

Highways
- US
- State
- Municipalities

Wildfire
- Medium
- High

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FLOOD

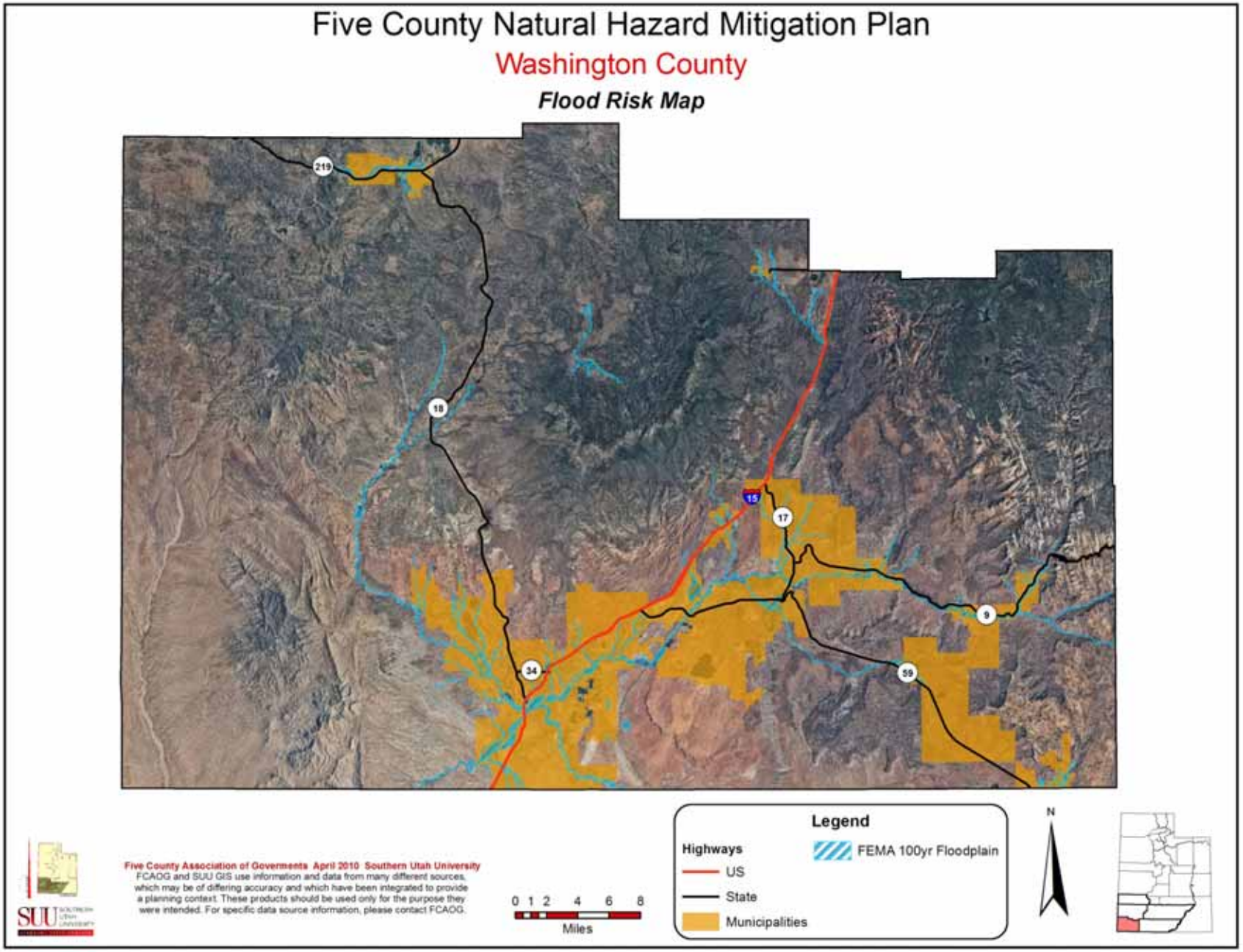
The Army Corps of Engineers conducted a *Flood Hazard Identification Study* for the Five County region in August, 2003. The intent of this study is to aid in detailing natural hazards associated with fluvial process for entities within the region. The study evaluates and identifies areas with a high flood hazard and identifies potential mitigation solutions. Municipalities within the region were studied if they met the following criteria: 1) Jurisdiction has not been mapped by FEMA; and 2) Jurisdiction mapped by FEMA as a Zone D, area of undetermined flood hazard. The following information is provided from the Study.

Dams are a critical support function for water managers in the State, and also can act as a flood control measure. If a dam remains stable, does not get overtopped, or is not impaired as the result of an earthquake, then at a minimum, they do provide incidental flood control. If not then they can add to the flood threat. There are 145 dams within the Five County region, of those 33 have received a high hazard rating by Utah Division of Water Right Dam Safety Section. The State Dam Safety Section has developed a hazard rating system for all non-federal dams in Utah. Downstream uses, size height, volume, and incremental risk/damage assessments are a variable used to assign dam safety classification. High hazard dams would cause a possible loss of life in the event of a rupture. The following are high hazard dams in Washington County: Gunlock, Baker, Santa Clara, Quail creek South Dam, Enterprise Lower, Ash Creek, City Creek Debris Basin, Enterprise Upper, Ivins Bench, Warner Draw, Quail Creek, South Creek-Washington County, Kolob Creek, Navajo Debris Basin, Sand Hollow North Dam, and Sand Hollow West Dam.

Only 6% of Washington County residents live in the unincorporated county making that population one of the smallest percentages in the state. The County, and its 14 incorporated cities/towns, participates in the National Flood Insurance Program (NFIP). Most development in the county is located in the St. George Metropolitan Statistical Area (MSA). The Virgin River and its tributaries are the main watercourses in the county. The major flooding that occurred in St. George and surrounding communities in January 2005, stimulated significant FEMA mapping and associated documentation which was completed/adopted April 2009. This effort has made great strides in reducing the risks associated with flooding as well as providing updated, quantifiable data to cities and communities as they assess developments as it relates to natural constraints.

In addition to the above analysis, the vulnerability assessment was conducted using GIS software to join: 1) County Property Tax data as it relates to 2) buildings located with a respective hazard area. This analysis was based upon the most recent County Property Tax data provided by each County Assessor's office. The values shown are based upon utilizing the ***market value*** for structures in each defined hazard area. The GIS software then quantified the number of units and total market value for all structures located within each defined hazard area.

Washington County - Flood		
Type of Structure	Market Value of Structures	Number of Structures
Residential	$519,202,769	2,810
Commercial	$254,595,334	466
Total	**$773,798,103**	**3,276**


Five County Natural Hazard Mitigation Plan
Washington County
Flood Risk Map
219
18
15
17
9
34
59
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0 1 2 4 6 8
Miles
Legend
Highways
US
State
Municipalities
FEMA 100yr Floodplain
N

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EARTHQUAKE

When assessing the vulnerability of structures as a result of an earthquake, an understanding of the building code, to which the structure was designed, is of extreme importance. Utah building codes began to address seismic design as early as 1976; although, the state did not adopt building codes fully addressing seismic safety until 1989. It is fairly safe to assume that structures constructed prior to 1976 will not perform in an earthquake as well as structures built following 1976. This is to say that an increased understanding of seismic events coupled with advances in building design has greatly increased our ability to design and construct buildings which perform better in earthquakes.

Earthquakes are regional hazards affecting multi-county areas, and because almost the entire state could experience a seismic event, all communities contain some degree of risk. The degree of risk is determined by several factors; however, the paramount factor is naturally the likelihood and magnitude of the earthquake. This being said, building design is a key factor when discussing potential structural damage. Vulnerability of structures was determined through age of construction with those structures built before 1976 considered possessing a higher risk.

Age of Housing Stock			
County	Structures built before 1976	Total Structures	**% of Structures built before 1976**
Beaver	1,559	2,660	**59%**
Garfield	1,497	2,767	**54%**
Iron	5,336	13,618	**39%**
Kane	1,398	3,767	**37%**
Washington	6,777	36,478	**19%**
Source: U.S. Census, November 2000.			

In addition to the above analysis, the vulnerability assessment was conducted using GIS software to join: 1) County Property Tax data as it relates to 2) buildings located with a respective hazard area. This analysis was based upon the most recent County Property Tax data provided by each County Assessor's office. The values shown are based upon utilizing the ***market value*** for structures in each defined hazard area. The GIS software then quantified the number of units and total market value for all structures located within each defined hazard area. The quantitative earthquake data provided below includes all structures which are: 1) on a fault line, or 2) within a 500' to 1,000' fault line buffer area. The range provided for the fault line buffer area is a determination made by Utah Geological Survey as it relates to the fault being studied or unstudied.

