Chapter 8 IRON COUNTY

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.

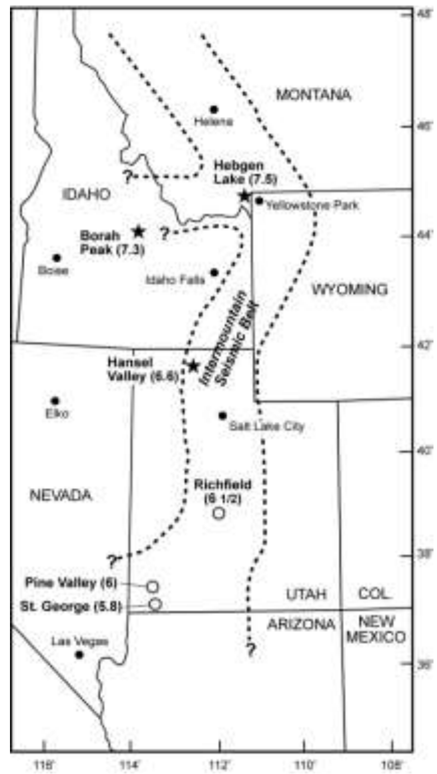
Four major riverine floods have affected southwestern Utah since the area was settled. They occurred in 1966, 1983, 1984 and 2005. The 1966 flood on the Santa Clara River near Pine Valley resulted from an intense three-day rainstorm that produced record peak flows on the Virgin River. This three-day 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

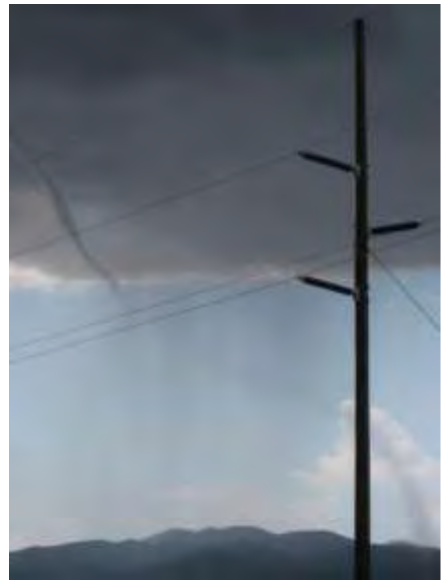
The term severe weather, as it pertains to this plan, is used to represent a broad range of weather phenomena which affect southwestern Utah, namely; downburst, lightning, heavy snowstorms, avalanches, and tornados. Severe weather events are the most deadly type of natural hazard in Utah. Interestingly,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

