U.S. Department of Homeland Security
Region VIII
Denver Federal Center, Building 710
P.O. Box 25267
Denver, CO 80225-0267

FEMA

R8-MT

March 18, 2015

Salt Lake County Council
2001 South State Street N2-200
Salt Lake City, UT 84114-4575

Dear County Council:

We are pleased to announce the approval of the **Salt Lake County Multi-Jurisdictional Multi-Hazard Mitigation Plan** as meeting the requirements of the Stafford Act and Title 44 of the Code of Federal Regulations §201.6 for a local hazard mitigation plan. The plan approval extends to the following participating jurisdictions that have adopted the plan: **Salt Lake County; the Town of Alta; and the Cities of Bluffdale, Draper City, Riverton City, South Jordan City, and West Jordan.**

The approved jurisdictions are eligible for FEMA Hazard Mitigation Assistance grant programs. All requests for funding will be evaluated individually according to the specific eligibility and other requirements of the particular programs under which the application is submitted. Approved mitigation plans may be eligible for points under the National Flood Insurance Program Community Rating System.

This plan is approved through March 17, 2020. A local jurisdiction must revise its plan to reflect changes in development, progress in local mitigation efforts, changes in priorities, and resubmit for approval within five years to continue to be eligible for mitigation project grant funding.

We have provided comments and recommendations on the enclosed Plan Review Tool. We wish to thank all jurisdictions that participated in the planning process and commend your continued commitment to reducing future disaster losses. Please contact Brad Bartholomew, State Hazard Mitigation Officer, at the Utah Department of Public Safety, Division of Emergency Management, at bbart@utah.gov or (801) 538-3769 with any questions on the plan approval or mitigation grant programs.

Sincerely,

Sharon Loper
Acting Regional Administrator

Enclosures: Plan Review Tool

cc: Brad Bartholomew, State Hazard Mitigation Officer

LOCAL MITIGATION PLAN REVIEW TOOL

The *Local Mitigation Plan Review Tool* demonstrates how the Local Mitigation Plan meets the regulation in 44 CFR §201.6 and offers States and FEMA Mitigation Planners an opportunity to provide feedback to the community.

- The Multi-jurisdiction Summary Sheet should be used to document contact information for each jurisdiction and if each met the requirements of the Plan, if a multi-jurisdictional plan.
- The Regulation Checklist provides a summary of FEMA's evaluation of whether the Plan has addressed all requirements.
- The Plan Assessment identifies the plan's strengths as well as documents areas for future improvement.

The FEMA Mitigation Planner must reference this *Local Mitigation Plan Review Guide* when completing the *Local Mitigation Plan Review Tool*.

Jurisdiction: Salt Lake County	**Title of Plan:** Salt Lake County Multi-Jurisdictional Multi-Hazard Mitigation Plan	**Date of Plan:** December 2014
Local Point of Contact: Roger Kehr	**Address:** 1110 State Office Building Salt Lake City, UT 84114	
Title: All-Hazards Mitigation Specialist		
Agency: Salt Lake County Emergency Management		
Phone Number: 801-538-3400	**E-Mail:** rkehr@UFA-SLCO.ORG	

State Reviewer: Eric Martineau	**Title:** Mitigation Specialist	**Date:** December 1, 2014

FEMA Reviewer: Shelby Hudson Margaret Doherty	**Title:** Mitigation Planner/GIS Analyst Community Planner	**Date:** December 17, 2014 January 7 & February 6, 2015
Date Received in FEMA Region VIII	**December 1, 2014 and February 5, 2015**	
Plan Not Approved	**January 8, 2015**	
Plan Approvable Pending Adoption	**February 6, 2015**	
Plan Approved	**March 18, 2015**	

SECTION 1:
MULTI-JURISDICTION SUMMARY SHEET

MULTI-JURISDICTION SUMMARY SHEET									
#	Jurisdiction Name	Jurisdiction Type	Jurisdiction Contact	Email/Phone	Requirements Met (Y/N)				
					A. Planning Process	B. HIRA	C. Mitigation Strategy	D. Update Rqtms.	E. Adoption Resolution
1	Alta	City	Chris Cawley	chris@townofalta.com	Y	Y	Y	Y	Y
2	Bluffdale	City	Natalie Hall	nhallbluffdale@gmail.com	Y	Y	Y	Y	Y
3	Cottonwood Heights	City	Mike Halligan	mhalligan@ch.utah.gov	Y	Y	Y	Y	N
4	Draper	City	Garth Smith	Garth.smith@draper.ut.us	Y	Y	Y	Y	Y
5	Herriman City	City	Tina Giles	tgiles@herriman.org	Y	Y	Y	Y	N
6	Holladay	City	David Chisholm	davidjohnc@msn.com	Y	Y	Y	Y	N
7	Midvale	City	Jesse Ventura	jessev@midvale.com	Y	Y	Y	Y	N
8	Murray City	City	Jon Harris	jharris@murray.utah.gov	Y	Y	Y	Y	N
9	Riverton City	City	Sheril Garn	sgarn@rivertoncity.com	Y	Y	Y	Y	Y
10	Salt Lake City	City	Cory Lyman	Cory.Lyman@slcgov.com	Y	Y	Y	Y	N
11	Salt Lake County	County	Jeff Graviet, Mike Barrett	JGraviet@slco.org	Y	Y	Y	Y	Y
12	Sandy	City	Jared Smith	jsmith@sandy.utah.gov	Y	Y	Y	Y	N

MULTI-JURISDICTION SUMMARY SHEET									
#	Jurisdiction Name	Jurisdiction Type	Jurisdiction Contact	Email/Phone	Requirements Met (Y/N)				
					A. Planning Process	B. HIRA	C. Mitigation Strategy	D. Update Rqtms.	E. Adoption Resolution
13	South Jordan	City	Dustin Lewis	dlewis@sjc.utah.gov	Y	Y	Y	Y	Y
14	South Salt Lake	City	Blaine Daimaru	bdaimaru@southsaltlakecity.com	Y	Y	Y	Y	N
15	Taylorsville	City	Ben Gustafson	bgustafson@taylorsvilleut.gov	Y	Y	Y	Y	N
16	West Jordan	City	Reed Scharman	reeds@wjordan.com	Y	Y	Y	Y	Y
17	West Valley City	City	John Evans	John.evans@wvc-ut.gov	Y	Y	Y	Y	N

SECTION 2:
REGULATION CHECKLIST

REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
ELEMENT A. PLANNING PROCESS			
A1. Does the Plan document the planning process, including how it was prepared and who was involved in the process for each jurisdiction? (Requirement §201.6(c)(1))	Pages xxi, 33-42, and Annexes	X	
A2. Does the Plan document an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, agencies that have the authority to regulate development as well as other interests to be involved in the planning process? (Requirement §201.6(b)(2))	Page 33-44 and Annexes	X	
A3. Does the Plan document how the public was involved in the planning process during the drafting stage? (Requirement §201.6(b)(1))	Page 36, 43 and Annexes	X	
A4. Does the Plan describe the review and incorporation of existing plans, studies, reports, and technical information? (Requirement §201.6(b)(3))	Pages 26 and 43-44	X	
A5. Is there discussion of how the community(ies) will continue public participation in the plan maintenance process? (Requirement §201.6(c)(4)(iii))	Pages 189-191	X	
A6. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a 5-year cycle)? (Requirement §201.6(c)(4)(i))	Pages 28; 158-159; 189-191; and 224-1220	X	
ELEMENT A: REQUIRED REVISIONS			
ELEMENT B. HAZARD IDENTIFICATION AND RISK ASSESSMENT			
B1. Does the Plan include a description of the type, location, and extent of all natural hazards that can affect each jurisdiction(s)? (Requirement §201.6(c)(2)(i))	Pages 47-142; 224-1220	X	
B2. Does the Plan include information on previous occurrences of hazard events and on the probability of future hazard events for each jurisdiction? (Requirement §201.6(c)(2)(i))	Pages 54-142	X	
B3. Is there a description of each identified hazard's impact on the community as well as an overall summary of the community's vulnerability for each jurisdiction? (Requirement §201.6(c)(2)(ii))	Pages 50-53; 54-142; 224-1220	X	
B4. Does the Plan address NFIP insured structures within the jurisdiction that have been repetitively damaged by floods? (Requirement §201.6(c)(2)(ii))	Page 79	X	
ELEMENT B: REQUIRED REVISIONS			

REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
ELEMENT C. MITIGATION STRATEGY			
C1. Does the plan document each jurisdiction's existing authorities, policies, programs and resources and its ability to expand on and improve these existing policies and programs? (Requirement §201.6(c)(3))	Pages 145-154; 224-1220	X	
C2. Does the Plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? (Requirement §201.6(c)(3)(ii))	Pages 224-1220	X	
C3. Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? (Requirement §201.6(c)(3)(i))	Pages 156-157; 224-1220	X	
C4. Does the Plan identify and analyze a comprehensive range of specific mitigation actions and projects for each jurisdiction being considered to reduce the effects of hazards, with emphasis on new and existing buildings and infrastructure? (Requirement §201.6(c)(3)(ii))	Pages 224-1220	X	
C5. Does the Plan contain an action plan that describes how the actions identified will be prioritized (including cost benefit review), implemented, and administered by each jurisdiction? (Requirement §201.6(c)(3)(iv)); (Requirement §201.6(c)(3)(iii))	Pages 38 and 224-1220	X	
C6. Does the Plan describe a process by which local governments will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate? (Requirement §201.6(c)(4)(ii))	Pages 191-195; 224-1220	X	
ELEMENT C: REQUIRED REVISIONS			
ELEMENT D. PLAN REVIEW, EVALUATION, AND IMPLEMENTATION (applicable to plan updates only)			
D1. Was the plan revised to reflect changes in development? (Requirement §201.6(d)(3))	Pages 505-507 and Annexes	X	
D2. Was the plan revised to reflect progress in local mitigation efforts? (Requirement §201.6(d)(3))	Pages 179-188	X	
D3. Was the plan revised to reflect changes in priorities? (Requirement §201.6(d)(3))	Pages 26-27; 37, and 224-1220	X	
ELEMENT D: REQUIRED REVISIONS			
ELEMENT E. PLAN ADOPTION			
E1. Does the Plan include documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval? (Requirement §201.6(c)(5))			NA

REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
E2. For multi-jurisdictional plans, has each jurisdiction requesting approval of the plan documented formal plan adoption? (Requirement §201.6(c)(5))		X	
ELEMENT E: REQUIRED REVISIONS E2. As of the date of the approval letter, the following jurisdictions had submitted documentation of adoption: Salt Lake County; the Town of Alta; and the Cities of Bluffdale, Draper City, Riverton City, South Jordan City, and West Jordan.			
ELEMENT F. ADDITIONAL STATE REQUIREMENTS (OPTIONAL FOR STATE REVIEWERS ONLY; NOT TO BE COMPLETED BY FEMA)			
F1.			NA
F2.			NA
ELEMENT F: REQUIRED REVISIONS			

SECTION 3: PLAN ASSESSMENT

A. Plan Strengths and Opportunities for Improvement

This section describes the strengths of the plan document and includes recommendations for how the plan could be improved as part of the next plan update.

Element A: Planning Process

Coordinating a process that will result in a plan that meets the multi-jurisdictional plan content requirements with this many complex jurisdictions is difficult. If the next plan update includes the same jurisdictions, much effort will be required to be more specific as to the unique circumstances, related to vulnerabilities, capabilities, mitigation action plans, and integration processes of each of the participating jurisdictions. The 2015 update, although a significant improvement over the 2009 plan, continues to include a mitigation strategy that is too general/broad brush. It includes too few specific actionable mitigation projects that each participating jurisdiction will be responsible for implementing.

Element B: Hazard Identification and Risk Assessment

Wildfire occurrences since the previous plan are described on Page 83. The plan meets the previous occurrence requirement for wildfire because the plan includes studies that included extensive event data; however, as part of the next update, the plan should summarize all known previous occurrences of wildfire.

The table on pages 50-53 summarizes sources of risk assessment data and impacts and vulnerabilities by hazard. A significance rating is assigned to hazards in Hazard Matrix M-1. This is a useful way to summarize data and information and compare hazards, but the analysis and data underlying the ratings needs to be included.

The risk assessment recognizes the interconnectedness between natural hazards and describes specific vulnerabilities to each hazard. Reputable datasets were used such as Hazus-generated flood and earthquake loss estimates, West Wide Wildfire Risk Assessment, and Risk MAP products and data. However, data and analysis need sources and dates, such as earthquake model loss estimates from FEMA Region VIII. Earthquake loss estimates in Tables 8, 9, and 10 should be described. Additionally, the wildfire, dam failure, and problem soils maps need jurisdiction names.

The risk assessment methodology is based on an old FEMA publication. The Local Mitigation Planning Handbook is a more up-to-date tool that provides guidance and updated ideas, examples, and methods for local planning. The plan refers to the 2011 Utah Hazard Mitigation Plan but should be looking at the more recent update of that plan. Page 145 states that Hazus-MH MR3 inventory data was used in assessments, but oftentimes in this plan it is more recent data.

In many jurisdictional annexes, critical facilities are listed in the Vulnerability Assessment section. The plan should go on to describe the relationship of these facilities with known hazard areas, i.e., the plan should answer, which facilities are vulnerable to which hazards?

Element C: Mitigation Strategy

The mitigation strategy considered a comprehensive range of mitigation actions to reduce the effects of hazards. Many jurisdictional annexes include a zoning map. As part of the next plan update, each jurisdiction should study hazard areas that intersect with future development plans to help steer development away from hazardous areas and/or determine mitigation priorities. Each jurisdiction should take the next five years to develop more specific action plans to implement their mitigation strategies and describe the processes by which they can incorporate and integrate mitigation into other planning mechanisms.

Element D: Plan Review, Evaluation, and Implementation

This is a marked improvement over the previous planning effort. We look forward to reading about the progress in mitigation in Salt Lake County over the next planning cycle.

B. Resources for Implementing Your Approved Plan

Congratulations on completing your local mitigation plan. Below are suggestions for moving the mitigation plan forward and continuing the relationship with your stakeholders:

- Urban and Community Forestry (UCF) is a cooperative program of the US Forest Service that focuses on the stewardship of urban natural resources. These grant programs are focused on issues and landscapes of national importance and prioritized through state and regional assessments. Go to http://www.fs.fed.us/ucf/program.html for more information.
- The Western States Wildland Urban Interface Grant may be used to apply for financial assistance towards hazardous fuels and educational projects within the four goals of: improved prevention, reduction of hazardous fuels, and restoration of fire-adapted ecosystems and promotion of community assistance. Visit http://forestry.alaska.gov/fire/cwpp/wuigrants.htm for more information.
- The National Oceanic and Atmospheric Administration's (NOAA) Office of Education supports education projects and programs through competitively awarded grants and cooperative agreements to a variety of organizations within the United States. For more information, visit: http://www.oesd.noaa.gov/grants/
- The US Department of Transportation's Hazardous Materials Emergency Preparedness (HMEP) grant program provides financial and technical assistance as well as national direction and guidance to enhance State, Territorial, Tribal, and local hazardous materials emergency planning and training. See this website for more information: http://www.phmsa.dot.gov/grants-state-programs

MEMORANDUM OF UNDERSTANDING

August 7th, 2012

Re: Commitment agreement for participating jurisdictions in Salt Lake County's upcoming Multi-Jurisdictional Hazard Mitigation Planning process.

Whereby the Federal Emergency Management Agency's (FEMA) Local Mitigation Plan requirements under 44 CFR §201.6 specifically identify criteria that allow for multi-jurisdictional mitigation plans (in that many issues are better resolved by coordination at the county, regional, or watershed level), the following named jurisdictions (and their designated emergency management representatives), are endorsing this memorandum of understanding as evidence of our collective commitment to participate in the upcoming Salt Lake County Multi -jurisdictional Hazard Mitigation Planning process.

Furthermore, as a condition of participating in the hazard mitigation planning process, we individually agree to meet the requirements for mitigation plans as identified in 44 CFR §201.6, and will provide such cooperation as is necessary (and in a timely manner) to assigned Salt Lake County Emergency Management personnel, so as to complete the plan in conformance with FEMA requirements, benchmarks and deadlines.

We understand that we must engage in the following planning process, as is more fully described in FEMA's ***LocalMulti-Hazard Mitigation Planning Guidance*** dated July 1, 2008, including, but not limited to:

- Identification of hazards unique to the jurisdiction and not addressed in the master planning document;
- The conduct of a vulnerability analysis and an identification of risks, where they differ from the general planning area;
- The formulation of mitigation goals responsive to public input, and development of mitigation actions complementary to those goals. A range of actions must be identified specifically for each jurisdiction;
- Demonstration that there has been a proactively offered opportunity for participation in the planning process, by all community stakeholders (examples of participation include relevant involvement in any planning process, attending meetings, contributing research, data, or other information, commenting on drafts of the plan, etc.);
- Documentation of an effective process to maintain and implement the plan; and,
- Formal adoption of the Multi-jurisdictional Hazard Mitigation Plan by the jurisdiction's governing body (each jurisdiction must officially adopt the plan), within the timelines designated within the State's FEMA approved Mitigation Plan.

Therefore, with a full understanding of the obligations incurred by participating in the FEMA hazard mitigation planning process, and as a participant in a multi-jurisdictional plan; we the following, commit ourselves to the aforementioned Salt Lake County Multi-jurisdictional Hazard Mitigation Planning effort.

(- OVER PLEASE -)

SIGNATURE PAGE – MITIGATION PLANNING PROCESS AGREEMENT

Jeff Graviet, Salt Lake County ES Director	Warren James, Salt Lake County EM Bureau Chief
Cory M. Lyman, Salt Lake City, Emergency Mgr	Beth Todd, VECC, Emer Prep. Coord.
Reed G. Scharman, City of West Jordan, Battalion Chief/Emergency Program Manager	Chris Dunn, Unified Police Dept. of Greater SL
John Evans, West Valley City, Chief/Emergency Services	Claire E. Runge, Town of Alta, Emergency Manager
Eldon L. Farnsworth, South Salt Lake City, Battalion Chief/Emergency Manager	David J. Chisholm, City of Holladay Emergency Committee
Dustin Lewis, City of South Jordan Emergency Mngr.	Jeff King, Jordan Valley Water Conservancy District Security & Emergency Response Coordinator
Joaquín Mixco, Utah National Guard Support Liaison	Tina Giles, Herriman City Emer prep. Coord.
Riverton City Emg. Mngt	Lisa L. Schwartz, City of Taylorsville Emergency Response Coord./EM
Connie Jones, Bluffdale City Em. Manager	Ken Kraudy, Sandy City, Emergency Mgt. Coordinator
Marty Shaub, University of Utah Emergency Manager	Maridene Hancock, Alta City Emergency Management; Garth Smith Emergency Manager

March 3, 2015

Mayor Ben McAdams
Mayor's Office
Rm. N2-100, Government Center
Salt Lake City, Utah

Dear Mayor McAdams:

The Salt Lake County Council, at its meeting held this day, approved the attached RESOLUTION NO. 4903 adopting and implementing the Salt Lake County Hazard Mitigation Plan.

Pursuant to the above action, you are hereby authorized to effect the same.

Respectfully yours,

SALT LAKE COUNTY COUNCIL

SHERRIE SWENSEN, COUNTY CLERK

By Linda Duffy
Deputy Clerk

ld

pc: Neil Sarin/District Attorney's Office

SALT LAKE COUNTY RESOLUTION

RESOLUTION NO. 4903 March 3, 2015

RESOLUTION FOR THE ADOPTION AND PROPOSED IMPLEMENTATION OF THE SALT LAKE COUNTY HAZARD MITIGATION PLAN.

RECITALS

WHEREAS, the Disaster Mitigation Act of 2000, Public Law 106-390, was enacted to establish a national disaster hazard mitigation program to reduce the loss of life and property, human suffering, economic disruption, and disaster assistance costs resulting from natural disasters, and to assist state, local and Indian tribal governments in implementing effective hazard mitigation measures designed to ensure the continuation of critical services and facilities after a natural disaster;

WHEREAS, the Disaster Mitigation Act requires such governments to develop hazard mitigation plans to identify the natural hazards that could impact their jurisdictions, identify actions and activities to mitigate the effects of those hazards, and establish a coordinated process to implement such plans;

WHEREAS, Salt Lake County has been and continues to be committed to reducing the loss of life and property, alleviating human suffering and economic disruption, and controlling disaster assistance costs resulting from natural hazards and accelerating the County's recovery after the occurrence of any such hazard;

WHEREAS, the Salt Lake County Bureau of Emergency Management, in coordination with governmental and non-governmental stakeholders having an interest in reducing the impact of natural hazards throughout the County and with input from the private sector and other members of the public, developed the Salt Lake County Multi-Jurisdictional Multi-Hazard Mitigation Plan (the "Plan"), which identifies natural hazards that have the potential to occur in the County and establishes mitigation strategies to address these hazards;

WHEREAS, the Plan has been approved by the Federal Emergency Management Agency ("FEMA") subject to adoption by the County.

RESOLUTION

NOW THEREFORE, BE IT RESOLVED THAT,

The County Council of Salt Lake County, State of Utah, hereby approves and adopts the Salt Lake County Disaster Mitigation Plan;

The Plan developed by the Salt Lake County Bureau of Emergency Management and approved by FEMA is adopted as the County's Hazard Mitigation Plan pursuant to the Disaster Mitigation Act;

The Salt Lake County Bureau of Emergency Management shall be the agency responsible for delivering a copy of this executed Resolution to FEMA and for monitoring, evaluating and updating the Plan in accordance with the Disaster Mitigation Act;

All agencies shall provide assistance and cooperation as may be necessary or appropriate to implement the provisions of the Plan and carry out the County's responsibilities under the Disaster Mitigation Act; and

This Resolution shall take immediate effect.

By: ______________________
Richard Snelgrove, Council Chair

ATTEST:

____
Sherrie Swensen
Salt Lake County Clerk

APPROVED AS TO FORM AND LEGALITY:

____
Deputy District Attorney
Date: 2/25/15

Council Member Bradley	Voting "Aye"
Council Member Bradshaw	Voting "Aye"
Council Member Burdick	Voting "Aye"
Council Member DeBry	Voting Absent
Council Member Granato	Voting "Aye"
Council Member Jensen	Voting Absent
Council Member Newton	Voting "Aye"
Council Member Snelgrove	Voting "Aye"
Council Member Wilson	Voting "Aye"

SALT LAKE COUNTY

Salt Lake County Multi-Jurisdictional Multi-Hazard Mitigation Plan

Executive Summary

It is an undeniable fact that the number of natural hazards has increased in recent years. Due to increased population density natural hazards have a greater effect. It is the responsibility of government to be prepared for these natural hazards. Government, by definition, has the responsibility for the planning and creation of mitigation strategies to lessen the damaging effects that disasters have. Government at all levels is not only responsible for creating these mitigation strategies with citizen involvement but is also responsible for their timely and cost effective implementation.

With these goals and objectives in mind, Salt Lake County was awarded a federal grant to continue the hazard mitigation process following the creation of the Wasatch Front Regional Council's Natural Hazards Pre-Disaster Mitigation Plan that was approved on November 20, 2009 and expires on November 20, 2014.

When the federal grant was awarded a Memorandum of Understanding (MOU) was created with all 17 jurisdictions located within Salt Lake County (16 cities/towns and Unincorporated Salt Lake County) defining the roles and responsibilities of all agencies. At this point, planning teams were created with Salt Lake County Emergency Management having the responsibility to complete the new plan. Public Works, School Districts and Universities, GIS specialists, city administrators, Emergency Managers, and the public were involved with the creation of the plan. Roger Kehr, Embret Fossum and Kate Smith have been the principal personnel at Salt Lake County Emergency Management involved with the coordination of the County and jurisdictional input.

This plan consists of two parts. (1) The general Salt Lake County overview including hazard history and previous mitigation strategies and the new mitigation strategies for the next five-year period. (2) Individual Jurisdictional plans with past hazard history and previous mitigation strategies that have been initiated or completed. New mitigation strategies have been designed based on the changing requirements of each jurisdiction moving forward for the next five-year period. There is some carry-over from plan to plan as ideas and strategies were created in groups, but they are also jurisdictionally specific, as every community will face different hazards using unique strategies on how to combat these hazards. Combined, they make up the Salt Lake County Multi-Jurisdictional Pre-Disaster Hazard Mitigation Plan. This plan and the implementation of these strategies will help Salt Lake County and its jurisdictions become better-prepared and more resilient communities. The plan was created to prevent and/or reduce the impacts of disasters on our citizens and communities.

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Acknowledgements

Salt Lake County Emergency Management (SLCo EM) would like to acknowledge the following individuals and agencies for their dedication and valuable contribution to this document.

Salt Lake County Emergency Management
Clint Mecham, Emergency Manager
Kate Smith, Mitigation Planner
Roger Kehr, Mitigation Planner
Cathy Bodily, Planner
Embret Fossum, Planner
Steve Sautter, PIO
Aaron Nelson, ECC Operations Officer
Val Greensides, Administrative Assistant
Joan Welch, Administrative Assistant

Salt Lake County Mitigation Planning Team
Chris Cawley, Town of Alta
Claire Woodman, Town of Alta
Connie Jones, Bluffdale City
Mike Halligan, Cottonwood Heights
Dawn Black, Cottonwood Heights
Garth Smith, Draper City
Bart LeCheminant, Draper City
Tina Giles, Herriman City
David Chisholm, Holladay City
Jarin Blackham, Midvale City
Jon Harris, Murray City
Sheril Garn, Riverton City
Ken Kraudy, Sandy City
Jared Smith, Sandy City
Cory Lyman, Salt Lake City
Justin Stoker, Salt Lake City Public Utilities
Dustin Lewis, South Jordan
Matt Jarman, South Jordan
Eldon Farnsworth, South Salt Lake
Ben Gustafson, Taylorsville City
Lisa Schwartz, Taylorsville City
Dirk Andersen, Taylorsville City
Reed Scharman, West Jordan
Bob Fitzgerald, West Valley
Jeff Graviet, Salt Lake County Emergency Services
Mike Barrett, Salt Lake County Emergency Services
Brent Beardall, Salt Lake County Flood Control

Kade Moncur, Salt Lake County Flood Control
Marty Shaub, University of Utah
Scott Jones, Salt Lake Community College
Jeff King, Jordan Valley Water Conservancy District

Team Support
Kevin Barjenbruch, National Weather Service
Justin Stoker, Jordan River Commission
Steve Bowman, Utah Geological Survey
Greg McDonald, Utah Geological Survey
Tyre Holfeltz, FFSL
Jeff King, Jordan Valley Water Conservancy District
Steve Bowman, Utah Geological Survey
Jessica Castleton, Utah Geological Survey
Tyre Holfeltz, Utah Forestry, Fire and State Lands
Riley Pilgrim, Unified Fire Authority
Dave Marble, Utah Division of Dam Safety
Brad Bartholomew, Utah Division of Emergency Management
Katie LeLaCheur, Utah DEM
Eric Martineau, Utah DEM
Amisha Lester, Utah DEM
John Crofts, Utah DEM
Julie Baxter, FEMA Region VIII
Shelby Hudson, FEMA Region VIII
Sean McNabb, FEMA Region VIII

PROMULGATION

This plan is promulgated as the *"Salt Lake County's Multi-Jurisdictional Multi-Hazard Mitigation Plan"*. The plan is designed to comply with all applicable Federal, State and local ordinances and resolutions and provides guidance to be followed to prepare for and mitigate hazards that threaten the community.

This plan has been constructed with the best information available and from a planning perspective. It is recognized that as new information becomes available, decisions and actions may be different than the plan envisioned at the time the plan was developed.

The County of Salt Lake gives full support to the plan and urges all officials, employees, and others involved in the total emergency management effort, individually and collectively, doing their share in making the Salt Lake County a disaster resistant and resilient community.

This plan supersedes all previous hazard mitigation plans.

Promulgated this _____ day of ________________, _______.

____

Ben McAdams
Mayor—Salt Lake County

SALT LAKE COUNTY
1 Introduction

1.1 Background:

This Mitigation Plan is a stand-alone plan based in part in part on a previous work entitled "Wasatch FRONT NATURAL HAZARDS PRE-DISASTER MITIGATION PLAN" completed in 2009. It assists the 16 municipalities and partner agencies within Salt Lake County in reducing the costs of natural disasters by providing comprehensive hazards identification, risk assessment, vulnerability analysis, mitigation strategies, and an implementation schedule.

Salt Lake County is vulnerable to natural and technological (human-caused) hazards that threaten the health, welfare, and security of our citizens. Action taken to reduce or eliminate the long-term risk to human life and property from these hazards is known as mitigation. The losses and life and property, as well as the cost of response to and recovery from potential disasters can be substantially reduced when attention is turned to mitigation of the impacts and effects before they occur or re-occur.

Hazard mitigation planning is the process of identifying hazard risks and vulnerabilities, and establishing goals, policies and procedures to implement risk-reducing actions. This plan represents a collaborative effort of many participants in our community with the mission to engage community stakeholders in developing a comprehensive approach to reduce long-term hazard risk by identifying and implementing effective mitigation strategies.

Mitigation planning creates safer communities by reducing loss of life and property damage, and protecting community assets from the negative impacts of hazards. Implementing mitigation strategies can also reduce the cost of disaster response and recovery by:

- Identifying cost-effective actions that reduce risk
- Focusing resources on the greatest vulnerabilities
- Building partnerships between jurisdictions
- Increasing public awareness of hazards and risk
- Communicating planning priorities
- Aligning risk-reduction efforts with other community plans and objectives
- Establishing eligibility for mitigation grant programs.

Hazard mitigation is any cost-effective action that has the effect of reducing, limiting, or preventing the vulnerability of people, property and/or the environment to potentially damaging, harmful, or costly hazards. Hazard mitigation actions, which can be used to eliminate or minimize the risk to life and property, fall into three categories:

1. Those that keep the hazard away from people
2. Those that keep people, property, and structures away from the hazard
3. Those that do not address the hazard, but rather reduce the impact of the hazard on the victims, such as insurance.

Local mitigation plans are required to be updated every five years. This plan will be an update to the Wasatch Front Regional Council Natural Hazard Pre-Disaster Mitigation Plan (WFRD PDM) that Salt Lake County participated in during 2008-2009. The Mitigation Plan is a collaborative effort, which will serve all of Salt Lake County, including each of the 16 cities, as well as special service districts within the county. The revision of this plan supports the State Hazard Mitigation Plan mission, which is "to permanently reduce the region's vulnerability to natural hazards".

The Plan is intended to promote sound public policy and protect or reduce the vulnerability of the citizens, critical facilities, infrastructure, private property and the natural environment within the region. The framework of this plan will now serve as a tool to guide, plan, and allocate resources across multi-jurisdictional boundaries. It will assist jurisdictions in making good assessments of their resilience to disasters and disruptions. It will serve as a guide to prioritize mitigation and preparedness efforts, allocate funding and guide development in innovative ways and to effectively utilize and share scarce resources. It is a representation of the county's commitment to reduce risks from natural hazards.

1.2 Purpose:

The four purposes of this Plan are:

1. To identify threats to the community
2. To create mitigation strategies to address those threats
3. To develop long-term mitigation planning goals and objectives
4. To fulfill federal, state and local hazard mitigation planning obligations

Mitigation actions in particular would serve to minimize conditions that have an undesirable impact on our citizens, the economy, environment and the well being of Salt Lake County and surrounding municipalities. This Mitigation Plan is intended to enhance the awareness for elected officials, agencies and the public of these hazards and their associated threat to life and property. The Plan also details what actions can be taken to help prevent or reduce hazard vulnerability to each jurisdiction.

Salt Lake County and 16 other jurisdictions, coupled with their respective citizens, prepared this local hazard mitigation plan to guide hazard mitigation planning to better protect the people and property of the County from the effects of hazardous events. This plan demonstrates the community's commitment to reducing risks from hazards and serves as a tool to help decision makers direct mitigation activities and resources. This plan was also developed to make Salt Lake County and participating jurisdictions eligible for certain federal disaster assistance, specifically, the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Grant Program and Pre-Disaster Mitigation program, and to earn points for the National Flood Insurance Program's Community Rating System (CRS), which could lower flood insurance premiums in CRS communities.

1.3 Scope:

This Mitigation Plan is a revision of the Wasatch Front Regional Council Natural Hazard Pre-Disaster Mitigation Plan (WFRC PDM) and crosswalk completed in 2009 with the intent to create a standalone mitigation plan for Salt Lake County. The goal of this Plan is to assist the 16 municipalities and partner agencies within Salt Lake County in reducing the costs of natural disasters by providing comprehensive hazards identification, risk assessment, vulnerability analysis, mitigation strategies, and an implementation schedule.

The WFRC plan was reviewed to evaluate its strengths, weakness and utility. The hazards, vulnerabilities and risks were reviewed as to their impact, how hazards may affect the population, and their severity. Updates also describe hazard impacts that have occurred since the last plan revision. The planning team considered previously unidentified hazards to include in the plan update. A capabilities assessment was conducted to identify potential mitigation needs and to further align the mitigation plan with other community planning efforts. The revision process also included a review of proposed mitigation goals, objectives and actions and to determine their validity and how effective they have been/or will be at reducing vulnerability in the county. New priorities have been set to support changes that were identified. The Mitigation Plan was also evaluated to support the State Mitigation Plan goals and objectives, as well as other local planning efforts. Finally, an implementation strategy and timeline will assign the responsibility and schedule for tracking implementation of the identified mitigation actions. The Mitigation Plan will be adopted through the normal legal process and will establish authority and guide all mitigation activities outlined in the plan.