Washington County - Earthquake		
Type of Structure	Market Value of Structures	Number of Structures
Residential	$327,330,710	2,273
Commercial	$72,404,448	129
Total	**$399,735,158.00**	**2,402**

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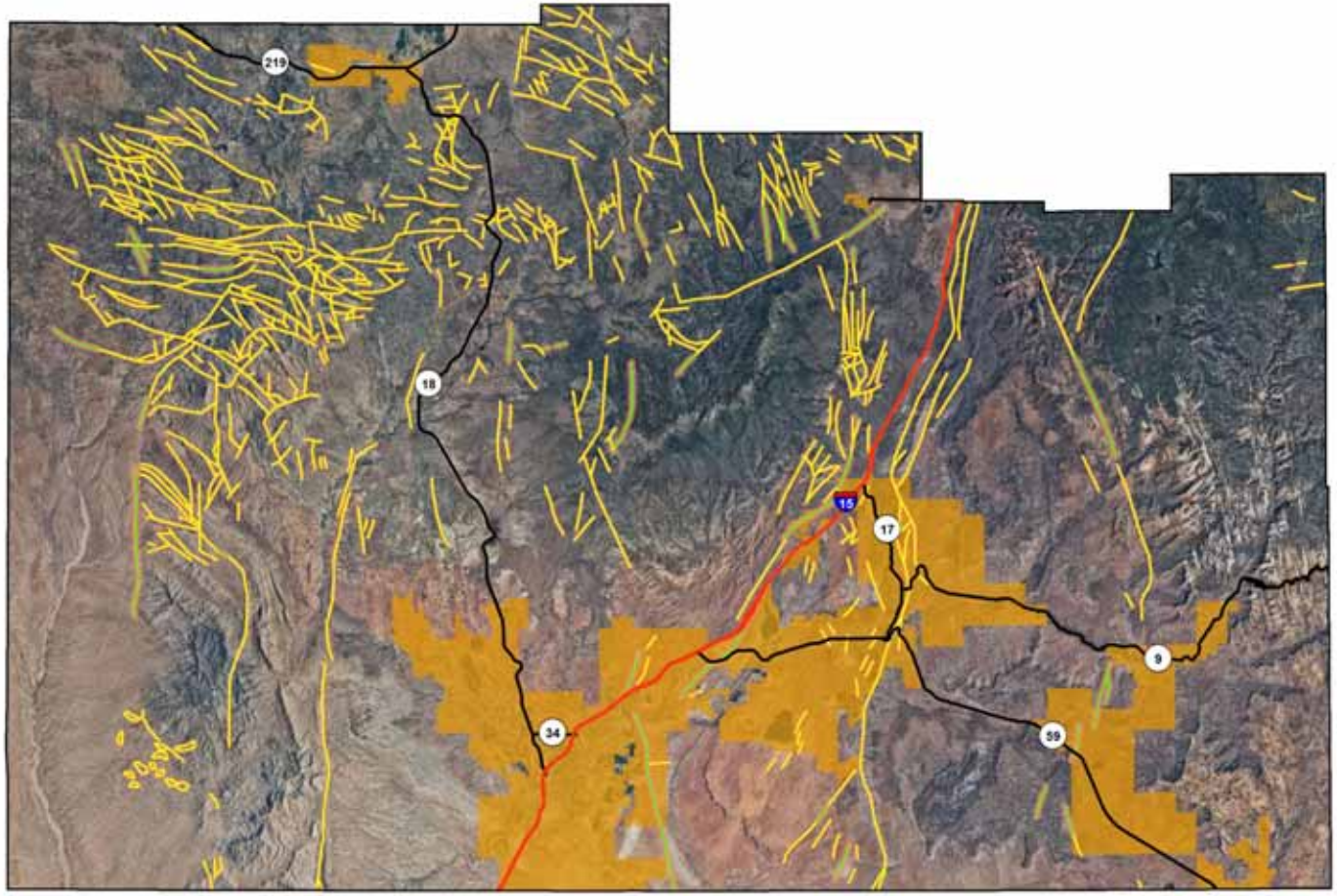
Five County Natural Hazard Mitigation Plan

Washington County

Earthquake Risk Map



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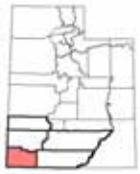
0 1 2 4 6 8
Miles

Legend

Highways	Fault Locations
US	Certain (Studied)
State	Concealed (Unstudied)
Municipalities	Surface Rupture Areas

N



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SEVERE WEATHER

There are many qualitative factors that point to potential vulnerability. Severe weather can cause power outages, transportation and economic disruptions, significant property damage, and pose a high risk for injuries and loss of life. The event can also be typified by a need to shelter and care for individuals impacted by the event. On numerous occasions, severe weather have brought economic hardship and affected the life of the residents of southwestern Utah. Higher elevations in The Five County region have greater exposure to snow and ice, but may be less economically vulnerable because they are sparsely populated. Quantitative assessment of severe weather vulnerability and determining which counties are more vulnerable is very challenging. However, using the principle of the past being the key to the future is effective. For example, one would assume that an area that has exhibited a high number of occurrences would continue to exhibit the same.

A quantitative vulnerability assessment is difficult based upon the simple fact that severe weather occurrences are random and difficult to predict. Several factors limit a determination of potential losses, they include:

- Limited GIS data availability;
- Lack of research on site-specific location;
- The entire state of Utah shares similar, if not identical risks; and
- Most hazards are tied to weather and cannot be predicted with location.

The vulnerability assessment was conducted using GIS software to join: 1) County Property Tax data as it relates to 2) buildings located with an area that has exhibited severe weather occurrences. This analysis was based upon the most recent County Property Tax data provided by each County Assessor's office. The values shown are based upon utilizing the ***market value*** for structures in each defined severe weather hazard area. The GIS software then quantified the number of units and total market value for all structures located within each defined severe weather hazard area.

Washington County – Severe Weather		
Type of Structure	Market Value of Structures	Number of Structures
Residential	$13,358,375	87
Commercial	$1,893,609	7
Total	**$15,251,984**	**94**

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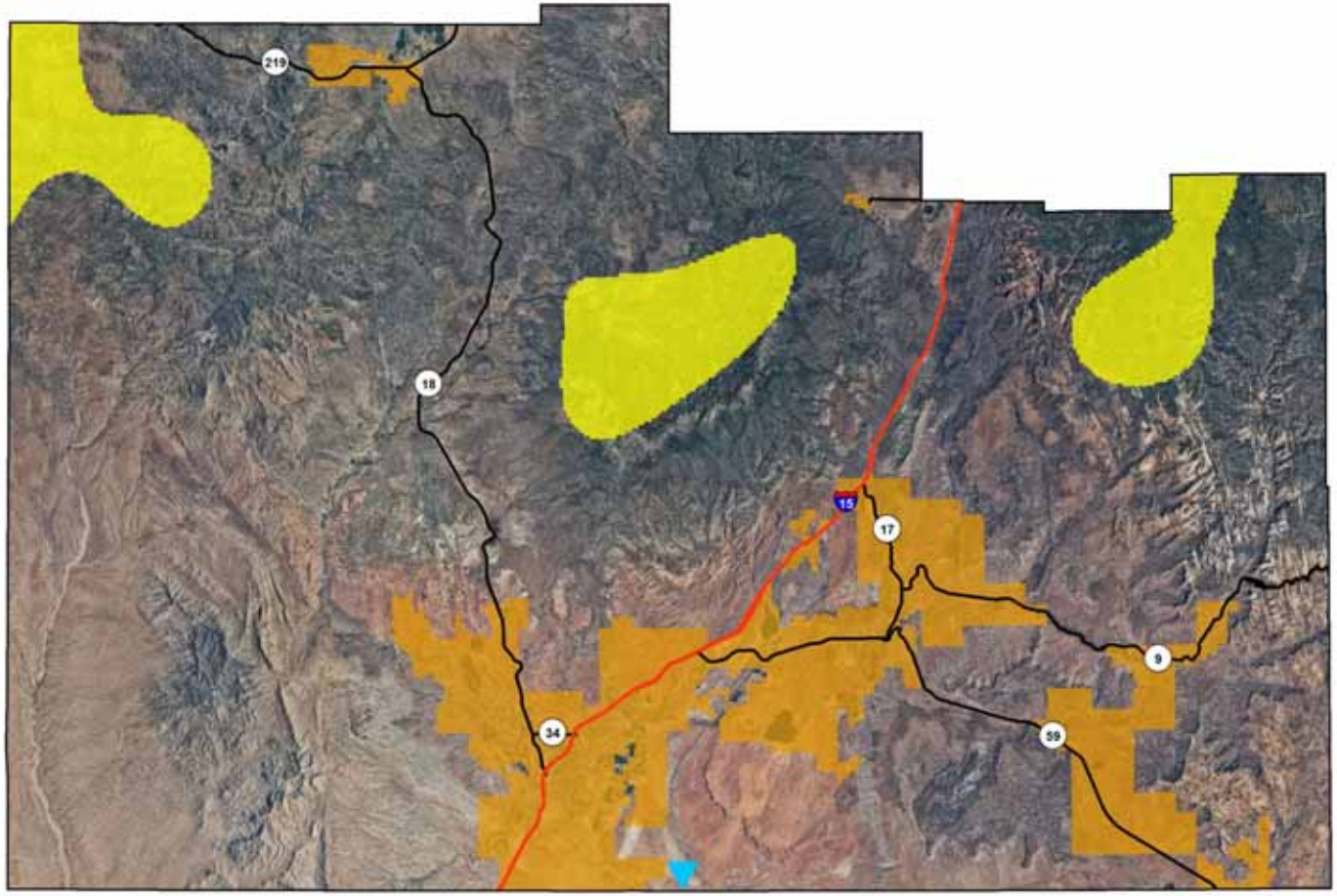
Five County Natural Hazard Mitigation Plan

