SECTION 4: COUNTYWIDE RISK ASSESSMENT & MITIGATION STRATEGIES

HISTORY AND BACKGROUND OF NATURAL HAZARDS IN TOOELE COUNTY

Flooding

Areas in Tooele County have low-moderate risks for flooding. In recent recorded history there have only been a few occurences. The most recent events were flash floods mostly due to excessive amounts of rainfall or snowmelt runoff. Most of these events happened in Tooele and Grantsville Cities. Several communities adjacent to these jursidictions also reported flooding events. The Great Salt Lake, located on the northeast side of the county boundary, poses minimal threats for flooding. However, several studies suggest risk from dam failure or overtopping, due to higher than usual water levels. These same studies recommend a base flood elevation of between 4,216 and 4,218 feet above sea level. As observed during years with greater flood potential such as 1984, there is a possibility of areas south of the Great Salt Lake having flooding issues. However, streams, creeks, and smaller tributaries located in various jurisdictions within the county pose the highest overall flood risks.

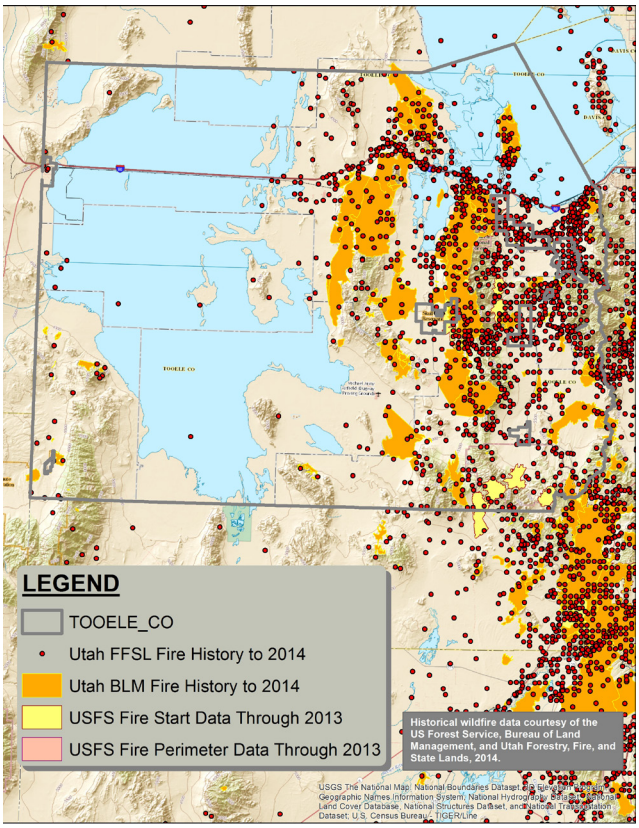
In addition, a number of canals, streams, and creeks are located in the county that under certain conditions may fail or overflow. Also, flooding can take place concurrently with some landslide events, particularly sediment/mud/debris flows. Flood water is rarely clean and clear, and much of the damage from flooding can be in the form of debris.

Some flooding events in Tooele County are attributed to snow melt rates in surrounding watersheds that are in excess of the capacity of the drainage systems or unusually heavy storm events that temporarily overwhelmed drainage capacity (or a combination of the both). Tooele County suffered flooding in 2005 and 2007 in Tooele City, Stansbury Park, Stockton, Grantsville and Hickman Canyon. This widespread Northern Utah flooding was due to a extremely fast mountain snowpack melt in early spring.

Wildfires

The vast majority of Tooele County and its jurisdictions are at risk to wildfire. There is a historical trend of wildfires occuring in areas where populations and residential development are most dense. In the hot summer months when there are long periods of time with little to no rainfall, severe droughts continue to increase risk. More populated areas pose the highest risk for wildfire, located around developed areas and the unincorporated land outside municipal boundaries where there is dry, low, dense grass and brush. Steep slopes also increase the potential for wildfire. These sloped areas are typically dry and vulnerable to wildfire, which poses great risk to residents along the eastern benches. Most of eastern Tooele County consists of desert land and vegetation types which are also vulnerable. The central and western parts of the county have less vegetation due to a high salinity content in the soil. There is minimal risk for wildfire in the central and western portions of the county, and much smaller populations. This means there is little to no threats to life and property in these areas.

There have been several wildfires that have occured in the last decade, many of which were caused by human activities, lightning, and some by unknown causes.