The plan utilized current county, city, and applicable private hazard mitigation, emergency operations plans, census data and available GIS and assessor's data as resources for the planning team. Salt Lake County Emergency Management staff, planning team members, county, city, and applicable emergency managers/planners, subject matter experts, recruits from other jurisdictions such as other local government units, private sector, non-governmental, academia, airports, military, and the public were also consulted during this planning activity.

The Salt Lake County Natural Hazards Pre-Disaster Mitigation (PDM) Plan was developed in accordance with the requirements of the FEMA Section 322 regulations, 44 CFR Part 201, the Utah Division of Emergency Management (UDEM) and local planning agencies. Regulations set forth by FEMA were followed during the development of this Plan. All participating jurisdictions are listed on pages 36 and 37. Future monitoring, evaluating, updating and implementation will occur annually or following any natural disaster. A major revision will occur every five years. Annual or any interim Plan review, updates and revisions will be the responsibility of each adopting jurisdiction.

Often, hazard mitigation is a neglected aspect within emergency management. When local governments place a low priority on mitigation implementation activities relative to the perceived threat, some important mitigation measures may be neglected in favor of higher priority activities. Mitigation success can be achieved, however, if accurate information is portrayed through complete hazard identification and impact studies, followed by effective mitigation management. Hazard mitigation is the key to greatly reducing long-term risk to people and property from natural hazards and their effects.

As part of the creation of this document the County agreed that the deliverables would contain:

Identification of hazards unique to the jurisdiction and not addressed in the master-planning document;

A vulnerability analysis and an identification of risks, where they differ from the general planning area;

The formulation of mitigation goals responsive to public input and development of mitigation actions complementary to those goals. A range of actions must be identified specifically for each jurisdiction;

Demonstration that there has been a proactively offered opportunity for participation in the planning process by all community stakeholders (examples of participation include relevant involvement in an any planning process, attendance at meetings, contributing research, data, other information, commenting on drafts of the plan);

Documentation of an effective process to maintain and implement the plan; and,

Formal adoption of the Multi-Jurisdictional Hazard Mitigation Plan by the jurisdictions' governing body (each jurisdiction must officially adopt the plan), within the timelines designated with the State's FEMA approved Mitigation Plan.

1.4 Authority:

Federal

Public Law (PL) 93-288 as amended, established the basis for federal hazard mitigation activity in 1974. A section of this act requires the identification, evaluation and mitigation of hazards as a prerequisite for state receipt of future disaster assistance outlays. Since 1974, many additional programs, regulations and laws have expanded on the original legislation to establish hazard mitigation as a priority at all levels of government. When the Stafford Act amended PL 93-288, several additional provisions were added that provide for the availability of significant mitigation measures in the aftermath of presidentially declared disasters. The current Stafford Act with addendums is "The Stafford Act" Robert T Stafford Disaster Relief and Emergency Assistance Act, as Amended April 2013.

State

State Authority

- The Governor's Emergency Operation Directive
- The Robert T. Stafford Disaster Relief and Emergency Assistance Act, amendments to Public Law 93-288, as amended.
- Title 44, CFR, Federal Emergency Management Agency Regulations, as amended.
- State Emergency Management Act of 1981, Utah Code 53-2, 63-5.
- Disaster Response Recovery Act, 63-5A.
- Executive Order of the Governor, Executive Order 11
- Emergency Interim Succession Act, 63-5B.

Utah State Code

In Utah Code 53-2-104, it is stated that the Utah Division of Emergency Management shall: (c) prepare, implement, and maintain programs and plans to provide for:

1. Prevention and minimization of injury and damage caused by disasters:
2. Identification of areas particularly vulnerable to disasters;
3. Coordination of hazard mitigation and other preventive and preparedness measures designed to eliminate or reduce disasters;
4. Assistance to local officials in designing local emergency action plans;
5. Coordination of federal, state, and local emergency activities; (vii) Coordination of emergency operations plans with emergency plans of the federal government; and
6. (x) Other measures necessary, incidental, or appropriate to this chapter.

Local

Local governments play an essential role in implementing effective mitigation. For the purposes of this plan, local governments include not only cities and counties, but also special service districts with elected boards. Each local government will review all present or potential damages, losses and related impacts associated with natural hazards to determine the need or requirement for mitigation action and planning. In the cities within Salt Lake County, the local executives are responsible for carrying out plans and policies, including the county council and city or town mayors and administrators. Local governments must be prepared to participate in the post-disaster hazard mitigation team process and pre-mitigation planning as outlined in this document in order to effectively protect their citizens. All jurisdictions in Salt Lake County participated in the development of this plan.

1.5 Goals and Objectives:

The following plan goals and objectives of the Mitigation plan were maintained from the WFRC plan. These include reducing the risk from natural hazards in Salt Lake County through coordinating with all local governments to develop a countywide planning process. They are shown from highest to lowest priority.

1. Protect life safety.
2. Eliminate and/or reduce property damage.
3. Promote public awareness through education about community hazards and mitigation measures.
4. Protect emergency response services and capabilities, critical infrastructure, critical facilities, communication and warning systems, mobile resources, and other lifelines.
5. Ensure government continuity.
6. Protect the cultural fabric of the community, including cultural resources, developed property, homes, businesses, industry, education and other institutions.
7. Combine hazard loss reduction efforts with other environmental, social and economic needs of the community.
8. Preserve and/or restore natural features, natural resources and the environment.
9. Eliminate or reduce long-term risk to human life and property.
10. Aid private and public sectors in understanding the risks they may be exposed to and identify mitigation strategies to reduce those risks.
11. Avoid risk of exposure to natural and technological hazards.
12. Minimize the impacts of risks that cannot be avoided.
13. Mitigate the impacts of damage as a result of identified hazards.
14. Accomplish mitigation strategies in such a way that negative environmental impacts are minimized.
15. Provide a basis for prioritizing and funding mitigation projects.
16. Establish a countywide platform to enable the community to take advantage of shared goals and resources.

Objectives

The following objectives are meant to serve as a measure upon which individual hazard mitigation strategies can be evaluated. These objectives become especially important when two or more projects are competing for limited resources.

1. Address a repetitive problem, or one that has the potential to have a major impact on an area or population.
2. Identify persons, agencies or organizations responsible for implementation.
3. Identify a time frame for implementation.
4. Explain how the project will be financed including the conditions for financing and implementation (as information is available).

5. Identify alternative measures, should financing not be available.
6. Be consistent with, support, and help implement the goals and objectives of hazard mitigation plans already in place.
7. Significantly reduce potential damages to public and/or private property and/or reduce the cost of state and federal recovery for future disasters.
8. Are practical, cost-effective and environmentally and politically sound after consideration of the options.
9. Can meet applicable permit requirements.
10. Benefits should outweigh the costs.
11. Have manageable maintenance and modification costs.
12. Accomplish multiple objectives when possible.
13. Should be implemented using existing resources, agencies and programs when possible.

Capital investment decisions must be considered in conjunction with natural hazard vulnerability. Capital investments can include homes, roads, public utilities, pipelines, power plants, chemical plants, warehouses and public works facilities. These decisions can influence the degree of hazard vulnerability of a community. Once a capital facility is in place, few opportunities will present themselves over the useful life of the facility to correct any errors in location or construction with respect to hazard vulnerability. It is for these reasons that zoning ordinances, which could restrict development in high vulnerability areas, and building codes, which could ensure that new buildings are built to withstand the damaging forces of hazards, are the most useful mitigation approaches a city can implement.

2 Community Profile

2.1 Geography:

At 737 square miles, Salt Lake County is the fifth smallest county in land area (Governor's Office of Planning and Budget). Tooele County borders Salt Lake County to the West while Summit County borders to the East. To the North, lie Davis and Morgan Counties with Utah County to the South. The Wasatch and Oquirrh Mountains form the East and West borders of the county respectively. The Great Salt Lake occupies much of the northwest corner of the county.

Within Salt Lake County are fifteen incorporated areas (Alta, Bluffdale, Cottonwood Heights, Draper City, Herriman, Holladay, Midvale, Murray, Riverton, Salt Lake City, Sandy City, South Jordan, South Salt Lake, Taylorsville, West Jordan, and West Valley) and sixteen unincorporated areas with substantial populations: (Big Cottonwood, Camp Williams, Canyon Rim, Copperton, East Millcreek, Emigration Canyon, Granite West, Kearns, Magna, Millcreek, Mount Olympus, Parley's Canyon, Sandy Hills, Southwest, White City, and Willow Canyon). Salt Lake County's land ownership is 72.8% private, 20.4% Federal, 2.3% State, and 4.6% water. The county is ranked second relative to the amount of private and local government ownership in Utah.

A significant portion of Salt Lake County is currently zoned for low-density residential development. Some higher densities are allowed in eastern Salt Lake City, while the Southeast and Southwest areas of Salt Lake County are zoned for lower housing densities. Industrial land uses are planned for West Salt Lake City, along the I-15 corridor, northern West Valley City, the western portion of North Salt Lake, and the West side of Salt Lake County. Areas primarily for commercial use include concentrations in Salt Lake City's central business district and along primary transportation corridors including I-15, I-215, State Street, 400 South, Highland Drive, 3500 South, 4500 South and 7200 South.

Additional commercial land use nodes are dispersed throughout Salt Lake County to serve adjoining residential communities. Many public and private lands still remain undeveloped because of specific environmental constraints, such as steep slopes or prime wetlands. Some areas currently being used for industrial or mining activity may be redeveloped for commercial and residential purposes. Kennecott Utah Copper Corporation currently holds much of this land.

2.2 Economy:

Salt Lake County is the backbone of Utah's economy, making up 50% of the job market. The service industry, the largest employment division within the County, supplies 26% of the area's wages. Trade is the second major component followed by government and manufacturing. The largest number of government-related employees in Utah is located in Salt Lake County. Salt Lake is a regional center for finance, health care, and high tech industries as well. Major employers include the University of Utah, the State of Utah, Intermountain Healthcare, Granite School District, Jordan School District, Salt Lake County, Wal-Mart, Discover Financial Services Inc., Delta Airlines, the United States Postal Service, Salt Lake City School District and Salt Lake City.

2.3 Population and Demographics:

Utah's April 1, 2010 population reached 2,763,885. This represents a population increase of 530,716 persons or 23.8% from the 2000 Census numbers. This increase ranked Utah third among states in the rate of population growth from 2000 to 2010.
Salt Lake County continues to be the most populous county in the state, with a population of 1,029,655 in the 2010 Census. Salt Lake County contains two of the largest cities in the state: Salt Lake City with 186,440 and West Valley City with 129,480. Herriman City was the second fastest growing city in the state with over 1330% growth in the past ten years.
The county's average annual growth rate from the 2000 Census to the 2010 Census was 14.6%. Utah's average household size is 3.10 people per household. The median age in the county is 29.2 (2010 Census). Utah's natural population growth averaged 37,000 and our in-migration was positive at around 10,000 people.

2.4 Land Use and Development:

The Salt Lake City Community and Economic Development Department (CED) is here to guide and promote the physical and economic development of Salt Lake City. Their goal is to provide leadership, policies and programs that will promote strong, vibrant neighborhoods and communities, and to proactively encourage the positive and orderly growth and development of the City. CED advocates incorporation of the diverse interests of our community to reduce barriers and enhance leadership capacity to continue to improve the quality of life for all who live, work and play here.

The CED Engineering Department assures that all future development meets building codes to prevent development in potential disaster areas.

3 Planning Process

3.1 Update Process and Participation Summary:

This Salt Lake County Mitigation Plan was prepared by Salt Lake County Emergency Management staff members Roger Kehr, Embret Fossum, Kate Smith and Cathy Bodily. A core Planning Team with representatives from each city and other major service districts provided extensive contributions to the information included in this plan. Other local and state agencies that have aided in the process include; city and county geographic information system (GIS) departments, elected officials, local officials, emergency managers, fire and law enforcement departments, planning departments, public works/engineering departments and other local government agencies. The planning process was based on Section 322 requirements of the Disaster Mitigation Act of 2000 (DMA 2000) and supporting guidance documents developed by FEMA and the Utah Division of Emergency Management (UDEM).

Step 1: Getting Started

In 2012, Salt Lake County applied for and was awarded a Pre-Disaster Mitigation Planning grant. The planning project is to update the Salt Lake County portion of the 2009 Wasatch Front Regional Council Pre-Disaster Mitigation Plan and develop a stand-alone mitigation plan that will meet the 44CFR 201.6 planning requirements and will result in a FEMA approved mitigation plan. Salt Lake County had oversight of this multi-jurisdictional plan, and prepared a Memorandum of Understanding to obtain a commitment from the cities and special service districts to participate in the planning process. A letter of intent was signed by all parties and is included in the Appendix.

Step 2: Jordan River Watershed/Risk MAP Collaboration

FEMA Region VIII and the Utah Division of Emergency Management initiated a project to identify flood mapping and risk analysis needs in the Jordan River watershed at approximately the same time as the Salt Lake County Mitigation planning project. The flood risk project and mitigation planning project shared the same planning area, participating jurisdictions, local officials, and many common objectives. This presented a unique opportunity to share resources, integrate programs and implement a more comprehensive approach to risk reduction.

Objectives of the Risk MAP project included:

- Assisting communities to identify, assess, communicate, and mitigate risk
- Documenting flood risk issues and floodplain mapping needs within the Jordan River watershed which could potentially initiate a new mapping project in a future year
- Developing non-regulatory flood risk data, analysis, and mapping based on local needs and priorities
- Identifying areas of mitigation interest for Salt Lake County, Salt Lake City, local communities and special districts

- Building capabilities of local jurisdictions to create and use risk analysis data, identifying mitigation actions, and access resources for implementing projects
- Incorporating a multi-hazard approach into the Risk MAP project by working with local staff and jurisdictions on analyzing and integrating impacts of wildfire, earthquake, and other major hazards in the planning area
- Providing technical assistance as needed to help support a comprehensive and inclusive mitigation planning process and the development of an effective, high quality plan. FEMA planning and GIS Staff provided technical assistance through risk assessment data, analysis and mapping, training to local staff, meeting facilitation, and guidance on meeting federal regulations for plan approval.

Collaboration between the Risk MAP team and county mitigation planning team improved coordination and partnerships between local, state and regional staff and used stakeholder time more efficiently by combining meetings and improved the quality of risk analysis by sharing data and technical expertise. This also improved the plan review and approval process through early and consistent involvement and guidance on regulations from FEMA.

Step 3: Organize Resources

Salt Lake County Emergency Management (SLCo EM) assigned a staff member to act as the lead planner throughout the planning process with additional support staff offering assistance as needed. SLCo EM planning team members are outlined in Table 3-1. These members were involved in the planning process from the initiation of the Planning grant request, to the development and coordination, and resolution of the Plan's adoption.

A core planning team, comprised of at least one representative from each city, was convened early in the planning process. The Planning Team started the planning process by reviewing the 2009 Pre-Disaster Mitigation Plan and recommended revisions, as well as guided the plan's overall revision process and content. Every jurisdiction in the county was invited to provide a representative to serve on the planning team to ensure local input. Every jurisdiction will also meet to adopt the final FEMA approved Plan.

3.2 The Planning Team:

Member Name	Organization Name
Kate Smith	Salt Lake County Emergency Management, Mitigation Planner
Cathy Bodily	Salt Lake County Emergency Management, Grant applicant and Planner
Roger Kehr	Salt Lake County Emergency Management, Mitigation Planner
Steve Sautter	Salt Lake County Emergency Management, Public Outreach
Matt Morrison	Salt Lake County Emergency Management, Planner
Bret Fossum	Salt Lake County Emergency Management, Planner
Val Greensides	Unified Fire Authority, Administrative Support
Joan Welch	Unified Fire Authority, Administrative Support
Clint Mecham	Unified Fire Authority, Salt Lake County Emergency Manager
Aaron Nelson	Unified Fire Authority, ECC Operations Officer
Dirk Andersen	Taylorsville City
Mike Barrett	Salt Lake County Emergency Services
Brent Beardall	Salt Lake County Flood Control
Leon Barrett	Salt Lake County
Dawn Black	Cottonwood Heights
David Chisholm	Holladay City
Eldon Farnsworth	South Salt Lake City
Bob Fitzgerald	West Valley City
Sheril Garn	Riverton City
Tina Giles	Herriman City
Jeff Graviet	Salt Lake County Emergency Services
Jon Harris	Murray City
Matt Jarman	South Jordan City
Connie Jones	Bluffdale City
Scott Jones	Salt Lake Community College
Jeff King	Jordan Valley Water Conservancy District
Ken Kraudy	Sandy City
Bart LeCheminant	Draper City
Dustin Lewis	South Jordan City
Cory Lyman	Salt Lake City
Kade Moncur	Salt Lake County Flood Control
Reed Scharman	West Jordan City
Lisa Schwartz	Taylorsville City/Midvale City
Marty Shaub	University of Utah
Garth Smith	Draper City
Jared Smith	Sandy City
Justin Stoker	Salt Lake City Flood Control

Claire Woodman	Town of Alta

Table 3-1. Core Planning Team

Name	Organization
Brad Bartholomew	Utah Division of Emergency Management
Eric Martineau	Utah Division of Emergency Management
Katie LeLaCheur	Utah Division of Emergency Management
Amisha Lester	Utah Division of Emergency Management
Cynthia Morgan	Salt Lake Valley Health Department
Kevin Barjenbruch	National Weather Service
Tyre Holfeltz	Utah Forestry Fire and State Lands
David Marble	Utah Division of Water Rights
Steve Bowman	Utah Geological Survey
Jessica Castleton	Utah Geological Survey
Julie Baxter	FEMA Region VIII
Sean McNabb	FEMA Region VIII
Shelby Hudson	FEMA Region VIII

Table 3-2. Supporting Agencies/Stakeholders

Step 4: Public Officials Outreach

To ensure the public and their officials were supportive of the Plan, the SLCo EM Mitigation Planner presented at the Salt Lake County Council of Governments meeting in March 2013. These public meetings have representation from each chief elected official in each county. The planners also attended other City/County Councils meetings. Additionally, some communities recommended meeting with their city council to better inform the community.

Step 5: Data Review and Acquisition

The 2009 WFRC PDM Plan was reviewed by SLCo EM and the planning team to evaluate which portions of the plan required updating and revision. Contact was made with the GIS technician and/or planning commission staff in cities and county departments to assess available data. Mapping data layers obtained included some or all of the following: local roads, plot maps, county tax assessor's data, hazard data, flood maps, topographic data, aerial photographs and land development data. The Planning Team evaluated revised data and maps, and through a consensus process developed the revised mitigation strategies based on current data.

Step 6: County Hazard Identification and Profile

These steps were conducted by gathering data on the hazards that threaten Salt Lake County. This information was gathered from reports and other publications from local, state and federal agencies, organizations, newspapers and other local media accounts, state and local weather records, conversations with the public and local officials, surveys, interviews and meetings with key informants within the planning area. County-level mitigation planning meetings were held during this process. During these meetings, attendees had the opportunity to review hazard information and provide comment. These meetings also provided a forum for discussion on the background information that was needed to gain a general understanding of the geography, geology, recreation and natural resources of the planning region.

Step 7: County Vulnerability Assessment

This step was conducted through a review of local hazard maps, topographical maps, floodplain maps, and Utah Geological Survey (UGS) maps, Automated Geographic Reference Center (AGRC) data, FEMA hazard maps and climate maps from the National Climatic Data Center (NCDC). Salt Lake County Assessor data was used to estimate the number of structures and their value that could potentially be affected by hazards. 2010 Census data was used to estimate the number of residents and households that could be affected by hazards. A detailed vulnerability assessment was completed with the use of GIS software. Vulnerability to earthquakes and floods was provided by analysis in conjunction with FEMA Region VIII.

In some cases where the values were considered to still be valid, data from the 2009 WFRC PDM plan were carried over into the current plan revision. These items are identified in the current plan as being carried over from the 2009 WFRC PDM plan. More details on the methodology used for these items can be found in the 2009 WFRC PDM plan. In summary, loss estimation methodology was developed by the core planning team, with assistance from the technical team, to determine vulnerability from each identified hazard. The FEMA modeling program Hazards United States – Multi-Hazards (HAZUS-MH) was used to determine earthquake and flood vulnerability. Transportation Analysis Zone (TAZ) and Census 2000 data were used to estimate the number of residents and households that could be affected by the hazard. Utah State sales tax and Equifax Business data were used to find the total number of businesses and annual sales vulnerable to hazards. HAZUS-MH infrastructure data was used to analyze the amount of infrastructure vulnerable to hazards.

Step 8: Capabilities Assessment

Each member of the Mitigation Planning Team was given a Capabilities Assessment Worksheet (see Appendix) and Hazard Identification Matrix to complete within their own jurisdiction. These worksheets were designed as an opportunity for the planning team to engage others in their community in the planning process. It encouraged them to review existing plans, studies, reports or other technical information with city planners, engineers, administrators and other individuals who contribute to decision making and community planning. The worksheets were also intended to help recognize established goals as well as identify known hazards or problem areas that could potentially be addressed by implementing mitigation actions. The Hazard Identification Matrix allowed each jurisdiction to identify which hazards present the greatest threat locally and are summarized in Table M-1.

Step 9: Risk Assessment Review

Every section of the Plan was updated and revised as part of the planning process. Each completed section of the updated Plan was reviewed and analyzed for accuracy by the Planning Team and county emergency managers. The Planning Team was tasked with reviewing the county risk assessments for accuracy and completeness and with developing mitigation strategies for all natural hazards threatening their respective jurisdiction. Changes or additions were conveyed to the lead planner for revision.

Step 10: Mitigation Strategy Development

Developing the mitigation strategies was a process in which all of the previous steps were taken into account. Each participating jurisdiction evaluated, identified and profiled the hazards, and vulnerability assessment completed by SLCo EM. The strategies from the 2009 WFRC plan were reviewed to identify which projects had been completed, which were ongoing, and whether others should be carried over into the current plan. The planning team met several times to brainstorm additional strategies and improve upon the existing strategies. Each mitigation strategy developed was evaluated to determine that actions met the objectives stated in the Introduction.

Step 11: Prioritization of Identified Mitigation Strategies

DMA 2000 requires state, tribal, and local governments to show how mitigation actions were evaluated and prioritized. The Mitigation Planning Team determined which strategies were highest priority, which jurisdiction was responsible, and evaluated them to ensure best action to take given limited budgets allocated to hazard mitigation efforts at the local level. The planning team completed the prioritization process over a series of planning meetings (workshops). Each action was assigned a responsible party, an anticipated cost, and a timeline. Prioritization was accomplished using the STAPLEE method as explained in the FEMA How to Guide, Document 386-3. This process resulted in each Mitigation Strategy given a High, Medium or Low priority by the local planning teams.

Step 12: Continued Outreach

The risk assessment and proposed mitigation strategies were made available on the SLCo EM and UFA websites for public comment from July 14, 2014 to October 1, 2014. Each jurisdiction on the planning team, as well as Special Service Districts, was contacted to solicit their review and comments of the draft plan. Comments and suggestions were conveyed to the lead planner for consideration and possible revision.

Step 13: State Review

Utah DEM created a formal Plan review committee to ensure local plans met the requirements of DMA 2000. This committee reviewed the Plans from October 20th, 2014 subsequent to submission to FEMA for final review and acceptance.

Step 14: Planning Timeline

The Plan will be adopted by the cities as described in the MOU.

3.3 Meetings and documentation

Year	Date	Activity	Purpose
2012	September	Utah Division of Emergency Management designates Salt Lake County Emergency Management/Unified Fire Authority as sub-grantees of the state to revise the Pre Disaster Mitigation Plan.	
	August 7	Memorandum of Understanding	An MOU was signed by participating jurisdictions committing to participate in the planning process.
	September-October	Phone conferences with UDEM and FEMA Region VIII to discuss the planning process, Risk MAP.	Identified planning team and available resources.
	November 7	Risk MAP Discovery, Mitigation Kickoff	Kick-off to introduce RiskMAP and Mitigation projects to reduce risk from natural hazards and increase disaster resiliency in the Jordan River Watershed/Salt Lake County
	November-December	Identifying Planning Team Members	Establish a contact person from each jurisdiction to participate in the planning process.
	December		Meeting with Salt Lake County Emergency Services to discuss cooperation with other county agencies and participation in mitigation planning process.
2013	January-May	Gather information.	Data collection.
	January 22	Mitigation Planning Team Meeting	Introduce project scope, identified team responsibilities, key terminology, and requirements of the planning process, timeline.
	February 11	Mitigation Planning Team Meeting	Review of hazard maps for earthquake, landslide, and dam failure. Worksheets to gather information of areas of concern. Subject matter experts available to answer questions.

Year	Date	Activity	Purpose
	February 27	Sandy City BCDM (Business Continuity Development Meeting)	Outreach effort, presentation/overview of mitigation plan to Sandy City business partners and emergency managers
	March 7	Salt Lake County Council of Government (COG)	Outreach presentation to elected officials to give overview of mitigation planning project.
	March 11	Mitigation Planning Team Meeting	Discussion with subject matter experts on severe weather and wildfire.
	April 8	Mitigation Planning Team Meeting	Presentation on pandemic flu and wildfire public education programs.
	May 16	Mitigation Planning Team, Risk MAP Joint Meeting	Presentation of flood and earthquake risk analysis from FEMA Region VIII, presentation from UDEM regarding community Risk MAP meetings to be held over summer, Mitigation team given Capabilities Assessment worksheets and hazard matrix.
	June-Aug	Community Risk MAP Meetings and Work on Worksheets	Risk MAP representatives met with individual communities to discuss flood study needs and areas of concern.
	Sept 11	Mitigation Team Meeting	Recap of Capabilities Assessment, preparing for next stages of plan.
	Oct 21	Salt Lake County Emergency Manager's meeting	Planner reported on mitigation plan progress to emergency managers. Encouraged completion of capabilities assessment worksheets. Provided copy of 2009 mitigation strategies to review and comment on progress.
	Oct-Nov	Risk Assessment Draft and Mitigation Strategies Preparation	Planner reviewed and summarized Capabilities Assessment and Hazard worksheets. Continued Revising Risk Assessment. Summarized responses to 2009 Strategies Review.
	Nov. 19	Mitigation Planning Team	Brainstorming meeting to begin

Year	Date	Activity	Purpose
		Meeting-Mitigation Strategies Part II	identifying possible mitigation strategies. Hazards discussed were flood, wildfire, earthquake, and avalanche. Rough draft of Risk Assessment made available.
	Nov. 20	Planner meeting with SHMO regarding plan progress	Discussed timeline and planning progress
	December	Reviewed Mitigation Strategies.	Planner compiled notes from mitigation strategies brainstorm meeting and worksheets
2014	Jan 14	Mitigation Planning Team Meeting – Mitigation Strategies Part II	Brainstorming meeting to begin identifying possible mitigation strategies. Hazards discussed were earthquake, pandemic, dams, canals, and drought.
	Feb-Mar	Mitigation Strategies Draft, Update Wildfire Risk Assessment.	Planner compiled notes from mitigation strategies brainstorm sessions, continued revision of Risk Assessment as new data became available for Wildfire.
	Apr-June	Mitigation Strategies Review	Create timeline to meet Grant requirements. Complete all elements of Plan.
	June	Review Best Practices SOG for Mitigation	Find a better system for Mitigation planning. Permission to use Salt Lake County's Mitigation SOG
	July 1	Review Progress with EM staff	Prepare Plan for submission to state and FEMA review boards
	July 14	Mitigation Planning Team Prioritization Workshop	Planning Team reviews final mitigation strategies to assign responsibility, estimate costs, and define priority
	August 8	Emergency Managers Meeting HMP explanation and scheduling	Have each individual Jurisdiction complete their plan.
	September 8-24	Emergency Managers Meeting HMP scheduling	Continue one-on-one meetings with each Jurisdiction to complete plan

Year	Date	Activity	Purpose
	October 7	Submit final plan from each Jurisdiction	Salt Lake County to review Jurisdiction plans and assemble entire County HMP
	October 20	Submit Mitigation Plan to State	State Submission requirement prior to FEMA submission
	November 1	State returns Mitigation Plan for submission to FEMA	Submit Final Plan to FEMA for approval
	November 15	FEMA returns plan for corrections	Correct deficiencies
	November 20	Submit Final Plan to FEMA	Plan complete

Table 3-8 Planning Process Timeline

3.4 Public Involvement:

Public involvement opportunities were available and incorporated throughout the development of this Plan. Such opportunities included a public website and public meetings for comment review. Emergency managers, fire and sheriff departments, state and local agencies, business leaders, educators, non-profit organizations, private organizations, and other interested members that could be affected by a hazard within the region or other interested members, were all a part of the planning process as listed in table 3-8.

The draft of the 2014 Mitigation Plan was placed on the UFA/SLCo EM website for greater than a 30-day public comment and review period. There were no public comments received on that draft of the Plan. Members of the public and elected officials from each jurisdiction were notified of the lack of public comments at county Council of Government meetings. The final plan draft was also presented to the County COG public meeting. Each jurisdiction and special service district will approve the plan in a public meeting.

3.5 Multi-Jurisdictional Planning—Rationale:

Information Sources and Revision Process

Background information and data for this Plan was obtained from the sources listed on the following page. From these sources, the WFRC PDM planner extracted relevant information and data. That information and data was subsequently submitted to the County Work Groups for their consideration and approval for inclusion into the Plan. Relevant information gathered from these sources was compiled by the Working Groups and incorporated into this Plan. Based on the large amount of growth in communities throughout the WFRC Region, it was determined by the Working Groups that the entire Plan would be updated.

This risk assessment covers the entire geographical extent of Salt Lake County. Since this plan is a multi-jurisdictional plan, the HMPC was required to evaluate how the hazards and risks vary from jurisdiction to jurisdiction. While these differences are noted in this chapter, they are expanded upon in the annexes of the participating jurisdictions. If no additional data is provided in an annex, it should be assumed that the risk and potential impacts to the affected jurisdiction are similar to those described here for the entire Salt Lake County planning area.

Each of the hazards that can affect Salt Lake County, and the potential impacts, will be described in this section, known as a Hazard Identification and Risk Assessment or HIRA.

Sources for Background Information

- Federal Emergency Management Agency (How-to Guides)
- National Weather Service (hazard profile)
- National Climate Data Center (drought, severe weather)

- Utah Division of Emergency Management (Salt Lake City Mitigation Plan, GIS data, flood data, HAZUS data for flood and earthquake)
- Utah Geologic Survey (GIS data, geologic information, various hazard reports)
- Utah Division of Forestry Fire and State Lands (fire data)
- Utah Avalanche Center, Snow and Avalanches, Annual Report 2006-2007 Forest Service
- Utah Department of Transportation (traffic data, avalanche?)
- Utah Automated Geographic Resource Center (GIS data)
- University of Utah Seismic Station (earthquake data)
- Utah State University (climate data)
- Councils or Government
- Association of Governments
- Utah Association of Special Districts
- State Office of Education
- Salt Lake County and municipalities (Emergency Operations Plans, histories, mitigation actions, public input, data: GIS, assessor, transportation, property and infrastructure)
- Earthquake Safety in Utah
- Utah Natural Hazard Handbook 2008
- Utah Statewide Fire Risk Assessment Project
- A Strategic Plan for Earthquake Safety in Utah
- State of Utah Wildfire Plan 2007
- State of Utah Drought Plan 2007
- West Wide Wildfire Assessment 2013

4 Risk Assessment

4.1 Update Process Summary:

As defined by FEMA, risk is a combination of hazard, vulnerability, and exposure. "It is the impact that a hazard would have on people, services, facilities, and structures in a community and refers to the likelihood of a hazard event resulting in an adverse condition that causes injury or damage."

The risk assessment process identifies and profiles relevant hazards and assesses the exposure of lives, property, and infrastructure to these hazards. The process allows for a better understanding of a jurisdiction's potential risk to hazards and provides a framework for developing and prioritizing mitigation actions to reduce risk from future hazard events.

This risk assessment followed the methodology described in the FEMA publication *Understanding Your Risks—Identifying Hazards and Estimating Losses* (FEMA 386-2, 2002), which breaks the assessment into a four-step process:

1. Identify hazards
2. Profile hazard events
3. Inventory assets
4. Estimate losses

Data collected through this process has been incorporated into the following sections of this chapter:

Section 4.2 Hazard Identification:

Natural Hazards identifies the natural hazards that threaten the planning area and describes why some hazards have been omitted from further consideration.

Guiding principle: All disasters are local first. Cities have the primary authority to prepare for and respond to disasters. County, state and federal government partners (in that order) stand ready and willing to help when needed. When an incident is expected to overwhelm resources at the local level, requests for assistance are made through mutual aid or to the county. The county then makes requests to the state, which can request help from other states or to the federal government through FEMA. Local declarations do not guarantee funding assistance, but are an important legal statement in the process.

How it works: Three types of assistance can come from FEMA: Individual assistance (to homeowners), public assistance (for infrastructure), and hazard mitigation (to lessen future disaster impacts).

Individual Assistance is rare in Utah. There has to be devastating effects to a community with more than 100 homes severely damaged.