Washington County

Severe Weather Risk Map



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0 1 2 4 6 8
Miles

Legend

Highways
- US
- State
- Municipalities

Lightning Death
Tornado Touchdown

Lightning Intensity
- Medium
- High

N

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MITIGATION STRATEGY

The following table provides a brief synopsis of the Washington County mitigation strategies. Additional information for each specific hazard, including specific mitigation strategies and associated information, are found following this table.

Washington County- Mitigation Strategies									
Mitigation Strategy	**Action**	**Timeline**	**Estimated Cost**	**Plan Goals Addressed**					
				Education / Outreach	**Emergency Services**	**Environmental Protection**	**Partnership / Coordination**	**Prevention**	**Property Protection**
Problem Soils- Mitigation Strategy #1	1-Address problem soils at the building/construction level by requiring all subdivision proposals to have a geotechnical report.	Ongoing	$1,000-$5,000					●	●
	2- If jurisdiction does not have trained staff to review the geotechnical report, the jurisdiction can, upon request, have UGS perform a review of the report.	Ongoing	Minimal				●	●	●
Problem Soils- Mitigation Strategy #2	Utilize the Problem Soils Risk Map provided in this plan as a tool to assess problem soils risks as it relates to any building/subdivision proposals. If deemed necessary, jurisdiction should require the builder/developer to conduct a site-specific geotechnical (soils) report.	Ongoing	$1,000-$5,000					●	●

Problem Soils-Mitigation Strategy #3	Through mapping, identify areas which contain collapsible and expansive soils. Require soils testing at the building/construction level and ensure that engineer's recommendations are followed.	Ongoing	$1,000-$5,000					●	●
Landslide-Mitigation Strategy #1	Increase public education related to landslide hazards by distributing UGS landslide informational brochures to local municipality level emergency mgmt., engineering, and planning departments.	Ongoing	Very minimal	●	●		●	●	
Landslide-Mitigation Strategy #2	Drafting/updating zoning and/or landslide ordinances to prevent development of structures near debris flows, landslides, and rock fall areas.	Ongoing	Minimal					●	●
Landslide-Mitigation Strategy #3	1-Address landslide risk at the building/construction level by requiring all subdivision proposals to have a geotechnical report.	Ongoing	Minimal					●	●
	2-If jurisdiction does not have trained staff to review the geotechnical report, the jurisdiction can, upon request, have UGS perform a review of the report.	Ongoing	Minimal				●	●	●
Wildfire-Mitigation Strategy #1	Promote public awareness campaign for property owners living in wildland urban interface areas.	Ongoing	Unknown	●			●	●	●
Wildfire-Mitigation Strategy #2	1-Continue interagency fuel treatments that are adjacent to and within communities at risk.	Ongoing	Unknown	●			●	●	●

	2-Develop cheatgrass focus areas, to include fire tolerant vegetation and strategic fuel breaks to protect communities at risk.	Ongoing	Unknown	●		●	●	●	●
	3-Encourage landowner mitigation and defensible space work.	Ongoing	Unknown	●			●	●	●
	4-Increase fuels reduction (mowing, fuel breaks/green stripping) along I-15 to decrease fire starts off the interstate.	Ongoing	Unknown	●		●	●	●	●
Wildfire-Mitigation Strategy #3	Develop a community fire plan for the Kolob Terrace and Blue Springs area.	Unknown	Unknown	●	●		●	●	●
Flood-Mitigation Strategy #1	Nonstructural measures appear to be the most prudent option for the county to implement. Zoning to prevent development of structures near all rivers, creeks, and lakes (100' min. setback).	Ongoing	Minimal		●		●		●
Flood-Mitigation Strategy #2	Address flood control at the building/construction level by requiring all subdivision proposals to have a storm water drainage system.	Ongoing	Minimal			●		●	●
Flood-Mitigation Strategy #3	Clear debris and other material from all waterways	Ongoing	Minimal			●		●	●
Flood-Mitigation Strategy #4	A structural alternative would be to construct a levee along Pace Draw creek through town, a levee distance of about 5,000 feet. (New Harmony)	Unknown	$290,893				●	●	●

Earthquake-Mitigation Strategy #1	Increase public education related to earthquake hazards by distributing Utah Seismic Safety Commission informational brochures to County and City emergency management agencies.	Ongoing	Very minimal	●			●		
Earthquake-Mitigation Strategy #2	Continued dedication/vigilance in enforcing the seismic standards established in the International Building Code.	Ongoing	Minimal					●	●
Earthquake-Mitigation Strategy #3	1-Utilize the Earthquake Risk Map provided in this plan as a tool to assess earthquake risks as it relates to any building/subdivision proposals. If deemed necessary, jurisdiction should require the builder/developer to conduct a site-specific earthquake hazard identification/mapping study.	Ongoing	$1,000-$5,000					●	●
	2- At the County level, contract with UGS to formally study/map earthquake hazard areas.	3-5 years	$7,109-$14,218 per jurisdiction				●	●	●
Severe Weather-Mitigation Strategy #1	Continued dedication/vigilance in enforcing the standards established in the International Building Code as it relates to wind-loading, electrical grounding, snow-loading, and other weather-related hazards.	Ongoing	Minimal					●	●
Severe Weather-Mitigation Strategy #2	1-Enhance the Emergency Alert System (tv & radio)	Ongoing	Unknown	●	●		●		
	2-Enhance NOAA Weather Radio All Hazard coverage.	Ongoing	Unknown	●	●		●		

Severe Weather-Mitigation Strategy #3	At the county Local Emergency Planning Committee (LEPC) level, meet the program guidelines then apply to the National Weather Service StormReady Program.	3-5 years	Minimal		●		●	●	●
Drought-Mitigation Strategy #1	1-County-level distribution of water conservation information via newsletter and/or website to affiliated constituents.	Ongoing	Minimal	●		●	●	●	
	2- Water purveyors distribute water conservation information to affiliated constituents.	Ongoing	Minimal	●		●	●	●	
Drought-Mitigation Strategy #2	Develop/demonstrate water conservation practices for agricultural use.	Ongoing	Minimal	●		●	●	●	●
Drought-Mitigation Strategy #3	County-level implementation of mitigation strategies identified in "*Drought in Utah-Learning from the Past-Preparing for the Future.*"	3-5 years	Unknown			●	●	●	●
Radon Gas-Mitigation Strategy #1	Increase public education related to radon gas hazards by distributing Utah Dept. of Environmental Quality informational brochures to County and City planning and engineering departments.	Ongoing	Very minimal	●		●	●	●	●

Radon Gas-Mitigation Strategy #2	Utilize the Radon Risk Map provided in this plan as a tool to assess radon gas risks as it relates to any building/ subdivision proposals. If deemed necessary, jurisdiction should require the builder/ developer to conduct a site-specific radon hazard identification study and implement applicable control techniques.	Ongoing	$25- $1,200	●		●		●	●

Requirement §201.6(c)(3): The plan shall include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.