Landslides/Steep Slopes

Most of the landslide risk in Tooele County is found on the bench, mountainous areas, and mouths of canyons where debris flows are likely to occur. Agricultural lands and residential areas adjacent to steep slopes are also susceptible to landslide risk.

Wildfires play a large contributing factor in the occurance of landslides. When a wildfire has occured, it makes the soil structure weak and unstable. When there is heavy rain, a slight ground disturbance, or wind, the soil column may slide because there is no stable root system to hold the soil structure. As the saturated ground becomes heavier and less stable, it gives way, and a landslide can occur.

Landslide history

Between 1982-1986 there were periods of significant precipitiation, and several landslides occured in Tooele Valley. Much of the sediment found in the mountains around the area was weak and susceptible to landslide. (Geology and Geologic Hazards of Tooele Valley and the West Desert Hazardous Industry Area, 1999).

Earthquakes

There are two major primary fault zones located within Tooele County. The Oquirrh Marginal Fault on the east and the Six Mile Creek Fault between Marshall and Interstate 80 pose the two highest risks. There are also 16 quarternary faults within the county located near the mountain benches and valley regions. Earthquakes of small magnitude are common in the county, although no major earthquake resulting in significant property damage has occurred in recent recorded history. Geologic evidence establishes the possibility of a major earthquake in Tooele County (WFRC, 2008).

One very important aspect of earthquake damage which is often overlooked is liquefaction. Liquefaction generally occurs when certain soil types when saturated with water can liquefy during an earthquake, moving, tilting, and destroying buildings. Whole foundations can be lifted and moved by the saturated soils.

Portions of Tooele County are located atop an ancient Lake Bonneville, the bed of which is made up of generally unstable soils. The area is also subject to shallow ground water and a relatively high earthquake threat. Five of the neighboring jurisdictions located along the south rim of The Great Salt Lake pose moderate-high risks of earthquake and liquefaction susceptibility. The jurisdictions located further south of The Great Salt Lake have a significantly lower risk for liquefaction.

Much of the populated corridor in Tooele County is located near the Wasatch Fault. According to Hecker (1992), the Wasatch Fault Zone is the longest and most active normal fault in Utah. The Wasatch Fault extends from south of Malad, Idaho to western Sanpete County in Utah, much along the populated Wasatch Front. The Wasatch Fault Zone is active and has the potential to produce a large 7.3-7.5 Richter magnitude earthquake on average every 300-400 years. (WRRC, 2008)

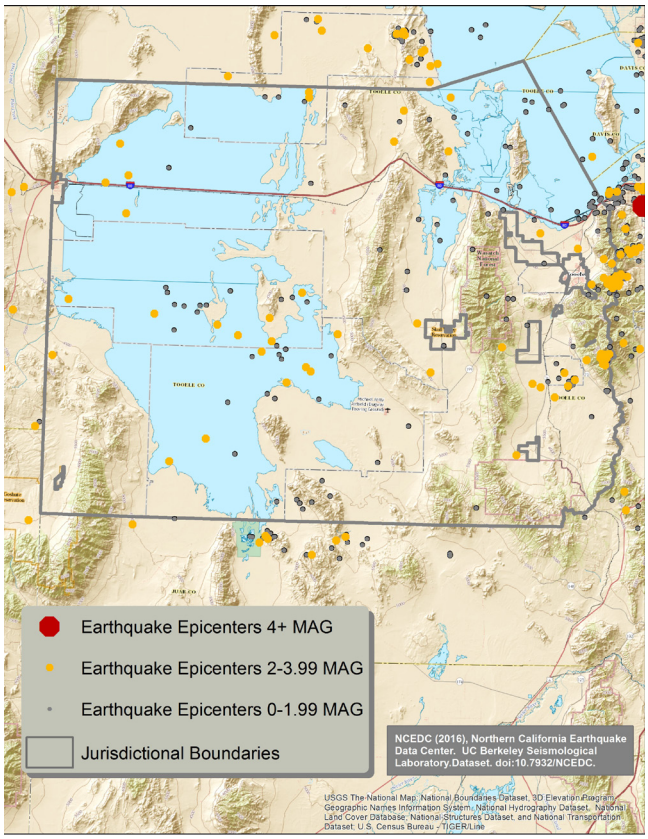
The Oquirrh Fault Zone also another threat for earthquakes affecting the County. The fault has an approximate recurrence interval of 20,000 years. Earthquakes up to Richter magnitude 7.0 are possible within the Oquirrh Fault Zone, but given its recurrence interval, earthquakes of this magnitude are not probable. Smaller earthquakes are more likely along this fault with Richter magnitudes around 6.0 (WFRC, 2008; Utah Geological Survey, 2015).