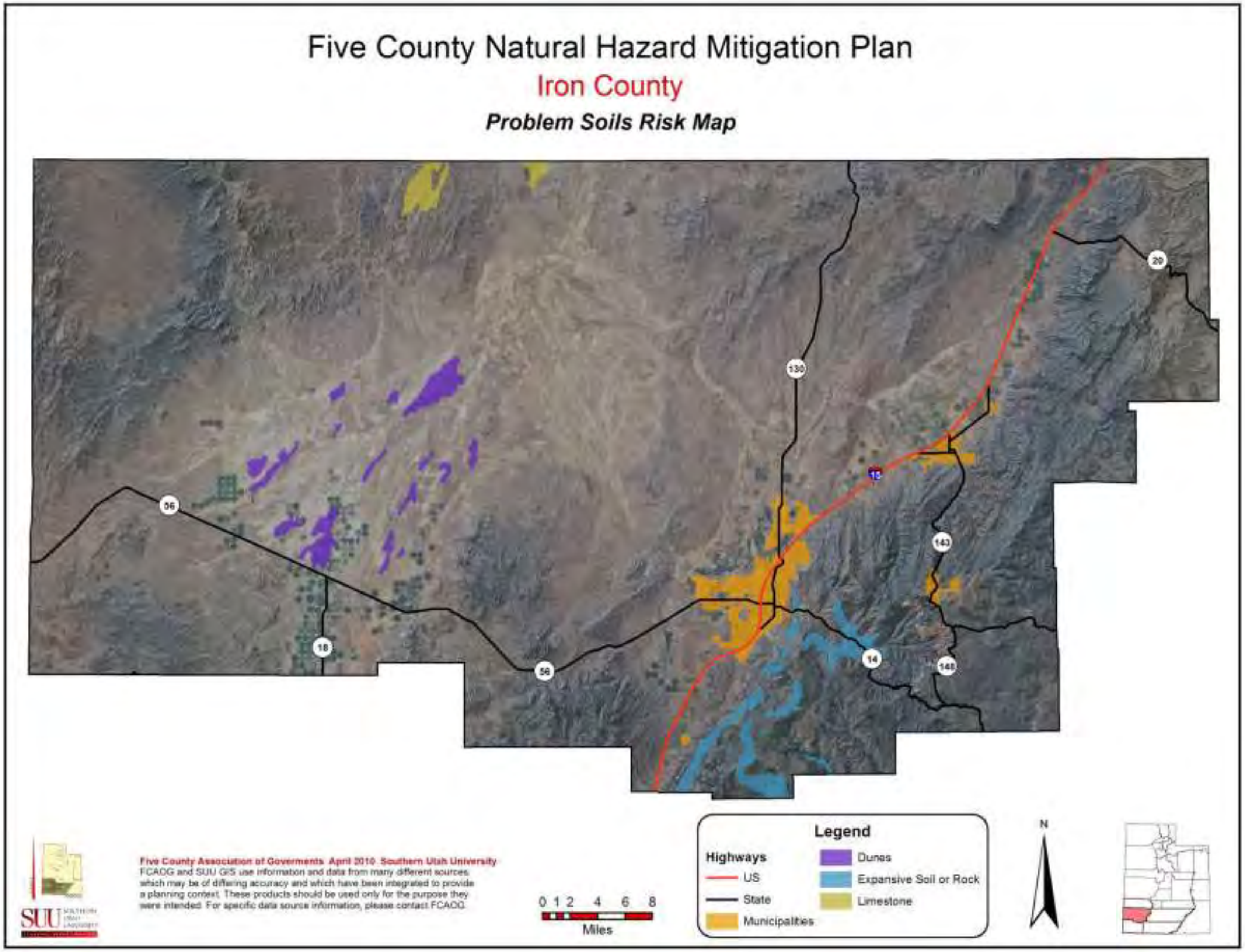
Soils Subject to Piping- Piping is subsurface erosion by ground water that moves along permeable, non-cohesive layers in unconsolidated materials and exits at a free face, usually along a stream bank or cliff that intersects the layer. Removal of fine-grained particles by this process creates voids within 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
130
20
56
18
14
143
148
Legend
Highways
US
State
Municipalities
Dunes
Expansive Soil or Rock
Limestone
0 1 2 4 6 8
Miles
N
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.
SUU

THIS PAGE INTENTIONALLY LEFT BLANK

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.