The following mitigation strategies, listed in accordance to their respective natural hazard, are presented in an effort to provide macro-level risk reduction. Although each mitigation measure is important and achievable, they have been prioritized and listed in order of:

1) Respective amount of potential loss of life/property value as a result of a natural hazard occurrence (as quantified through GIS analysis) ; and
2) Implementation priority through utilization of the STAPLEE process (as explained in Chapter 3 of this Plan and in FEMA 386-3).

PROBLEM SOILS

Problem soils pose a significant hazard to the current/future built environment. This being said, many of these problems can be dramatically reduced through proper assessment of the risk and adherence to applicable mitigation measures. Factors included in assessing problem soils risk include built property distribution in the hazard area. This type of analysis generates estimates of the damages in the county due to problem soils occurrences in the current built environment. The mitigation strategies listed below identify cost effective measures that will yield measurable benefits toward reducing the risk of problem soils as they relate to the built environment. Further, these mitigation strategies include general actions that agencies are capable of implementing during the next five years, given their existing resources and authorities.

Problem Soils Mitigation Strategy #1	
Objective:	Lessen the risk to buildings from problem soils.
Action:	1-Address problem soils at the building/construction level by requiring all subdivision proposals to have a geotechnical report. 2-If jurisdiction does not have trained staff to review the

	geotechnical report, the jurisdiction can, upon request, have Utah Geological Survey (UGS) perform a review of the report.
Timeline:	Ongoing
Estimated Cost:	$1,000 to $5,000
Possible Funding:	Private funds/ developer; Local government operating budget; Utah Geologic Survey operating budget.
Responsible Agencies:	Local, jurisdictional level; Utah Geological Survey

Problem Soils Mitigation Strategy #2	
Objective:	To reduce problem soils related losses by mapping and identifying problem soils hazard areas.
Action:	Utilize the Problem Soils Risk Map provided in this plan as a tool to assess problem soils risks as it relates to any building/subdivision proposals. If deemed necessary, jurisdiction should require the builder/developer to conduct a site-specific geotechnical (soils) report.
Timeline:	Ongoing
Estimated Cost:	$1,000 to $5,000
Possible Funding:	Private funds/ developer; Local government operating budget
Responsible Agencies:	Local, jurisdictional level; Private property owner.

Problem Soils Mitigation Strategy #3	
Objective:	Lessen the risk to buildings from collapsible and expansive soils.
Action:	Through mapping, identify areas which contain collapsible and expansive soils. Require soils testing at the building/construction level and ensure that engineer's recommendations are followed.
Timeline:	Ongoing
Estimated Cost:	$1,000 to $5,000
Possible Funding:	Private funds/ developer; Local government operating budget.
Responsible Agencies:	Local, jurisdictional level.

LANDSLIDE

Factors included in assessing landslide risk include built property distribution in the hazard area, the frequency of landslide or debris flow occurrences, slope steepness, and soil characteristics. This type of analysis generates estimates of the damages to the county due to a landslide or debris flow event on the current built environment. The mitigation strategies listed below identify cost effective measures that will yield measurable benefits toward reducing the risk of landslide hazards.

Landslide Mitigation Strategy #1	
Objective:	Increase the level of knowledge related to landslides.
Action:	Increase public education related to landslide hazards by distributing

	Utah Geological Survey (UGS) landslide informational brochures to local municipality level emergency management, engineering and planning departments.
Timeline:	Ongoing
Estimated Cost:	Very Minimal: request UGS to deliver brochures; and/or download brochures directly from: http://geology.utah.gov
Possible Funding:	Local, jurisdictional level.
Responsible Agencies:	Local, jurisdictional level.

Landslide Mitigation Strategy #2	
Objective:	Minimize future landslide damage in the unincorporated County.
Action:	Drafting/updating zoning and/or landslide ordinances to prevent development of structures near debris flows, landslides, and rock fall areas.
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	Local government operating budget; State and Federal planning grant programs.
Responsible Agencies:	Local government

As part of this NHMP Update process, Five County Association of Governments developed a *Natural Hazards Questionnaire* in an effort to solicit information from a sampling of citizens. Of the responses obtained through this questionnaire, 67% of the respondents indicated they would be willing to spend more money on a home/business that had features that made it more disaster resistant.

Landslide Mitigation Strategy #3	
Objective:	To reduce landslide risk as it relates to the built environment.
Action:	1-Address landslide risk at the building/construction level by requiring all subdivision proposals to have a geotechnical report. 2-If jurisdiction does not have trained staff to review the geotechnical report, the jurisdiction can, upon request, have Utah Geological Survey (UGS) perform a review of the report.
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	Private funds/ developer; Local government operating budget; Utah Geologic Survey operating budget.
Responsible Agencies:	Local, jurisdictional level; Utah Geological Survey

WILDFIRE

The Color Country Interagency Fire Center Fuels Committee has identified the general location of ten "Focus Areas" within the southwest Utah region. The selection of these specific areas was

based on the need for fuels reductions as understood by fuels specialists and fire wardens, risk levels in the Regional Wildfire Protection Plan risk assessment, values at risk in the area, firefighting concerns including access and evacuation routes, the presence of Communities At Risk (CARs), and local interest in the community documented by having a Community Wildfire Protection Plan in place.

The Color Country Interagency Fire Center Fuels Committee has not prioritized these ten focus areas. The Committee determined that to do so would have the effect of minimizing the fact that every one of these areas is in need of treatment and all are of concern. Each focus area also includes a list of general goals resulting from activities and treatments for the area.

Goals common to all treatment areas include fuels reduction, public education, and increases in equipment and training available to firefighting personnel. Goals that are generally applicable to all of the focus areas include the following:

- Protection of human life, firefighter and public safety as the highest priority.
- Public education and partnerships with citizens or community-centered approaches to manage fire risks and hazards in WUI areas located in the focus area, including effort aimed towards the implementation and maintenance of defensible space projects to reduce risk to homes and personal property.
- Protection of high value resources and watersheds through fuels reduction treatments as determined locally.
- Restoration and maintenance of ecosystems consistent with land uses and historic fire regimes. Restoration of vegetation to the appropriate Condition Classes and Fire Regimes.
- Maintenance and/or improvement of fire prevention and road/structure identification signage. Dissemination of fire restriction information through appropriate signage and/or visitor contacts when necessary.
- Improvement of wildland firefighting equipment, training and information for volunteer fire departments located in the focus area, including the improvement of GIS and road data.

The ten Focus Areas, as they pertain to Washington County, developed by the Color Country Interagency Fire Center Fuels Committee include the 1) Central/Dixie Deer, 2) New Harmony, and the 3) Kolob Terrace Focus Areas. This being said, the Communities at Risk within Washington County (from high to medium risk) include: Brookside, Central, Pine Valley, Pintura, Zion Panorama, Black Ridge Ranches, Blue Springs, Dammeron Valley, Diamond Valley, Kolob Terrace, Motoqua, Mountain Meadow, New Harmony, Pinto, Shivwits, Veyo, Anderson Jct., Bloomington, Gunlock, Rockville, Santa Clara, Silver Reef, Springdale, Toquerville, Virgin, Winchester Hills, Enterprise, LaVerkin, Leeds, Washington, Apple Valley, Grass Valley, Harrisburg, Hilldale, Hurricane, St. George, and Ivins.

As part of this NHMP Update process, Five County Association of Governments developed a *Natural Hazards Questionnaire* in an effort to solicit information from a sampling of citizens. Of

the responses obtained through this questionnaire, 67% of the respondents indicated they would be willing to spend more money on a home/business that had features that made it more disaster resistant. Further, 41% of the respondents indicated they were extremely/very concerned about the wildfire risks within the county.

Wildfire Mitigation Strategy #1	
Objective:	Promote public awareness campaign for property owners living in wildland urban interface areas.
Action:	Mailings; Printed Information; Public Service Announcements;
Timeline:	Ongoing
Estimated Cost:	Unknown
Possible Funding:	State and Federal wildfire grant programs
Responsible Agencies:	State and Federal government

The primary concern within the Central/Dixie Deer Focus Area is that the expanding cheatgrass increases the risk for fast moving fires, especially in dry, windy conditions. The Communities at Risk within this focus area are: Brookside, Central, Dixie Deer, Pine Valley, and Veyo.

The primary concern within the New Harmony Focus Area is the dense stands of pinyon-juniper, chaparral and oak along steeper slopes can increase rapid fire spread. The Communities at Risk within this focus area are: Chekshani, Kanarraville, Black Ridge Ranches, New Harmony, New Harmony Heights, and Pintura.