While a geological fault may not be very wide physically, damage around the fault can be detrimental. This is often referred to as the “damage zone (Susanne Janecke, personal communication, 9/25/08).” This damage zone is now thought to be much larger than recognized previously. While geologists used to recommend a general fault buffer of fifty feet on either side of the fault, they now recognize a much larger damage zone. According to the Utah Geological Survey, up thrown sides of well defined quaternary faults require planning for a 250 foot damage zone; while down thrown sides of well defined faults require planning for a 500 foot damage zone. For those faults not well defined, a general 1,000 foot damage zone should be considered (Richard

Giraud, personal communication, 10/6/08; Christopher Duross, personal communication, 10/30/08; Christensen et al., 2003). Because of data inaccuracies in geologic fault data, a standard 1,000 foot damage zone was analyzed for all quaternary faults in the region.

It is believed that the Oquirrh Fault Zone just east and north of Tooele City and nearby communities is capable of producing a 7.0 magnitude earthquake (Utah Geological Survey, Utah Division of Emergency Management, 2015). No earthquake computer scenarios have been created for that magnitude. However, the Utah Division of Emergency Management has completed a scenario for a 6.5 magnitude earthquake that shows potential damage from an event of that size (See **Appendix 34** for more information courtesy of Josh Groeneveld, Utah DEM, 2015).

Below is a map of historical earthquake locations in Tooele County as of 2016:



Dam Failure

The majority of the dams located in the county are used for farming and irrigation purposes. The dams used for farming are usually small detention ponds or livestock watering facilities and most pose a minimal threat to human life or property.

The dams used for irrigation purposes are generally small and help to reserve and divert water in canals. They have minimal threat to human life or property.

Of the 18 active dams identified, 3 have been identified as high hazard threats. If high hazard dams were to fail, there would be a significant loss to human life and the economy. 3 dams have been found to have moderate threats. If moderate hazard dams were to fail they would have a lesser probability of causing loss to human life, property, infrastructure, environmental, and agricultural amenities. (www.waterrights.utah.gov; WFRC, 2008). Most of the dams in Tooele County have been found to have low hazard threats by the State of Utah Division of Water Rights. As defined by state statue, low hazard dams are those dams which, if they fail, would cause minimal threat to human life, and economic losses would be minor or limited from damage sustained.

It should be noted that dam safety hazard classifications are in the event of the failure of a dam, based upon the consequences of failure of the dam given by the State Engineer. Therefore, the classification of a high hazard dam does not mean that the dam has a high probability of failure (WFRC, 2008). If The Great Salt Lake water level were to rise significantly and the southern levees and dikes were to fail, the majority of Tooele City and parts of Erda and Grantsville Cities could potentially flood. Dams in the county that pose the highest threat are Settlement Canyon Reservoir, Grantsville Reservoir, and the Bonneville Dike of the Great Salt Lake.

No significant dam failures have been reported in Tooele County. However it is strongly suggested that municipalities with risks to flood and dam inundation should think highly about creating mitigation strategies for their individual communities in the event it does occur.

High Hazard Dams

1. Settlement Canyon Reservoir
2. Grantsville Reservoir
3. Bonneville Dike, GSL

Moderate Hazard Dams

1. Grantsville Regulating Pond
2. Vernon Reservoir
3. Last Chance Ski Pond

(Utah Division of Water Rights, 2016).

Dam failure inundation maps and emergency action plans for each of the high risk dams can be found on the Utah Division of Water Right's website at www.waterrights.utah.gov.

Problematic Soils

Problematic soils are prevalent in the region. Hazards can not be fully determined until a local engineering and/or geotechnical study has been performed on site. Most of the larger local communities require studies to determine risk and most, if not all, local communities require contractors to utilize the International Building Code (IBC) which helps mitigate most effects. While most city engineers and other staff are familiar with the hazards problematic soils can incur, more can be done to prevent structure damage and threats to life and property. Since problematic soils are so prevelant in the county, see countywide natural hazards section on page 4-35 for more details.

NATURAL HAZARD PROFILES

Table 8: Tooele County Flood Hazard Profile

Frequency	Some flooding occurs nearly every year in Tooele County
Severity	Moderate
Location	Generally along rivers, streams, ravines, and canals.
Seasonal Pattern	Spring flooding as a result of snowmelt. Mid-late summer cloudburst events.
Duration	A few hours or up to three weeks for snowmelt flooding
Speed of Onset	1-6 hours
Probability of Future Occurrences	High-for delineated flood plains there is a 1% chance of flooding in any given year.