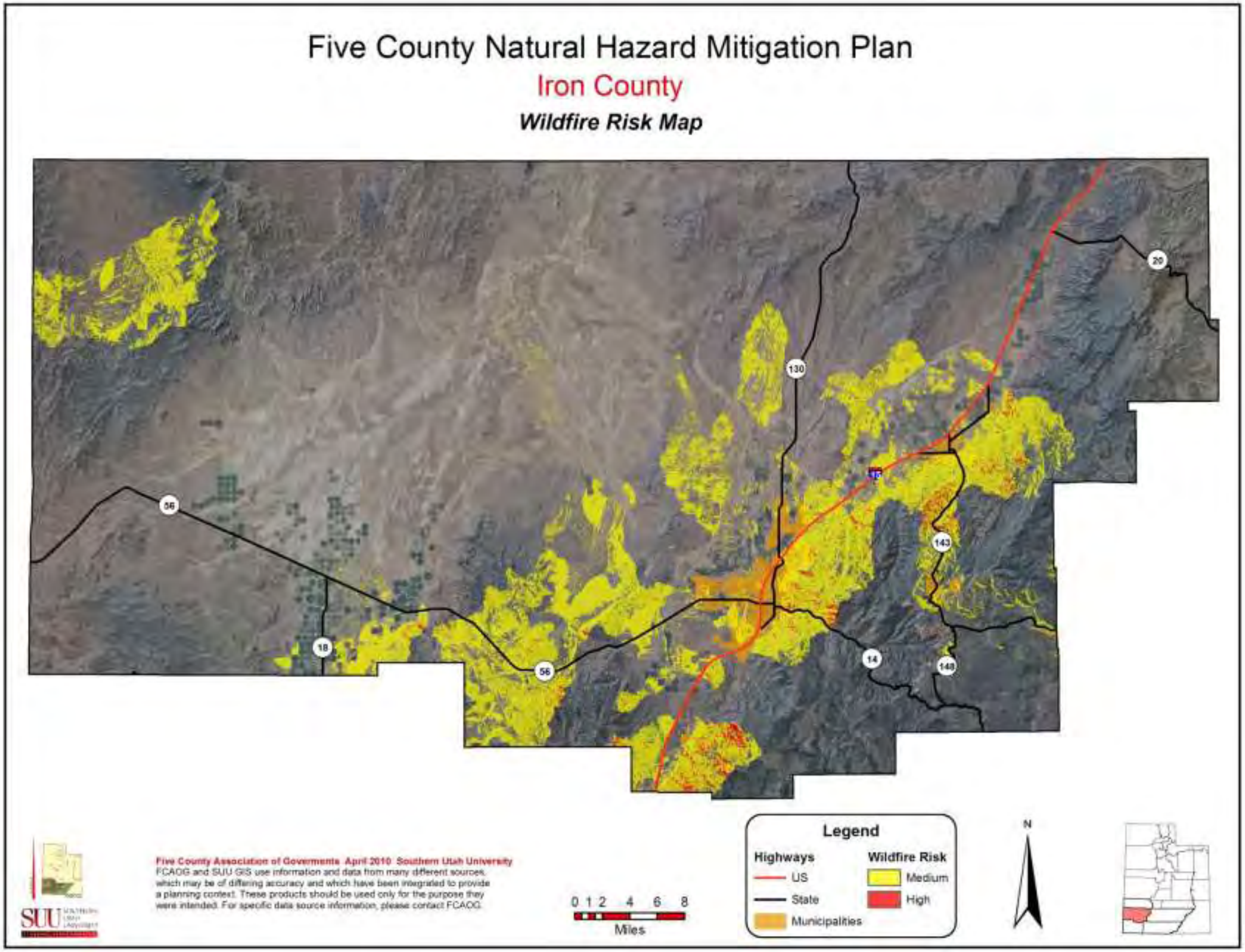
Iron County- Communities at Risk and Risk Score (2005)	
Quichapa	12
Brian Head	11
Comstock	11
Far West	11
Iron Springs	11
Old Iron Town	11
Bumblebee Ridge	10
Castle Valley	10
Cedar Highlands	10
Chekshani	10
Ireland Meadow	10
Rainbow Meadow	10
Kanarraville	9
Summit	9
Braffits Creek/Red Canyon	8
Hamblin 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
56
18
56
130
15
20
143
14
148
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
Wildfire Risk
Medium
High
N

THIS PAGE INTENTIONALLY LEFT BLANK

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 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.