The primary concern within the Kolob Terrace Focus Area is that most of the area consists of slopes greater than 20%. The steep slopes, combined with many different aspects, create extreme fie behavior and risk to firefighters. The Communities at Risk within this focus area are: Kolob Terrace, and Blue Springs.

Wildfire Mitigation Strategy #2	
Objective:	Fuels reduction.
Action:	1-Continue interagency fuel treatments that are adjacent to and within communities at risk. 2-Develop cheatgrass focus areas, to include fire tolerant vegetation and strategic fuel breaks to protect communities at risk. 3-Encourage landowner mitigation and defensible space work. 4-Increase fuels reduction (mowing, fuel breaks/green stripping) along I-15 to decrease fire starts off the interstate.
Timeline:	Ongoing
Estimated Cost:	Unknown
Possible Funding:	Local government operating budget; Special Service District

	operating budget; private property owner
Responsible Agencies:	Community & local government entities; private property owner

Wildfire Mitigation Strategy #3	
Objective:	Develop a community fire plan for the Kolob Terrace and Blue Springs area.
Action:	
Timeline:	Unknown (dependent upon funding and community interest)
Estimated Cost:	Unknown
Possible Funding:	Local government operating budget; Special Service District operating budget; private property owner
Responsible Agencies:	Community & local government entities; private property owner

FLOOD

The Army Corps of Engineers *Flood Hazard Identification Study* (August, 2003), identifies areas with a high flood hazard and identifies potential mitigation solutions. The following prioritized mitigation strategies are provided from this Study as well as from the Five County *Natural Hazard Mitigation Plan (2004).*

As part of this NHMP Update process, Five County Association of Governments developed a *Natural Hazards Questionnaire* in an effort to solicit information from a sampling of citizens. Of the responses obtained through this questionnaire, 67% of the respondents indicated they would be willing to spend more money on a home/business that had features that made it more disaster resistant. Further, 37% of the respondents indicate they are extremely/very concerned about the flood risks found within the county. Interestingly, 85% of the county households and/or businesses do not have insurance coverage for flood events.

Flood Mitigation Strategy #1	
Objective:	Minimize future flood damage in the unincorporated County.
Action:	Nonstructural measures appear to be the most prudent option for the county to implement. Zoning to prevent development of structures near all rivers, creeks, and lakes (100' min. setback).
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	Local government operating budget; State and Federal flood and planning grant programs
Responsible Agencies:	Local government

Washington County addresses flood hazards through implementation of its comprehensive flood control Code. The purpose of this code section is to minimize public and private losses due to flood conditions in specific areas. This is accomplished by requiring all new construction

and substantial improvements to minimize flood damage. In concert with this purpose, the following mitigation strategy is provided.

Flood Mitigation Strategy #2	
Objective:	To reduce flooding risk as it relates to the built environment.
Action:	Address flood control at the building/construction level by requiring all subdivision proposals to have a storm water drainage system.
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	Private funds/ developer.
Responsible Agencies:	Local, jurisdictional level.

Flood Mitigation Strategy #3	
Objective:	To reduce flooding risk at the community level.
Action:	Clear debris and other material from all waterways.
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	Related public/private property owners.
Responsible Agencies:	Private property owners, irrigation companies, local jurisdictions.

As a result of the Army Corps of Engineers *Flood Hazard Identification Study* (August, 2003), the following mitigation strategies are provided.

Flood Mitigation Strategy #4	
Objective:	Minimize future flood damage in New Harmony.
Action:	A structural alternative would be to construct a levee along Pace Draw creek through town, a levee distance of about 5,000 feet.
Timeline:	Unknown
Estimated Cost:	$290,893 (2003 cost, inflation adjusted)
Possible Funding:	Local government operating budget; State and Federal flood grant programs
Responsible Agencies:	Local government

EARTHQUAKE

Earthquake mitigation strategies include general mitigation actions that agencies are capable of implementing during the next five years, given their existing resources and authorities. In addition to the earthquake mitigation strategies provided herewith, this Natural Hazard Mitigation Plan endorses any seismic mitigation proffered by the Utah Seismic Safety Commission. In particular, numerous and varied earthquake mitigation strategies are provided in *A Strategic Plan for Earthquake Safety in Utah (January, 1995)* completed by the Utah Seismic Safety Commission. It is highly recommended that jurisdictions whom desire to provide more specific

earthquake mitigation strategies consult the aforementioned plan, which can be accessed at: http://ussc.utah.gov/.

Earthquake Mitigation Strategy #1	
Objective:	Promote building safety through non-structural improvements.
Action:	Increase public education related to earthquake hazards by distributing Utah Seismic Safety Commission informational brochures to County and City emergency management agencies.
Timeline:	Ongoing
Estimated Cost:	Very Minimal: request Utah Seismic Safety Commission to deliver brochures; and/or download brochures directly from: http://ussc.utah.gov/
Possible Funding:	County and City operating budget; Utah Seismic Safety Commission operating budget.
Responsible Agencies:	Local, jurisdictional level.

As part of this NHMP Update process, Five County Association of Governments developed a *Natural Hazards Questionnaire* in an effort to solicit information from a sampling of citizens. Of the responses obtained through this questionnaire, 67% of the respondents indicated they would be willing to spend more money on a home/business that had features that made it more disaster resistant. Further, 70% of the respondents indicated that their household/business does not have insurance coverage for earthquake events.

Earthquake Mitigation Strategy #2	
Objective:	To reduce earthquake risk as it relates to the built environment.
Action:	Continued dedication/vigilance in enforcing the seismic standards established in the International Building Code (IBC).
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	County or City government operating budget (where applicable).
Responsible Agencies:	County or City government (where applicable).

Earthquake Mitigation Strategy #3	
Objective:	To reduce earthquake losses by mapping and identifying earthquake hazard areas.
Action:	1-Utilize the Earthquake Risk Map provided in this plan as a tool to assess earthquake risks as it relates to any building/subdivision proposals. If deemed necessary, jurisdiction should require the builder/developer to conduct a site-specific earthquake hazard identification/mapping study. 2-At the County level, contract with Utah Geological Survey (UGS) to formally study/map earthquake hazard areas.

Timeline:	Action 1-Ongoing Action 2- 3 to 5 years
Estimated Cost:	Action 1-$1,000 to $5,000 Action 2- $7,109 to $14,218 per jurisdiction (1995 cost as reflected in *A Strategic Plan for Earthquake Safety in Utah* adjusted for inflation)
Possible Funding:	Action 1-Private funds/ developer. Action 2- Local government operating budget; Utah Geologic Survey operating budget.
Responsible Agencies:	Local, jurisdictional level; Private property owner; Utah Geological Survey

SEVERE WEATHER

Quantitative assessment of severe weather vulnerability and determining which specific areas of the county are more vulnerable is very challenging. This being said, the vulnerability assessment quantified the number of units and total market value for all structures located within a defined severe weather hazard area; said area includes: known lightning deaths, lightning intensity (based upon actual lighting strike data), and tornado touchdowns. The following severe weather hazard mitigation strategies are specific to the aforementioned severe weather hazards.

As part of this NHMP Update process, Five County Association of Governments developed a *Natural Hazards Questionnaire* in an effort to solicit information from a sampling of citizens. Of the responses obtained through this questionnaire, 67% of the respondents indicated they would be willing to spend more money on a home/business that had features that made it more disaster resistant. Further, 44% indicated their preference for receiving severe weather information would be through the radio, internet and/or television sources.

Severe Weather Mitigation Strategy #1	
Objective:	To reduce severe weather risk as it relates to the built environment.
Action:	Continued dedication/vigilance in enforcing the standards established in the International Building Code (IBC) as it relates to wind-loading, electrical grounding, snow-loading, and other weather-related hazards.
Timeline:	Ongoing
Estimated Cost:	Minimal
Possible Funding:	County or City government operating budget (where applicable).
Responsible Agencies:	County or City government (where applicable).

Severe Weather Mitigation Strategy #2	
Objective:	Ensure that the general public is warned of severe weather occurrences via broadcast media.
Action:	1-Enhance the Emergency Alert System (television and radio). 2-Enhance NOAA Weather Radio All Hazard coverage.

Timeline:	Ongoing
Estimated Cost:	Unknown
Possible Funding:	Federal and State government operating budget.
Responsible Agencies:	Federal and State government.