Table 9: Tooele County Wildfire Hazard Profile

Frequency	Annually to some extent
Severity	Severe
Location	Dispersed throughout the whole county
Seasonal Pattern	Generally the worst from early July to mid September (depends on drought conditions)
Duration	A few hours to two weeks
Speed of Onset	1-6 hours
Probability of Future Occurrences	Very High

Table 10: Tooele County Landslide/Steep Slopes Hazard Profile

Frequency	Annually to some extent
Severity	Potentially Severe
Location	Dispersed throughout the whole county, but mostly in the mountains on the east.
Seasonal Pattern	Generally the worst from early July to mid September (depends on drought conditions)
Duration	A few hours to two weeks
Speed of Onset	1-6 hours
Probability of Future Occurrences	Moderate

Table 11: Tooele County Earthquake Hazard Profile

Frequency	Low magnitude events occur occasionally. Larger magnitude events are rare (although not necessarily on geologic time).
Severity	Potentially Catastrophic
Location	Entire County with highest frequency in the mountains on the east side of the county. Surface fault ruptures are likely to occur in fault zones and liquefaction would impact communities closest to the Great Salt Lake.
Seasonal Pattern	None
Duration	A few minutes with potential aftershocks
Speed of Onset	No warning
Probability of Future Occurrences	Based on 1962-2015 data, there is a 24% chance every year of an earthquake of 3.0 magnitude or greater.

Table 12: Tooele County Dam Failure Hazard Profile

Frequency	Rare
Severity	Potentially Catastrophic
Location	Areas downstream of failed dam.
Seasonal Pattern	Anytime. Highest risk in spring during snowmelt.
Duration	A few hours
Speed of Onset	No warning
Probability of Future Occurrences	Low

Repetitive Loss Properties

There are no repetitive loss properties in Tooele County (FEMA, 2016).

COMMUNITY NATURAL HAZARD MAPS

(Please see sections 5 to 19 for natural hazard maps for each local community in Tooele County)

COUNTYWIDE NATURAL HAZARDS

- Drought
- Severe Weather
- Agricultural Hazards
- Radon
- Avalanche
- Tornado
- Tsunami
- Volcanic Activity
- Unsuitable Soils

Each of the hazards listed in Section 2 are addressed at some level in this plan. However, drought, severe weather, radon, avalanche, tornado, tsunami, and volcanic risks are very difficult to analyze due to lack of data or the inability to predict destructive events in particular locations. All potential hazards were discussed in county working group meetings. Although geographic data is lacking, the more prevalent county wide hazards, such as drought, severe weather, and radon were addressed in the mitigation strategies lists for the entire county. All 14 communities are susceptible on some level to those hazards and can mitigate effects from those in similar ways.

However, avalanches, tornados, tsunamis, and volcanic activity are limited to smaller geographic areas, physiographic or climatic variation, or have not produced predictable or, in some cases, significant damage. For example, while tornados have caused substantial damage in various parts of Utah, there has not been any reoccurrence of events which merit a reliable prediction on where future events could occur. Communities were allowed, and encouraged, to include mitigation strategies for any and all hazards they felt required mitigation on some level. Unsuitable soils are also so prevelant in the county, that local conditions need to be assessed by a licensed engineer in order to determine the true risk. These soils are often expansive in nature and through freeze-thaw processes, can shift or collapse, causing considerable damage to structures. Almost every community in Tooele County is at risk from unsuitable soils.

Risk Assessment and Mitigation Strategy Surveys were sent to each chief elected official for all jurisdictions in Tooele County. Among other questions, the surveys requested local input on the

following:

- NFIP status
- Existing natural hazards
- Natural hazard events since November 2008
- List of maps, documents, or plans related to natural hazards planning
- Current zoning and ordinances related to natural hazards
- Future developments that could be affected by natural hazards
- Mitigation strategies completed since 2008
- New mitigation strategies

(See **Appendix D** for survey responses and summaries).

HISTORY OF COUNTYWIDE NATURAL HAZARDS

Residents and communities in Tooele County have knowingly been effected by drought and severe weather since modern settlers came to the area in the mid-1800's. Native American's and early explorers were also well aware of the variation in the climate and temperature in the area and planned accordingly. One of the most famous sayings about the weather in the Rocky Mountains is, "If you don't like the weather, just wait 5-minutes!" Long-time residents of the area have experienced the variation which exists and plan accordingly (See **Appendix J** for regional historic severe weather events and losses to life and property).