For *Public Assistance*, FEMA has established disaster thresholds based on population for each county and each state. For Utah, the State threshold is $3.84 million. The threshold must be met in each affected county and at the state level. Thresholds are met with consideration towards eligible damages to public facilities, infrastructure, and historical properties. Damages covered by insurance must first be deducted before figuring cost estimates against the threshold amount. Private property damages are not a considered cost towards the threshold. If it appears that Utah would meet the threshold, the Governor can request a preliminary damage assessment from FEMA. A team would arrive and work with state and local partners to determine if the thresholds are met and are likely eligible. If so, the Governor would likely declare a state of emergency and request a disaster declaration to the President through FEMA Region VIII in Denver. If approved by the President in consultation with FEMA, eligible infrastructure damages are reimbursed by the federal government at a 75 percent share. The other 25 percent is a shared state and local cost. The Hazard Mitigation Grant Program is available only when the President has declared a disaster and is 15% of the total FEMA cost of the disaster.

Section 4.3 Hazard Profiles:

Discusses the threat to the planning area and describes previous occurrences of hazard events and the likelihood of future occurrences.

Section 4.4 Vulnerability Assessment:

Assesses the County's total exposure to natural hazards, considering assets at risk, critical facilities, and future development trends.

Section 5 Capability Assessment:

Inventories existing mitigation activities and policies, regulations, and plans that pertain to mitigation and can affect net vulnerability.

4.2 Hazard Identification—Natural Hazards:

4.2.1 Previous Declarations:

Identifies previous Presidential disaster declarations since the previous Hazard Mitigation Plan.

Presidential Declarations since 2009:

1. Utah Flooding (DR-4011) Incident period: April 18, 2011 to July 16, 2011 Major Disaster Declaration declared on August 8, 2011
2. Utah Machine Gun Fire (FM-2859) Incident period: September 19, 2010 to December 31, 1969 Fire Management Assistance Declaration declared on September 19, 2010

4.2.2 Summary of Hazards:

Using existing natural hazards data and input gained through planning meetings, the HMPC agreed upon a list of natural hazards that could affect Salt Lake County. Hazard data from the Utah State Department of Emergency Management and Mitigation, FEMA, the National Oceanic and Atmospheric Administration, and many other sources were examined to assess the significance of these hazards to the planning area. Significance was measured in general terms and focused on key criteria such as frequency and resulting damage, which includes deaths and injuries and property and economic damage. The natural hazards evaluated as part of this plan include those that occurred in the past or have the potential to cause significant human and/or monetary losses in the future. Only the more significant (or priority) hazards have a more detailed hazard profile and are analyzed further in Section 4.3 Vulnerability Assessment.

The natural hazards identified and investigated for the Salt Lake County Multi-Hazard Mitigation Plan include:

- Earthquake
- Flood
- Wildland Fire
- Slope Failure
- Severe Weather
- Dam Failure
- Avalanche
- Pandemic
- Drought
- Infestation
- Radon
- Problem Soils

The HMPC eliminated the natural hazards listed below from further consideration in this risk assessment because they occur rarely or not at all in Salt Lake County.

- Hurricane

4.3 Hazard Profiles:

The hazards identified in Section 4.1 Hazard Identification: Natural Hazards—are profiled individually in this section. In general, information provided by planning team members is integrated into this section with information from other data sources, such as those mentioned in Section 4.1. These profiles set the stage for Section 4.3 Vulnerability Assessment, where the vulnerability is quantified, where possible, for each of the priority hazards.

The following sections provide profiles of the natural hazards that the HMPC identified in Section 4.1 Identifying Hazards

The HIRA was initiated through a series of meetings with the Core Planning Team and subject matter experts from the following organizations:

City and county agencies
Jordan Valley Water Conservancy District
Salt Lake City Public Utilities
Utah Geological Survey
National Weather Service
Utah Division of Water Rights
Utah Forestry, Fire, and State Lands
Unified Fire Authority
Salt Lake Valley Health Department

Each hazard is profiled in the following format:
Hazard/Problem Description—This section gives a description of the hazard and associated issues followed by details on the hazard specific to the Salt Lake County planning area. Where known, this includes information on the hazard extent, seasonal patterns, speed of onset/duration, and magnitude and/or secondary effects.

Past Occurrences—This section contains information on historical incidents, including impacts where known. The extent or location of the hazard is also included here. Historical incident worksheets were used to capture information from participating jurisdictions on past occurrences.

Frequency/Likelihood of Future Occurrence—The frequency of past events is used in this section to gauge the likelihood of future occurrences. Where possible, frequency was calculated based on existing data. It is determined by dividing the number of events observed by the number of years on record and multiplying by 100. This gives the percent chance of an event happening in any given year (e.g., three droughts over a 30-year period equates to a 10 percent chance of a drought in any given year). The likelihood of future occurrences is categorized into one of the following classifications:

Highly Likely—Near 100 percent chance of occurrence in next year or happens every year.
Likely—Between 10 and 100 percent chance of occurrence in next year or has a recurrence interval of 10 years or less.
Occasional—Between 1 and 10 percent chance of occurrence in the next year or has a recurrence interval of 11 to 100 years.
Unlikely—Less than 1 percent chance of occurrence in next 100 years or has a recurrence interval of greater than every 100 years.

Hazard Matrix M-1 provides an initial assessment of the profiles and assigns a level of significance to each hazard. Those hazards determined to be of high significance were characterized as priority hazards that required further evaluation in Section 4.3 Vulnerability Assessment. Those hazards that occur infrequently or have little or no impact on the planning area were determined to be of low significance. Significance was determined based on the hazard profile, focusing on key criteria such as frequency and resulting damage, including deaths/injuries and property, crop, and economic damage. This assessment was used by the HMPC to prioritize those hazards of greatest significance to the planning area; thus enabling the County to focus resources where they are most needed.

The Mitigation Planning Team identified the hazards in Table 4 as having the potential to affecting all or a portion of Salt Lake County, based on history of occurrences and/or future probability. Each of these was reconsidered and—having been found applicable, carried over from the 2009 WFRC Pre-Disaster Mitigation Plan, with the addition of Avalanche and Flu Epidemic.

The HIRA process was aided through the use of FEMA How-to Guidance Documents, FEMA Local Mitigation Planning Handbook, Local Mitigation Plan Review Guide, the Utah State Hazard Mitigation Plan, Utah Natural Hazards Handbook 2008, FEMA 386-1,2,3,7, Disaster Mitigation Act of 2000, 44 CFR Parts 201 and 206, Interim Final Rule, and FEMA Region VIII Crosswalk. The risk assessment process also utilized assistance from local GIS departments using the best available data.

Hazard	How Identified	Why Identified
Earthquake	• Review of County Emergency Operations Plans • Review of past disaster declarations • Input from City and County Emergency Operations	• Utah has a 1/5 chance, of experiencing a large earthquake within the next fifty years. • Numerous faults throughout Utah including the Intermountain Seismic Zone. • Yearly, Utah averages approximately 13 earthquakes having a magnitude 3.0 or greater.

Flood	• Review of past disaster declarations • Input from City and County Emergency Operations Managers, Utah DWS, UGS, Utah Army Corps of Engineers, Utah DEM, and community members • Review of Flood Insurance Studies, Floodplain maps, and FIRMs	• Several incidents have caused severe damage and loss of life. • Many of the rivers and streams are located near neighborhoods. • Many neighborhoods are located on floodplains, alluvial fans. • Topography and climate lead to cloudburst storms and heavy precipitation can result in flash flooding throughout most of the Wasatch Front.
Wildland Fire	• Review of County Emergency Operations Plans • Review of Community Wildfire Plans • Input from County Emergency Managers, Utah DEM, Utah FFSL, Utah FS, NWS, FEMA, and local community members	• Serious threat to life and property. • Much of Salt Lake County is at risk • Increasing threat due to urban growth in WUI areas. • Secondary threat associated with flooding, drought, and earthquake. • Additional funding and resources offered by local and state agencies to reduce risk. • To increase community awareness.
Slope Failure	• Input from City and County Emergency Operations Managers, USGS, UGS, NCDC, Utah DEM, and community members	• Have caused damage in the past to residential and commercial infrastructure. • Can be life threatening. Generally occur in known historic locations therefore risks exist throughout much of the Wasatch Front. • To increase community awareness.
Severe Weather	• Review of County Emergency Operations Plans • Review of past	• Damage to communities, homes, infrastructure, roads, ski areas, and people. • Can cause property damage and loss of life. • Results in economic loss.

	disaster declarations • Input from City and County Emergency Operations Managers, Utah Avalanche, Forecast Center, Utah Department of Transportation, and community members	• Lightning is number one cause of natural hazard death in Utah. • Can be costly to recover from. • Affects the young and old more severely.
Dam Failure	• Review of County Emergency Operations Plans • Input from community members, Utah DWS, Dam Safety Section, Utah DEM • Review of inundation maps	• Can cause serious damage to life and property and have subsequent effects such as flooding, fire, debris flow, etc. • Many reservoirs located in the county. • Threat to downhill communities. • Subsequent effects include flooding, fire, and debris flows. • To increase community awareness. • To incorporate mitigation measures into existing plans to help serve local residents.
Avalanche	• Input from community members, previously considered as part of severe weather, now addressed as separate hazard	• Canyon residents and tourist populations can become isolated • Transportation routes to canyons can be obstructed.
Flu Epidemic	• Salt Lake Valley Health Department • Input from City and County Emergency Managers • Review of County Emergency Operations Plan	• Can affect large number of population • Disrupt services and result in economic loss • Can overwhelm health care providers
Drought	• Review of Utah State Water Plan • Input from community	• Affects local economy and residents. • Reduces available water in reservoirs impacting culinary, irrigation, and municipal water supplies.

	members, Utah DHLS, NWS, NCC, and NCDC	• Drought periods may extend several years. • Secondary threat associated with wildfire. • Utah is the nation's second driest state. • Can impact farming and ranching operations. • Neighboring communities have been affected by culinary and irrigation water shortages
Infestation	• Review of Utah Department of Agriculture and Food Annual Insect Report and the Utah Forest Insect and Disease Report • Input from community members, UDAF, Utah FFSL, and the Utah State University Extension Service	• Consistently affects this region. • Declined forest health and agriculture losses. • Previous experiences have affected the residents of the Wasatch Front. • Results in economic loss. • Destruction can be severe and is very costly to mitigate. • To better understand mitigation and response techniques.
Radon	• UGS Maps • Utah Division of Radiation Control Testing Data.	• Is odorless and colorless. • Can cause lung cancer over time.
Problem Soils	• Review of County Emergency Operations Plans • Input from community members, Utah, DEM, and UGS • Researched historical data	• Related to subsequent effects from earthquakes. • Have affected infrastructure and local economy in the past.

Table 4 Local Hazards Identification

	Avalanche	Dam Failure	Drought	Earthquake	Flood	Infestation	Landslide	Pandemic	Problem Soils	Radon	Severe Weather	Wildfire
Alta	High	Low	Low	Mod	Mod	Mod	Mod	Low	Low	Low	High	Mod
Bluffdale	Low	Low	Low	High	High	Mod	Low	Low	Mod	Low	Mod	Mod
Cottonwood Heights	Low	Low	Low	High	Low	Low	Low	Low	Low	Low	Mod	Low
Draper	Low	Low	Mod	High	Low	Low	Mod	Low	Mod	Mod	High	High
Herriman	Low	Mod	Low	Mod	High	Low	L/M	Low	Low	Low	Low	High
Holladay	Low	Low	Mod	Low	Mod	Low	Mod	Low	Low	Low	Low	Mod
Midvale	Low	Low	Mod	High	Mod	Low	Low	High	High	Low	Mod	Low
Murray	Low	Mod	Low	High	Mod	Low	Low	Low	Low	Low	Mod	Mod
Riverton												
Sandy	Mod	Mod	High	High	Low	Low	High	Mod	Low	Mod	Mod	High
Salt Lake City	Low	Low	Mod	High	High	Low	Low	Low	Low	Low	Mod	High
South Salt Lake	Low	Mod	Mod	Mod	High	Mod	Low	Mod	Low	Mod	High	Low
South Jordan	Low	Low	Low	High	Low	Low	Low	Mod	Low	Low	High	Low
Taylorsville	Low	Low	Mod	Mod	Mod	Low	Low	Low	Low	Low	Low	Low
West Jordan	Low	Low	Low	High	High	Low	Low	Mod	Low	Low	High	Low
West Valley	Low	Low	Low	High	Mod	Low	Low	Mod	Low	Low	Mod	Mod
Unincorporated SL County	Mod	Low	High	High	Mod	Low	Mod	High	Mod	Low	High	Mod

Hazard Matrix M-1

4.3.1 Earthquake

The Utah Geologic Survey defines an earthquake as the “abrupt, rapid shaking of the Earth caused by sudden breakage of rocks that can no longer withstand the stresses that build up deep beneath the earth’s surface”. The rocks break along zones of weakness, called faults. Seismic waves are then transmitted outward and also produce ground shaking or vibrations in the earth (Utah Natural Hazards Handbook. 2008).

The Richter scale measures the magnitude of earthquakes on a seismograph. Generally an earthquake needs to be at least a magnitude 2.0 to be felt by humans, and about magnitude 5.5 before significant damage occurs. The amount of damage that occurs from an earthquake depends on soil type, rock type, ground-water depth and topography. Other factors include the type of construction in an area and the population density.

Secondary Hazards:

Associated earthquake hazards include ground shaking, surface fault rupture and tectonic subsidence, soil liquefaction, flooding, avalanches, dam failure, fire, and slope failure.

Ground Shaking:

Ground shaking is caused by the passage of seismic waves generated by an earthquake. Shaking can vary in intensity but is the greatest secondary hazard because it affects large areas and stimulates many of the other hazards associated with earthquakes. Moderate to large earthquake events generally produce trembling for about 10 to 30 seconds. Aftershocks can occur erratically for weeks or even months after the main earthquake event.

The waves move the earth's surface laterally and vertically and vary in frequency and amplitude. High frequency, small amplitude waves cause more damage to short, stiff buildings. Low frequency, large amplitude waves have a greater effect on high-rise buildings. The intensity depends on geologic features such as bedrock and rock type, topography, and the location and magnitude of the earthquake. Other significant factors include ground water depth, basin shape, thickness of sediment, and the degree of sediment consolidation (UNHH 2008).

Surface Fault Rupture and Tectonic Subsidence:

Surface fault rupture is the result from relative movement between blocks in the Earth's crust. In Utah, the result is the formation of scarps or steep breaks in the slope. The 1934 Hansel Valley earthquake resulted in a surface displacement of approximately 1.6 feet. Earthquakes having a magnitude of 6.5 or greater could result in surface faulting 16 to 20 feet high and 12 to 44 mile long break segments. Surface displacement generally occurs over a zone of hundreds of feet wide called the zone of deformation and can cause severe damage to building foundations or lifelines (roads, pipelines, communication lines) that cross the fault. Tectonic subsidence, or down dropping and tilting of the valley floor, generally depends on the amount of surface fault rupture, and can cause flooding by tilting lakebeds or dropping ground surface below the water table. The greatest amount of subsidence will be in the fault zone and will gradually diminish out into the valley (UDCEM 1991).

Soil Liquefaction:

Liquefaction can occur when water-saturated, cohesionless, sandy soils are subjected to ground shaking. The soils "liquefy" or become like quicksand, lose bearing capacity and shear strength, and readily flow on the gentlest of slopes. Liquefaction is common in areas of shallow ground water and sandy or silty sediments. Liquefaction can produce lateral spreading and flows, where surface soil layers break up and move independently. Displacement of up to 3 feet may occur, accompanied by ground cracking and differential vertical displacement. Soil may move downhill, pulling apart roads, buildings, pipelines and buried utilities. Bearing capacity will lessen and can cause buildings to settle or tip, while lightweight buoyant structures such as empty storage tanks may “float” upward. Liquefaction can also cause foundation materials beneath earthfill dams to liquefy and fail, flooding by ground water in low-lying areas, back up of gravity fed systems, and/or cause sand boils. Sand boils are deposits of sandy sediment ejected to the surface during an earthquake along fissures. Liquefaction can occur during earthquakes of magnitude 5.0 or greater (UNHH 2008).

Slope Failure:

Ground shaking can cause rock falls and landslides in mountainous or canyon areas. Rock falls are the most common slope failure and can occur up to 50 miles away from a 6.0 magnitude earthquake. Landslides occur along steep slopes and benches in wet, unconsolidated materials. During a 6.0 magnitude earthquake, landslides typically occur within 25 miles of the source (UNHH 2008).

Flooding:

“Flooding can happen due to tectonic subsidence and tilting, dam failure, seiches (waves generated in standing bodies of water) in lakes and reservoirs, surface-water diversion or disruption, and increased ground-water discharge.” (UNHH 2008).

Avalanches:

Avalanches could be triggered because of the associated ground movement. The most vulnerable areas include those that have steep terrain, high precipitation, high earthquake potential, and high population density, and heavy backcountry use (UNHH 2008).

Sensitive Clays:

Sensitive clays are a soil type that loose strength and are subject to collapse when shaken. The resulting type of ground failure is similar to liquefaction (UNHH 2008).

Subsidence:

A settling or sinking of loose granular materials such as sand and gravel that do not contain clay. Western Utah is subject to this type of ground settlement (UNHH 2008).

Earthquake Hazard Profile

Potential Magnitude	X	Catastrophic (>50%)	Probability		Highly Likely
		Critical (25-50%)		X	Likely
		Limited (10-25%)			Possible
		Negligible (< 10%)			Unlikely

Location	Ground shaking will be felt throughout the entire county. Surface fault rupture can be found in areas of known historic fault movements. Liquefaction can be expected in areas of high to moderate liquefaction potential.
Seasonal Pattern	None.
Conditions	Liquefaction potential within areas with shallow ground water. Soil that is comprised of old lakebed sediments. Historic movement along faults. Intermountain Seismic Zone, Wasatch Fault.
Duration	Actual ground shaking will be under one minute, aftershocks can occur for weeks or even months.
Secondary Hazards	Fire, landslide, rock falls, avalanche, flooding, hazardous material release, transportation and infrastructure disruptions, essential service disruptions (communications, utilities).
Analysis Used	Review of hazard analysis plans and other information provided by the University of Utah Seismograph Station, UGS, USGS, FEMA, UDEM, AGRC.

Table 5

4.3.1.1 Location and Extent:

Utah's earthquake hazard is greatest within the Intermountain Seismic Belt (ISB), which extends 800 miles from Montana to Nevada and Arizona, and trends from North to South through the center of Utah (The Wasatch Fault, UGS PIS 40).

4.3.1.2 Range of Magnitude:

The ISB contains the Wasatch Fault—one of the longest and most active normal faults in the world—with a potential for earthquake with a magnitude up to 7.5. The largest earthquakes in Utah occur in the ISB, where at least 35 earthquakes of magnitude 5.0 or greater have occurred since 1850 (UNHH 2008).

The Wasatch Fault traces along the base of the Wasatch Mountain Range. It is made up of 10 segments that act independently, meaning that a part of the fault ruptures separately as a unit during an earthquake. The Salt Lake City Segment traverses Salt Lake County from North to South, roughly along the Eastern foothills of the Wasatch Mountains. Within the Salt Lake City Segment of the Wasatch Fault are three smaller segments from North to South known as the Warm Springs Fault, the Virginia Street Fault and the East Bench Fault.

Other faults within Salt Lake County include the West Valley Fault Zone and the East Great Salt Lake Fault Zone. Each of these fault zones has much longer return interval (2,500 years or more) and is not expected to produce a major quake in the near future.

Name	Fault Type	Length (km)	Time of Most Recent Deformation	Recurrence Interval

East Great Salt Lake fault zone, Antelope Island section	Normal	35	586+201/-241 cal yr B.P.	4,200 years
Wasatch fault zone, Salt Lake segment	Normal	43	1,300±650 cal yr B.P.	1,300 years
West Valley fault zone, Granger segment	Normal	16	1,500±200 cal yr B.P.	2,600-6,500 years
West Valley fault zone, Taylorsville segment	Normal	15	2,200±200 cal yr B.P.	6,000-12,000 years
Cal yr B.P.=calendar years before present				

Table 6. Quaternary Faults, Salt Lake County (UGS 2002, UGS 2006)

4.3.1.3 History:

Although no surface-faulting earthquakes have occurred on the Wasatch fault since settlement in Utah, evidence of numerous prehistoric events exists in the geologic record (The Wasatch Fault, UGS PIS 40). The segments between Brigham City and Nephi have a composite recurrence interval (average time between earthquake events) for large surface-faulting earthquakes (magnitude 7.0-7.5) of 300-400 years. The average repeat time on an individual segment is 1,200-2,600 years. The most recent surface-faulting earthquakes occurred about 500 years ago on the Provo and Weber segments, and about 350 years ago on the Nephi segment (UNHH 2008).

4.3.1.4 Future Occurrence:

Utah experiences approximately 700 earthquakes each year, and approximately six of those have a magnitude 3.0 or greater. On average, a moderate, potentially damaging earthquake (magnitude 5.5 to 6.5) occurs every 10 years. Large earthquakes (magnitude 6.5-7.5) occur on average every 50 years (UNHH 2008). The history of seismic activity in Utah and along the Wasatch Front suggests that it is not a matter of "if" but when an earthquake will occur. The probability of a large earthquake occurring along the central segments of the Wasatch Front is 13 percent in 50 years, or 25 percent in 100 years (The Wasatch Fault, UGS PIS 40).

The two largest measured earthquakes to occur in Utah were the Richfield earthquake of 1901, with a magnitude of 6.5 and the Hansel Valley earthquake of 1934 with a magnitude of 6.6.

> The Hansel Valley earthquake produced MM intensities of VIII in Salt Lake City, with numerous reports of broken windows, toppled chimneys, and structures twisted on their foundations. A clock mechanism weighing more than 2 tons fell from the main tower of the Salt Lake City County Building and crashed through the building. The only death that occurred during the event was caused when the walls of an excavation collapsed on a public-works employee south of downtown Salt Lake City. (Lund 2005).

Utah's most damaging earthquake was of a smaller magnitude (5.7), which occurred near Richmond in Cache Valley in 1962. This earthquake damaged over 75 percent of the houses in Richmond, as well as roads and various other structures. The total damage was about $1 million (in 1962), or with inflation accounted for, $7,768,300 today (UNHH 2008).

Significant earthquakes have occurred in Salt Lake County within the last 50 years. In 1962, a 5.2 Richter magnitude quake jolted the Magna area. In 1992, a magnitude 4.2 quake shook the southern portion of the county.

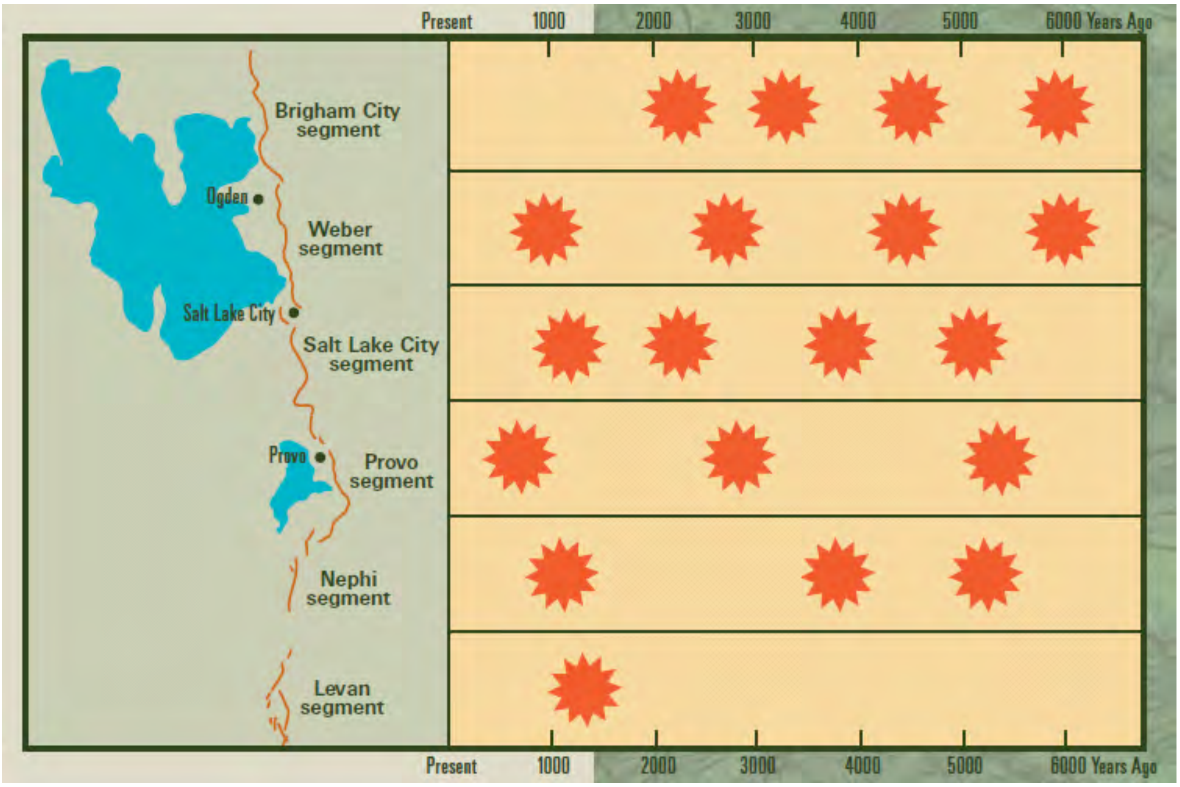


Table 7. Wasatch Fault Segments and Timeline of Major Ruptures ("The Wasatch Fault", Utah Geological Survey Public Information Series 40)

Liquefaction is one of the secondary hazards associated with an earthquake and affects nearly all of Salt Lake County. The County is located atop the ancient Lake Bonneville Lakebed, which is made up of unconsolidated sandy soils. Much of the valley is also subject to shallow ground water and a relatively high earthquake threat. These three factors are prevalent in the northern quarter of the county.

4.3.1.5 Vulnerability Assessment:

Vulnerability of people and infrastructure to earthquake hazards in Salt Lake County was obtained from the modeling program HAZUS-MH, completed by FEMA Region VIII.

Jurisdiction	Total Building Economic Loss	Loss Ratio	Total Debris (tons)
Alta	-	-	-
Bluffdale	$75,909,747	7%	52,992
Cottonwood Heights	$817,648,029	19%	604,376

Draper	$815,409,260	16%	563,887
Herriman	$19,753,740	1%	12,682
Holladay City	$774,328,409	26%	622,027
JVWCD	-	-	-
Midvale	$704,507,575	23%	475,181
Murray	$1,777,099,237	25%	1,223,103
Riverton	$252,898,310	7%	166,609
Salt Lake City	$12,249,473,845	28%	7,966,834
Sandy	$1,563,253,806	12%	1,145,039
South Jordan	$304,492,930	5%	168,343
South Salt Lake	$1,995,423,120	37%	1,394,470
Taylorsville	$555,466,197	12%	385,072
Unincorporated	$3,340,999,835	21%	2,384,159
West Jordan	$370,486,178	4%	178,435
West Valley City	$1,890,864,776	15%	1,280,884
County Total	$27,488,261,254		18,611,411

Table 8.

Jurisdiction	Displaced Households	Individuals Seeking Public Shelter	Total Casualties	Life-Threatening Injuries and Fatalities	URM Count
Alta	-	-	-	-	9
Bluffdale	155	116	25	2	120
Cottonwood Heights	2,297	1,237	379	37	3,335
Draper	861	576	253	21	472
Herriman	1	1	-	-	47
Holladay	2,869	1,656	572	59	3,578
JVWCD	-	-	-	-	
Midvale	2,617	1,720	610	59	2,978
Murray	6,200	3,448	2,147	217	4,987
Riverton	393	260	100	10	596
Salt Lake City	35,786	21,629	13,698	1,397	32,341
Sandy	3,858	2,297	773	70	2,917
South Jordan	201	125	54	5	524
South Salt Lake	3,567	2,674	2,312	235	2,569
Taylorsville	2,462	1,610	444	44	2,547
Unincorporated	11,220	6,602	2,778	274	17,043
West Jordan	521	356	193	17	1,612
West Valley City	5,830	4,944	1,686	169	7,143
County Total	78,839	49,249	26,025	2,616	82,818

Table 9.

Jurisdiction	Life-Threatening Ratio to Total Pop	URM Ratio to Total Structures
Alta	0.000%	7%
Bluffdale	0.032%	6%
Cottonwood Heights	0.113%	33%
Draper	0.053%	5%
Herriman	0.000%	1%
Holladay City	0.291%	57%
JVWCD	-	-
Midvale	0.212%	42%
Murray	0.467%	37%
Riverton	0.025%	6%
Salt Lake City	0.762%	60%
Sandy	0.081%	10%
South Jordan	0.009%	4%
South Salt Lake	0.997%	37%
Taylorsville	0.075%	17%
Unincorporated	0.173%	38%
West Jordan	0.016%	6%
West Valley City	0.130%	23%

Table 10.

2009 Vulnerability Assessment

The following values are from the HAZUS analysis performed by WFRC for the 2009 Regional Mitigation Plan. Because no significant changes in the level of risk or the condition of infrastructure, these values are still considered valid estimates of potential impacts to earthquake in Salt Lake County. They are based on a probabilistic 2500-year event with a Richter magnitude of 7.1 as well as an arbitrary 5.9 event located in close proximity to the county's most populated areas. These locations and magnitudes were chosen for their likelihood and proximity respectively. Default HAZUS-MH inventory for all infrastructure was used. (**For a more detailed explanation of the loss estimation methodology of HAZUS-MH MR2, please see Part VI or the HAZUS-MH Technical Manual (Earthquake Model) at www.fema.gov/hazus).

Building Damage

HAZUS-MH classifies building damage into five states: none, slight, moderate, extensive and complete. Table 11 lists the number of buildings by occupancy estimated to sustain moderate to complete levels of damage during an arbitrarily-determined Richter magnitude 5.9 (M5.9) earthquake scenarios or a probabilistic Richter magnitude 7.1 (M7.1) earthquake scenario. Also listed are the estimated monetary losses to structures, contents/inventory, and income.

Category	Number of Structures with > 50% Damage		Category	Estimated Losses	
	Salt Lake M5.9	2500-yr M7.1		Salt Lake M5.9	2500-yr M7.1
Residential	30,342	157,705	Structural Losses	$519,320,000	$3,419,030,470
Commercial	1,896	5,199	Non-Structural Losses	$1,818,647,000	$12,331,504,070
Industrial	495	1,367	Content Losses	$719,709,000	$4,114,455,740
Government	167	475	Inventory Losses	$29,216,000	$175,756,410
Education	51	159	Income and Relocation Losses	$623,140,000	$3,263,449,580
Totals	32,951	164,905	Totals	$3,710,032,000	$23,304,196,270

Table 11. Building Damage Counts and Estimated Losses using HAZUS MH

Transportation and Utilities Damage

Damages to transportation and utility infrastructure are in Table 12. Infrastructure sustaining moderate or worse damage and estimated monetary losses are both shown.

Category	Total	At Least Moderate Damage >50%		Estimated Losses	
		Salt Lake M5.9	2500-yr M7.1	Salt Lake M5.9	2500-yr M7.1
Waste Water Facilities	5	2	4	$44,008,000	$146,243,000
Waste Water Pipelines	3.975 km	637 leaks/breaks	14,005 leaks/breaks	$2,294,000	$50,416,000
Potable Water Pipelines	6,625 km	805 leaks/breaks	17,706 leaks/breaks	$2,900,000	$63,744,000
Natural Gas Pipelines	2,650 km	681 leaks/breaks	14,970 leaks/breaks	$2,452,000	$53,893,000
Electrical Power Facilities	7	3	7	$92,024,000	$343,874,000
Communication Facilities	42	9	34	$242,000	$1,478,000
Highway Bridges	698	126	496	$81,646,000	$468,944,000
Railway Bridges	17	0	8	$9,000	$358,000
Railway Facilities	6	0	6	$3,494,000	$7,525,000
Bus Facilities	2	0	2	$490,000	$1,157,000
Airport Facilities	3	0	3	$2,675,000	$7,450,000
Total Losses				$232,234,000	$1,145,082,000

Table 12. Damage to Transportation and Utilities

Debris Removal

Table 13 shows how much debris would be generated by the earthquake and how many loads it would take to remove the debris, based on 25 tons per load. One truck can likely haul one load per hour. A second debris removal issue is landfill space. Fifty thousand tons at a weight-to-volume ratio of one ton per cubic yard would cover more than ten acres to a depth of three feet.

Category	Salt Lake M5.9	2500-yr M7.1
Brick, Wood & Others	581,000 tons / 23,240 loads	3,356,000 tons / 134,240 loads
Concrete & Steel	1,195,000 tons / 47,800 loads	7,678,000 tons / 307,120 loads

Table 13. Debris Generated/Number of Loads

Fires Following an Earthquake

Multiple ignitions and broken water mains following an earthquake can make firefighting nearly impossible. HAZUS-MH uses estimated building damages, loss of transportation infrastructure and estimated winds to calculate the estimated area that would be burned following an earthquake. Table 14 provides estimates of ignitions, people at risk and the building stock exposed to fires following an earthquake.