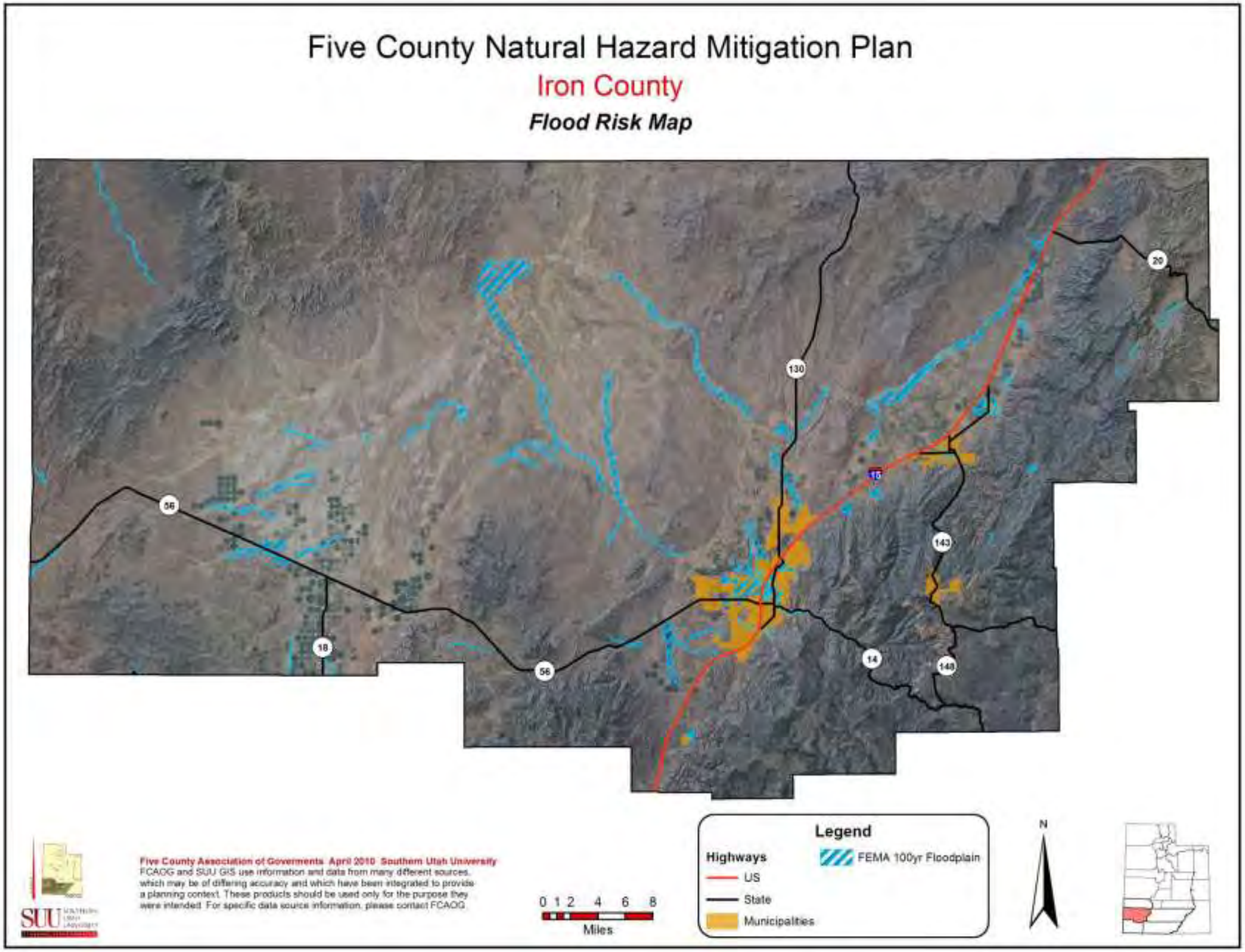
Dams are a critical support function for water managers in the State, and also can act as a flood control measure. If a dam remains stable, does not get overtopped, or is not impaired as the result of an earthquake, then at a minimum, they do provide incidental flood control. If not then they can add 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**

THIS PAGE INTENTIONALLY LEFT BLANK


Five County Natural Hazard Mitigation Plan
Iron County
Flood Risk Map
130
20
15
56
143
18
56
14
148
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.
SUU
0 1 2 4 6 8
Miles
Legend
Highways
US
State
Municipalities
FEMA 100yr Floodplain
N

THIS PAGE INTENTIONALLY LEFT BLANK

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.