Nearly 90% of all presidentially declared disasters are weather related. In an effort to guard against the negative effects of severe weather, the National Weather Service has designed the StormReady program. This program is a nationwide community preparedness program that uses an approach which helps communities develop plans to handle all types of severe weather. To be classified as a StormReady community several criteria must be met; however, the county Local Emergency Planning Committee (LEPC) is positioned well to satisfy the StormReady application/program guidelines. Ultimately the benefit of becoming formally recognized as a StormReady community lies in the additional planning/preparation/preparedness for severe weather occurrences; however, some grant opportunities are available through the National Weather Service as well as possible adjustment to insurance rates through the Insurance Services Organization (ISO).

Severe Weather Mitigation Strategy #3	
Objective:	Guard against the negative effects of severe weather by becoming a StormReady community.
Action:	At the county Local Emergency Planning Committee (LEPC) level, meet the program guidelines then apply to the National Weather Service StormReady program.
Timeline:	3 to 5 years
Estimated Cost:	Minimal
Possible Funding:	County and City operating budget.
Responsible Agencies:	County and City government.

APPENDIX A- MAPS

FIVE COUNTY REGION MAPS

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WILDFIRE……...…….10-23

FLOOD……..……....……...….10-27

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APPENDIX B- GIS METADATA

NATURAL HAZARD MITIGATION PLAN GIS METADATA

A Geographic Information System was used, to the extent that data was available, to identify specific natural hazards and provide a vulnerability assessment as it relates to natural hazard events in the Five County region. Information about the data used to create the maps is contained in this appendix. For further information about the data used or the process involved in generating hazard identification maps, contact the Five County Association of Governments Community and Economic Development staff.

BACKGROUND IMAGERY

File	Name	Source
DEM5m.gdb/DEMasc5m	Digital Elevation Model 5 meter	AGRC, FCAOG
DEM5m.gdb/HillShade5m	Hillshade 5 meter accuracy	AGRC, FCAOG

BOUNDARIES/CADASTRAL

File	Name	Source
B_Output.gdb/B_Owner	Beaver Land Ownership	AGRC
B_Output.gdb/B_Owner09	Beaver Land Ownership	AGRC
B_Output.gdb/BeaverCounty	Beaver County Boundary	AGRC
B_Output.gdb/BeaverMunicipalities	Beaver County Municipalities	AGRC
G_Output.gdb/G_ControlPnt	Garfield County PLSS Control Points	AGRC
G_Output.gdb/G_Municipalities	Garfield County Municipalities	AGRC
G_Output.gdb/G_Owner	Garfield Land Ownership	AGRC
G_Output.gdb/G_Quarter	Garfield County PLSS Quarter Divisions	AGRC
G_Output.gdb/G_SecDiv	Garfield County PLSS Second Div Quarter	AGRC
G_Output.gdb/G_Sections	Garfield County PLSS Sections	AGRC
G_Output.gdb/G_Township	Garfield County PLSS Townships	AGRC
G_Output.gdb/GarfieldCounty	Garfield County Boundary	AGRC
G_Output.gdb/Municipalities	Garfield County Municipalities	AGRC
I_Output.gdb/I_Municipalities	Iron County Municipalities	AGRC
I_Output.gdb/I_Owner	Iron Land Ownership	AGRC
I_Output.gdb/IronCounty	Iron County Boundary	AGRC
K_Output.gdb/K_Municipalities	Kane County Municipalities	AGRC
K_Output.gdb/K_Owner	Kane County Land Ownership	AGRC
K_Output.gdb/K_Owner09	Kane County Land Ownership	AGRC
K_Output.gdb/K_Township	Kane County PLSS Township	AGRC
K_Output.gdb/KaneConty	Kane County Boundary	AGRC
W_Output.gdb/W_Municipalities	Washington County Municipalities	AGRC
W_Output.gdb/W_Owner	Washington County Land Ownership	AGRC
W_Output.gdb/W_Parcels	Washington County Parcels	AGRC
W_Output.gdb/WashingtonCounty	Washington County Boundary	AGRC
Counties.shp	State Wide County Boundaries	AGRC
FiveCounties.shp	Region Wide County Boundaries	AGRC
Municipalities.shp	Region Wide Municipalities	AGRC
Overlap.shp	Overlap of Region Boundaries	FCAOG GIS
Quads100k.shp	Region PLSS Quads 100k Scale	AGRC
Quads24k.shp	Region PLSS Quads 24k Scale	AGRC

Sections.shp	Region PLSS Sections	AGRC
State.shp	State Boundary	AGRC
StateOwner.shp	State Wide Ownership 2009	AGRC

CRITICAL FACILITIES

File	Name	Source
CritFacil.gdb/Airports500k	500k State Wide Airports	AGRC
CritFacil.gdb/CommunicationTowersGNIS	Radio, Television, Transmission Towers	AGRC
CritFacil.gdb/ElectricalLines	State Wide Electrical Lines	AGRC
CritFacil.gdb/FireStations	State Wide Fire Stations	AGRC
CritFacil.gdb/HealthCareFacilities	State Wide Health Care Facilities	AGRC
CritFacil.gdb/Hospitals	State Wide Hospitals	AGRC
CritFacil.gdb/HospitalsGNIS	State Wide Hospitals	AGRC
CritFacil.gdb/LawEnforcement	State Wide Law Enforcement Offices	AGRC
CritFacil.gdb/OilGasPipelines	State Wide Oil and Gas Pipelines	AGRC
CritFacil.gdb/PoliceStations	State Wide Police Stations	AGRC
CritFacil.gdb/PublicFacilitiesESRI	Schools, prisons, cemeteries, etc.	AGRC
CritFacil.gdb/Schools	Schools, Colleges, Private Schools	AGRC
CritFacil.gdb/StateFacilities	State Controlled or Operated Facilities	AGRC
CritFacil.gdb/StateGovernmentBuildings	State Controlled or Operated Facilities	AGRC
CritFacil.gdb/TransmissionLines	Major Power Lines	AGRC
FiveCritFac.gdb/Airports500k	500k Region Wide Airports	AGRC
FiveCritFac.gdb/CommunicationTowers	Radio, Television, Transmission Towers	AGRC
FiveCritFac.gdb/FireStations	Region Wide Fire Stations	AGRC
FiveCritFac.gdb/HealthCareFacilities	Region Wide Health Care Facilities	AGRC
FiveCritFac.gdb/LawEnforcement	Region Wide Law Enforcement Offices	AGRC
FiveCritFac.gdb/PublicFacilitiesESRI	Schools, prisons, cemeteries, etc.	AGRC
FiveCritFac.gdb/Schools	Schools, Colleges, Private Schools	AGRC
FiveCritFac.gdb/StateFacilities	State Controlled or Operated Facilities	AGRC
Hospitals_SW.shp	State Wide Hospitals	AGRC
LawEnforcement_SW.shp	State Wide Law Enforcement Offices	AGRC
PoliceStations_SW.shp	State Wide Police Stations	AGRC
PowerLinesAGRC.shp	State Wide Power Lines	AGRC
SGID_U024_FireStations.shp	State Wide Fire Stations	AGRC
StateFacilities_SW.shp	State Controlled or Operated Facilities	AGRC

DROUGHT

File	Name	Source
Drought.gdb/Climate_Divisions	State Wide Climate Divisions	AGRC
Drought.gdb/ClimateDivisions_5C GIS	State Wide Climate Divisions	AGRC, NOAA, FCAOG
Pdi1895.gif	Palmer Drought Severity Index Map	NOAA

EARTHQUAKE

File	Name	Source
Earthquake.gdb/Faults500k	Faults at 500k scale	AGRC
Earthquake.gdb/Fin_FltBuf	Surface Rupture Zones	FCAOG, AGRC, UGS

FLOOD

File	Name	Source
Flood.gdb/WashFlood	Washington Flood Zones	FEMA
bcfloodzones.shp	Beaver Flood Zones	FEMA, FCAOG
gcfloodzones.shp	Garfield Flood Zones	FEMA, FCAOG
icfloodzones.shp	Iron Flood Zones	FEMA, FCAOG
kcfloodzones.shp	Kane Flood Zones	FEMA, FCAOG