Category	Number of Structures	
	Salt Lake M5.9	2500-yr M7.1
Ignitions	49	80
Persons Exposed	806	2,116
Value Exposed	$50,232,000	$120,188,000

Table 14. Fire Following Event, Population Exposed, and Building Stock Exposed

Casualties

Table 15 estimates casualties likely to occur during each earthquake scenario. The nighttime scenario (2 a.m. local time) assumes a primarily residential concentration of persons, the daytime scenario (2 p.m. local time) a commercial concentration, and the commute scenario (5 pm. local time) a concentration of persons on commuting routes. Categories of casualties include those not requiring hospitalization (minor), those requiring treatment at a medical facility (major), and fatalities.

Night Event	Salt Lake M5.9	2500-yr M7.1	Day Event	Salt Lake M5.9	2500-yr M7.1	Commute Event	Salt Lake M5.9	2500-yr M7.1
Minor	1,024	10,475	Minor	1,883	17,110	Minor	1,432	13,442
Major	219	3,224	Major	502	6,192	Major	369	4,688
Fatalities	44	758	Fatalities	122	1,742	Fatalities	87	1,258

Table 15. Casualties

Community Assets

The planning team identified additional significant community assets with potential impacts by earthquake hazards. These include areas of particular concern, critical facilities and infrastructure, areas of future development, major employers or economic sectors, cultural or historic facilities, significant populations or significant natural resources. The following is a broad-stroke look at community assets, which will be covered in more detail in each respective Jurisdiction's Annex.

Murray:

Future development: Birkhill Subdivision, near Jordan River
Facilities: Fire Station #82, Murray City Hall (1970, not earthquake retrofit), older schools need retrofitting
Population: Major apartment complexes, large nighttime population
Economic: limited access to businesses following earthquake
Natural: Jordan River Conservatory

Sandy City:

Areas of concern: High ground shaking on east side, high liquefaction potential west of I-15
Future development: large hotels
Structures: Becton-Dickinson Medical Products, I-15 corridor, South Towne Expo Center, Alta View Hospital
Populations: Health South Rehabilitation, Sandy Regional Convalescent Center
Economic: Becton-Dickinson Medical Products, Jordan Commons, Costco, Scheels, Macy's, Dillards, Harmons, Lowes, Layton Companies
Natural: Little Cottonwood Canyon

South Salt Lake:

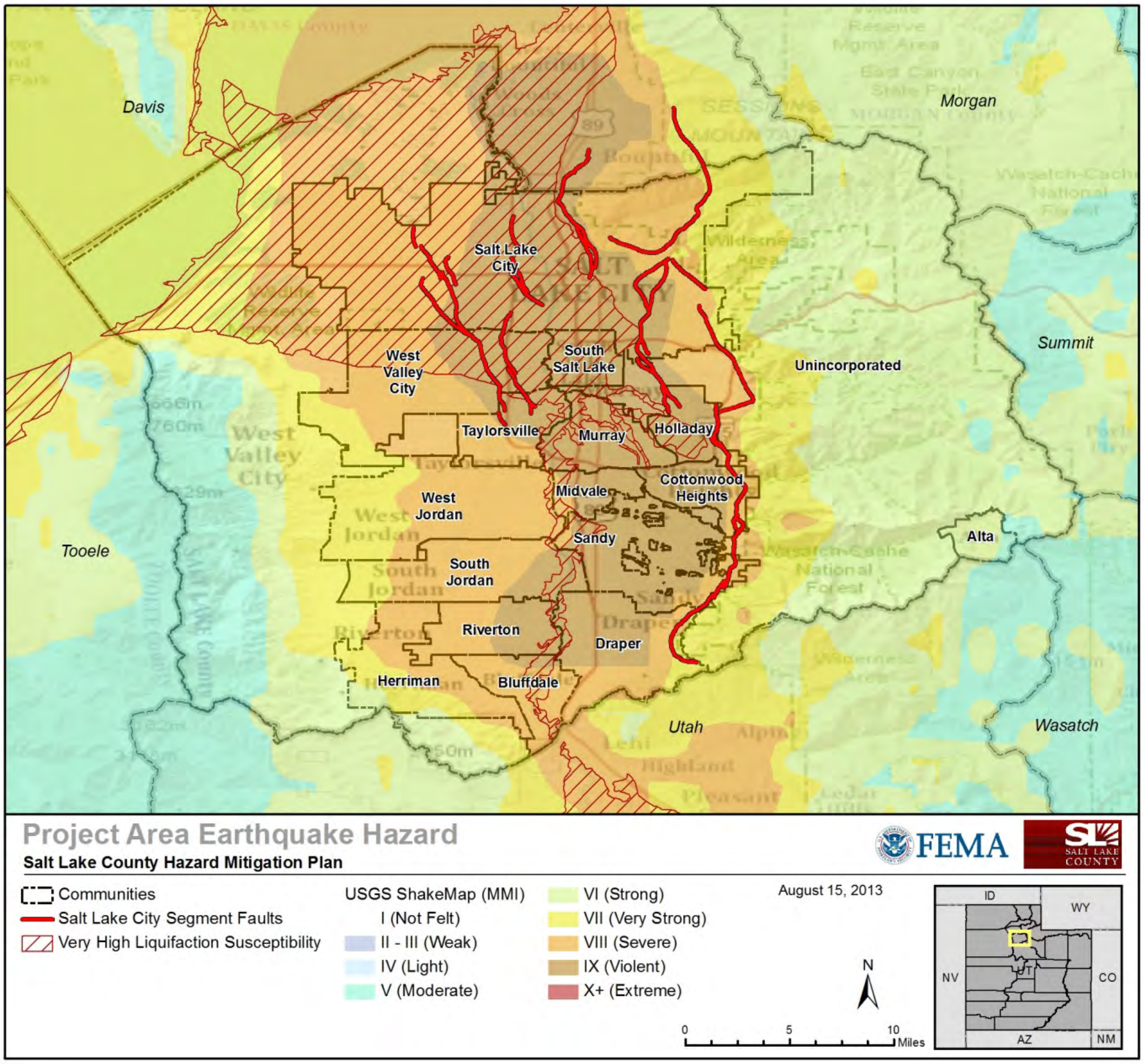
Areas of concern: High liquefaction potential.
Future development: 2100 S- 2400 South State St. – 400 W.,
Facilities: County Jail, Youth Corrections Facility, Oxbow facility, Salt Lake County EOC, major railway corridor and repair shops, I-15 and I-80 corridor/interchange, UTA transportation routes, 5 elementary schools, 1 Jr High, 1 High school
Population: Larger daytime population (60-80,000 day, 23,000 night). Prisoner population. Non-English speakers.
Economic: Marriott, RC Willey, Union Pacific RR.

Taylorsville:

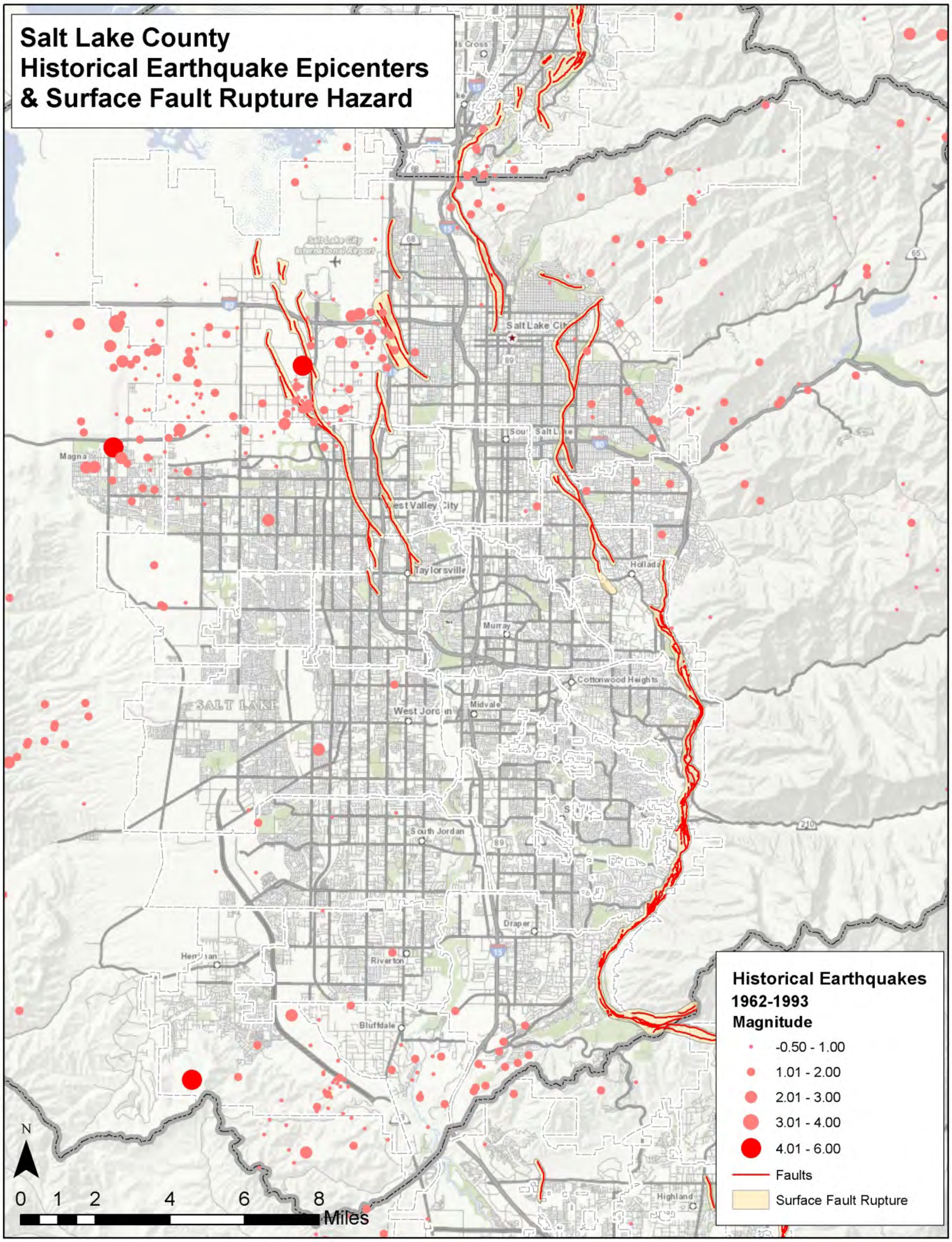
Areas of concern: West Valley Fault zone, runs under Public Safety building and near American Express, Unified Lab, I-215 corridor, Redwood Rd., Station 117, Eisenhower Jr. High. Historical evidence of 10' displacement along fault at 2700 W from 4100 – 5200 S
Structure: Calvin Rampton Public Safety Bldg., Fire Station 117, Eisenhower Jr. High, John Fremont Elementary, Plymouth Elementary (near canal)
Population: Daytime business populations, schools
Economic: American Express, State of Utah, UDOT, Unified Labs, Jordan Valley Water

Draper:

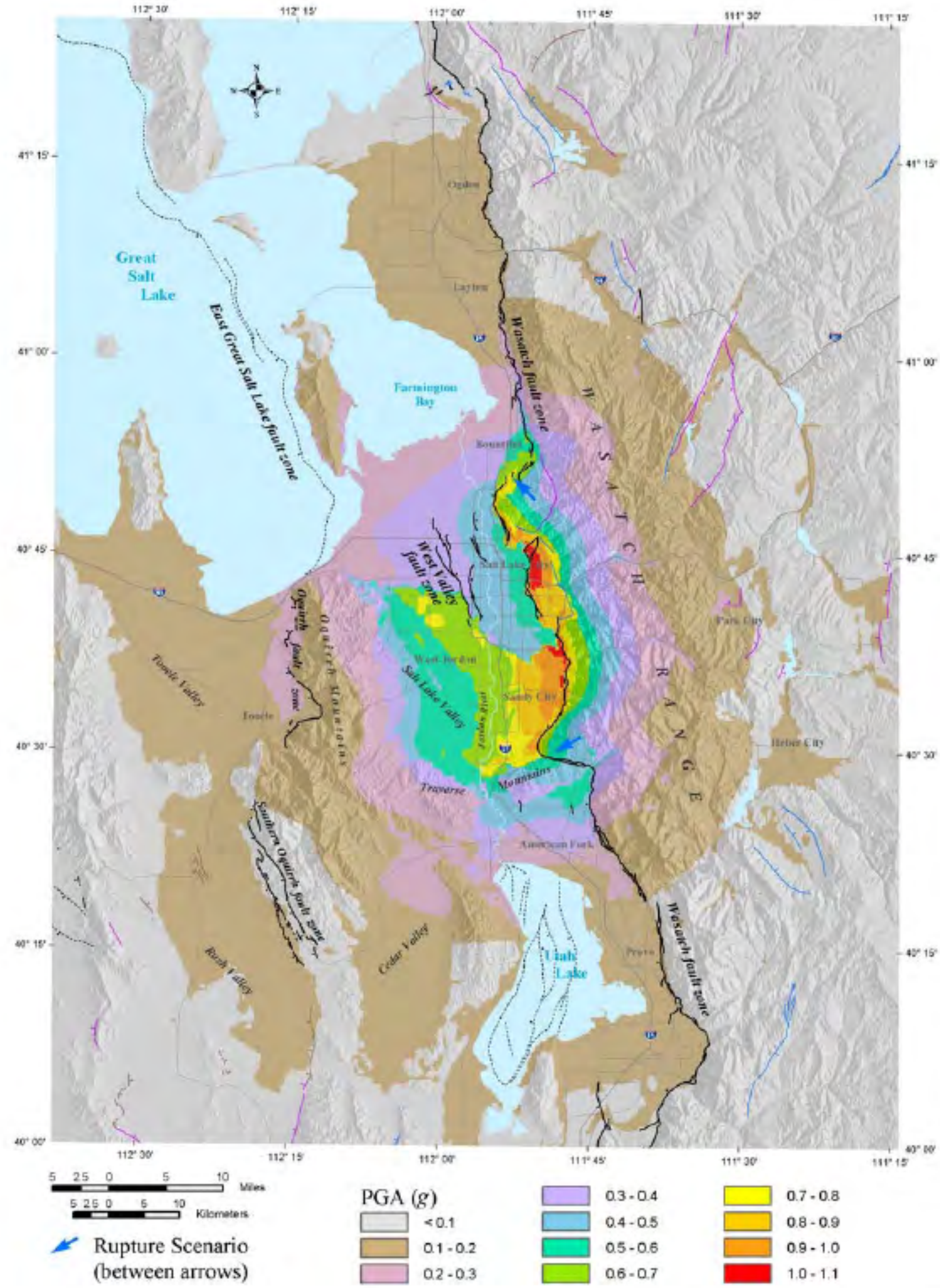
Areas of concern: Point of the Mountain aqueduct, Corner Canyon – Salt Lake Aqueduct, Little Cottonwood Treatment Plant
Future development: Suncrest, Draper
Structures: Draper Water, Water Pro, Southeast Regional WTP, Point of the Mountain WTP, Little Cottonwood WTP, Big Cottonwood WTP


Davis
Morgan
Salt Lake City
West Valley City
South Salt Lake
Unincorporated
Summit
Taylorsville
Murray
Holladay
Cottonwood Heights
Midvale
West Jordan
Sandy
Alta
Tooele
South Jordan
Riverton
Draper
Herriman
Bluffdale
Utah
Wasatch
Project Area Earthquake Hazard
Salt Lake County Hazard Mitigation Plan
FEMA
Communities
Salt Lake City Segment Faults
Very High Liquifaction Susceptibility
USGS ShakeMap (MMI)
I (Not Felt)
II - III (Weak)
IV (Light)
V (Moderate)
VI (Strong)
VII (Very Strong)
VIII (Severe)
IX (Violent)
X+ (Extreme)
August 15, 2013
N
0
5
10
Miles
ID
WY
NV
UT
CO
AZ
NM

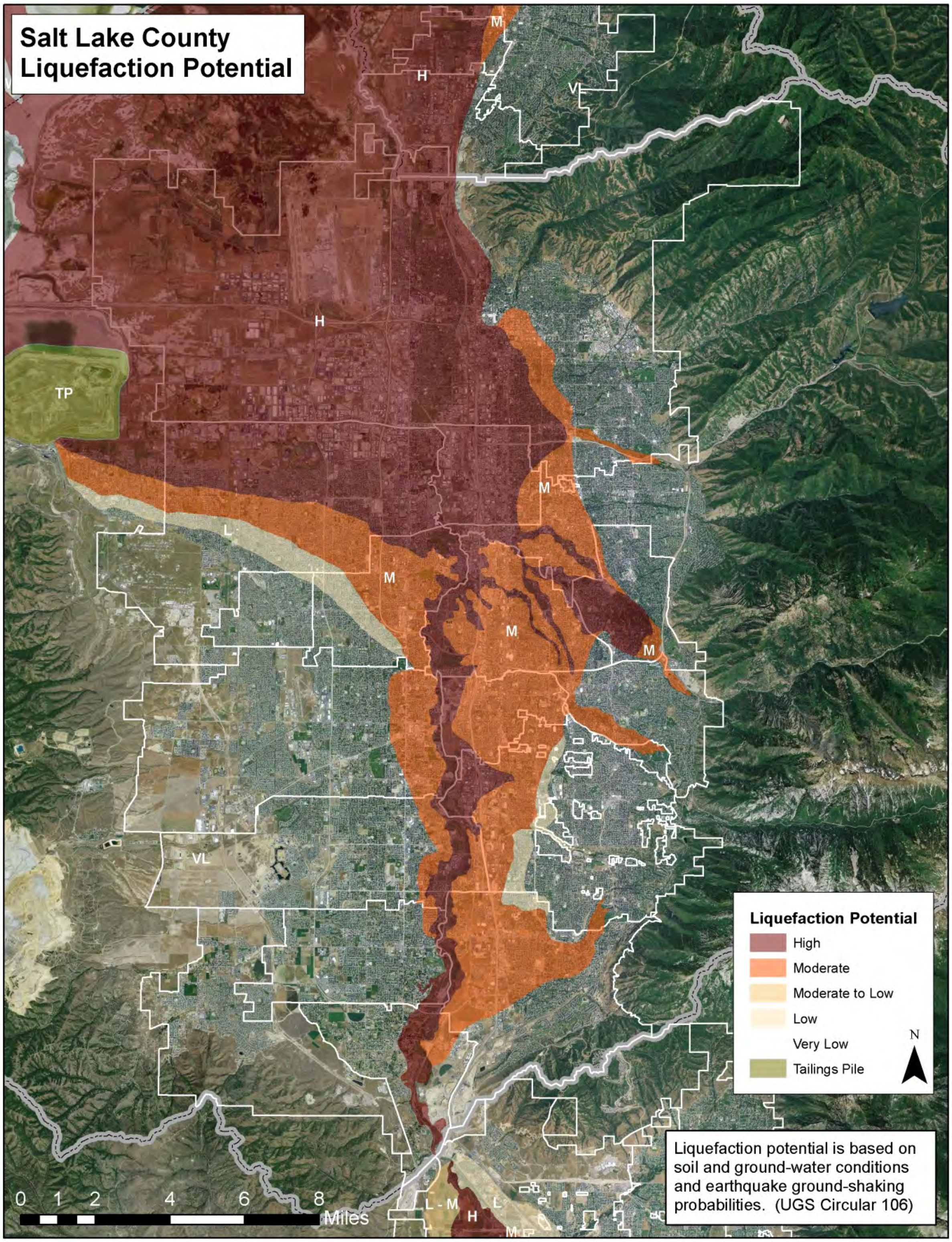
Map 1.



Map 2. Salt Lake County Earthquakes, 1962-1993



Map 3 (figure 4) from Earthquake-Hazards Scenario for a M 7 Earthquake on the Salt Lake City Segment of the Wasatch Fault Zone, Utah, Utah Geological Survey Special Study 111, 2004.



Map 4. Liquefaction Potential, Salt Lake County

4.3.2. Flood

Floods are related to fast snowmelt, heavy rainfall, or failure of natural or engineered impoundments onto riverbanks and adjacent floodplains. Floodplains are lowland areas near rivers, lakes, reservoirs, oceans and low terrain urban areas that are subject to recurring floods. Stream flooding occurs when the peak discharge, or rate of flow in cubic feet per second (cfs), is larger than the channel of the river or storm sewer capacity. In Salt Lake County, floods are typically localized events running out of mountain canyons. Urban areas are also prone to flooding because urban development such as buildings, streets, and parking lots prevent water infiltration into the soil and greatly increase runoff. Undersized piping, manmade drainage channels, or debris that obstructs passageways may further contribute to flooding. Flood damage includes saturation of land and property, erosion, deposition of mud and debris, and fast flowing water. Most injuries and deaths occur from fast moving floodwaters, while most property damage results from inundation by sediment-filled water.

Snowmelt Floods

These are caused by rapid spring snowmelt of mountain snowpack. Most times, intense spring rainfall assists the flood scenario, causing additional rapid river rises. These events can last for weeks during the spring (generally April-June) and may result in loss of life and extensive damage affecting property owners and municipalities. More damage is occurring over the years as a result of increased development near the riverbanks of mountain streams (UNHH 2008). Snowmelt risk is greatest when snowpack is at or above normal and/or accompanied by an abrupt warming trend.

Flash-Flooding

These are caused by intense thunderstorms and resultant intense rainfall. Intense rainfall may fall on areas of sparse vegetation, steep slopes, and impervious surfaces, and is then channeled into smaller waterways or conduits. Once the large volume of runoff begins to accumulate across the basin, it typically increases in volume and speed in a short time. Events are often short-lived, but very dangerous for those caught in a confined area, such as a canyon, during the time of the flood (UNHH 2008). Flash flooding has caused 32 fatalities in Utah since 1950 (NOAA, Know Your Risk).

Areas of localized flooding may occur in urban areas not associated with existing waterways. Rain from high intensity thunderstorms may accumulate in low-lying areas with no outlet or where storm drains have become overwhelmed. These types of flood and the resulting impacts are difficult to anticipate due to the uncertainty of when and where such storms will occur.

Long-term Rainfall Events

These rain events occur mostly in the fall or winter months and are produced by large synoptic weather systems originating out of the South, Southwest or West that produce rainfall for an extended period. Some melting of snow may occur as a result of the rainfall. This occurs mainly in the southern half of the state (UNHH 2008).

Canal Breach

Although not a natural hazard, the flood waters from a breached canal may behave similarly and cause similar types of damage to other flooding incidents. Federally required inspections by the U.S. Army Corps of Engineers Sacramento District have shown a need for Salt Lake County, to address important maintenance issues of the levee systems along the 12-mile Surplus Canal. This canal, which was upgraded by the Corps in 1960, drains Jordan River water into the Great Salt Lake. The county has begun an aggressive program to correct deficiencies and come into compliance. As part of this effort, the county has hired an engineering consultant to evaluate the structural and hydraulic performance of the system. Additionally, the county has been involved in a thorough investigation of the actual right-of-way of the canal to better identify where encroachments exist.

Funding requests are included in the county's 2014 budget to continue the repairs. In addition, Salt Lake County will be applying for a system-wide improvement framework agreement with the Corps, which would allow the levees to remain eligible for federal aid in repairing flood or storm damage while the deficiencies are being corrected.

Post-fire Debris Flow Flooding

Enhanced runoff conditions from a fire-damaged watershed can result in debris flow flooding. As fires burn, they destroy vegetation and leave soils in a hydrophobic state, resulting in greater peak flows (UNHH 2008). This issue will be discussed further in the landslide section.

Flooding Hazard Profile

Potential Magnitude		Catastrophic (>50%)	Probability		Highly Likely
	X	Critical (25-50%)		X	Likely
		Limited (10-25%)			Possible
		Negligible (< 10%)			Unlikely
Location	Largely in and along floodplains (See Maps 5,6, and 7); debris flows could cause natural damming of water if nearby streams were to become blocked.				
Seasonal Conditions	Spring, heavy rainfall, and spring snowmelt runoff.				
Conditions	Thunderstorms w/heavy rainfall, extended wet periods.				
Duration	Flooding can last anywhere from hours to days and even months.				
Secondary Hazards	Raw sewage/health risk, electrical fires, gas spills.				
Analysis Used	Review of FIS, FIRM, Army Corp of Engineers Flood Study.				

Profile 1

4.3.2.1 Location and Extent:

Flooding in Salt Lake County is typically the result of excessive snowmelt runoff and/or heavy rainfall. Snowmelt flooding is usually the result of rapid melting of snowpack and occurs between April through June, and occurs along the major existing streams and waterways. Thunderstorms can produce high intensity, short duration heavy rainfall that occurs over a relatively small area in the summer months. However, flooding can also occur from non-thunderstorm rainfall events.

June 2010 Flooding, Photo from Salt Lake County

The major waterways in the county include the Jordan River, Big and Little Cottonwood Creeks, Parley's Creek, Emigration Creek, Red Butte Creek, City Creek, and Millcreek. Smaller waterways include Bingham Creek, Midas Creek, Rose Creek, Corner Canyon Creek, Dry Creek, Wood Hollow, Willow Creek, and Barney's Creek. All have the potential to flood. However, significant flood mitigation measures were implemented following the major floods of 1983-84 that greatly reduced the flood threat.

The flows of the Jordan River from Utah Lake into Salt Lake County are controlled and the flood potential from is somewhat reduced upstream of the major Jordan River tributaries. Parley's Creek has flood storage capacity at Mountain Dell and Little Dell Reservoirs and is routed through a retention basin in Sugarhouse Park. Big and Little Cottonwood Creeks and have a number of smaller flood storage lakes and ponds providing some flood protection, such as Wheeler Historic Farm. In Salt Lake City, Emigration Creek and Red Butte Creek come together at 700 East and 1300 South and can be discharged in or bypass Liberty Park pond. Parley's Creek discharges to the 1300 South drain at State Street.

Areas to monitor include 1300 South between 700 East and State Street, 700 West and North Temple Streets. Retention ponds are also used to store runoff from commercial and residential development areas.

4.3.2.2 Range of Magnitude:
Refer to maps 5-7.

4.3.2.3 History:
The following flood events are of notable significance:

- **2011** - Large snowpack meant larger resulting spring runoff flows
- **2010** - Spring snowmelt combined with heavy rains caused several streams to overtop their banks
- **1987** – Great Salt Lake reached its all-time maximum water level (4211.6 feet)

- **1983** - Large snowpack was coupled with a rain-on-snow event, (City Creek diverted down State Street)
- **1983/1984** - Large snowpack overwhelmed Utah Lake and affected Jordan River downstream
- **1952** - Rapid melt of a large snowpack

Utah has received four Presidential disaster declarations related to flooding: in 1983, 1984, and two in 2005 (in Southern Utah). Following the events of 1983-84, an enormous amount of mitigation was completed along the urban areas of the Wasatch Front. The State of Utah constructed a county flood control project in which pumps were installed on the Great Salt Lake to pump excess water into the west desert. An advanced water-monitoring network of stream gauges, SNOTEL sites, and automated stream flow gates give warning of elevated flows (UHNN 2008).

During the past 149 years, the Great Salt Lake has three times peaked over 4,211 feet above sea level: to 4,211.60 feet in June 1873, to 4,211.50 feet in June 1986 and to 4,211.60 feet in June 1987.

4.3.2.4 Future Occurrence:

This picture of the Saltair Resort on the southeast shore of the Great Salt Lake was taken during the flood years of the 1980s. Large pumps were installed on the West side of the Great Salt Lake (at a cost of $60 million) and began pumping water into the West Desert in 1987. These pumps are currently not in operation, but could be reactivated if necessary (Utah Department of Water Resources 2007b). There is no question that flooding will occur in the future. Depending upon the amount of snowfall in the winter and the speed with which it melts flows can vary dramatically from year to year. Flood mitigation is on every jurisdictions mind each spring and a myriad of mitigation plans are in place to prevent damage.

4.3.2.5 Vulnerability Assessment:

A community assessment exercise was performed at the Risk MAP Discovery Meeting and at several community follow-up meetings. Community representatives worked together to gain a comprehensive understanding of previous flooding events and areas of concern (including future development areas), existing community studies that can be leveraged as part of the Risk MAP project, and the status of flooding mitigation actions from the Wasatch Front Regional Council Natural Hazard Pre-Disaster Mitigation Pan. The assessment exercise also helped to identify vulnerable community assets including critical

Great Salt Lake Flooding, Salt Air Resort
(Photo courtesy of the National Weather Service)
***(Source*: http://www.utahweather.org/)**

facilities, socially vulnerable populations, and areas of mitigation interest. The participants identified and prioritized several future flood study needs. A number of potential mitigation actions were identified and will be described in the Mitigation Strategies section.

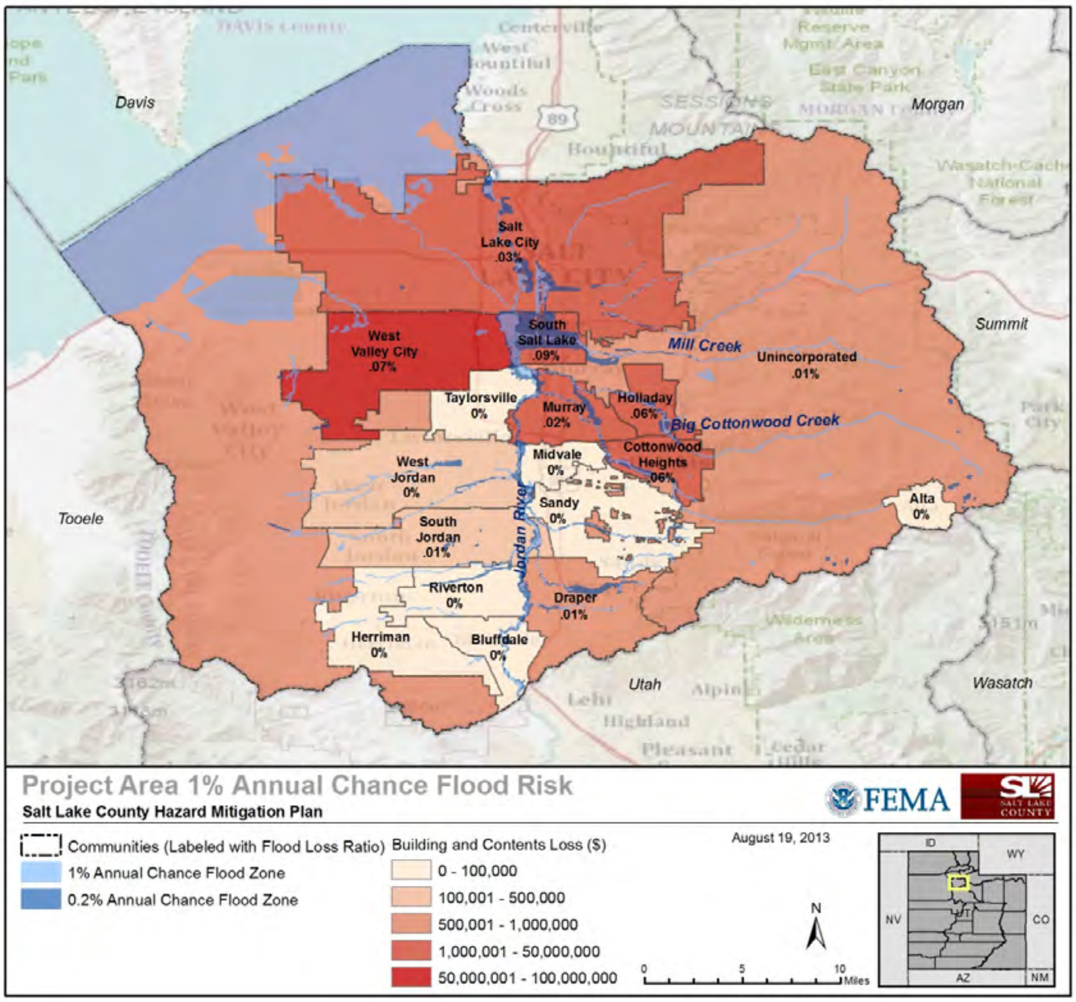
FEMA Region VIII, Sept 2013 as part of the Mitigation Planning/Risk MAP partnership, estimated the following table showing structure exposures and Hazus-generated losses.