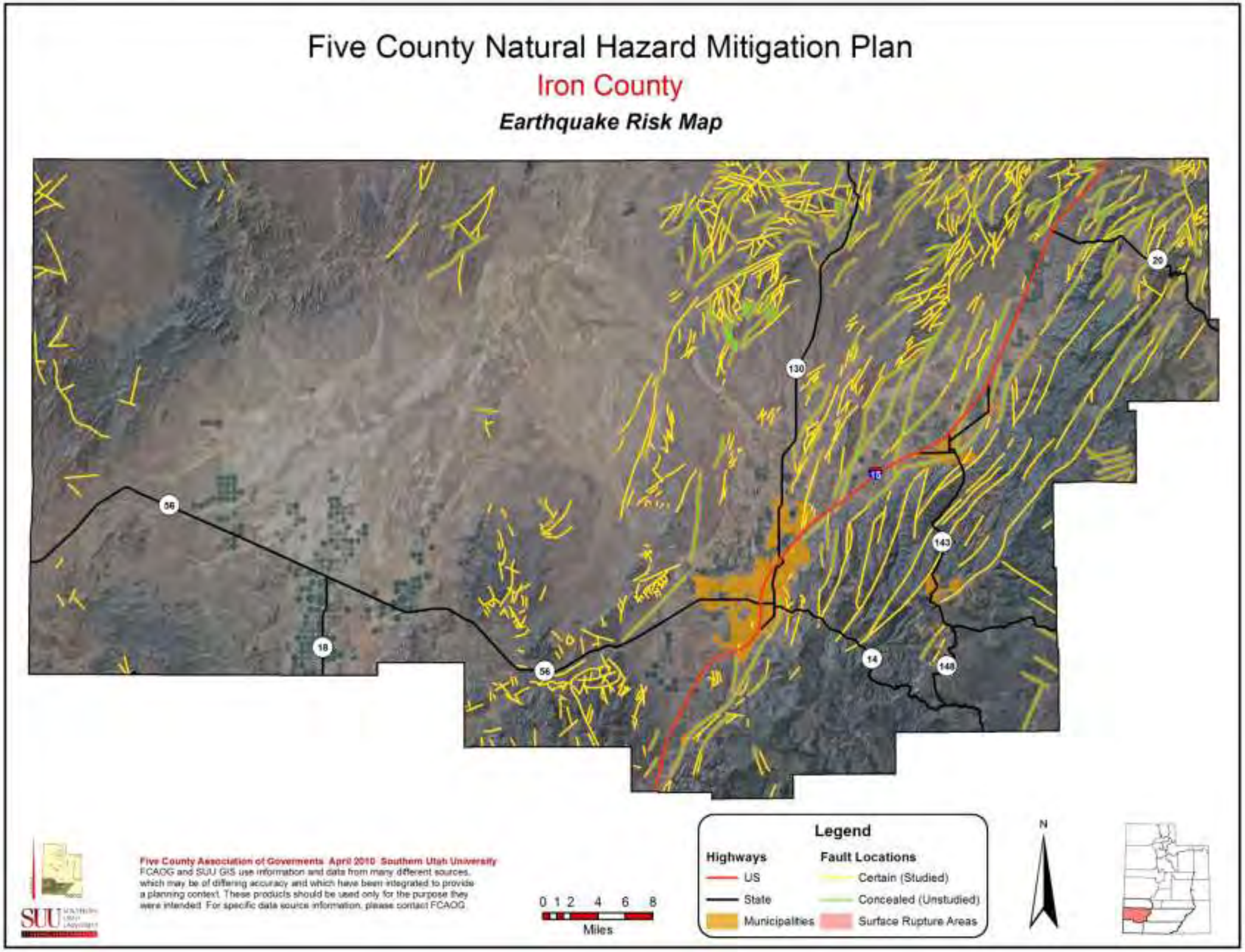
Earthquakes are regional hazards affecting multi-county areas, and because almost the entire state could experience a seismic event, all communities contain some degree of risk. The degree of risk is determined by several factors; however, the paramount factor is naturally the likelihood and magnitude 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**

THIS PAGE INTENTIONALLY LEFT BLANK


Five County Natural Hazard Mitigation Plan
Iron County
Earthquake Risk Map
56
18
56
130
15
143
14
148
20
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
Fault Locations
Certain (Studied)
Concealed (Unstudied)
Surface Rupture Areas
N
SUU