HYDROLOGY

File	Name	Source
B_Output.gdb/B_Rivers	Beaver Rivers	AGRC
B_Output.gdb/BHLakes	Beaver High Resolution Lakes	AGRC
G_Output.gdb/G_Lakes	Garfield Lakes	AGRC
G_Output.gdb/G_Rivers	Garfield Rivers	AGRC
G_Output.gdb/Lakes	Garfield Lakes	AGRC
G_Output.gdb/Rivers	Garfield Rivers	AGRC
I_Output.gdb/I_Lakes	Iron Lakes	AGRC
I_Output.gdb/I_Rivers	Iron Rivers	AGRC
I_Output.gdb/Lakes	Iron Lakes	AGRC
I_Output.gdb/Rivers	Iron Rivers	AGRC
K_Output.gdb/K_Lakes	Kane Lakes	AGRC
K_Output.gdb/K_Rivers	Kane Rivers	AGRC
W_Output.gdb/W_Lakes	Washington Lakes	AGRC
W_Output.gdb/W_River	Washington River	AGRC
HighResLakes.shp	Statewide High Resolution Lakes	AGRC
HighResStream.shp	Region Wide High Resolution Streams	AGRC
Lakes.shp	Statewide Lakes	AGRC
Rivers.shp	Statewide Rivers	AGRC

LANDSLIDE

File	Name	Source
landslide1	Region Wide Landslide Potential	AGRC, FCAOG
BeavLand.gdb/B_Slide	Beaver Landslide Potential Polygon	AGRC, FCAOG
GarLand.gdb/G_Slide	Garfield Landslide Potential Polygon	AGRC, FCAOG
IronLand.gdb/I_Slide	Iron Landslide Potential Polygon	AGRC, FCAOG
KaneLand.gdb/K_Slide	Kane Landslide Potential Polygon	AGRC, FCAOG
WashLand.gdb/W_Slide	Washington Landslide Potential Polygon	AGRC, FCAOG

PARCELS

File	Name	Source
BeaverParcels.shp	Beaver County Parcels	Beaver County
Beaver.gdb/B_Sections_Erase	Sections used to fill gaps in Parcels	AGRC, FCAOG
Beaver.gdb/B_Sections	Beaver Sections	AGRC
Beaver.gdb/B_TaxImprove	Tax Database of all Improved Parcels	Beaver County
Beaver.gdb/BeaverParcels	Beaver Parcels	Beaver County
Beaver.gdb/BeaverTax	Full Beaver Tax Database	Beaver County

Beaver.gdb/Improv_Sec	Tax Database for related Sections	FCAOG
Referance.gdb/working/Gar_Par	Garfield Parcels	FCAOG, Garfield County
Referance.gdb/working/GarPar_Topology	Garfield Parcel Topology	FCAOG, Garfield County
Referance.gdb/ Gar_Par_Analysis	Garfield Parcels for Analysis	FCAOG, Garfield County
Referance.gdb/GarImprove	Garfield Improved Parcel Tax Database	Garfield County
Iron09_Parcels.gdb/Iron09_Edits	Iron Parcels	Iron County
IronTax.gdb/IronTaxdb	Iron Tax Database	Iron County
Kane.gdb/Kane44_41Comp	Kane Parcels	Kane County
Kane.gdb/Kane_ParT	Kane Parcels	AGRC
K_Output.gdb/K_Owner_PLS_Erase_all	Sections used to fill gaps in Parcels	FCAOG,AGRC
Kane.gdb/KaneTax	Kane Tax Database	Kane County
Kane.gdb/TaxSections2	Kane Tax Database For Sections	Kane County
W_Tax.gdb/ParcelsGD	Washington Parcels	Washington GIS
W_Tax.gdb/W_TaxGD	Washington Tax Database	Washington County

PROBLEM SOILS

File	Name	Source
Soils.gdb/AGRCSoil24k	AGRC Soils at 24k scale	AGRC
Soils.gdb/ProblemSoils500	AGRC Problem Soils at 500k scale	AGRC
hydrocompaction soils.shp	Cedar City Problem Soils	Cedar City GIS Department
hydrocompaction soils point.shp	Cedar City Problem Soils Point	Cedar City GIS Department

RADON

File	Name	Source
Radon.gdb/Radon	Radon Risk Areas	FCAOG

TRANSPORTATION

File	Name	Source
B_Output.gdb/B_Hwy	Beaver Highways	AGRC
B_Output.gdb/B_Hwy_Clip	Beaver Highways	AGRC
B_Output.gdb/B_Streets	Beaver Streets	AGRC
B_Output.gdb/B_Streets09	Beaver Streets	AGRC
G_Output.gdb/G_Hwy	Garfield Highways	AGRC
G_Output.gdb/G_Streets	Garfield Streets	AGRC
G_Output.gdb/Hwy	Garfield Highways	AGRC
I_Output.gdb/Hwy	Iron Highways	AGRC
I_Output.gdb/I_Hwy	Iron Highways	AGRC
I_Output.gdb/I_Streets	Iron Streets	AGRC
I_Output.gdb/I_Streets09	Iron Streets	AGRC
K_Output.gdb/K_Highways	Kane Highways	AGRC
K_Output.gdb/K_Streets	Kane Streets	AGRC
K_Output.gdb/K_Streets09	Kane Streets	AGRC
W_Output.gdb/W_Highways	Washington Highways	AGRC
W_Output.gdb/W_Streets09	Washington Streets	AGRC
FiveCnty.gdb/Five_Streets09	Region wide 2009 Streets	AGRC
Highways.shp	Region wide highways	AGRC
HighwaysRegion.shp	Modified Region wide highways	AGRC
Streets09.shp	Statewide streets 2009	AGRC

VOLCANO

File	Name	Source
Volcano.gdb/VolcanicFlow100k	Volcanic Flows	AGRC
Volcano.gdb/VolcanicVents100k	Volcanic Vents	AGRC
VolcanicFlow100k.shp	Volcanic Flows	AGRC
VolcanicFlow100k.shp	Volcanic Flows	AGRC

VULNERABILITY ASSESSMENT TABLES

File	Name	Source
beaver_com_par_fault.csv	Beaver Property Values Faults	FCAOG GIS, Tax Database
beaver_res_par_fault.csv	Beaver Property Values Faults	FCAOG GIS, Tax Database
beaver_com_par_Fire3.csv	Beaver Property Values Wildfire	FCAOG GIS, Tax Database
beaver_com_sec_Fire4.csv	Beaver Property Values Wildfire	FCAOG GIS, Tax Database
beaver_res_par_Fire3.csv	Beaver Property Values Wildfire	FCAOG GIS, Tax Database
beaver_res_par_Fire4.csv	Beaver Property Values Wildfire	FCAOG GIS, Tax Database
beaver_com_sec_Slide3.csv	Beaver Property Values Landslide	FCAOG GIS, Tax Database
beaver_res_par_Slide3.csv	Beaver Property Values Landslide	FCAOG GIS, Tax Database
beaver_res_lstn.csv	Beaver Property Values Problem Soils	FCAOG GIS, Tax Database
beaver_com_sec_weather.csv	Beaver Property Values Weather	FCAOG GIS, Tax Database
beaver_res_lighting3.csv	Beaver Property Values Weather	FCAOG GIS, Tax Database
beaver_res_sec_weather.csv	Beaver Property Values Weather	FCAOG GIS, Tax Database
G_Faults_Com_Statistics.csv	Garfield Property Values Faults	FCAOG GIS, Tax Database
G_Faults_Res_Statistics.csv	Garfield Property Values Faults	FCAOG GIS, Tax Database
G_Fire3_Com_Statistics.csv	Garfield Property Values Wildfire	FCAOG GIS, Tax Database
G_Fire3_Res_Statistics.csv	Garfield Property Values Wildfire	FCAOG GIS, Tax Database
G_Fire4_Com_Statistics.csv	Garfield Property Values Wildfire	FCAOG GIS, Tax Database
G_Fire4_Res_Statistics.csv	Garfield Property Values Wildfire	FCAOG GIS, Tax Database
G_Flood_Com_Statistics.csv	Garfield Property Values Flood	FCAOG GIS, Tax Database
G_Flood_Res_Statistics.csv	Garfield Property Values Flood	FCAOG GIS, Tax Database
G_Slide3_Com_Statistics.csv	Garfield Property Values Landslide	FCAOG GIS, Tax Database
G_Slide3_Res_Statistics.csv	Garfield Property Values Landslide	FCAOG GIS, Tax Database
G_Soils_Com_Statistics.csv	Garfield Property Values Problem Soils	FCAOG GIS, Tax Database
G_Soils_Res_Statistics.csv	Garfield Property Values Problem Soils	FCAOG GIS, Tax Database
G_Volcano_Res_Statistics.csv	Garfield Property Values Volcanoes	FCAOG GIS, Tax Database
G_Weather3_Com_Statistics.csv	Garfield Property Values Weather	FCAOG GIS, Tax Database
G_Weather3_Res_Statistics.csv	Garfield Property Values Weather	FCAOG GIS, Tax Database
G_Weather4_Com_Statistics.csv	Garfield Property Values Weather	FCAOG GIS, Tax Database
G_Weather4_Res_Statistics.csv	Garfield Property Values Weather	FCAOG GIS, Tax Database
i_fualts_com_sum.csv	Iron Property Values Faults	FCAOG GIS, Tax Database
i_fualts_res_sum.csv	Iron Property Values Faults	FCAOG GIS, Tax Database
I_Fire3_Com_Statistics.csv	Iron Property Values Wildfire	FCAOG GIS, Tax Database
I_Fire3_Res_Statistics.csv	Iron Property Values Wildfire	FCAOG GIS, Tax Database
I_Fire4_Res_Statistics.csv	Iron Property Values Wildfire	FCAOG GIS, Tax Database
I_Floods_Com_Statistics.csv	Iron Property Values Floods	FCAOG GIS, Tax Database
I_Floods_Res_Statistics.csv	Iron Property Values Floods	FCAOG GIS, Tax Database
I_Slide3_Com_Statistics.csv	Iron Property Values Landslide	FCAOG GIS, Tax Database
I_Slide3_Res_Statistics.csv	Iron Property Values Landslide	FCAOG GIS, Tax Database
I_Slide4_Res_Statistics.csv	Iron Property Values Landslide	FCAOG GIS, Tax Database
I_Soils_Com_Statistics.csv	Iron Property Values Problem Soils	FCAOG GIS, Tax Database
I_Soils_Res_Statistics.csv	Iron Property Values Problem Soils	FCAOG GIS, Tax Database