Jurisdiction	1% Annual Chance Structure Exposure	Building and Contents Loss*	Loss Ratio**	0.2% Annual Chance Structure Exposure	Building and Contents Loss	Loss Ratio
Alta	-	-	-	-	-	-
Bluffdale	-	-	-	3	$189,687	0.02%
Cottonwood Heights	57	$2,639,436	0.063%	195	$15,812,243	0.38%
Draper	37	$541,815	0.010%	470	$8,173,033	0.16%
Herriman	6	-	-	-	-	-
Holladay City	101	$1,855,054	0.062%	111	$6,302,996	0.21%
JVWCD	-	-	-	-	-	-
Midvale	2	$29,721	0.001%	6	$1,043,604	0.03%
Murray	79	$1,382,712	0.020%	412	$23,160,899	0.33%
Riverton	2	$14,374	0.000%	102	$1,209,806	0.03%
Salt Lake City	424	$14,806,691	0.034%	1,835	$24,286,386	0.06%
Sandy	14	$40,507	0.000%	25	$347,186	0.00%
South Jordan	20	$369,930	0.006%	73	$2,902,932	0.05%
South Salt Lake	68	$4,713,084	0.087%	2,387	$180,433,389	3.32%
Taylorsville	1	$11,139	0.000%	58	$4,075,208	0.09%
Unincorporated County	278	$742,298	0.005%	587	$42,522,149	0.27%
West Jordan	45	$147,241	0.002%	326	$5,108,358	0.05%
West Valley City	399	$90,923,943	0.704%	173	$4,741,553	0.04%
County Total	1,533	$118,217,947		6,763	$320,309,430	0.23%

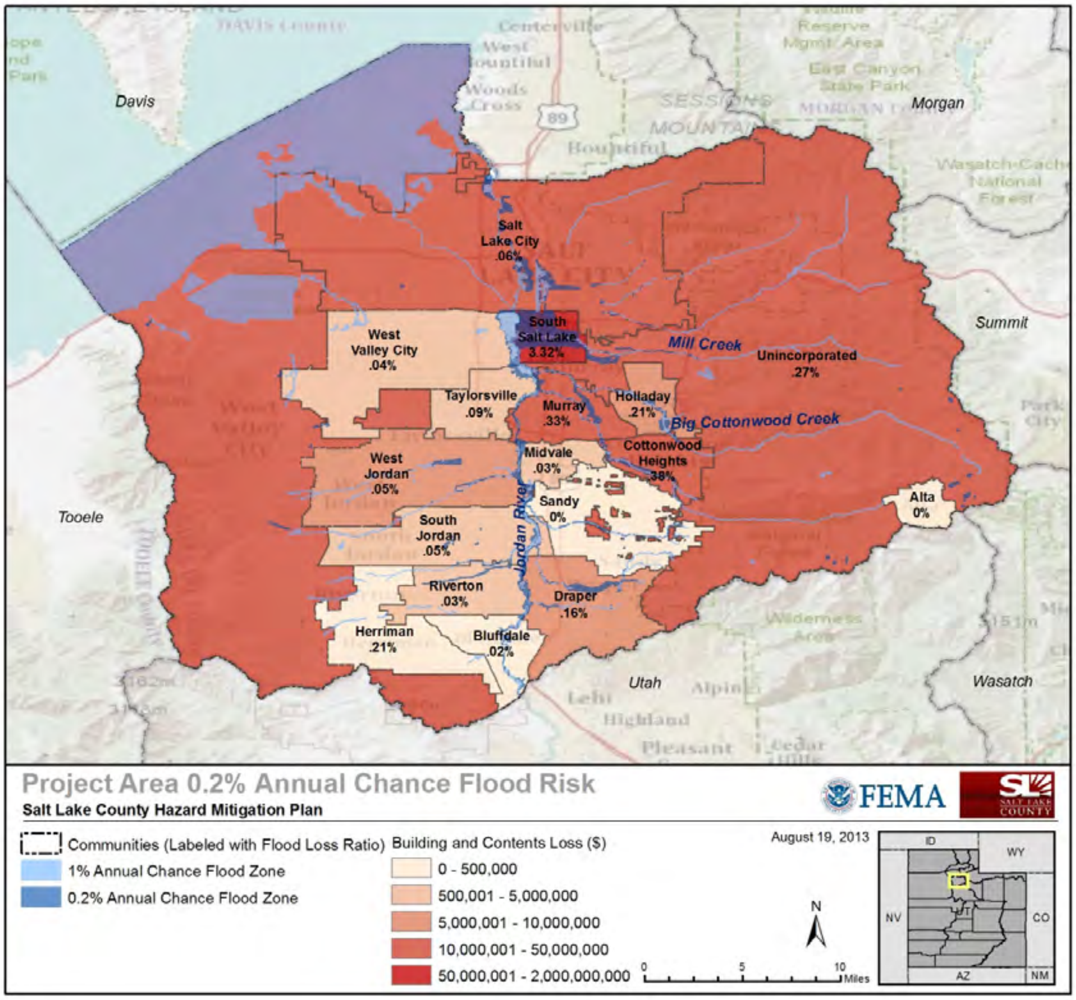
Table 16*Data not available for 1% annual chance loss calculation for x structures. More detail on structures without associated losses available in jurisdictional tables. Structure count is accurate.
****Ratio of damages/losses by hazard and total building inventory.**

Population Exposure

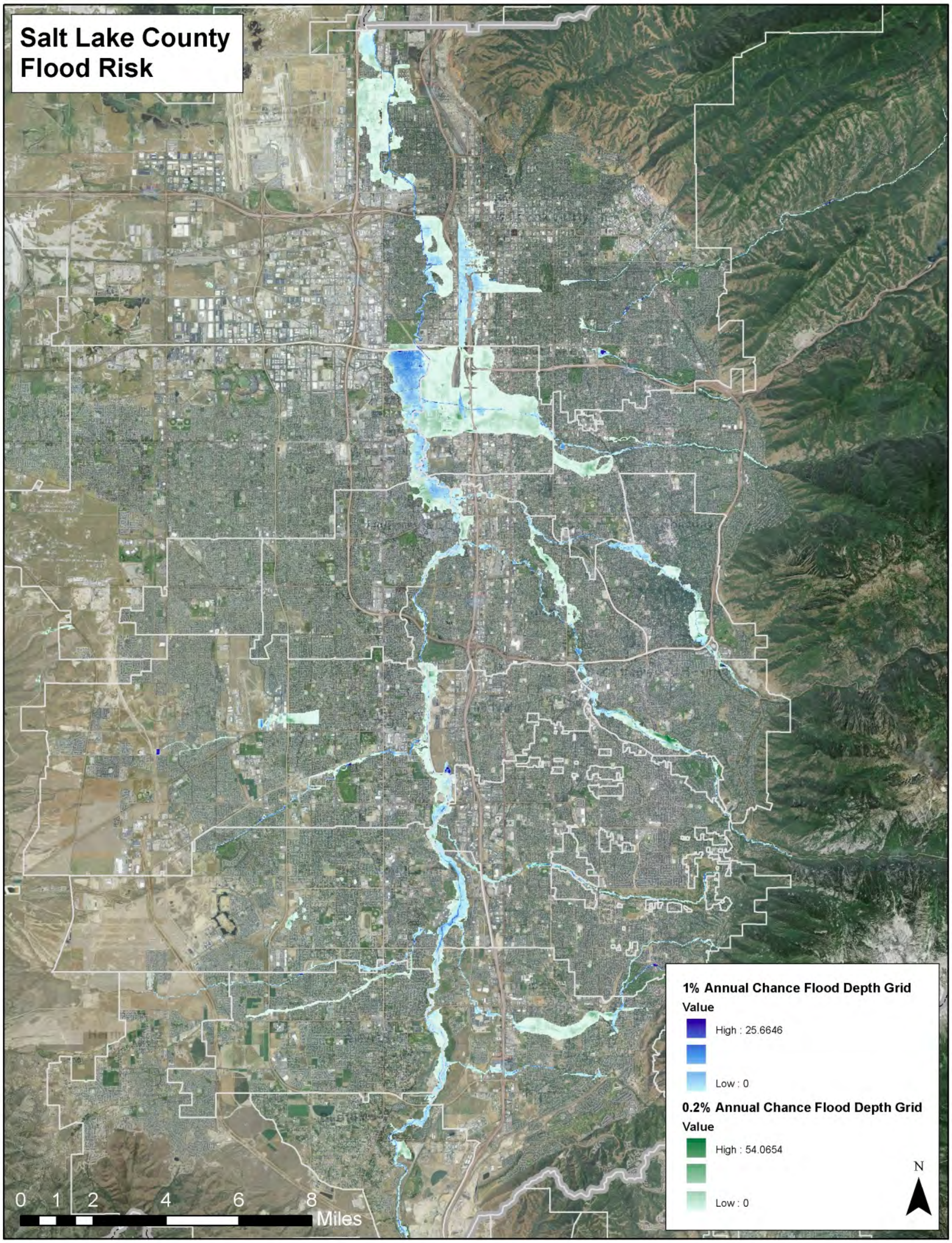
1% Annual Chance	7,421
0.2% Annual Chance	23,126



Map 5.


Davis
Morgan
Summit
Tooele
Utah
Wasatch
Salt Lake City .06%
South Salt Lake 3.32%
West Valley City .04%
Taylorsville .09%
Murray .33%
Holladay .21%
Unincorporated .27%
Mill Creek
Big Cottonwood Creek
Cottonwood Heights .38%
Midvale .03%
West Jordan .05%
Sandy 0%
Alta 0%
South Jordan .05%
Jordan River
Riverton .03%
Draper .16%
Herriman .21%
Bluffdale .02%
Project Area 0.2% Annual Chance Flood Risk
Salt Lake County Hazard Mitigation Plan
FEMA
Communities (Labeled with Flood Loss Ratio)
1% Annual Chance Flood Zone
0.2% Annual Chance Flood Zone
Building and Contents Loss ($)
0 - 500,000
500,001 - 5,000,000
5,000,001 - 10,000,000
10,000,001 - 50,000,000
50,000,001 - 2,000,000,000
August 19, 2013
N
0 5 10 Miles
ID
WY
NV
CO
AZ
NM

Map 6.


Salt Lake County
Flood Risk
1% Annual Chance Flood Depth Grid
Value
High : 25.6646
Low : 0
0.2% Annual Chance Flood Depth Grid
Value
High : 54.0654
Low : 0
N
0 1 2 4 6 8
Miles

Map 7.

The following vulnerability assessment data for flooding in Salt Lake County (Tables 17 through 20) is carried over from the WFRC Pre-Disaster Mitigation Plan and was obtained from HAZUS-MH**. Vulnerability was assessed for both 100-year (NFIP Zone A) and 500-year (NFIP Zone B or Zone X (shaded) flood events. Analysis was completed using Digital Flood Insurance Rate Maps (DFIRM). Only streams that contained detailed flood cross-section data could be used. Flooding from the Great Salt Lake was not included. Consequently, the results should be considered conservative. (***For a more detailed explanation of the loss estimation methodology of HAZUS-MH MR2, please see Part VI of the WFRC Mitigation Plan or the HAZUS-MH Technical Manual (Flood Model) at www.fema.gov/hazus).*

	Acres Flooded	Population Displaced	Number of Structures in Floodplain	
			Residential Units (Total Losses)	Commercial/Industrial Units (Total Losses)
100-year Flood	2,588.7	13,777	2,255 $342,730,000	47 $331,750,000
500-year Flood	8,346.4	14,613	2,490 $409,820,000	47 $401,500,000

Table 17. Salt Lake County Flood Hazard

Agricultural Losses

Agricultural losses are listed in Table 18. Losses are computed according to the number of days in which the crops are inundated with water. All numbers are estimated for a flood occurring near April 15th.

	100-year Losses Day 3	100-year Losses Day 7	500-year Losses Day 3	500-year Losses Day 7
Barley	$45,134	$60,179	$49,078	$65,438
Corn Silage	$565,932	$754,577	$566,310	$820,518

Table 18. Agricultural Losses, April 15th Scenario

Vehicle Losses

Table 19 contains losses for vehicles in floods during both daytime and nighttime scenarios. The scenarios assume ninety percent (90%) of vehicles being removed from hazard areas due to warning.

Category	100-year	500-year
Daytime Scenario	$8,934,176	$12,019,101
Nighttime Scenario	$16,956,505	$21,976,899

Table 19. Vehicle Losses

Debris Removal

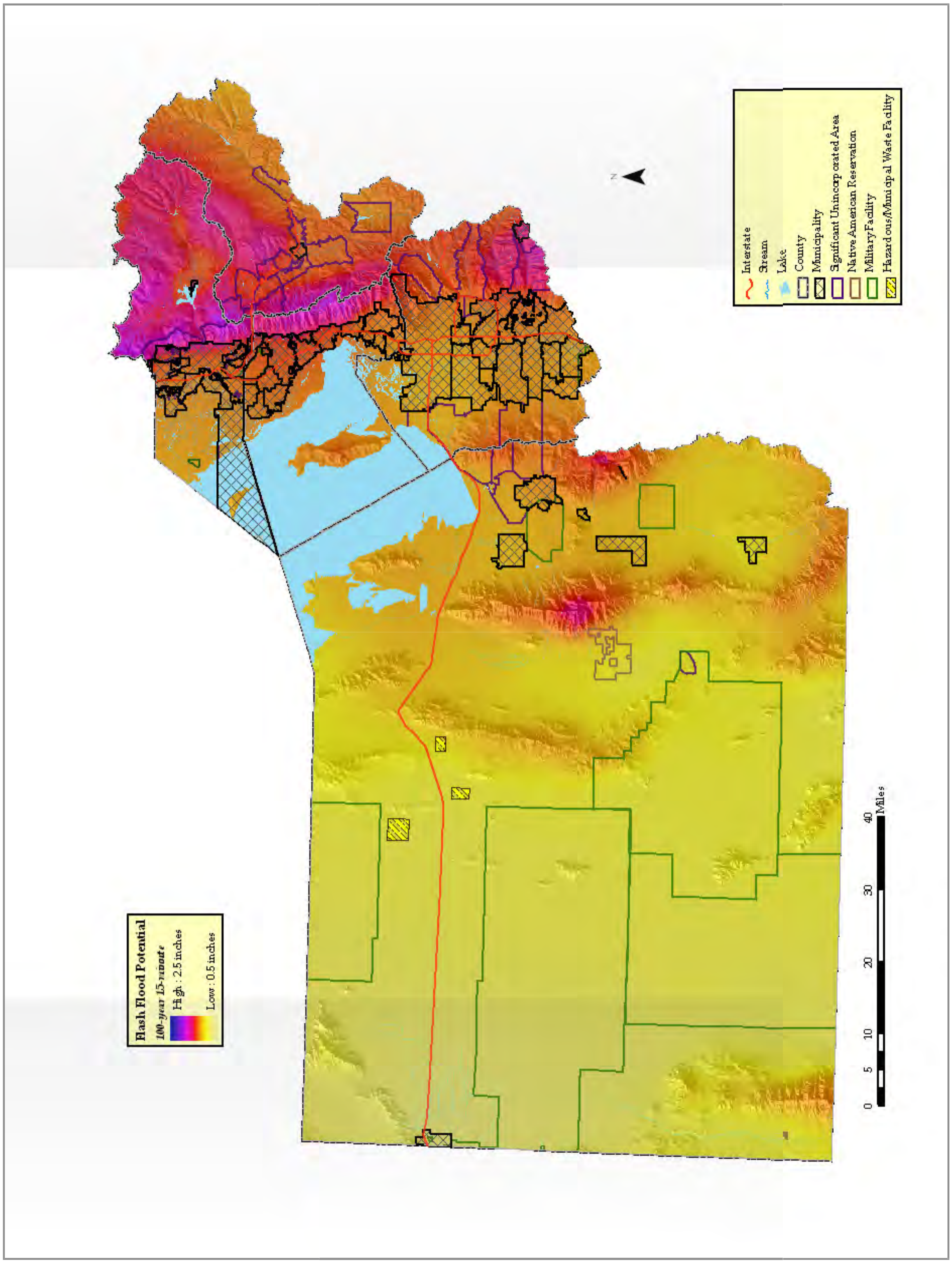
Table 20 shows how much debris would be generated by flooding and how many loads it would take to remove the debris, based on a capacity of 25 tons per load. One truck can likely haul one load per hour. A second debris removal issue is landfill space. Fifty thousand tons at a weight-to-volume ratio of one ton per cubic yard would cover more than ten acres to a depth of three feet.

Category	100-year	500-year
Finishes	37,402 tons/1,497 loads	44,481 tons/1,780 loads
Structures	64,725 tons/2,589 loads	69,936 tons/ 2,798 loads
Foundations	61,660 tons/2,467 loads	66,747 tons/2,670 loads
Totals	163,786 tons/6,553 loads	181,164 tons/7,248 loads

Table 20. Debris Generation and Removal

4.3.2 Flood

Salt Lake County, both the Unincorporated area and all of the jurisdictions participate in the National Flood Insurance Program (NFIP). There are no repetitive loss properties located in any areas with the exception of five properties located in Unincorporated Salt Lake County. Further information may be found under their annex.



Map 7-FF Regional Flash Flood Hazard (Source: NWS Hydrometeorological Design Studies Center)

4.3.3. Wildfire

Fire is a natural process in wildland areas. Wildfires are particularly concerning in the wildland-urban interface. The wildland-urban interface (WUI) is the line, area or zone where structures or other human development meet or intermingle with undeveloped wildland or vegetative fuel. Homes, storage sheds, recreational facilities, transmission lines and other buildings may meet or intermingle with trees, brush, and grasses in the WUI. Significant human development has taken place in the WUI in Salt Lake County that has placed many people in fire-prone areas (UNHH 2008). 65% of Utah's wildfires are started by lightning, although 35% of fires are initiated by human activity.

The three conditions that affect fire behavior are topography, vegetation and weather.
Topography: Topography includes factors such as slope, aspect and elevation. Fires spread faster upslope because fuels are closer to flames. Aspect influences fuel moisture content. Fuels tend to be drier on south and west-facing slopes. Higher elevation is related to cooler temperatures and higher relative humidity, as well as changes in vegetative fuel types (UNHH 2008).

Vegetation: The type of vegetation has a major effect on how quickly a fire will spread. For example, light grasses burn rapidly, whereas heavy, dense fuels like Douglas fir burn slowly but with greater intensity. Different fuels burn at different rates of spread, intensity, and will resist control to different degrees (UNHH 2008).

Size, continuity and compactness also affect the fuel's rate of spread. Large fuels do not burn as readily as small fuels, and take more heat to ignite. Small fuels ignite easier and fire will spread more rapidly through them. Continuity describes how a fuel is arranged horizontally. Fuels that are broken up in patches burn unevenly and slower than uniform fuels. Compactness is how fuel is arranged vertically. Compact fuels burn slower than tall, deep fuels that have more oxygen available (UNHH 2008)

Weather: Weather (temperature, humidity, precipitation, and wind) affects the ease with which a fuel ignites, the intensity at which it burns, and how easy control may be. High temperatures heat fuels and reduce water content, which increases flammability. A decrease in relative humidity causes a proportionate decrease in fuel moisture, promoting easier ignition and more intense burning. Wind carries the heat from a fire into unburned fuels, drying them out and causing them to ignite easier. The wind may also blow burning embers into unburned areas ahead of the main fire that may start spot fires (UNHH 2008).

Wildfire removes vegetation that protects soil from excessive rainfall and resulting runoff. It also damages soil by making the soil hydrophobic, or water repellent. These conditions contribute to depletion of wildlife resources, soil erosion, water runoff, and in some cases severe slope failures and debris flows (UNHH 2008).

Providing adequate fire protection in the WUI can be difficult. Local suppression methods and resources may not be suited to wildfire suppression, and personnel can become easily overwhelmed when multiple structures are threatened simultaneously. Energy output from a wildfire may make protection of homes almost impossible and involves tremendous danger to firefighters and homeowners (UNHH 2008).

Frequency/Likelihood of Future Occurrence—
Highly Likely—Near 100 percent chance of occurrence in next year or happens every year.

4.3.3.1 Wildfire Hazard Profile:

Potential Magnitude		Catastrophic (>50%)	Probability		Highly Likely
	X	Critical (25-50%)		X	Likely
		Limited (10-25%)			Possible
		Negligible (< 10%)			Unlikely
Location	Wildland-Urban Interface (WUI) zones near the foothills and in forested areas (see Map 10). Canyons, along Jordan River, undeveloped islands within urban areas (Dimple Dell)				
Seasonal Pattern	June-October.				
Conditions	Areas affected by drought; heavily overgrown and dry brush and debris; lightning and human triggers.				
Duration	Days to months; depends on climate and fuel load as well as resources (financial, manpower) to extinguish the fire.				
Secondary Hazards	Landslides, debris flows/flash floods, erosion, traffic accidents, air pollution.				
Analysis Used	Review of plans and data provided by US Forest Service, FFSL, FEMA, AGRC, County Hazard Analysis Plans, WWA, and UDEM.				

Profile 2

4.3.3.2 Location and Extent:

The portions of Salt Lake County that could experience the most significant amount of destruction due to a wildland fire include the foothills and the bench areas on or near the Wasatch Range, Traverse Mountain and the Oquirrhs. These WUI areas are threatened most because of the amount of forested lands and the increasing population growth spreading into the foothills. Another concern is vegetation type in these areas such as sagebrush, mountain scrub oak, cheat grass, pinion and juniper trees, and rural and riparian vegetation. Sagebrush and mountain shrub burn hot and fast, spreads easily and is found throughout the county. During prime burning conditions (hot, dry and windy) the pinion juniper class will burn.

As population growth continues, pressure to develop in WUI areas is likely to increase the threats associated with fire. Mitigation measures will need to be recognized and enforced to reduce these threats.

Past wildfires in Salt Lake County have had a significant impact on watersheds, resulting in slope failure, debris flows and other forms of erosion. State and local agencies have worked together to enhance ordinances and other measures to protect County watersheds.

4.3.3.3 History:

Several notable wildfires have occurred in Salt Lake County since the last Mitigation Plan was completed. These include the Corner Canyon Fire in Draper City in August 2008, The Machine Gun fire in Herriman City in September 2010, and the Rose Crest fire and Pinion Fire also in Herriman City in 2012. These fires prompted major fire response, required evacuations of large numbers of citizens, and created the threat of debris flows in following years. The Machine Gun and Rose Crest fires both received Fire Management Assistance Declarations. The Machine Gun Fire burned 3 homes, and required and initial evacuation of an estimated 1600 homes, later reduced to 225 families (KSL, Sept 21, 2010). The Rose Crest fire destroyed 3 homes, damaged 2 others, and forced evacuations for more than 900 families, and prompted a declaration of emergency by the Salt Lake County Mayor (FEMA FM-2991).

4.3.3.4 Future Occurrence:

Is contained in the FRI (Fire Risk Index) section below.

4.3.3.5 Vulnerability Assessment:

Table 21 and Table 22 estimate the total area, population and buildings vulnerable to wildland fire for individual cities and unincorporated areas. These values are based on a new GIS analysis to account for population growth and new structures. Salt Lake County Assessor data and 2010 Census data were overlaid on the located within Moderate, High or Extreme Wildfire risk. Wildfire Hazard Risk data is shown in Map 10 to determine population and structures.

Incorporated Areas	Total Population Affected	Total Households	Total Structures	Residential (Total Assessed Value)	Commercial (Total Assessed Value)
Alta	322	298	82	348 $71,200,800	0
Bluffdale	1338	334	376	100 $35,995,600	22 $52,329,256
Cottonwood Heights	306	122	38	67 $13,708,200	9 $3,517,434
Draper	14480	4644	4210	2,934 $599,061,540	113 $44,163,338
Herriman	10445	2773	2778	908 $185,232,600	143 $55,888,140
Holladay	841	291	224	0	0
Midvale	0	0	0	0	0

Murray	0	0	0	0	0
Riverton	2414	587	550	429 $85,545,142	12 $8,018,261
Salt Lake City	2680	1095	611	410 $83,640,000	60 $209,789,232
Sandy City	845	287	285	228 $47,648,800	16 $529,697,373
South Jordan	8627	2736	2266	0	0
South Salt Lake	0	0	0	0	0
Taylorsville	0	0	0	0	0
West Jordan	2261	593	533	0	0
West Valley City	2068	886	901	0	44 $525,835,874
Unincorporated County	7722	3892	2819	$663,280,006	$380,616,634

Table 21. Population vulnerability and structures in areas of Moderate or Greater Hazard based on BLM Wildfire Hazard data. 2007

Wildfire is a natural part of Utah's ecosystems, but the development within and around wild lands over the last decade or two has posed challenges for wildfire and safety officials. In 2005, Utah initially identified almost 600 communities and their surrounding natural resources as "at risk" from wildland fire.

The annually updated list consists of communities throughout Utah that have been determined by wildland fire officials to be at risk from wildland fire. The "Overall Score" represents the sum of multiple risk factors analyzed for each community. Examples of some risk factors are fire history, local vegetation, and firefighting capabilities. The Overall Score can range from 0 (No risk) to 12 (Extreme risk). This score allows Utah's fire prevention program officials to assess relative risk and create opportunities for communications with those communities on the list.

Communities At Risk	Fire Occurrence	Fuels Hazards	Values Protected	Fire Protection Capability	Overall Score
Alta	1	1	2	2	6
Big Cottonwood	1	1	3	2	7
Bluffdale	2	3	2	1	8
Brighton	1	1	3	2	7
Copperton	2	2	2	1	7
Cottonwood Heights	1	2	3	1	7
Dimple Dell	2	3	3	1	9

Draper	2	2	3	1	8
Emigration Canyon	2	3	3	2	10
Herriman	2	3	2	1	8
High Country Estates	2	3	3	1	9
Holladay	1	2	1	1	5
Lambs Canyon	2	2	2	3	9
Little Cottonwood	1	1	2	2	6
Mount Aire	2	2	2	3	9
Olympus Cove	2	3	2	1	8
Salt Lake City	2	3	2	1	8
Sandy	2	3	2	1	8
Suncrest	1	2	2	1	6

Table 22. Communities at Risk, FFSL 2013

Further wildfire vulnerability information was considered from the West Wide Wildfire Risk Assessment, or "WWA" produced by Sanborn on behalf of the Oregon Department of Forestry for 17 western states, including Utah. This assessment included partner states and agencies to quantify the magnitude of wildland fire risk to provide a baseline for quantifying mitigation activities and to monitor change over time. For a full description of the analysis methodology used, please see the full WWA report.
http://www.odf.state.or.us/gis/data/Fire/West_Wide_Assessment/WWA_FinalReport.pdf

The WWA produced three primary outputs: The Fire Effects Index, the Fire Threat Index, and the Fire Risk Index.

The Fire Effects Index is based on a rating of suppression difficulty and values impacted, which identifies areas that have important values at risk to wildland fire and/or are costly to suppress.

The Fire Threat Index (FTI) is a mathematical calculation to estimate the probability of an acre igniting and the expected final fire size.

The Fire Risk Index (FRI) is determined by the Fire Threat Index multiplied by and Fire Risk Index. It is one of the two primary outputs of the WWA and is a measure of overall wildfire risk. It combines the probability of an acre burning with the expected effects if a fire occurs. This reflects the possibility of suffering loss. The FRI can be used to identify areas where mitigation options may be of value, allow agencies to work together and better define priorities, develop a refined analysis of a complex landscape and fire situations using GIS, and increase communication with local residents to address community priorities and needs.

Wildland Development Areas (WDA) indicates where people live in wildland areas that are threatened by fire from wildland fuels. WDA reflects housing density depicting where people live in the wildland. The analysis process derives the number of house per square kilometer but is presented as "houses per acre" to aid in interpretation of the data.

Output values are grouped into nine classes based on their distribution across burnable acres. The breakpoints between classes use a consistent target cumulative percentile value. By design the categories were developed to display the highest rated 14.5% of the cells in categories 6-9 so the user will truly located the differences within these highly rated cells. The class values represent a West Wide distribution of acres.

Utah Summary:

- 33% of burnable acres in the state are Moderate-to-High wildfire risk (classes 4 to 9).
- 45 million burnable acres across the state (82% of all lands)
- 457,090 are living at risk to wildfire within Wildland Development Areas
- 15.1 million acres of forest assets at risk to wildfire

Salt Lake County Acres, acres per risk class

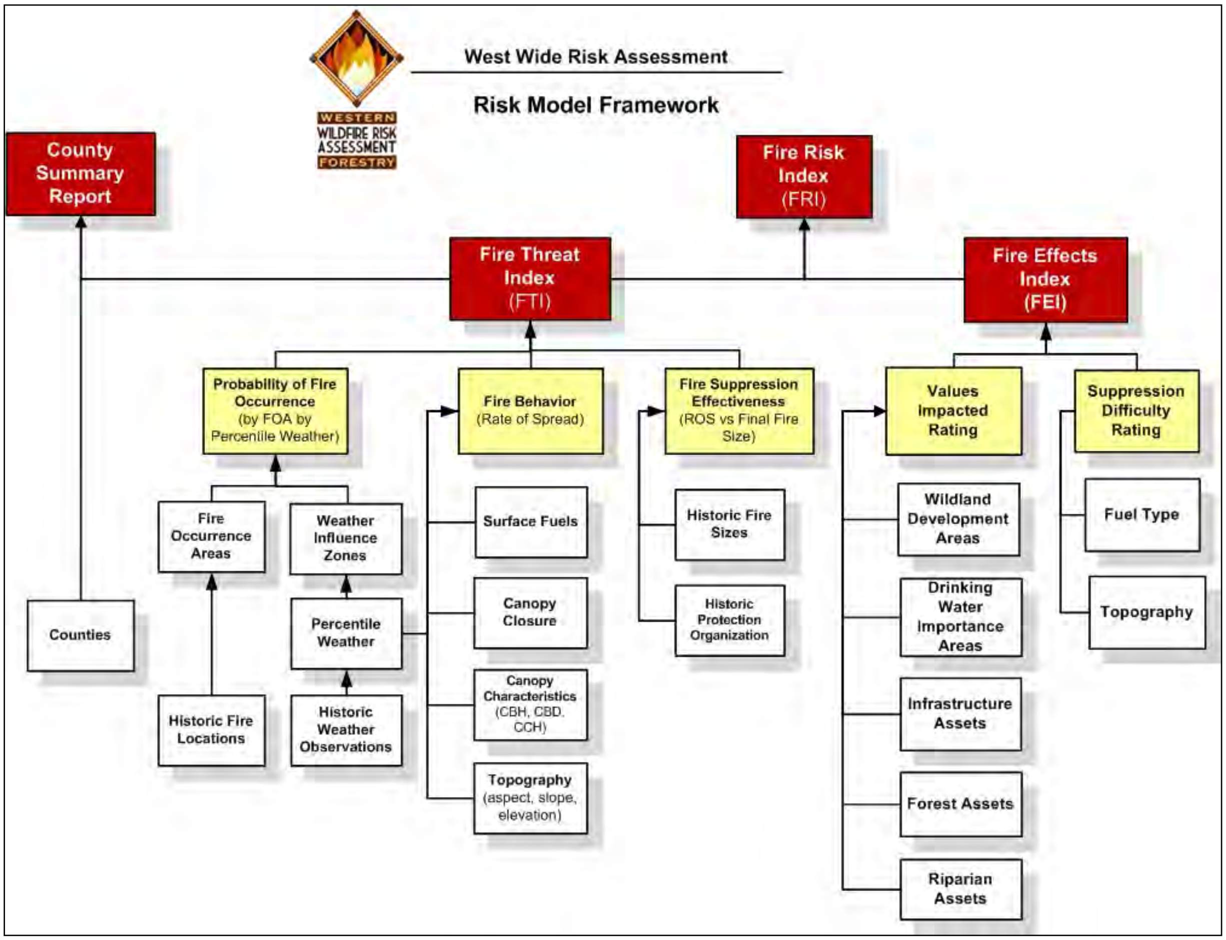
	1	2	3	4	5	6	7	8	9	Total	Ave.
FRI	11,796	32,623	14,453	26,843	37,571	43,154	41,988	35,263	63,719	307,385	6
FTI	22,208	40,671	13,257	23,243	38,992	49,997	36,924	30,857	51,235	307,385	6
FEI	33,172	58,237	11,032	10,588	38,838	30,976	51,829	42,984	29,730	307,385	5