THIS PAGE INTENTIONALLY LEFT BLANK

LANDSLIDE

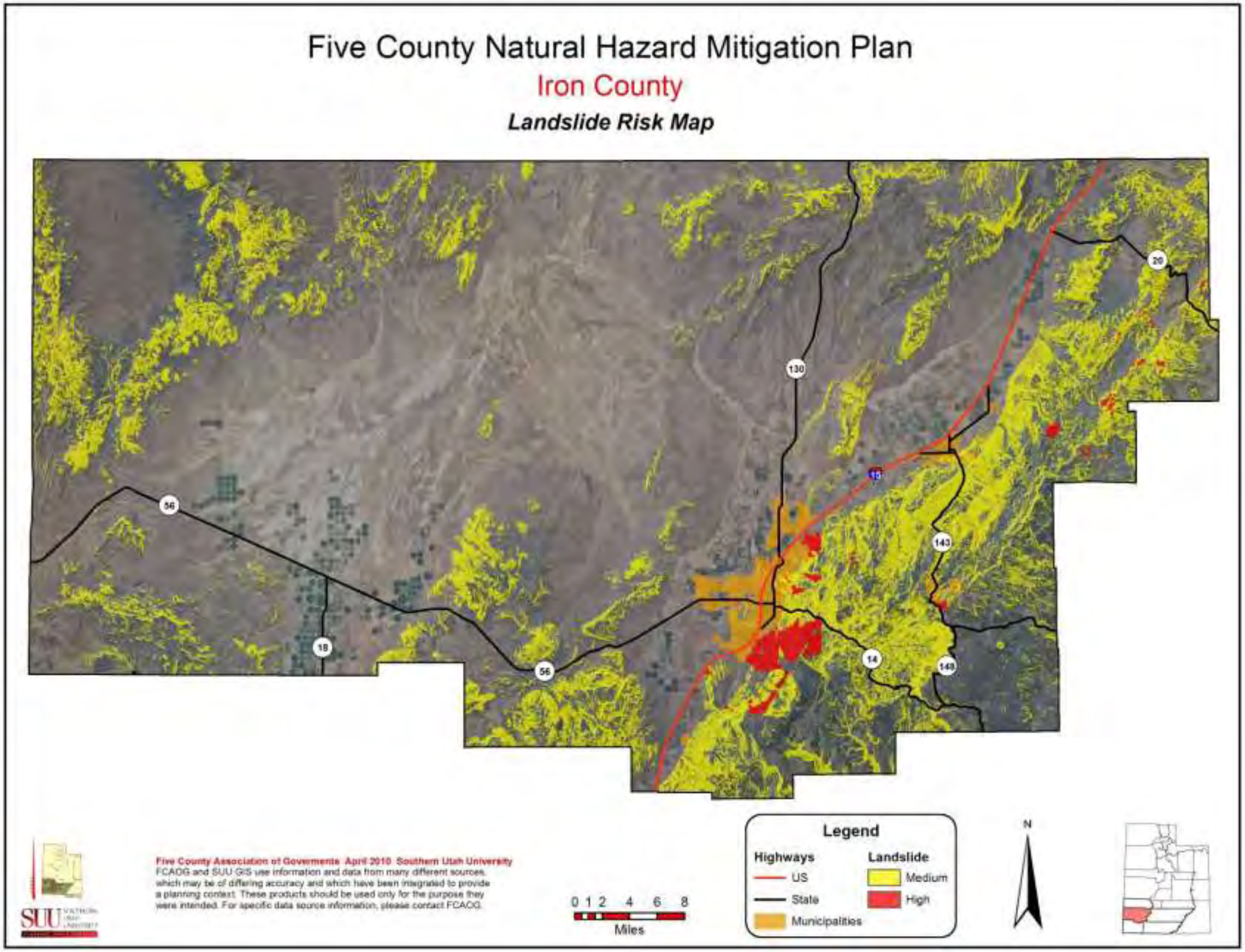
According to the USGS, landslides are a widespread geologic hazard that can occur in all 50 states. On average, landslides cause $1-2 billion annually in damages and claim 25 lives per year. Urban development in and along hillside areas increase the number of people threatened by landslide events each 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**

THIS PAGE INTENTIONALLY LEFT BLANK


Five County Natural Hazard Mitigation Plan
Iron County
Landslide Risk Map
130
20
56
15
143
18
56
14
148
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
Landslide
Medium
High
N

THIS PAGE INTENTIONALLY LEFT BLANK

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.