However, for others, mitigating the effects of severe weather and drought can be difficult. Educational activities and public awareness campaigns seem to help, but can always be improved. Local communities and other organizations train for emergencies and events on a regular basis.

Other natural hazards, such as avalanche, tornado, tsunami, and volcanic activity are rare, but can be mitigated on some level. Local building codes and ordinances keep most residents and structures safe, but events can be sporadic and variable.

Agricultural hazards, as addressed in this plan, relate mostly to insect infestation. The most prevalent of these is grasshopper and cricket infestation, but bark beetles, ticks, mosquitos, and termites have also been identified by the Utah Department of Agriculture and Food as threats (2015). See **Appendix I** for the statewide cricket and grasshopper infestation map and information.

The threats of Radon have not been very well known by residents and local governments until recent years. Thanks to educational activities promoted by the Utah Department of Health and others, knowledge of Radon has become more prevalent. However, while Radon levels can be relatively high in the region, they cannot be detected for each individual home or other structure unless individual tests are done following construction (See **Appendix K** for Radon risk maps and information).

Countywide Natural Hazard Profiles

Table 13: Drought Hazard Profile

Frequency	Frequent
Severity	Severe mostly for agricultural producers
Location	Un-irrigated areas are most impacted
Seasonal Pattern	Water supply dependent on winter snowfall. Summer is when impact is realized.
Duration	As many as 10 years
Speed of Onset	Incremental with impact increasing
Probability of Future Occurrences	High

Table 14: Agricultural Hazard Profile

Frequency	Sporadic
Severity	Severe mostly for agricultural producers and gardeners
Location	Everywhere
Seasonal Pattern	Spring & early summer
Duration	Months
Speed of Onset	Days
Probability of Future Occurrences	High

Table 15: Severe Weather Hazard Profile

Frequency	Frequent
Severity	Severe for communities, residents, and agricultural producers
Location	Everywhere (Some areas have more inherent risk due to geographic conditions)
Seasonal Pattern	Summer severe thunderstorms/hail & wind, late spring freezing, and heavy winter storms
Duration	Days/weeks
Speed of Onset	Immediate
Probability of Future Occurrences	High

Table 16: Radon Hazard Profile

Frequency	Persistent
Severity	Potentially Severe
Location	Everywhere
Seasonal Pattern	All, higher in winter months
Duration	Always
Speed of Onset	Years for detrimental effects
Probability of Future Occurrences	High

Table 17: Unsuitable Soils Hazard Profile

Frequency	Varies
Severity	Potentially Destructive to Structures
Location	Varies
Seasonal Pattern	Anytime. Highest risk for noticable damage in spring.
Duration	Long term
Speed of Onset	Varies
Probability of Future Occurrences	Moderate

Vulnerability and Potential Losses

People have been living with knowledge of current regional natural hazards since settlers first came to the area. Cold, snowy winters, hot dry summers, and other sporadic severe weather events are a part of life in the Rocky Mountains. Over the past decades, science has provided beneficial data related to soils and hazards from various soil types.

Radon and problematic soils data has helped local communities understand risks and studies have provided critical information on how to mitigate their effects. While engineering and technical studies can provide information on what types of soils are evident in particular areas, it is difficult to give precise predictions. However, through education and updated local building and development regulations, most severe problems can be avoided.

Implications for Future Growth and Development

In general, as population increases in Tooele County, risk to residents, infrastructure, and property will likely increase for all regional hazards. The more people that live in an area, the more people will likely exposed to potential hazards by utilizing more resources, and spreading out across the landscape. In short, as more people move into the area, more are likely to be affected by currently existing natural hazards.

COUNTYWIDE HAZARD MITIGATION STRATEGIES

(See following page)