I_Volcano_Com_Statistics.csv	Iron Property Values Volcanoes	FCAOG GIS, Tax Database
I_Volcano_Res_Statistics.csv	Iron Property Values Volcanoes	FCAOG GIS, Tax Database
i_lightning3_com_statistics.csv	Iron Property Values Weather	FCAOG GIS, Tax Database
i_lightning3_res_statistics.csv	Iron Property Values Weather	FCAOG GIS, Tax Database
K_Faults_Com_Statistics.csv	Kane Property Values Faults	FCAOG GIS, Tax Database
K_Faults_Res_Statistics.csv	Kane Property Values Faults	FCAOG GIS, Tax Database
K_Fire3_Com_Statistics.csv	Kane Property Values Wildfire	FCAOG GIS, Tax Database
K_Fire3_Res_Statistics.csv	Kane Property Values Wildfire	FCAOG GIS, Tax Database
K_Fire4_Com_Statistics.csv	Kane Property Values Wildfire	FCAOG GIS, Tax Database
K_Fire4_Res_Statistics.csv	Kane Property Values Wildfire	FCAOG GIS, Tax Database
K_Flood_Com_Statistics.csv	Kane Property Values Flood	FCAOG GIS, Tax Database
K_Flood_Res_Statistics.csv	Kane Property Values Flood	FCAOG GIS, Tax Database
K_Slide3_Com_Statistics.csv	Kane Property Values Landslide	FCAOG GIS, Tax Database
K_Slide3_Res_Statistics.csv	Kane Property Values Landslide	FCAOG GIS, Tax Database
K_Slide4_Res_Statistics.csv	Kane Property Values Landslide	FCAOG GIS, Tax Database
K_SoilDun_Res_Statistics.csv	Kane Property Values Problem Soils	FCAOG GIS, Tax Database
K_SoilsExpan_Res_Statistics.csv	Kane Property Values Problem Soils	FCAOG GIS, Tax Database
K_SoilsExpan_sec_Com_Statistics.csv	Kane Property Values Problem Soils	FCAOG GIS, Tax Database
K_VolFlow_Res_Statistics.csv	Kane Property Values Volcanoes	FCAOG GIS, Tax Database
K_VolFlow_sec_Com_Statistics.csv	Kane Property Values Volcanoes	FCAOG GIS, Tax Database
K_lghting3_Res_Statistics.csv	Kane Property Values Weather	FCAOG GIS, Tax Database
W_Faults_Com_Statistics.csv	Washington Property Values Faults	FCAOG GIS, Tax Database
W_Faults_Res_Statistics.csv	Washington Property Values Faults	FCAOG GIS, Tax Database
W_Fire3_Com_Statistics.csv	Washington Property Values Wildfire	FCAOG GIS, Tax Database
W_Fire3_Res_Statistics.csv	Washington Property Values Wildfire	FCAOG GIS, Tax Database
W_Fire4_Res_Statistics.csv	Washington Property Values Wildfire	FCAOG GIS, Tax Database
W_Floods_Com_Statistics.csv	Washington Property Values Flood	FCAOG GIS, Tax Database
W_Floods_Res_Statistics.csv	Washington Property Values Flood	FCAOG GIS, Tax Database
W_Landslide3_Com_Statistics.csv	Washington Property Values Landslide	FCAOG GIS, Tax Database
W_Landslide3_Res_Statistics.csv	Washington Property Values Landslide	FCAOG GIS, Tax Database
W_Landslide4_Com_Statistics.csv	Washington Property Values Landslide	FCAOG GIS, Tax Database
W_Landslide4_Res_Statistics.csv	Washington Property Values Landslide	FCAOG GIS, Tax Database
W_Soils_Com_Statistics.csv	Washington Property Values Problem Soils	FCAOG GIS, Tax Database
W_Soils_Res_Statistics.csv	Washington Property Values Problem Soils	FCAOG GIS, Tax Database
W_Volcanic_Com_Statistics.csv	Washington Property Values Volcanoes	FCAOG GIS, Tax Database
W_Volcanic_Res_Statistics.csv	Washington Property Values Volcanoes	FCAOG GIS, Tax Database
W_lightning3_com_Statistics.csv	Washington Property Values Weather	FCAOG GIS, Tax Database
W_lightning3_res_Statistics.csv	Washington Property Values Weather	FCAOG GIS, Tax Database

WEATHER

File	Name	Source
density3and4	Lightning Density High and Medium Risk	USPLN/WSI, FCAOG
density8	Lightning Density in 8 categories	USPLN/WSI, FCAOG
k1	Lightning Density Raw Data	USPLN/WSI, FCAOG
Weather.gdb/Lightning_Death	Lightning Strike Deaths	NOAA, FCAOG
Weather.gdb/Tornado_Touchdown	Tornado Touch Downs	NOAA

WILDFIRE

File	Name	Source
Fire.gdb/Poly_ bc_wui_risk	Beaver Wildfire Risk areas	FCAOG

Fire.gdb/Poly_gc_wui_risk	Garfield Wildfire Risk areas	FCAOG
Fire.gdb/Poly_ic_wui_risk	Iron Wildfire Risk areas	FCAOG
Fire.gdb/Poly_kc_wui_risk	Kane Wildfire Risk areas	FCAOG
Fire.gdb/Poly_wc_wui_risk1	Washington Wildfire Risk areas	FCAOG
Fire.gdb/Poly_wc_wui_risk2	Washington Wildfire Risk areas	FCAOG
bc_f_s_a_fo	Beaver County Risk Areas	FCAOG
BC_WUI.shp	Beaver Wilderness Urban Interface	FCAOG
bc_wui_risk	Beaver Wildfire Risk areas	FCAOG
gc_wui_risk	Garfield Wildfire Risk areas	FCAOG
ic_wui_risk	Iron Wildfire Risk areas	FCAOG
kc_wui_risk	Kane Wildfire Risk areas	FCAOG
wc_wui_risk1	Washington Wildfire Risk areas	FCAOG
wc_wui_risk2	Washington Wildfire Risk areas	FCAOG
gc_f_s_a_fo	Garfield County Risk Areas	FCAOG
ic_f_s_a_fo	Iron County Risk Areas	FCAOG
kc_f_s_a_fo	Kane County Risk Areas	FCAOG
wc_f_s_a_fo	Garfield County Risk Areas	FCAOG
GC_WUI.shp	Garfield Wilderness Urban Interface	FCAOG
IC_WUI.shp	Iron Wilderness Urban Interface	FCAOG
KC_WUI_calc.shp	Kane Wilderness Urban Interface	FCAOG
WC_WUI.shp	Washington Wilderness Urban Interface	FCAOG
WC_WUI_Cat3.shp	Washington Wilderness Urban Interface	FCAOG