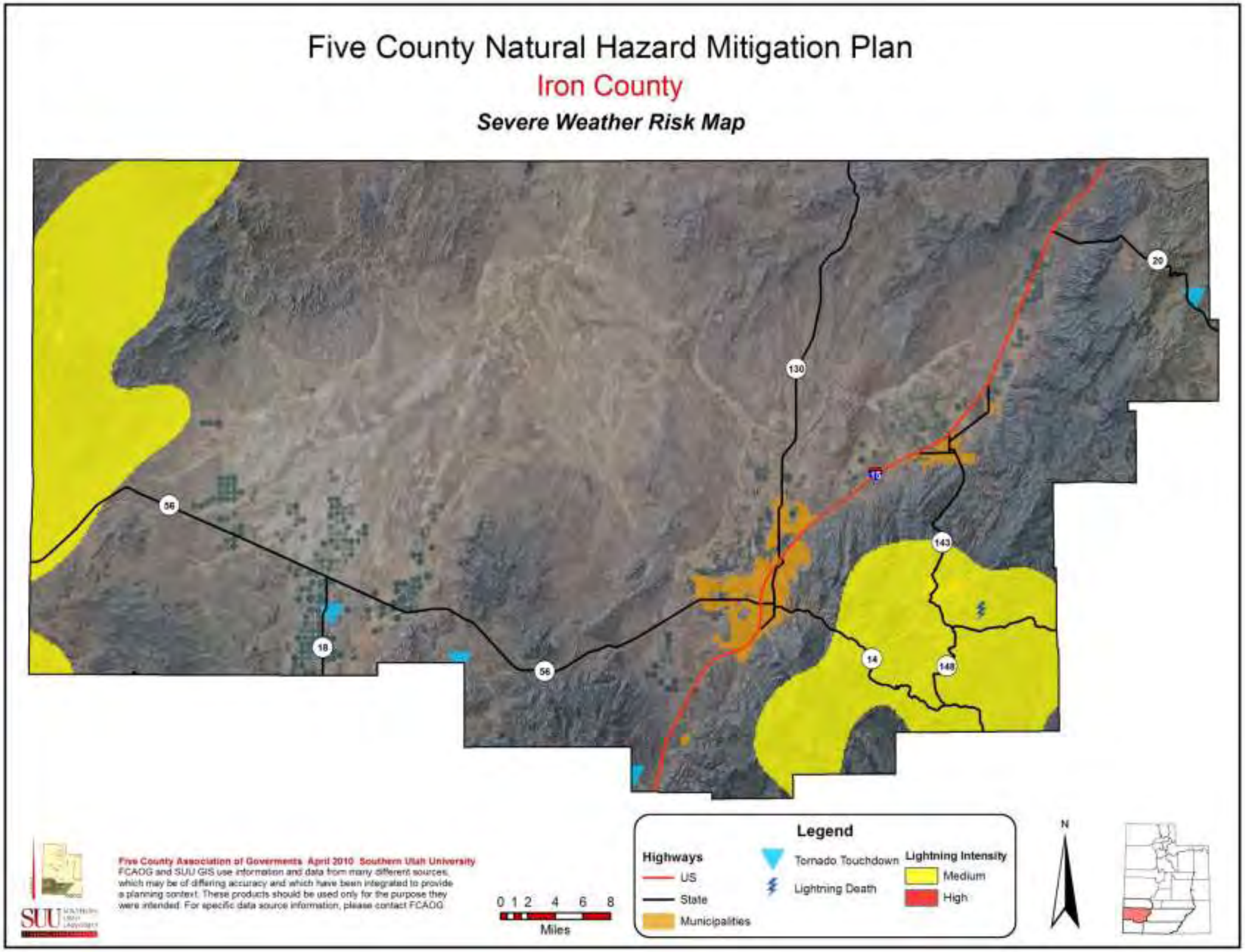
A quantitative vulnerability assessment is difficult based upon the simple fact that severe weather occurrences are random and difficult to predict. Several factors limit a determination of potential losses, they include:

- 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**

THIS PAGE INTENTIONALLY LEFT BLANK



Five County Natural Hazard Mitigation Plan
Iron County
Severe Weather Risk Map
130
20
56
18
56
143
14
148
15
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
N

THIS PAGE INTENTIONALLY LEFT BLANK

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 (especially Enoch City), 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 (especially Kanarraville Town, Brian Head Town); 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 (Iron County, Cedar City, Parowan City, Paragonah Town), 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.