Table 23

Salt Lake County, acres per risk class in each Wildland Development Area class

	WDA 1	WDA 2	WDA 3	WDA 4	WDA 5	WDA 6	WDA 7	Total WDA	Avg. WDA
WDA	14,401	5,013	5,318	6,518	9,364	18,910	36	59,622	4

Table 24. 307,385 total acres wildland, 209,120 non-wildland acres



Flowchart 1

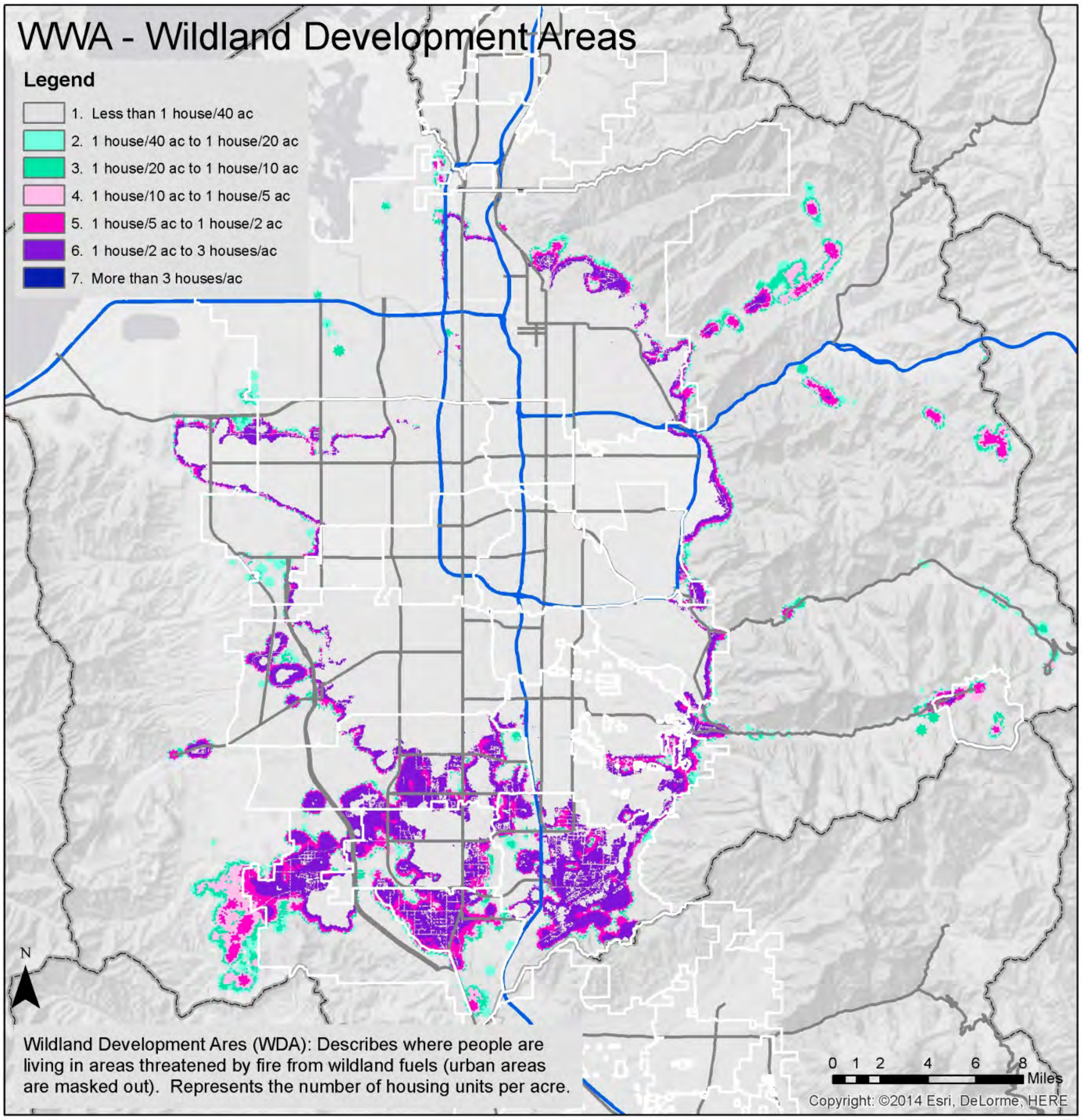
Class	Cumulative % Acres
1 (Lowest)	0.0 - 32.9%
2	33.0 - 63.5%
3	63.5 -70.0%
4	70.0 - 77.5%
5	77.5 - 85.5%
6	85.5 - 92.5%
7	92.5 - 96.5%
8	96.5 - 98.5%
9 (Highest)	98.5 - 100%

Table 24. WWA Wildfire Risk Assessment Process

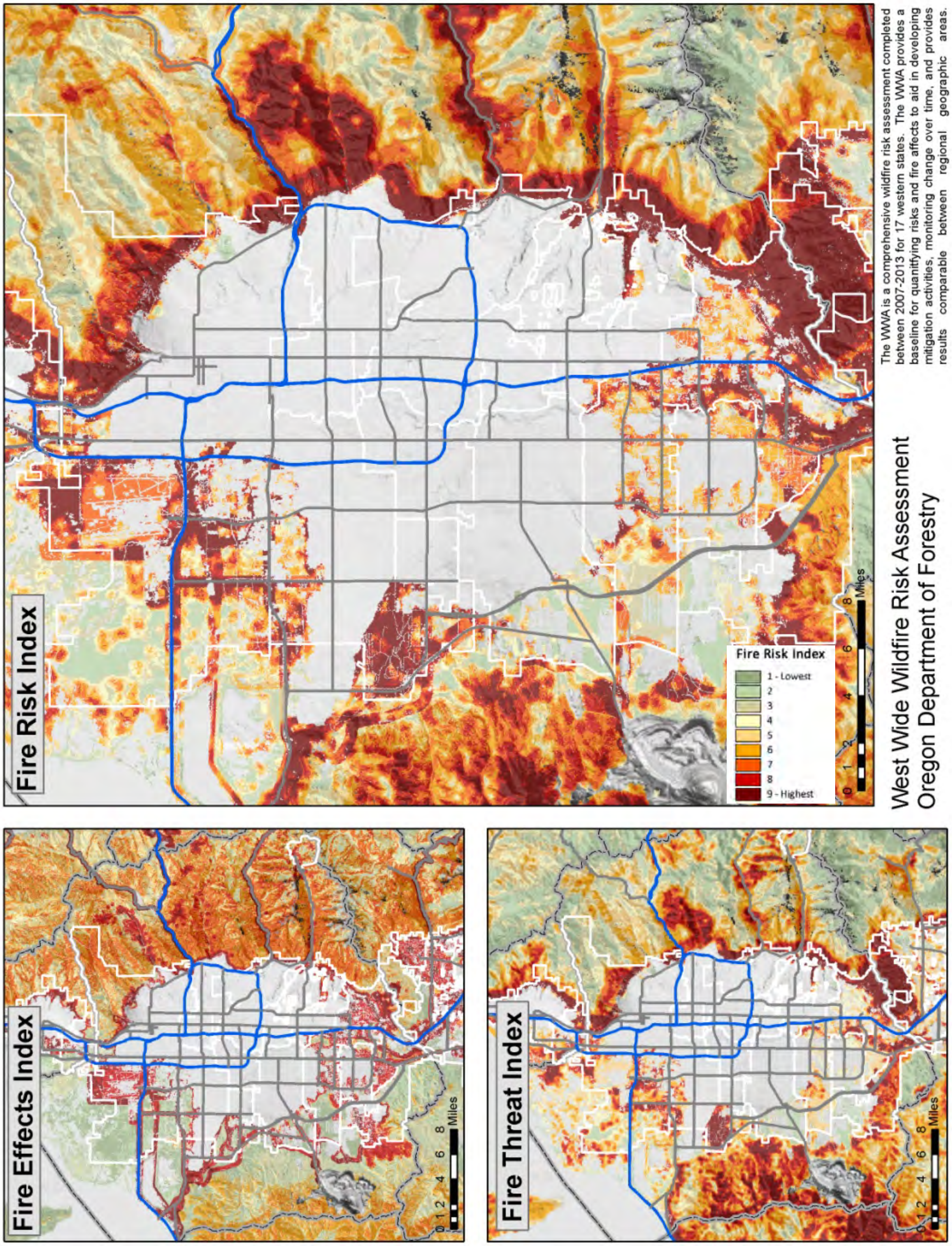
Table 25 estimates infrastructure vulnerable to wildland fire in Salt Lake County. Provided are the number of units or total length of infrastructure vulnerable and the estimated replacement costs as provided by HAZUS-MH lost estimation software.

Item	Length (Miles) or Number of Units	Replacement Cost
Highways/Interstates	366.71 miles	$1,991,590,683
Highway Bridges	608 bridges	$1,298,659,176
Railway Segments	179.70 miles	$206,434,364
Railway Bridges	17 bridges	$2,275,560
Water Distribution Lines	N/A	N/A
Gas Lines	N/A	N/A
Sewer Lines	N/A	N/A
Total Estimated Infrastructure Replacement Cost		$3,498,959,783

Table 25. Infrastructure Vulnerable to Wildland Fire, Salt Lake County

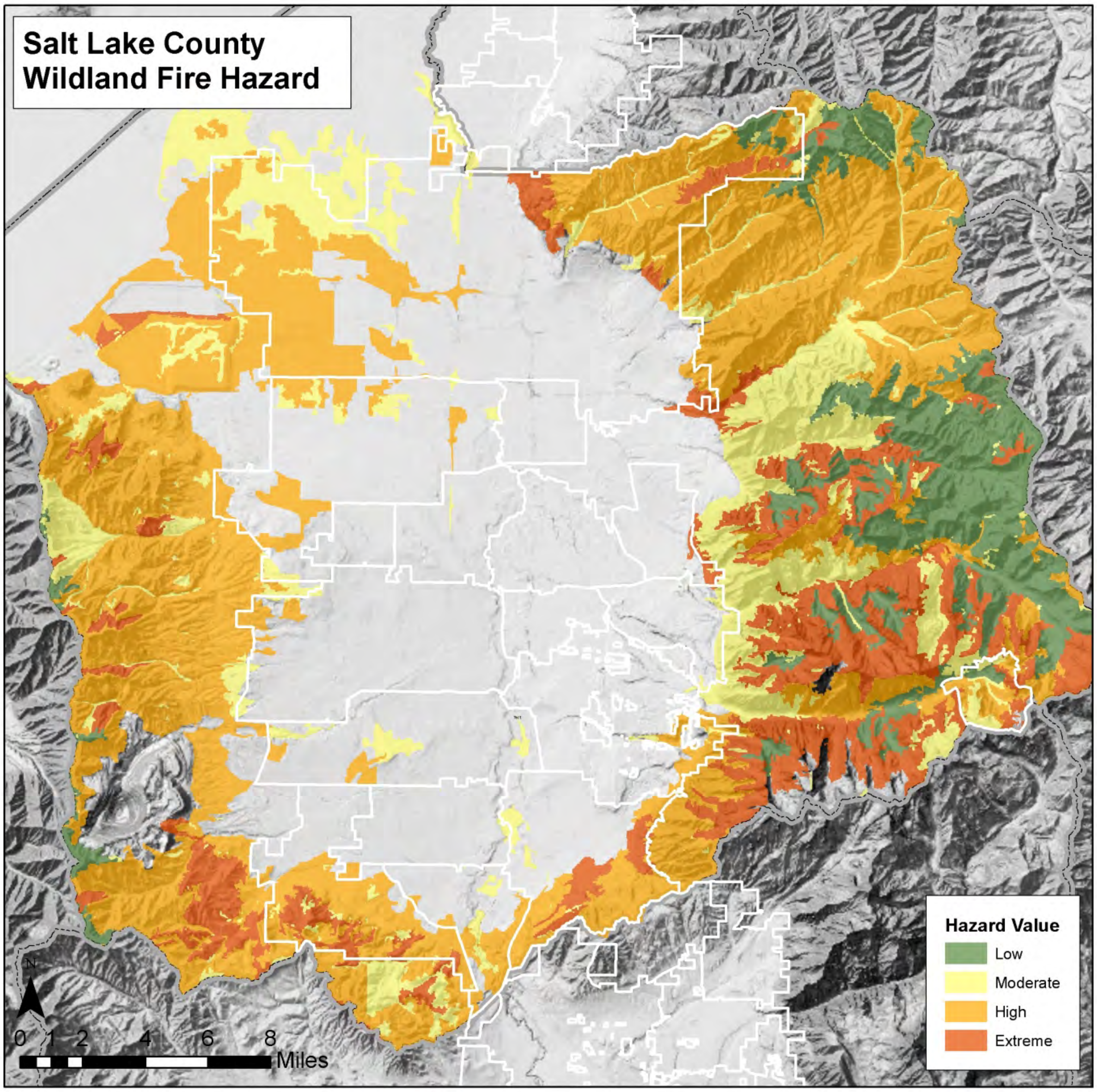

WWA - Wildland Development Areas
Legend
1. Less than 1 house/40 ac
2. 1 house/40 ac to 1 house/20 ac
3. 1 house/20 ac to 1 house/10 ac
4. 1 house/10 ac to 1 house/5 ac
5. 1 house/5 ac to 1 house/2 ac
6. 1 house/2 ac to 3 houses/ac
7. More than 3 houses/ac
N
Wildland Development Ares (WDA): Describes where people are living in areas threatened by fire from wildland fuels (urban areas are masked out). Represents the number of housing units per acre.
0 1 2 4 6 8
Miles
Copyright: ©2014 Esri, DeLorme, HERE

Map 8.



Fire Risk Index
Fire Risk Index
1 - Lowest
2
3
4
5
6
7
8
9 - Highest
0 1 2 4 6 8 Miles
West Wide Wildfire Risk Assessment
Oregon Department of Forestry
The WWA is a comprehensive wildfire risk assessment completed between 2007-2013 for 17 western states. The WWA provides a baseline for quantifying risks and fire affects to aid in developing mitigation activities, monitoring change over time, and provides results comparable between regional geographic areas.
Fire Effects Index
0 1 2 4 6 8 Miles
Fire Threat Index
0 1 2 4 6 8 Miles

Map(s) 9.



Map 10. Wildfire Hazard Map, Salt Lake County (UDFFSL 2007)

4.3.4. Landslide and Slope Failure

Slope failure is any type of ground disturbance on a surface with any slope and not on flat ground. Landslides, also referred to as slope failures, are classified according to the type of movement and material involved. Movement types include falls, topples, slides, lateral spreads and flows. Materials include rocks, debris (coarse-grained soil), and earth (fine-grained soil). The most common landslides in Utah include rack falls, rock topples, debris slides, debris flows, earth slides, and earth flows (UNHH 2008).

A landslide is a mass of earth or rock which moves downslope by flowing, spreading, sliding, toppling or falling. Landslides are one of the most commonly occurring natural hazards in Utah. They are most common in areas having moderate to steep slopes, weak slope materials, and relatively wet climates. In these areas, most landslides are associated with precipitation events sustained above-average precipitation, individual intense rainstorms, or snowmelt events. Erosion, removal of vegetation by wildfires, and earthquake ground shaking increase the likelihood of landslides. Human activities such as grading of slopes or increasing soil moisture through landscape irrigation can also trigger landslides (UNHH 2008).

Rock falls and topples are downslope movements of loosened blocks or boulders from a bedrock area. These generally occur along steep canyons with cliffs, deeply incised stream channels in bedrock, and steep bedrock road cuts**.** The greatest damage from rock falls has been to roads, railroads, and aboveground pipelines (UNHH 2008).

Debris slides and flows occur in steep mountainous areas and involve the relatively rapid, viscous flow of coarse-grained soil, rock, vegetation and other surface materials. Debris flows contain more water than slides and are potentially more dangerous because they can form quickly, move at high speeds, and travel long distances. Debris flows generally remain in stream channels but can flow out from canyon mouths for a considerable distance. They can damage buildings, bridges, roads, railroads, and pipelines (UNHH 2008).

Earth slides and flows are composed of fine-grained material, but earth flows contain more water than earth slides. Earth slides and flows vary in size, including some of the largest past earth slides in Utah. Like other landslides, they can damage anything in their path (UNHH 2008).

Slumps are common along road embankments and river terraces. They slip or slide along a curved plane away from the upper part of a slope, leaving a scarp. They generally do not move far from the source area.

Landslide distribution is dependent on geology, topography, and climate. They are most numerous in the Middle Rocky Mountains physiographic providence and in the High Plateaus section of the Colorado Plateau province. Weak rock types, steep slope gradients and relatively abundant precipitation are primary contributors to land sliding. Vegetative cover, slope aspect, and ground shaking from earthquakes can also influence slope stability (UNHH 2008). Nearly all landslides in Utah are reactivations of pre-existing landslides. Risk can be reduced by avoiding and/or stabilizing landslides (UNHH 2008).

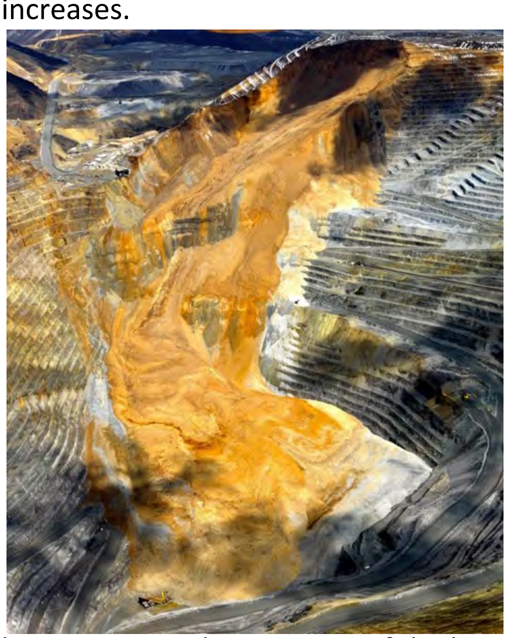
Landslide and Slope Failure Hazard Profile

Potential Magnitude		Catastrophic (>50%)	Probability		Highly Likely
		Critical (25-50%)		X	Likely
	X	Limited (10-25%)			Possible
		Negligible (< 10%)			Unlikely
Location	Generally in canyon mouths and foothills and areas of recent wildfire activity (Map 11).				
Seasonal Pattern	Spring and summer months.				
Conditions	Usually caused by the stress release of over-weighted soils or loosening of rock and debris by wind, water or ground shaking.				
Duration	Landslides/Rock falls: Hours to Months. *Debris flows*: Instantaneous.				
Secondary Hazards	Flooding (natural dams), traffic accidents.				
Analysis Used	Information and maps provided by UGS, UDEM, AGRC.				

Profile 3.

4.3.4.1 Location and Extent:

Landslides and debris flows are most common in the foothills along the base of the Wasatch Mountain Range from wet climatic conditions. Some major landslide areas include the Grand View Peak rockslide in upper City Creek Canyon, the Little Valley Red Rock landslide in Draper and the shallow disrupted landslides in and near Steep Mountain in Draper (refer to Map 11.) As urbanization spreads into geologically unstable areas of the county, the risk to life and property increases.



4.3.4.2 Range of Magnitude:

The Rio Tinto Landslide was the single largest natural disaster in Salt Lake County's history. The recent landslide in North Salt Lake City falls into the "major" category. Due to the nature of Salt Lake County's topography and development moving into the steeper areas the magnitude of damage is increasing. It is possible that future landslides can range in costs from hundreds of thousands of dollars to hundreds of millions of dollars.

4.3.4.3 History:

A cluster of historical landslides is visible from the hairpin turn in Bonneville Boulevard in lower City Creek Canyon in Salt Lake City. The UGS and the Salt Lake City surveyor have monitored movement of the largest and most damaging of these landslides since June 1998.

Since June 1998, the toe of the landslide has moved about 24 feet, and the main scarp has offset the ground surface about the same amount. Like most recurrently active landslides in northern Utah, movement typically occurs between March and June as ground-water levels rise following the snowmelt. Four houses at the top of the slide are threatened, and efforts to protect one house have cost in excess of $300,000. In 2006 the landslide reactivated again, moving about 2 feet, despite drier-than-normal conditions in Salt Lake City (Utah Hazard Mitigation Plan).

At 9:30 pm on April 10, 2013, a landslide occurred at the mine. It was the largest non-volcanic landslide in the history of North America. Around 65–70 million cubic meters (2.3×10^9–2.5×10^9 cu. Ft.) of dirt and rock were displaced.

4.3.4.4 Future Occurrence:

The Grand View Peak slide is a candidate for an earthquake-induced landslide. This slide also has a strong susceptibility to seismic failure. The Little Valley Red Rock slide in Draper is the largest in southern Salt Lake County. The Draper Heights landslide is a post Lake Bonneville slide that occurred on the steep north slope of Steep Mountain. This slide is an earthquake triggered soil slide.

Subsidence is possible in City Creek, Emigration, Parley's, and Big Cottonwood Canyons due to the prevalence of dissolvable limestone. Subsidence can also occur in the Avenues area of Salt Lake City and in the Taylorsville-Kearns area due to collapsible soils that are compactable upon wetting (Mulvey 1992).

4.3.4.5 Vulnerability Assessment:

Table 26 estimates infrastructure vulnerable to landslides in Salt Lake County. Provided are the number of units or total length of infrastructure vulnerable and the estimated replacement costs as provided by HAZUS-MH lost estimation software. Table 27 estimates the total area, population, and buildings vulnerable to landslides for individual cities. Table 28 examines the same for unincorporated areas. This data is carried over from the 2009 WFRC plan due to time constraints and minimal concern about change in hazard risk.

Item	Length (Miles) or Number of Units	Replacement Cost
Highways/Interstates	46.86 miles	$259,322,175
Highway Bridges	38 bridges	$33,527,413
Railway Segments	4.98 miles	$5,716,617
Railway Bridges	1 bridges	$23,520
Water Distribution Lines	609.38 miles	$19,621,849
Gas Lines	243.64 miles	$7,848,732
Sewer Lines	365.61 miles	$11,773,110
Total Estimated Infrastructure Replacement Cost		$337,833,416

Table 26. Infrastructure Vulnerable to Landslides, Salt Lake County

Incorporated Areas	Acres Affected	Population Affected	Structures in Areas of Moderate or Greater Hazard	
			Residential (Replacement Value)	Commercial (Annual Sales)
Alta	2,477	986	322 $65,881,200	0
Bluffdale	1,457	3,626	1,061 $217,080,600	1 $110,705
Cottonwood Heights	1,296	5,982	2,014 $412,064,400	93 $38,368,162
Draper	2,816	8,318	2,380 $486,948,000	26 $7,143,464
Herriman	2,508	4,139	1,242 $254,113,200	0
Holladay	397	1,721	506 $103,527,600	23 $3,371,052
Midvale	11	53	18 $3,682,800	0
Murray	35	258	88 $18,004,800	4 $2,407,223
Riverton	75	362	88 $18,004,800	2 $120,490
Salt Lake City	15,701	15,762	6,327 $1,294,504,200	176 $47,480,280
Sandy City	1,567	8,199	2,301 $470,784,600	77 $15,535,108
South Jordan	72	213	60 $12,276,000	0
South Salt Lake	0	0	0	0
Taylorsville	19	179	55 $11,253,000	2 $346,531
West Jordan	368	439	171 $34,986,600	0
West Valley City	65	59	17 $3,478,200	0

Table 27. Vulnerability Assessment for Landslides, Incorporated Salt Lake County

Unincorporated Areas	Acres Affected	Population Affected	Structures in Areas of Moderate or Greater Hazard	
			Residential (Replacement Value)	Commercial (Annual Sales)
Big Cottonwood Canyon	32,822	4,635	1,543 $315,697,800	0
Camp Williams	9,746	5,475.0	1,571 $321,426,600	2 $724,308
Canyon Rim	168	2,865	928 $189,868,800	0
Copperton	14,390	510	215 $43,989,000	1 $9,785
East Millcreek	18	162	57 $11,662,200	1 $27,753
Emigration Canyon	11,281	3,562	1,378 $281,938,800	25 $12,583,730
Granite	17,372	8,817	2,724 $557,330,400	6 $2,300,292
Kearns	10	109	31 $6,342,600	1 $85,797
Magna	40	254	157 $32,122,200	0
Millcreek	4	54	20 $4,092,000	0
Mount Olympus	18,263	5,226	1,706 $349,047,600	39 $9,634,013
Parley's Canyon	31,744	6,188	2,245 $459,327,000	1 $530,390
Sandy Hills	1	7	2 $409,200	0
Southwest	15,295	2,383	656 $134,217,600	7 $5,411,633
Willow Canyon	5	45	11 $2,250,600	1 $387,562

From UHMP: Total Daytime Population within High or Moderate Landslide Susceptibility Areas = 23,573, Total Night-time Population within High or Moderate Landslide Susceptibility Areas=24,443

Table 28. Vulnerability Assessment for Landslides, Unincorporated Salt Lake County (2006 socioeconomic projections)

Community Assets:

The Planning Team identified additional significant community assets with potential impacts by earthquake hazards. These include areas of particular concern, critical facilities and infrastructure, areas of future development, major employers or economic sectors, cultural or historic facilities, significant populations, or significant natural resources. Below is a broad summary of assets, which are more specifically described in each Jurisdiction's Annex.

Alta:

Areas of Concern: Steep slopes adjacent to road and home in much of community
Previous impacts: 2 landslides in last 2-3 years. Flooded road, clogged culverts, minor property damage, changes to mountain drainage
Structures: SR 210 Highway is only access in and out of town,
Population: Small resident population, large visitor/tourist population (often unprepared)
Economic: Ski tourism in winter, summer recreation
Natural: Creek water quality (SL City has to let affected water bypass treatment facility)

Cottonwood Heights:

Areas of concern: Point of the mountain, transportation and water aqueduct concerns
Structures: Old Mill, new commercial buildings 6200 S 3000 E, some local roads, residential areas in potential rock fall, debris flow areas
Population: Dense commercial areas, 6200 S 3000 E, Fort Union and 1500 E
Economic: Gravel Pit in possible failure area
Natural: possible impact to creek

Murray:

Little or no impact

Taylorsville:

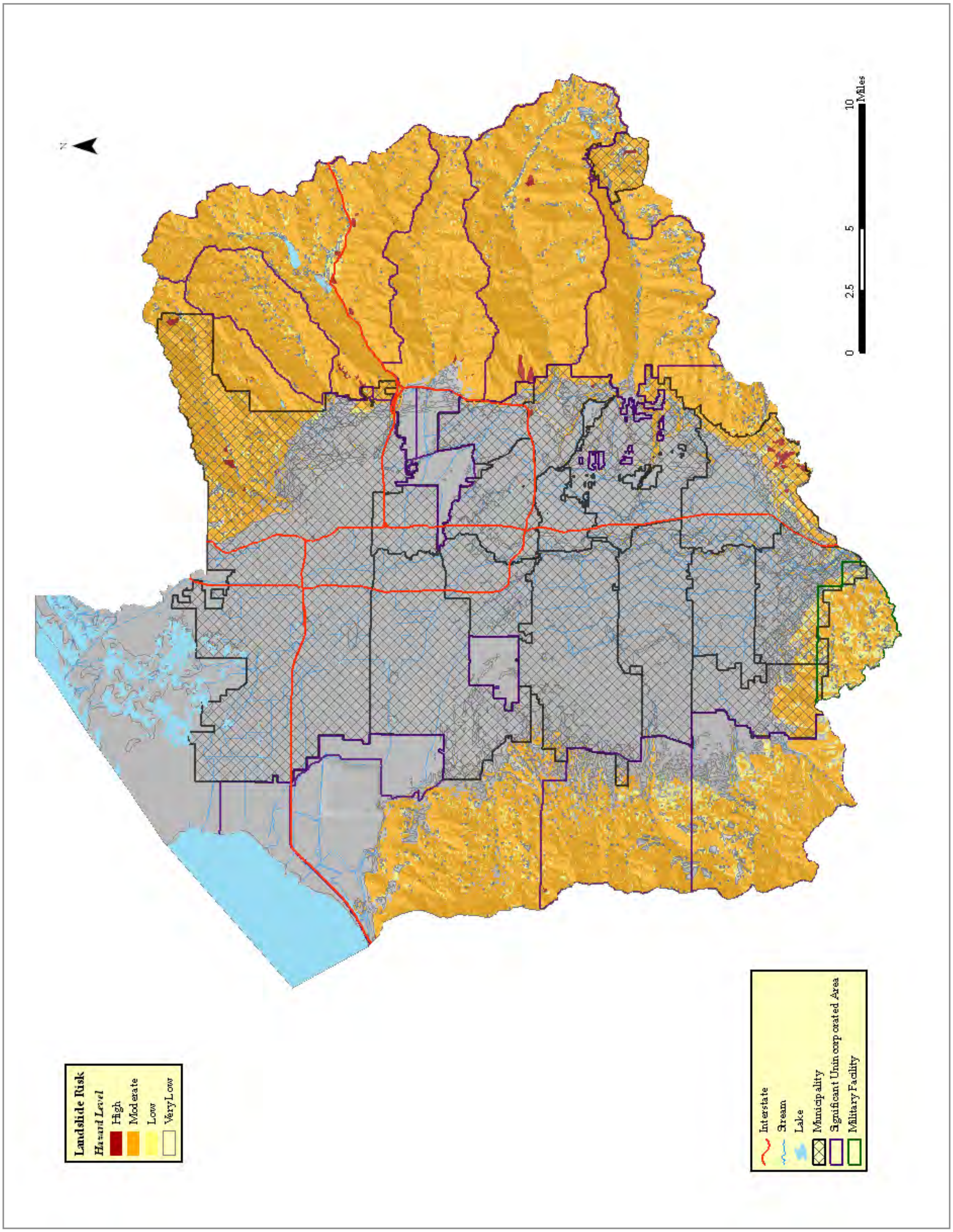
Areas of concern: possibly along canal slopes following heavy rain or earthquake
Previous events: 2010 incident near 1300 W 5300-5400 S that affected road. High utility infrastructure underneath. Made adjustments to canal, flattened slope to fix road.
Structures: 2 high-pressure gas lines, water lines, other utilities run under slopes
Population: residential and school populations

Jordan Valley Water:

Areas of concern: Point of the Mountain transportation and water, Corner Canyon water
Areas of growth: West Jordan, Herriman, and South Jordan/Daybreak
Structures: Jordan Aqueduct, Salt Lake Aqueduct, Metropolitan Water Treatment Plant, Southeast Regional WTP, Jordan Valley Water WTP

Frequency/Likelihood of Future Occurrence

Likely: Between 10 and 100 percent chance of occurrence in next year or has a recurrence interval of 10 years or less.
Population: Suncrest, Old Mill, Bluffdale residents near Jordan Valley WTP raw water reservoir



Map 11. Salt Lake County Landslide Hazard (Giraud and Shaw 2007)

4.3.5. Severe Weather

4.3.5.1-4.3.5.5

Due to the generality of severe weather we have included the location and extent, range of magnitude, past occurrence, future occurrence and vulnerability assessment under each type of severe weather.

Severe Storms:

Severe storms can include thunderstorms, lightning, hailstorms, heavy snow or rain. These storms are generally related to high precipitation events during the summer and winter months and can happen anywhere in the region. Damage can be extensive especially for agriculture, farming, and transportation systems. They can also disrupt business due to power outages.

Severe Thunderstorms:

Severe thunderstorms are storms that either produce tornadoes, winds 58 mph or greater, wind damage, and/or hail three-quarters of an inch or larger in diameter. Thunderstorms can also lead to flash flooding from heavy rainfall.

Strong, rising air currents bring warm, moist air from the surface into the upper atmosphere where it condenses forming heavy rains, hail, strong winds and lightning. Based on historical evidence thunderstorms can strike anywhere in the region, mainly during the spring and summer months.

Salt Lake Valley, September 3rd, 1983 - Thunderstorms produce 0.5” – 1.5” hail *(Source: Utah’s Weather and Climate, Photo: National Weather Service)*

Hailstorms:

Hailstorms occur when freezing water (in thunderstorm clouds) accumulates in layers around an icy core generally during the warmer months of May through September. Hail causes damage by battering crops, structures and automobiles. When hailstorms are large, damage can be extensive, especially when combined with high winds.

Heavy Precipitation:

Heavy amounts of precipitation from rain or snow can result in flash flood events. The Wasatch Front has been susceptible to these types of storms because of close proximity to the mountain ranges. Major winter storms can produce five to ten times the amount of snow in the mountains than in the valley locations. Heavy snow can cause a secondary hazard in avalanches.

East Bench, Salt Lake Valley, October 18, 1984 – 22 inches of snow falls in 24 hours. *(Source: Utah's Weather and Climate,*

Much of the valley's development has occurred on old alluvial fans from the canyon mouths. During heavy rain events, water and debris collect on these same alluvial fans, damaging residential, commercial property and infrastructure.

Tornado:

A tornado is a "violently rotating column of air extending from a thunderstorm to the ground". Some tornadoes can have wind speeds greater than 250 mph with a damage zone 50 miles long and greater than a mile wide. Although they are less common in the Intermountain Region, an average of 3 tornadoes per year occurs in Utah. Examples are the Salt Lake City tornado August 11, 1999 and the Manti tornado in 2002. Most tornadoes in Utah typically have winds less than 110 mph (F2 or smaller), and no wider than 60 feet and are on the ground no longer than a few minutes.

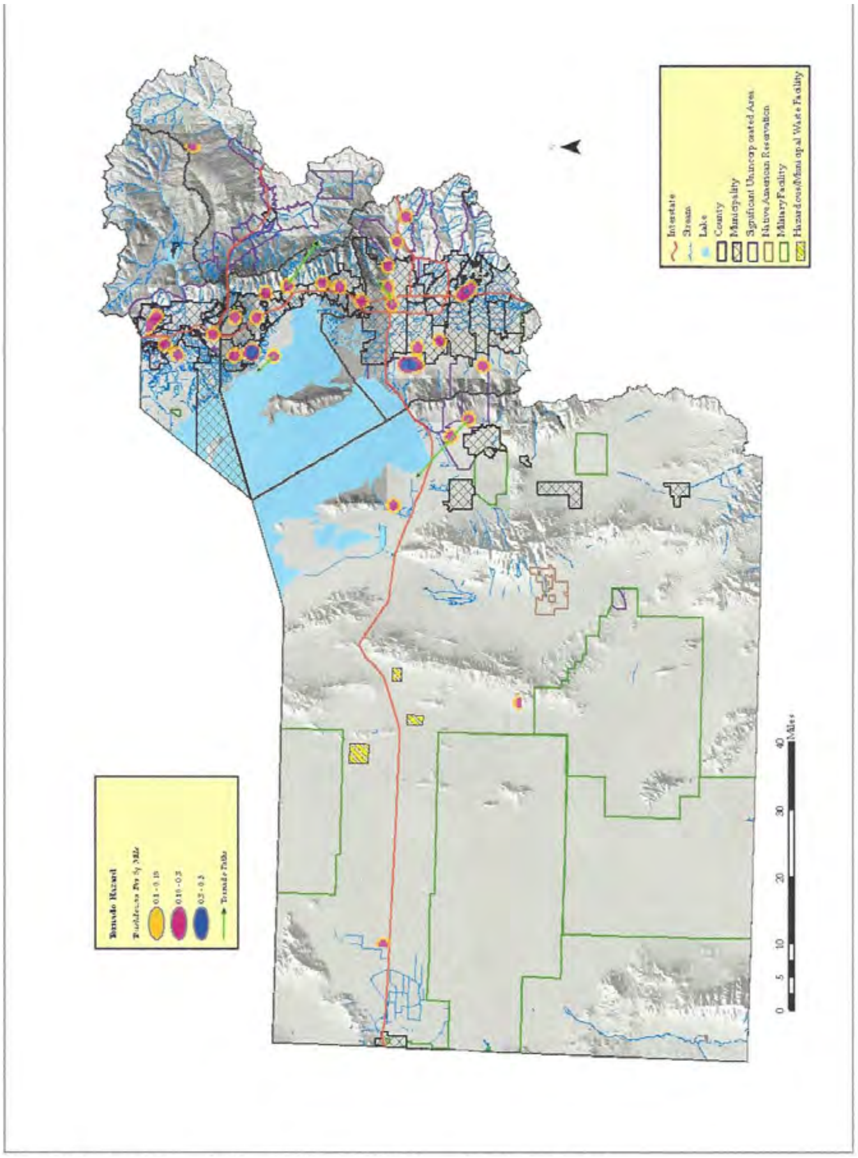
Great Salt Lake, September 12th, 1998 – Waterspout *(Photo: KTVX News 4)*

Historically, atmospheric conditions have not been favorable for tornado development in Utah due to a dry climate and mountainous terrain. Utah is one of the lowest ranked in the nation for incidences of tornadoes with only one F2 or stronger tornado every seven years. Utah averages about two tornados per year, which typically occur between May and August.