COUNTYWIDE MITIGATION STRATEGIES										
Protecting Current Residents and Property										
Jurisdiction	**Hazard**	**Goal**	**Action**	**Action (For NFIP Compliance, if**	**Priority (High,**	**Time-frame**	**Potential Funding Sources**	**Responsible Entity**	**Estimated Cost**	**Resources**
Tooele County Region	All	Protect current residents and property	Participate in the Weather Ready Nation Ambassador Initiative	N/A	Medium	Ongoing	Counties	Tooele County and BRAG	Minimal	National Weather Service, Tooele County
Tooele County Region	Severe Weather	Protect current residents and property	Public education/training including 3-5 day power outage survival, emergency response (CERT), emergency shelter locations, emergency kits, backup utilities, livestock issues, and interoperable emergency communications planning.	N/A	High	Annually	Counties, Utah ESHS, BRAG, Cities, FEMA	Tooele County and BRAG	$50,000	Counties, Utah ESHS, BRAG, Cities, FEMA, NOAA
Tooele County Region	Agricultural	Protect current residents and property	Encourage crop diversity, weed and pest management, and coordination with local, State, and Federal agencies on agricultural land management and production.	N/A	Medium	2018	Utah Department of Agriculture and Food, USDA, USU Extension, USFS, BLM	Tooele County and BRAG	Minimal	Utah Department of Agriculture and Food, USDA, USU Extension, USFS, BLM,
Tooele County Region	Agricultural	Protect current residents and property	Educate residents on crop insurance program, alternative planting and CRP programs, value of agriculture, pest control, crop diversity, urban tree planting guidelines, etc	N/A	Medium	2017	State, Local, USDA	Tooele County and BRAG	Minimal	State, Local, USDA
Tooele County Region	Drought	Protect current residents and property	Set up a monthly schedule to monitor drought conditions. A monthl report sent to residents could inform them of mandatory water conservation measures in high drought susceptible months and emergencies	N/A	High	Ongoing	Cities, County	All jurisdictions	Minimal	County, Cities
Tooele County Region	Drought	Protect current residents and property	Study feasibility of increasing current water storage capabilities. Encourage water conservation techniques for all land uses	N/A	Low	2017	Utah ESHS, BRAG	All jurisdictions	Minimal	Utah ESHS, BRAG
Tooele County Region	Radon	Protect current residents and property	Provide educational materials to owners of new homes and/or all residents in the local communities	N/A	High	Ongoing	Local	All jurisdictions	Minimal	Bear River Health Department

COUNTYWIDE MITIGATION STRATEGIES										
Protecting Future Residents and Property										
Jurisdiction	**Hazard**	**Goal**	**Action**	**Action (For NFIP Compliance, if Applicable)**	**Priority (High, Medium, Low)**	**Time-frame (Year)**	**Potential Funding Sources**	**Responsible Entity**	**Estimated Cost**	**Resources**
Tooele County Region	All	Protect future residents and property	Participate in the Weather Ready Nation Ambassador Initiative	N/A	Medium	Ongoing	Counties	Tooele County and BRAG	Minimal	National Weather Service, Tooele County
Tooele County Region	Severe Weather	Protect future residents and property	Discuss planning needs on the county and city levels to coordinate land use regulations regarding Severe Weather events and response. This would be intended to prevent damages from extreme weather trigger events and incorporate severe weather into current response plans.	N/A	Medium	Annually	Counties, Municipalities, BRAG	All jurisdictions	Minimal	Counties, Municipalities, BRAG, Utah ESHS, Army Corp., Be Ready Utah, FSSL, LEPC, NOAA, NRCS
Tooele County Region	Agricultural	Protect future residents and property	Encourage crop diversity, weed and pest management, and coordination with local, State, and Federal agencies on agricultural land management and production.	N/A	Medium	2018	Utah Department of Agriculture and Food, USDA, USU Extension, USFS, BLM	Tooele County and BRAG	Minimal	Utah Department of Agriculture and Food, USDA, USU Extension, USFS, BLM,
Tooele County Region	Agricultural	Protect future residents and property	Educate residents on crop insurance program, alternative planting and CRP programs, value of agriculture, pest control, crop diversity, urban tree planting guidelines, etc	N/A	Medium	2017	State, Local, USDA	Tooele County and BRAG	Minimal	State, Local, USDA
Tooele County Region	Drought	Protect future residents and property	Set up a monthly schedule to monitor drought conditions. A monthl report sent to residents could inform them of mandatory water conservation measures in high drought susceptible months and emergencies	N/A	High	Ongoing	Cities, County	All jurisdictions	Minimal	County, Cities
Tooele County Region	Drought	Protect future residents and property	Study feasibility of increasing current water storage capabilities. Encourage water conservation techniques for all land uses	N/A	Low	2017	Utah ESHS, BRAG	All jurisdictions	Minimal	Utah ESHS, BRAG
Tooele County Region	Radon	Protect future residents and property	Provide educational materials to owners of new homes and/or all residents in the local communities	N/A	High	Ongoing	Local	All jurisdictions	Minimal	Bear River Health Department