Salt Lake City Tornado, August 11, 1999 – Orange fireball is a power sub-station exploding (*Photo:*

Despite this fact, interactions of the relatively cool air of the Great Salt Lake and relatively warm air of urban areas could create situations more favorable for tornado development. This phenomenon possibly contributed to the formation of the August 1999 Salt Lake City tornado (Dunn and Vasiloff 2001). The $170 million in damages caused by this tornado make it the costliest disaster in Salt Lake County history.

Tornado distribution for the region (Map 13) suggests many tornadoes are funnel clouds aloft coming into contact with the increasing elevation of the region's foothills and mountains (See Map 8-5).



Map 8 Regional Tornado Hazard (Source: NWS Storm Prediction Center)

Lightning:

Lightning is the electric discharge between clouds or from a cloud to the earth. Lightning casualties occur most frequently during the summer monsoonal flow in July and August. Lightning is consistently one of the top three causes of weather-related deaths in the country, claiming more lives on average than tornadoes. In the U.S., an average of 400 individuals are struck by lightning per year and an average 67 lives are lost per year.

Lewis Peak, North Ogden, Utah, August 8th, 2003 – Lightning *(Source: Utah's Weather and Climate, Photo by Gene Poncelet)*

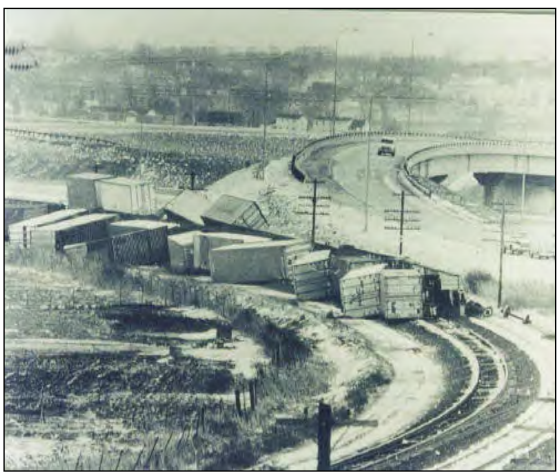
In Utah, lightning causes the highest number of weather-related fatalities (NWS 2008). Lightning has claimed 65 lives in Utah since 1950, more than any other thunderstorm-related hazard. 8 of those fatalities were within Salt Lake County.

Lightning is also the primary cause of wildland fires in Utah (NWS 2008), which could cause casualties or be disruptive to the economy. $4-5 billion is lost each year due to structural and wildland fire ignitions, and an additional $2 billion in costs to airline operations and passenger delays (UNHH 2008).

High Winds:

High winds can occur with or without the presence of a storm and are unpredictable in regards to time and place. Salt Lake County has experienced high winds in the past and can expect future events.

Straight-line winds produced by thunderstorms are any winds not associated with the rotation of a tornado. Straight-line winds are responsible for most thunderstorm wind damage, and speeds can exceed 125 mph. Other damaging winds originating from thunderstorms include downbursts and microbursts. Utah has also experienced down slope wind events, which occur when wind generated as a deep layer of air is forced over a barrier. Winds accelerate down mountain slopes and generate high winds in a wave region formed at the base of the terrain. A down slope windstorm in December 2011 generated numerous reports of 60-80 mph winds, and maximum gusts of 80-100 mph in the Bountiful/Centerville area, resulting in loss of power and significant damage in the region (NWS 2012, Definitions for Severe Weather).



Wasatch Front, April 4-6, 1983 – 70 mph "East Winds" derailed this train in the Lagoon area. Peak gusts were recorded at 104 mph. *(Source: Utah's Weather and Climate, Photo: Ogden*

Canyon winds can bring wind gusts greater than 100 mph through the canyon mouths into the populated areas of the Wasatch Front. Winds are usually strongest near the mouths of canyons and have resulted in the loss of power and the inability to heat homes and businesses. Winds have also damaged roofs, destroyed and knocked down large trees and fences, overturned tractor-trailers, railroad cars and downed small airplanes.

Winter Storms:

Winter storms can pose a significant threat due to vehicle traffic accidents on icy roads, prolonged exposure to cold, damage to electrical, telephone or communication systems from ice or heavy snow accumulation and indirectly related health threats such as individuals suffering heart attacks while shoveling snow. Prolonged exposure to cold can cause frostbite or hypothermia and can become life threatening. Winter weather can also have significant economic costs associated with snow removal, revenue and wage losses from road and airport delays or closures, flooding damage from rapid snowmelt and agricultural/timber losses from frost and ice (UNHH 2008).

Fog:

Temperature inversions often occur during the winter months as a result of high pressure trapping cold air in the valley. These inversions keep cold, moist air trapped on the Wasatch Front valley floor forming super-cooled fog. This fog can cause visibility restrictions and icy surfaces. Wind is needed to clear the inversion and fog. The Great Salt Lake has been shown to affect the prevalence of fog, especially when lake levels are high (Hill 1987).

Extreme Temperatures:

Temperatures in Utah can reach the extreme ends of the thermometer. Winter months often experience temperatures below zero degrees Fahrenheit. Summer temperatures regularly reach into the nineties with many days above 100 degrees Fahrenheit. Drastic temperature changes also occur, even in matter of hours. Temperature swings in such a short period of time can cause severe emotional stress in people.

Sub-zero temperatures occur during most winters; however, prolonged periods of extremely cold weather are infrequent. An exception was January 2013, the coldest month on record for Salt Lake City since 1949. There was a mean temperature of 19.4 degrees (10.1 degrees below normal), average daily maximum temperature of only 26.6 degrees and extended periods of inversions. January is generally the coldest month of the year in Utah. Historically, extreme cold in the region has disrupted agriculture, farming and crops. Especially vulnerable to extreme cold are the young, elderly, homeless and animals. Wind chill can enhance the effects of extreme cold.

Extreme heat is “summertime weather that is substantially hotter and/or more human than average for a location at that time of year” (EPA 2006).   Extreme heat not only causes discomfort, but personal health can be affected through heat cramps, heat exhaustion or heat stroke. This can particularly affect vulnerable populations such as the very young, elderly, poor and homeless. Extreme heat places a substantial burden on power grids through widespread use of evaporative coolers and air conditioning. This strain can lead to brownouts or blackouts leaving many without power.

Freezing Rain:

Freezing rain is rare in Salt Lake County, but occurs on occasion. A freezing rainstorm occurred along the Wasatch Front in the record cold January of 2013, causing the closure of all runways at the Salt Lake City International Airport and resulting in numerous traffic accidents. (Deseret News Published: Thursday, Jan. 24 2013).

Extreme Temperature Hazard Profile:

Potential Magnitude		Catastrophic (>50%)	Probability	X	Highly Likely
		Critical (25-50%)			Likely
	X	Limited (10-25%)			Possible
		Negligible (< 10%)			Unlikely
Location	Occur in localized areas throughout the county. Although many severe weather phenomena generally have recognizable patterns of recurrence, it is difficult to identify exactly when and where the next event will take place.				
Seasonal Pattern	Year round.				
Conditions	Vary based on latitude, elevation, aspect and landforms.				
Duration	Severe weather hazards generally last hours; some conditions can persist for days.				
Secondary Hazards	Wildfire, flooding.				
Analysis Used	National Climate Data Center, National Weather Service, Utah Avalanche Center, UDEM, local input, and review of historic events and scientific records.				

Profile 4

Location and Extent:

The entire region of Salt Lake County is affected by temperature extremes. Mountains and valleys are prone to the highest and lowest temperatures and their effects.

Salt Lake County Weather Damage by Event								
Year	Dense Fog	Flash Flood	Flood	Heavy Snow/ Winter Storm	High Wind	Thunderstorm/ Wind	Wildfire	Total
2003	$200,000	$0	$0	$350,000	$200,000	$0	$0	$750,000
2004	$0	$0	$0	$100,000	$0	$0	$0	$100,000
2005	$0	$0	$0	$0	$0	$18,000	$0	$18,000
2006	$0	$35,000	$0	$0	$0	$2,050,000	$0	$2,085,000
2007	$0	$175,000	$0	$0	$0	$10,000	$0	$185,000
2008	$0	$0	$0	$0	$501,000	$0	$0	$501,000
2009	$0	$0	$0	$0	$110,000	$0	$0	$110,000
2010	$0	$150,000	$1,500,000	$0	$60,000	$200,500	$5,000,000	$6,910,500
2011	$0	$350,000	$200,000	$0	$263,000	$42,000	$0	$855,000
2012	$0	$0	$0	$110,000	$25,000	$0	$3,440,000	$3,575,000

Table 29. Provided by National Weather Service Salt Lake City Forecast Office, March 2013

Frequency/Likelihood of Future Occurrence

Highly Likely: Near 100 percent chance of occurrence in next year or happens every year.

4.3.6. Dam Failure

Dams are usually man-made, and therefore not inherently considered naturals hazards—however, dam failures can occur by natural hazard loading events. The impacts of a dam failure can also be similar to natural flood events, although they are often more sudden and violent than normal stream floods (Living with Dams). Causes include breach from flooding, overtopping, ground shaking from earthquakes, settlement from liquefaction, slope failure and slumping, internal erosion from piping, failure of foundations and abutments, outlet leaks or failures, and internal weakening caused by vegetation and rodents. Possible effects include flooding, silting, loss of water resources, loss of property, and loss of life (UNHH 2008).

There are two types of dam failures – "rainy day" and "sunny day" failures. Rainy day failures occur because floodwaters overstress the dam, spillway, or outlet capacities. The floodwaters eventually flow over the top of the dam and erode the structure from the top down. The breach flows of the dam are added to the floodwaters from the rainstorm to produce a flood of large proportion and destructive power. Sunny day failure occurs from seepage and erosion inside the dam that removes fine material, creating a large void that can cause the dam to collapse or overtop and wash away. Sunny day failures can be the most dangerous because they can happen quickly with no warning to owners or downstream residents (UNHH 2008).

Dam Failure Hazard Profile:

Potential Magnitude		Catastrophic (>50%)	Probability		Highly Likely
	X	Critical (25-50%)			Likely
		Limited (10-25%)		X	Possible
		Negligible (< 10%)			Unlikely
Location	Dam locations are located throughout the county, with most of the high and moderate hazard dams in the eastern and southern portion of the county (Map 13).				
Seasonal Conditions	Rainy Day Failure: Spring, late summer Sunny Day Failure: Anytime				
Conditions	*Rainy Day Failure* happens mainly during heavy precipitation events, can have some warning time. *Sunny Day Failure* can happen anytime without warning.				
Duration	Hours or days - depends on spillway type and area, maximum cubic feet per second (cfs) discharge, overflow or breach type and dam type.				
Secondary Hazards	Raw sewage/health risk, electrical fires, gas spills.				
Analysis Used	Review of BOR inundation maps and plans, FIS, Utah Division of Water Rights.				

Profile 5

4.3.6.1 Location and Extent:

There are 233 dams and other impoundments are located in Salt Lake County. These dams are built by different agencies, and may serve various functions such as flood control, water storage, recreation, and power generation. Most are privately owned and are the responsibility of dam owners to maintain, with the state regulating their safety. The dam safety hazard is classified as no threat to high risk by the State Engineer. Hazard ratings are determined by downstream uses, by size, height and volume and by incremental risk/damage assessments. This classification is based upon the damage caused if the dam were to fail, not the dam's probability of failure. Therefore, the classification of a high hazard dam does not mean that the dam has a high probability of failure. Utah Division of Water Rights inspects high-hazard dams annually, moderate-hazard dams biennially and low-hazard dams every five years (Living With Dams, UNHH 2008).

4.3.6.2 Range and Magnitude:

- 27 High-hazard: Risk of loss of life, extensive economic loss
- 27 Moderate-hazard: Low probability of loss of life, appreciable property damage
- 135 Low-hazard: Minimal threat to life, minor economic loss
- 44 No Hazard Rating: No threat

Name	Rating	Name	Rating
Draper Pressure Irrigation Project	High	AJ Dean Concrete Sediment Pond	Mod
Ensign Downs DB (AKA Victory Road DB)	High	Barney's Wash Detention Basin (6400 West)	
Kennecott Mine – Bingham Creek	High	Jordan Valley Water Purification Lower	
Lake Mary – Phoebe	High	Jordan Valley Water Purification Upper	Mod
Little Dell	High	Kennecott Mine – 4000 West Pond	Mod
Mountain Dell	High	Kennecott Mine – Small Reservoir	Mod
Oquirrh Lake Dam - Kennecott Daybreak	High	Kennecott Smelter – Kessler Canyon #06	Mod
Point of the Mountain Raw Water Reservoir	High	Kennecott Smelter – Kessler Canyon #10	Mod
Red Butte Dam	High	Kennecott Smelter – Kessler Canyon #11	Mod
Red Pine	High	Kennecott Smelter – Tailings Pond	Mod
Riverton City – 3200 West Pond	High	Magna Water Company & Improvement District	Mod
Riverton City – 4200 West Pond	High	Monroc	Mod
Riverton City – Black Ridge Reservoir	High	Oakridge Development	Mod
Salt Lake County – Big Cottonwood (Spencer's)	High	Riverton Dam (Formerly American Contract)	Mod
Salt Lake County – Creekside Park (Big Cottonwood)	High	Salt Lake County – Wheeler Farm	Mod
Salt Lake County – Rotary Glen Park	High	Salt Lake County –Upper I-9	Mod
Salt Lake County – Scott Ave	High	Sandy City – Alta Canyon	Mod
Salt Lake County – Sugarhouse	High	Sandy City – Aspen Meadows	Mod
Salt Lake County – Chandler Drive (#13)	High	Sandy City – Buttercup	Mod
Salt Lake County – Federal Heights (#1A)	High	Sandy City – Crescent Park	Mod
Salt Lake County – School Pond (#14)	High	Sandy City – Falcon Detention Basin	Mod
Salt Lake County – Shriners (#12)	High	Sandy City – Willow Creek	Mod
Sandy City – East Sandy Elementary	High	Secret Lake (Cecret Lake)	Mod
Sandy City – Flat Iron Mesa	High	South Jordan City	Mod
Sandy City – Storm Mountain DB	High	Utah Dept. of Transportation Basin 1	Mod
Twin Lakes (Salt Lake)	High	Weber/Box Elder Reservoir #3	Mod
White Pine	High	West Jordan City	Mod

Table 26. High and Moderate Hazard Dams, Salt Lake County *(Source: Utah Division of Water Rights)*

4.3.6.3 History:

No record was found of dam failure incidents within Salt Lake County. However, incidents have occurred in other parts of Utah, including St. George in 1989 and Santa Clara in 2012.

Vulnerability Assessment:

According to the 2011 Utah Hazard Mitigation Plan, a hazard evaluation designed by the Federal Energy Regulatory Commission FERC, compiled a ranking of high priority dams based on a number of variables which include:

- Public access
- Population at risk
- Breach flow
- Inundation depth
- Dam type

8 of the 50 highest priority dams are located within Salt Lake County.

1. Mountain Dell
2. Little Dell
5. Salt Lake County Sugarhouse
10. Red Butte Dam
17. Twin Lakes Salt Lake County
29. Lake Mary-Phoebe
30. Salt Lake County Big Cottonwood Spencer's
36. Kennecott Mine Bingham Creek

4.3.6.4 Future Occurrence:

The Utah Hazard Mitigation Plan includes additional loss estimates for Salt Lake County based on GIS analysis using dam inundation area shape files from AGRC and the Bureau of Reclamation, and population from LandScan.

Total Potential Inundation area (Sq. Miles)	49.5
Percent Potential Inundation area (Sq. Miles)	6.1%
Total Daytime Population within High Hazard Dam Failure Inundation Areas	112,748
Total Nighttime Population within High Hazard Dam Failure Inundation Areas	100,826
Total number of Critical Facilities in Dam Failure Inundation Areas	66 4 Fire (SLC Fire Stations 3, 6, 8, South Salt Lake Fire Department) 2 Hospitals (Jordan Valley Medical Center) 4 Police (Sandy Police Substation, Salt Lake County Sheriff's Office, South Salt Lake Police Dept., Fort Douglas Public Safety) 8 UTA Transportation Stations 48 Schools

Table 27.

4.3.6.5 Vulnerability Assessment:

Table 28 estimates infrastructure vulnerable to dam failure in Salt Lake County. Provided are the number of units or total length of infrastructure vulnerable and the estimated replacement costs as provided by HAZUS-MH lost estimation software. Table 29 estimates the total area, population and buildings vulnerable to dam failure for individual cities and Table 30 examines the same for unincorporated areas.

Item	Length (Miles) or Number of Units	Replacement Cost
Highways/Interstates	49.35 miles	$270,712,431
Highway Bridges	141 bridges	$194,240,663
Railway Segments	18.68 miles	$21,462,350
Railway Bridges	0 bridges	$0
Water Distribution Lines	N/A	N/A
Gas Lines	N/A	N/A
Sewer Lines	N/A	N/A
Total Estimated Infrastructure Replacement Cost		$486,415,444

Table 28. Infrastructure Vulnerable to Dam Failure, Salt Lake County

			Structures in Inundation Areas	
Incorporated Areas	Acres Affected	Population Affected	Residential (Replacement Value)	Commercial (Annual Sales)
Alta	0	0	0	0
Bluffdale	577	1,066	281 $57,492,600	9 $2,792,296
Cottonwood Heights	618	4,299	1,498 $306,490,800	170 $68,626,409
Draper	479	1,444	486 $99,435,600	52 $126,907,719
Herriman	0	0	0	0
Holladay	1,159	7,369	3,080 $630,168,000	371 $232,693,583
Midvale	323	3,714	1,546 $316,311,600	49 $33,150,823
Murray	1,066	7,423	3,324 $680,090,400	715 $550,016,335
Riverton	853	3,710	969 $198,257,400	28 $14,217,055

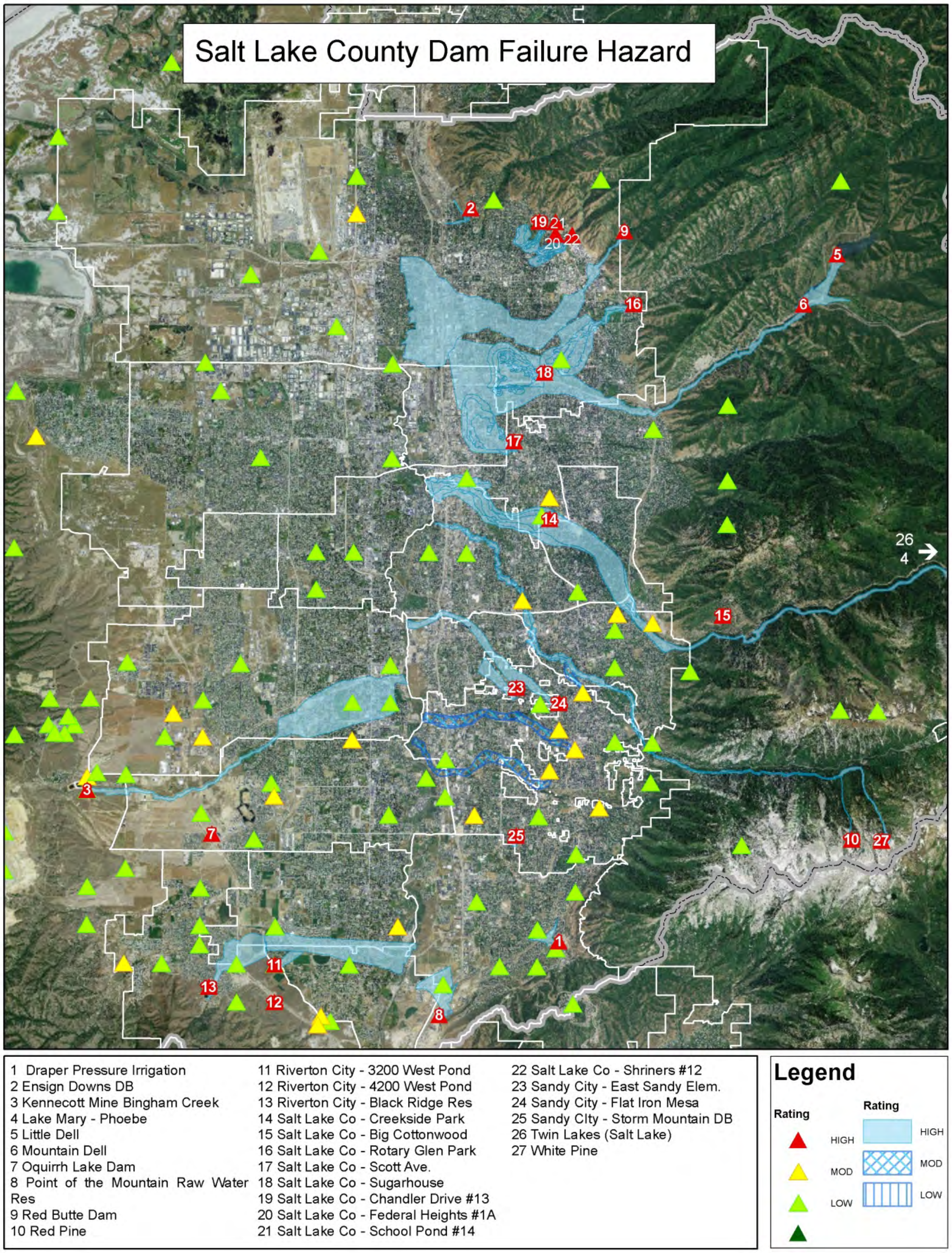
Salt Lake City	5,487	44,174	18,186 $3,720,855,600	2,259 $1,319,027,117
Sandy City	1,357	12,191	4,221 $863,616,600	442 $216,962,013
South Jordan	222	474	137 $28,030,300	1 $110,705
South Salt Lake	1,719	12,973	5,974 $1,222,280,400	1,344 $855,609,248
Taylorsville	1	60	32 $6,547,200	0
West Jordan	2,126	13,322	3,830 $783,618,000	313 $109,253,013
West Valley City	40	324	80 $16,368,000	16 $9,492,390

Table 29. Vulnerability Assessment for Dam Failure, Incorporated Salt Lake County

Unincorporated Areas	Acres Affected	Population Affected	Structures in Inundation Areas	
			Residential (Replacement Value)	Commercial (Annual Sales)
Big Cottonwood Canyon	913	55	19 $3,887,400	0
Camp Williams	0	0	0	0
Canyon Rim	127	936	332 $67,927,200	0
Copperton	92	1	0	0
East Millcreek	0	0	0	0
Emigration Canyon	0	0	0	0
Granite	328	269	80 $16,368,000	1 $27,753
Kearns	0	0	0	0
Magna	0	0	0	0
Millcreek	640	6,428	3,153 $645,103,800	282 $180,987,936
Mount Olympus	27	45	13 $2,659,800	0
Parley's Canyon	708	146	44	0

			$9,002,400	
Sandy Hills	25	280	83 $16,981,800	1 $27,753
Southwest	0	0	0	0
Willow Canyon	0	0	0	0

Table 30. Vulnerability Assessment for Dam Failure, Unincorporated Salt Lake County



Map 13. Dam Hazard Map, Salt Lake County (Utah Division of Water Rights 2013)

Community Assets:

Additional significant community assets with potential impacts by dam failure hazards were identified by the Mitigation Planning Team. These include areas of particular concern, critical facilities, critical infrastructure, areas of future development, major employers or economic sectors, cultural or historic facilities, and significant populations or significant natural resources. More detailed information on jurisdictional assets is listed in their individual annex.

Murray:

Previous events: none, but similar to other flooding events. Many residential homes impacted near Little Cottonwood Creek, Murray Park, State St and Vine St, some roads impassable.

Growth: Birkhill Apartment complex

Structures: Fire Station #82

Population: Nighttime residential and apartment complexes near Little Cottonwood Creek

Economic: Some business impacts in north end of city

Natural: Jordan River Conservatory

South Salt Lake

Areas of concern: Scott Ave., Little Dell and Mountain Dell, Sugarhouse, Jordan River

Previous events: none, but similar areas to other flood events. Scott Ave Millcreek Damage, flooding in Jordan River area

Growth: 2100 S-2400 S, State St – 400 W

Structures: County EOC, Jails, Metro, Oxbow, Youth, Sewer Treatment Facility, Transportation corridors, I-15, I-80, railroad, Trax, Schools

Population: Larger daytime population, prisoner population, Non-English speakers

Taylorsville

Areas of concern: All tributaries coming into Jordan River

Previous events: Flooding near 3900 S and 4800 S along Jordan River in 2011. High-density housing affected, Calloway Apts. and Bridgesite Apts.

Growth

Structures: high density housing along rivers, Sorenson Research Park, businesses

Population: residential and business population along river/drainage area

Economic: Sorenson Research Park, Golf Course 3900-4300 S and river

Natural: Possibly along the river

Frequency/Likelihood of Future Occurrence

Unlikely—Less than 1 percent chance of occurrence in next 100 years or has a recurrence interval of greater than every 100 years.

4.3.7. Avalanche

A snow avalanche is the rapid down slope movement of a mass of snow, ice and debris. Snow avalanches occur in the mountains of Utah during the winter and spring as a result of snow accumulation and unstable snowpack conditions. Avalanches can be extremely destructive due to the forceful energy of rapidly moving snow and debris, and the burial of areas in the run out zones. Avalanches can cause damage to property, interruption of communications, blockage of transportation routes and streams and can result in injury and death (UNHH 2008).

Avalanches have caused more fatalities than any other natural hazards in Utah. Over the past 20 years on average four people have been killed in the state each year. The primary risk exists in the Wasatch Range and Uinta mountains—due to their high recreation use and increasing development—although they occur throughout Utah's mountainous areas. Avalanche paths may not have a serious avalanche for years or even decades, but the potential is there especially during above average snowfall years (UNHH 2008). In Utah, 100 avalanche deaths have occurred from 1958-2010, and by comparison 61 deaths from lightning since 1950.

Even though most avalanches occur in wildland areas, recreational endeavors—hiking, hunting, mountain climbing, skiing, snowboarding, snowmobiling and other wintertime activities—bring the population into contact with avalanche-prone areas. Due to the immense popularity of these activities, avalanches are actively mitigated within well-traveled areas. Persons venturing into the backcountry are more at risk. Homes and businesses along the foothills and in mountain areas have been damaged from avalanches.

White Pine, Little Cottonwood Canyon, December 23rd, 1988 – two to three feet of snow deposited in the mountains causes many avalanches *(Source: Utah's Weather and Climate, Photos: National Weather Service)*

Avalanches can occur naturally, or can be triggered artificially by explosives or by people such as snowmobilers, backcountry skiers, or other outdoor recreationists. Two main natural factors that affect avalanche activity are weather and terrain.

Weather events create a layered snow pack. When strong layers or slabs form on top of weak layers, the snow pack can become unstable. The amount of snow, rate of accumulation, wind speed and direction, moisture content and snow crystal type all contribute to snowpack stability conditions. Most natural avalanches occur during or within 24 hours after a storm. In Utah, the avalanche potential is greatest from December through April.

Terrain factors affecting avalanches include slope angle, elevation, aspect, shape and roughness. Slope angle is the primary factor of avalanche probability, with most occurring in the optimum angles between 30 and 45 degrees. Elevation and aspect dictate the depth, temperature and moisture characteristics of the snow pack. Slope shape and roughness contribute to stability. For example, bowl-shaped slopes are more prone to avalanches than ridges. Boulders, shrubs and trees contribute to the slope's roughness and provide some stability (UNHH 2008).

Types of avalanches include wet and dry slab. Wet-slab avalanches occur most often in warming conditions on southerly-facing slopes. Dry-slab avalanches occur mostly on northerly-facing slopes in mid-winter. Wind can accelerate snow deposition leading to larger and/or more frequent avalanches (UAC 2008).

Avalanche Hazard Profile

Potential Magnitude		Catastrophic (>50%)	Probability	X	Highly Likely
		Critical (25-50%)			Likely
	X	Limited (10-25%)			Possible
		Negligible (< 10%)			Unlikely
Location	Occur in localized areas in canyons and foothills, primarily in the canyons of the Wasatch Mountains. See Map 14.				
Seasonal Pattern	Winter, spring				
Conditions	Vary based on weather conditions, slope, aspect, and land forms.				
Duration	Initial impact seconds, possibly days if avalanche impacts roads or structures				
Secondary Hazards	Traffic restrictions, limited access to and from canyon communities				
Analysis Used	National Weather Service, Utah Avalanche Center, UDEM, local input, and review of historic events and scientific records.				

Profile 6.

4.3.7.1 Location and Extent:

Avalanche risk in Salt Lake County is primarily found in the Wasatch Mountains, particularly in Big and Little Cottonwood Canyons. The Town of Alta is particularly at risk to the impacts of avalanches. State Highway 210 follows Little Cottonwood Creek for the length of Little Cottonwood Canyon and serves as the primary access route to the town. Culvert blockages, bank erosion, landslides and avalanches all have the potential to close down the town's only arterial connection with the rest of the county.

Highway 210 also has the highest avalanche hazard-rating index of any major roadway in the country. At times when UDOT and Alta agree that conditions are unsafe, the town goes into an Interlodge Alert, meaning all occupants of the town (including both visitors and residents) must remain indoors until conditions are deemed safe. During large storm cycles, an Interlodge can last days until the storm cycle is over and proper avalanche control work has been performed.

Figure 50

The Town's General Plan (dated November 2005, Updated 2013) covers Highway 210 access and possible mitigation activities to keep this critical road open (Figure 50). It also provides background on the Little Cottonwood Canyon Road Committee, a group consisting of representatives from Alta, Snowbird, Salt Lake County (including the Unified Fire Authority), UDOT, UTA, and USFS, that meet monthly to discuss access, usage, and safety and security issues related to the canyon road. No Evacuation Plan exists at this time, however it is something that the Town would like to accomplish.

4.3.7.2 Range of Magnitude:

There currently is no standard for quantifying avalanche magnitude. Our county uses the following measurements to quantify avalanche magnitude:

- Number of injuries and/or fatalities
- Depth of snow on the road
- Time to remove snow so that the roads are passable
- Number of days it takes for people to be able to return from the mountain resort

4.3.7.3 History:

In 1983, a large avalanche completely covered Highway 210, buried a number of automobiles and wiped out the first floor of the Peruvian Lodge (Figures 51 and 52). A Salt Lake City motorist was seriously injured in a 1998 avalanche in Little Cottonwood Canyon.

In general, Alta does not have any ordinances or land use regulations specifically for avalanche hazards. They are beginning to implement avalanche analysis into their construction design and the new Town Hall building was constructed to withstand a 1%-annual-chance avalanche hazard. The update to Alta Ski Lifts Master Plan does cover potential considerations for avalanche mitigation. This represents an important first step for the town and ski area as their current methods (firing artillery shells) are becoming outdated.

Additionally, these methods may no longer be available to them in the near future—and they are currently 100% dependent on the current method in order to function as a town and from an economic standpoint. The town has received communication from the U.S. Department of Defense informing them that they need to consider alternative methods for control work, as artillery will soon be unavailable.

4.3.7.4 Future Occurrence:

There is no way to predict the number and severity of avalanches each year. It is dependent upon a myriad of factors such as previous snow conditions, amount of new snowfall, wind speeds, wind direction, snow density, and avalanche control work success.

4.3.7.5 Vulnerability Assessment:

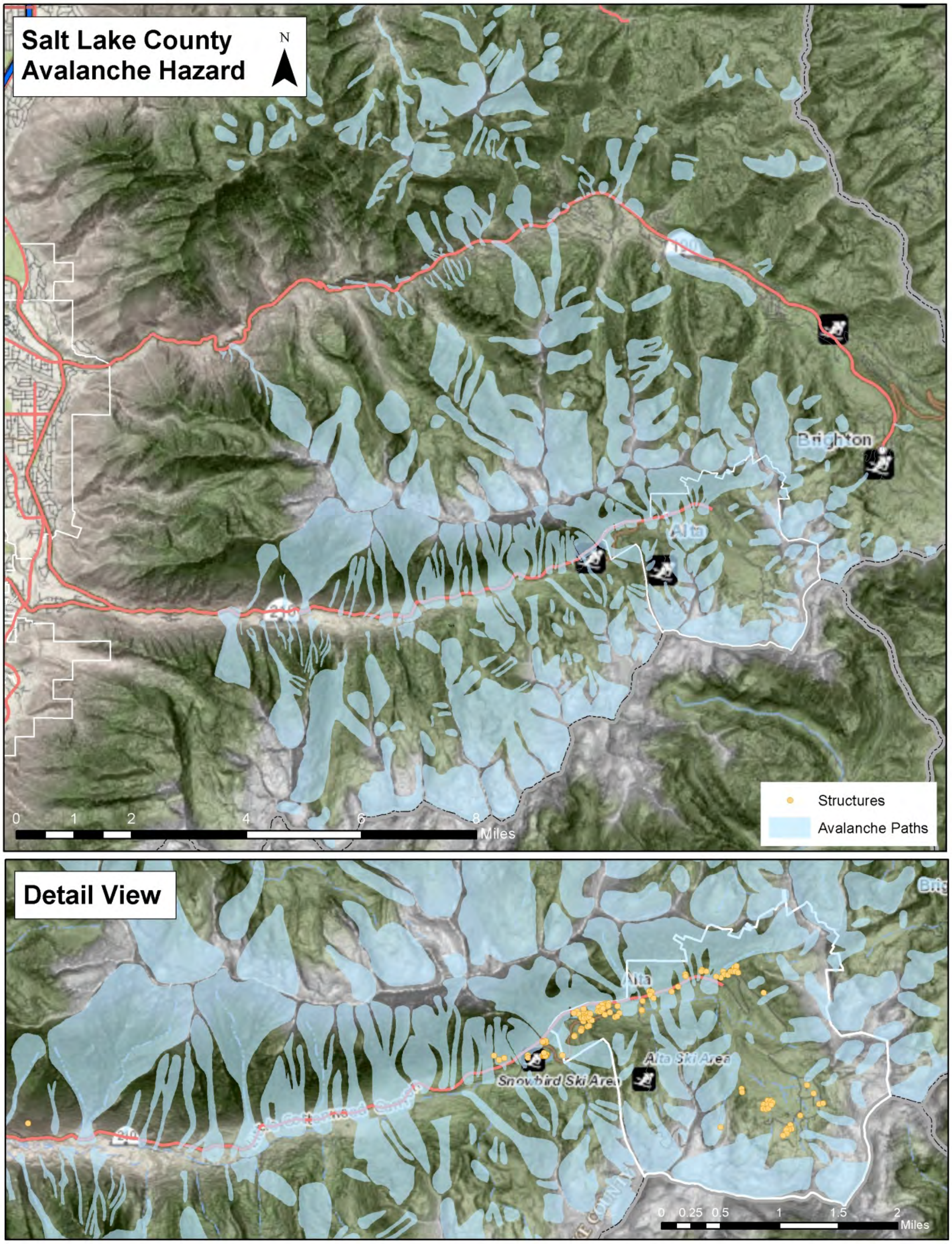
95 Structures within Avalanche Paths
56 Commercial – $54,647,250

1 Government – $183,696
38 Residential – $2,869,264

Although the Town of Alta only has a population of 383 (per the town's website), it has a significant, fluctuating tourist population, which would be greatly impacted if Highway 210 is blocked by an avalanche.

Community Assets:

Highway 210, Ski Resort Infrastructure


Salt Lake County
Avalanche Hazard
N
190
Brighton
Alta
210
0 1 2 4 6 8 Miles
Structures
Avalanche Paths
Detail View
Alta
Alta Ski Area
Snowbird Ski Area
0 0.25 0.5 1 1.5 2 Miles

Map 14.

4.3.8 Public Health Epidemic/Pandemic

A pandemic is a worldwide disease outbreak. An influenza pandemic occurs when a new Influenza A virus emerges and there is little or no immunity in humans. An influenza pandemic occurs when a new, virulent strain of the influenza virus circulates globally. Because the virus is new, there is little to no immunity among the population. The virus therefore can be easily transmitted and has the ability to make many people very sick in a relatively short period of time. A pandemic influenza virus causes serious illness and spreads easily from person-to-person. It could be mild, moderate, or very severe even leading to death (SLVHD Family Emergency Preparedness Guide).

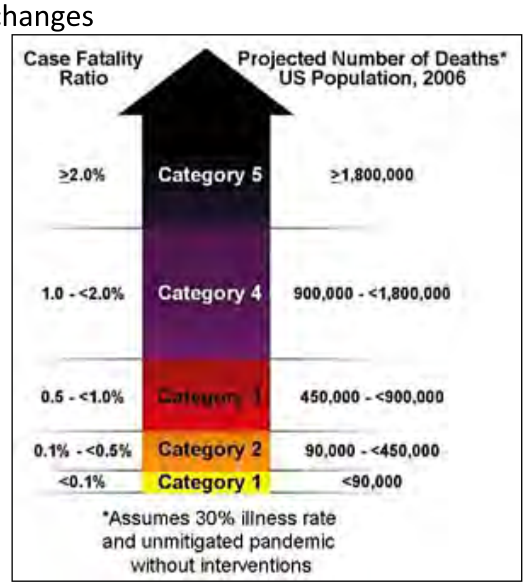
Influenza is caused by a virus that is spread from person-to-person primarily through respiratory droplets generated from coughing or sneezing. Transmission is most efficient among crowded populations in enclosed spaces. The virus may persist in the environment for several hours, particularly in cold and low humidity. It spreads rapidly because it has a short incubation period (period between infection and onset of symptoms) of 1-3 days and because persons are infectious (able to transmit the virus to others) during early illness or even before the onset of symptoms. (SLVHD 2010)

4.3.8.1 Location and Extent:

No defined geographic extent. Pandemics can spread throughout the county/region/state & beyond.

Pandemics are different from other types of hazards. They may have a much wider geographic impact, last several months, the evidence tends to be less visible, casualties are predominantly human rather than material or structural, state and federal aid resources may be limited, and the economic impacts may be more widespread.

A widespread outbreak of influenza could require temporary changes in many areas of society, such as schools, work, transportation, and other public services. Although the most effective tool for mitigating a pandemic is a well-matched vaccine, it is likely no perfectly matched vaccine will be available for a new virus for several months. There may also be insufficient quantities of antiviral medications (CDC Pre-Pandemic Planning Guidance: Community Strategy for Pandemic Influenza Mitigation). Therefore, mitigation measures are designed to limit the impact on the community by slowing transmission, limiting opportunities for exposure, and delaying the outbreak peak to lessen the impact on the health care system (SLVHD 2010). Social distancing measures could be implemented where public gatherings such as sporting events, church meetings, schools, and others would be closed to prevent further spread of the disease. (SLVHD FEPG)



4.3.8.2 Range of Magnitude:

The Pandemic Severity Index is a tool to assess the severity of pandemic illness and appropriate mitigation measures to implement.

	Pandemic Severity Index		
Interventions* by Setting	**1**	**2 and 3**	**4 and 5**
Home			
Voluntary isolation of ill at home (adults and children); combine with use of antiviral treatment as available and indicated	Recommend†§	Recommend†§	Recommend †§
Voluntary quarantine of household members in homes with ill persons¶ (adults and children); consider combining with antiviral prophylaxis if effective, feasible, and quantities sufficient	Generally not recommended	Consider**	Recommend**
School **Child social distancing**			
-dismissal of students from schools and school based activities, and closure of child care programs	Generally not recommended	Consider: ≤4 weeks††	Recommend: ≤12 weeks§§
-reduce out-of school social contacts and community mixing	Generally not recommended	Consider: ≤4 weeks††	Recommend: ≤12 weeks§§
Workplace / Community **Adult social distancing**			
-decrease number of social contacts (e.g., encourage teleconferences, alternatives to face-to-face meetings)	Generally not recommended	Consider	Recommend
-increase distance between persons (e.g., reduce density in public transit, workplace)	Generally not recommended	Consider	Recommend
-modify, postpone, or cancel selected public gatherings to promote social distance (e.g., stadium events, theater performances)	Generally not recommended	Consider	Recommend
-modify work place schedules and practices (e.g., telework, staggered shifts)	Generally not recommended	Consider	Recommend

Pandemic Hazard Profile:

Potential Magnitude		Catastrophic (>50%)	Probability		Highly Likely
	X	Critical (25-50%)		X	Likely
		Limited (10-25%)			Possible
		Negligible (< 10%)			Unlikely
Location	May occur throughout the county. It is difficult to identify exactly when and where the next event will take place.				
Seasonal Pattern	Primarily fall and winter, with potential impacts year round.				
Conditions	Variable timeframe and variable severity. Once novel virus is introduced to the area, person-to-person transmission may spread virus rapidly.				
Duration	4-6 weeks to several months, possibly up to a year				
Secondary Hazards	Social and economic consequences, possible surge on healthcare resources.				
Analysis Used	Salt Lake Valley Health Department, Center for Disease Control, UDEM, local input, and review of historic events and scientific records.				

Profile 7

4.3.8.3 History:

The Great Pandemic of 1918-1919 was the first reported pandemic in the Salt Lake County. The first cases in Utah undoubtedly appeared in the military camp at Fort Douglas. Like many states with a large rural population, Utah did not provide a report to the Public Health Service in the early weeks of the pandemic. This may have been because they were overwhelmed by the spread of the disease or it may have been because the state did not have enough public health officials available to make the weekly reports the Public Health Service demanded. Utah's Pandemic Preparedness Plan was first released in 2005, http://health.utah..gov/epi/diseases/flu/ClinicianPublicHealth/pandemic/pandemic influenza plan.pdf

4.3.8.4 Future Occurrence:

There is no way to predict the future occurrences of pandemics.

4.3.8.5 Vulnerability Assessment:

Individuals, families, employers, and communities will all experience difficulties dealing with community mitigation measures. Many problems will come from having children dismissed from schools and childcare programs. There are 546,000 children less than 18 years old currently in school in Utah, accounting for 21.8% of the population. An additional 205,000 residents (8.2%) are enrolled in college. Dismissing students from school would directly disrupt the schedule of 30% of the population. Secondary disruptions would occur for parents who would need to balance working with tending their children. Tertiary disruptions would occur for employers with absent employees that must stay home to care for children and could potentially result in workplaces closing or reducing operations and limiting the availability of essential services. Additionally 156,000 (17.9%) of Utah residents live alone; 30.1% are 65 years of age and older. Persons who live alone may be unable to follow isolation requirements if they need to acquire medications or shop for other essentials (SLVHD 2010).

Characteristics	Pandemic Severity Index				
	Category 1	Category 2	Category 3	Category 4	Category 5
Case Fatality Ratio (Percentage)	<0.1	0.1-<0.5	0.5-<1.0	1.0-<2.0	>=2.0
Excess Death Rate (per 100,000)	<30	30-<150	150-<300	300-<600	>=600
Illness Rate (percentage of the population)	20-40	20-40	20-40	20-40	20-40
Potential Number of Deaths (based on 2008 population estimate*)	<312	312-<1,562	1,562-<3,125	3,125-<6,249	>=6,249
20th Century UT experience	Seasonal Influenza (illness rate 5-20%)	1957, 1968 Pandemic	None	None	1918 Pandemic

* 1,041,578 = Salt Lake County population, 2008 estimate, Utah Population Estimate Committee and the Governor's Office of Planning and Budget, 2008 Baseline Economic and Demographic Projections.

Table 31. Community Mitigation Plan, Appendix H to the Salt Lake Valley Health Department Pandemic Influenza Preparedness and Response Plan

4.3.9 Drought

According to the National Drought Mitigation Center, drought is a "deficiency of precipitation over an extended period of time, resulting in a water shortage for some activity, group, or environmental sector." Although variation in the amount of precipitation recorded each year is normal, a drought is beyond these norms in terms of low precipitation for an extended period or over a large area. While most natural hazards are sudden and result in immediate impacts, droughts "sneak up on us quietly disguised as lovely sunny weather" (McKee, Doesken, and Kleist 2005) and can last a long time resulting in significant socioeconomic impacts. Drought can be categorized according to unique characteristics and may be thought of as phases of the same drought (UNHH 2008).

- Meteorological drought: a measure of departure of precipitation from normal for a particular location.
- Agricultural drought: where the amount of moisture in the soil no longer meets the needs of a particular crop.
- Hydrological drought: when surface and subsurface water supplies are below normal.
- Socioeconomic drought: when dry conditions persist long enough and are severe enough to impact sectors beyond the agricultural community, such as community drinking supply and other social and economic enterprises.

Although the agricultural community is usually the most heavily impacted by drought, direct and indirect impacts extend into economic, social, or environmental sectors as well (UNHH 2008).

4.0 or more	Extremely wet
3.0 to 3.99	Very wet
2.0 to 2.99	Moderately wet
1.0 to 1.99	Slightly wet
0.5 to 0.99	Incipient wet spell
0.49 to -0.49	Near normal
-0.5 to -0.99	Incipient dry spell
-1.0 to -1.99	Mild drought
-2.0 to -2.99	Moderate drought
-3.0 to -3.99	Severe drought
-4.0 or less	Extreme drought

Table 32. Palmer Drought Severity Index (NDMC 2006)

The Palmer Drought Severity Index (PDSI) developed by Wayne Palmer in the 1965, measures drought severity using temperature, precipitation and soil moisture (Utah Division of Water Resources 2007a). The PDSI has become the "semi-official" drought index as it is standardized across various climates. The index uses zero as normal and assigns a number between +6 and -6, with dry periods having negative numbers and wet periods expressed using positive numbers (Table 8-2) (NDMC 2006).

Times of extended drought can turn into socioeconomic drought, or drought that begins to affect the general population. When this occurs, reservoirs, wells and aquifers are low and conservation measures are required. Some forms of water conservation are water-use restrictions, implementation of secondary water or water recycling and xeriscaping. Other conservation options include emergency water agreements with neighboring water districts or transporting water from elsewhere.

Drought Hazard Profile:

Potential Magnitude		Catastrophic (>50%)	Probability		Highly Likely
	X	Critical (25-50%)		X	Likely
		Limited (10-25%)			Possible
		Negligible (< 10%)			Unlikely
Location	Countywide.				
Seasonal Pattern	Impacts typically noticeable in summer, conditions can be year round.				
Conditions	Meteorological Drought: Lack of precipitation Agricultural Drought: Lack of water for crop production Hydrologic Drought: Lack of water in the entire water supply Socioeconomic Drought: Lack of water sufficient to support population				
Duration	Months, Years				
Secondary Hazards	Wildfire, dust storms, air quality.				
Analysis Used	National Weather Service, Utah Climate Center, Utah Division of Water Resources, Newspapers, Local input.				

Profile 8.

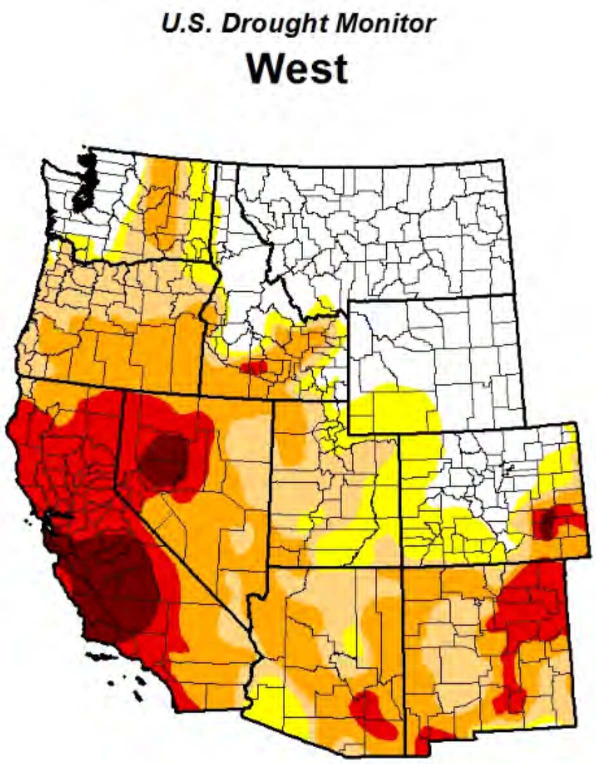
4.3.9.1 Location and Extent:

Utah is the second driest state in the nation. Drought dramatically affects this area because of the lack of water for agriculture and industry, which limits economic activity, irrigation and culinary uses. The severity of the drought results in depletion of agriculture lands and deterioration of soils. In the Wasatch Front Region, the risk of drought is high.

Salt Lake County falls within two climatic regions: the North Central Region (3), and the Northern Mountains Region (5) (See Map 15). Each of these regions has differing characteristics, but often experience similar drought periods. The two regions experience mild drought (PDSI ≥ -1) every 2.6-3.3 years, moderate drought (PDSI ≥ -2) every 3.7-5.2 years, and severe drought (PDSI ≥ -3) every 6.9-8.5 years. The Northern Mountain Region typically experiences droughts less frequently (Utah Division of Water Resources 2007a). Conversely, the Northern Mountain Region averages more severe drought conditions at its peak than the Western Region. It may be Northern Mountains Region simply has more water to lose as the Wasatch and Uinta Mountains receive much more precipitation on average.

4.3.9.2 Range of Magnitude:

The most severe drought period in recorded history for the North Central and Northern Mountains Regions occurred in 1934 at the height of the Great Depression and during the same drought period (1930 to 1936) that caused the “Dust Bowl” on the Great Plains. The longest drought period varies from 11 years for the North Central region (1953-1963), and 6 years for the Northern Mountains (twice; 1900-1905 and 1987-1992) (Utah Division of Water Resources 2007a).



March 25, 2014
(Released Thursday, Mar. 27, 2014)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	28.12	71.88	60.33	41.95	16.31	4.02
Last Week *3/18/2014*	28.49	71.51	60.44	41.95	16.19	3.61
3 Months Ago *12/24/2013*	22.20	77.80	51.15	30.75	7.62	0.63
Start of Calendar Year *12/31/2013*	22.20	77.80	51.44	31.11	7.75	0.63
Start of Water Year *10/1/2013*	25.25	74.75	58.96	34.18	5.57	0.63
One Year Ago *3/26/2013*	19.44	80.56	63.42	41.27	15.54	2.49

Intensity:

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

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

Author:
David Simeral
Western Regional Climate Center

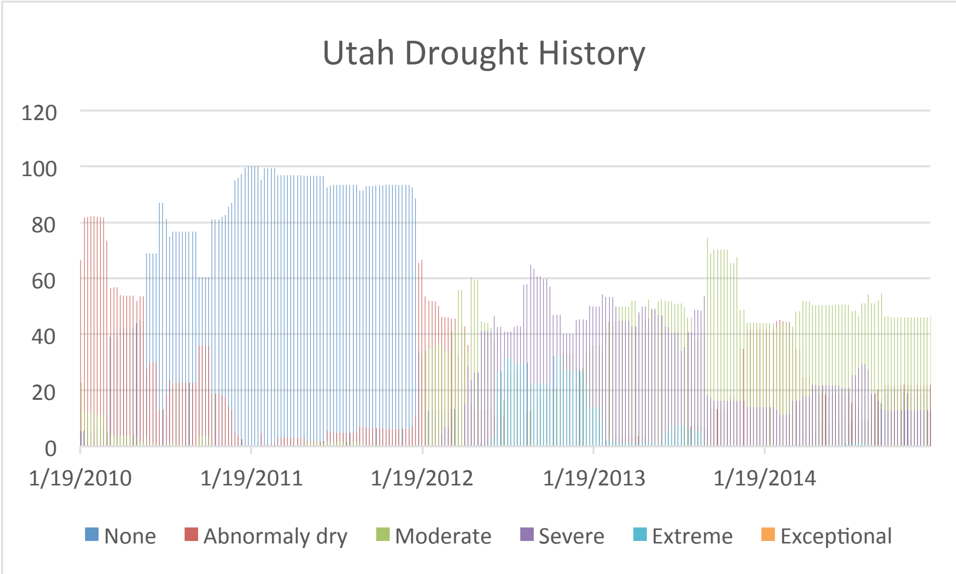
http://droughtmonitor.unl.edu/

Map 15.

4.3.9.3 Recent Conditions:

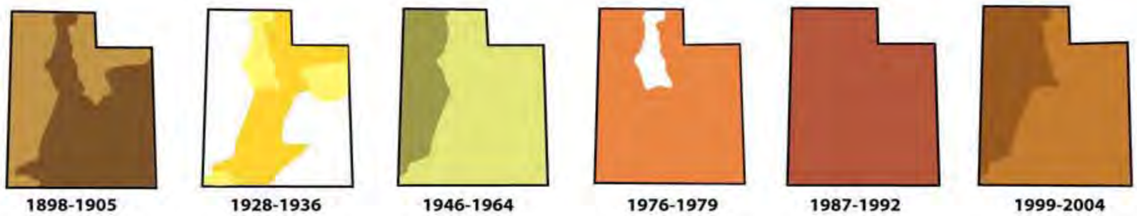
Recent conditions are summarized in the Historical drought information below:

http://droughtmonitor.unl.edu/MapsAndData/DataTables.aspx

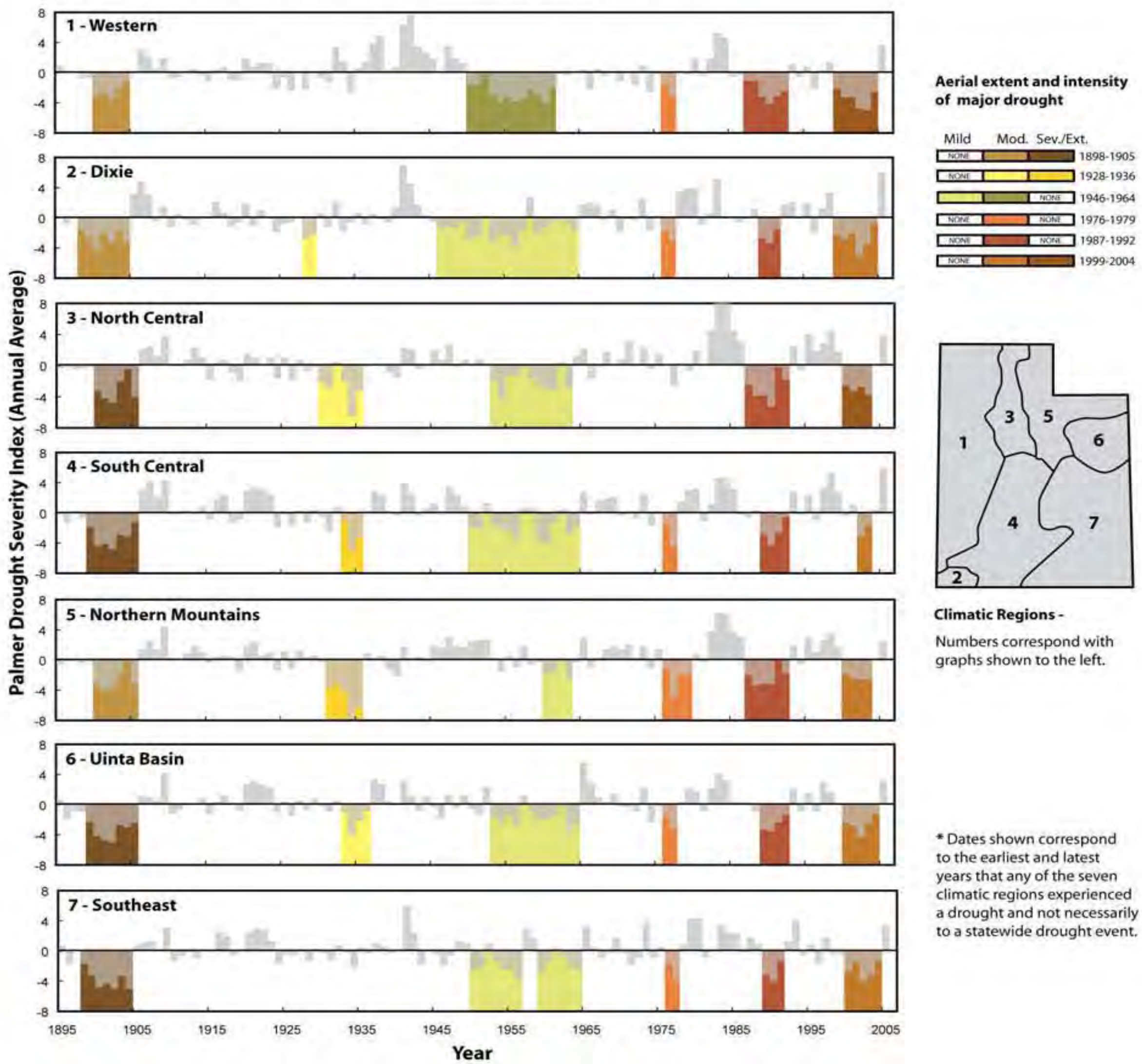


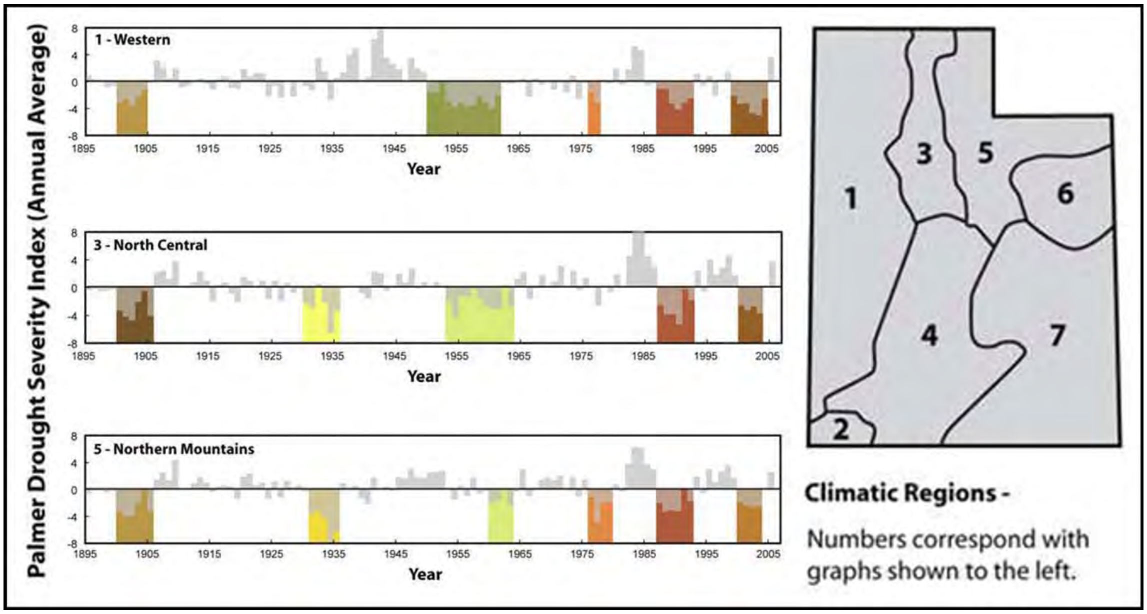
United States Drought Monitor

Areal Extent of Historical Drought Events *



Palmer Drought Severity Index by Region





Map 16. Annual Average PDSI *(Modified from* Utah Division of Water Resources 2007a*)*

4.3.9.4 Future Occurrence:

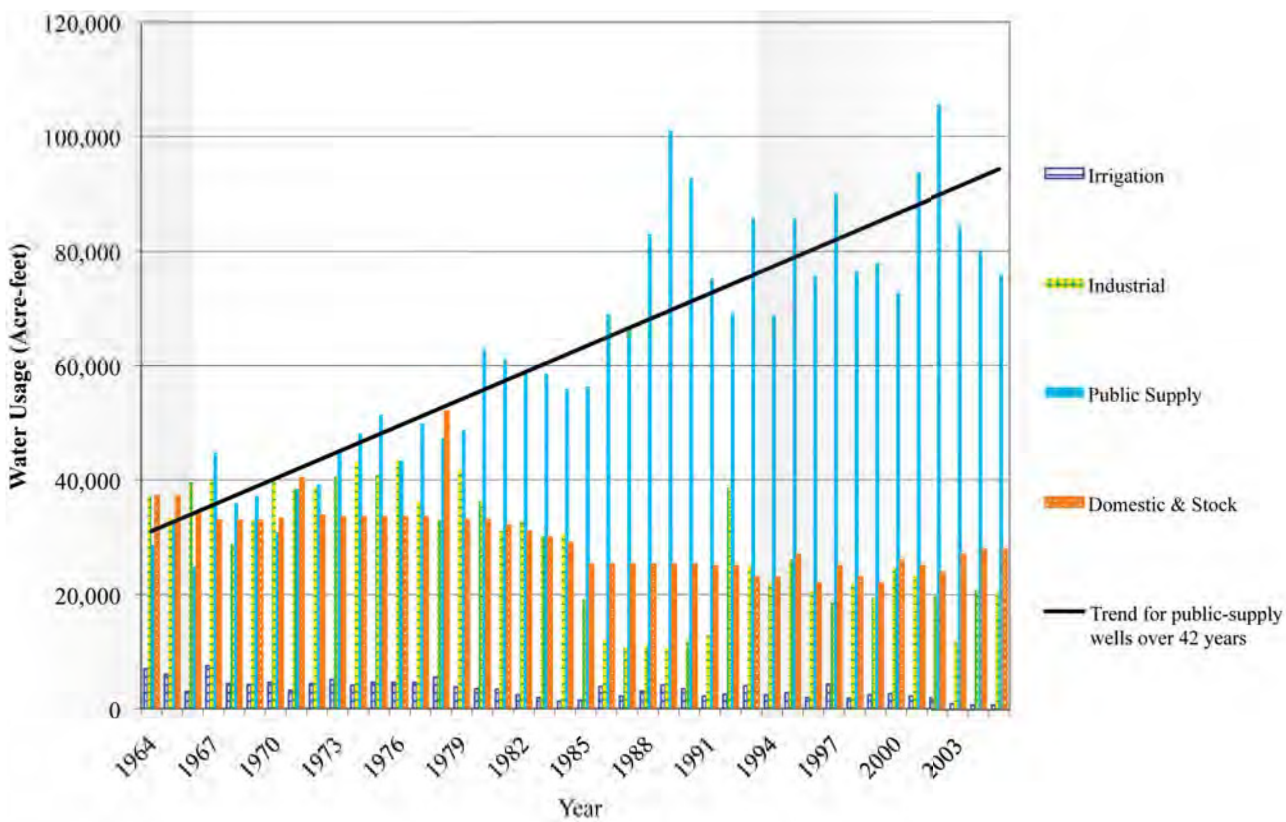


Figure 3. Annual water usages by category for Salt Lake Valley (based on data from Utah Division of Water Rights).

There is no doubt that droughts or water shortages are a factor in Salt Lake County's future. The expectation of a population doubling in the next 20 years creates an absolute certainty for increasing water shortages. Future zoning ordinances, use of secondary water for irrigation, mandatory no watering days are already an every year occurrence.

Salt Lake Valley is a largely urban area with a growing population. Most of the development in Salt Lake Valley uses municipal water sources, principally wells completed in the basin-fill aquifer system. The population growth and concomitant increase in municipal ground-water pumping could significantly decrease the amount of ground water discharged from the principal aquifer system (where most wells are completed) to the shallow unconfined aquifer system.

The shallow unconfined aquifer overlies confining beds above the principal aquifer system in the central and northern parts of the valley, and provides water to springs and approximately 58,000 acres (23,500 hm2) of wetlands in ground-water dis- charge areas. Decreased recharge to the shallow unconfined aquifer from the principal aquifer due to increased ground- water pumping could reduce water supply to these springs and wetlands. Also, water supply to the springs and wetlands is affected by climatic conditions and Great Salt Lake level. Drought conditions during 1999–2004 reduced the amount of recharge to ground-water aquifers across the state, including the Great Salt Lake area, negatively impacting the Salt Lake Valley wetlands. In 2005 and 2008, the elevation of Great Salt Lake declined to near its historic low stand reached in 1963, allowing some parts of the Salt Lake Valley wetlands to de- water.

To evaluate the potential impacts of drought and increased development on the Salt Lake Valley wetlands, we used existing data to estimate a water budget and develop regional, three-dimensional, steady-state and transient MODFLOW models to evaluate water-budget changes for the wetland areas; these efforts focused on wetlands around the margins of Great Salt Lake, although the results may apply to all of the wetlands in Salt Lake Valley. The modeling suggests that subsurface inflow into the wetland areas would be most affected by de- creased subsurface inflow due to long-term (20-year) drought conditions, which would also cause changes in Great Salt Lake levels, but subsurface inflow would also decrease due to increased municipal and industrial well withdrawals over the same time period. Therefore, the worst-case scenario for the wetlands would be a combination of both conditions. If the
U.S. Environmental Protection Agency's goal on no net loss of wetlands is to be met, the Salt Lake Valley wetland areas should be managed to maintain their current budget of water (estimated at about 52,420 acre-feet per year [65 hm3/yr] of recharge).

WETLANDS IN NORTHERN SALT LAKE VALLEY, SALT LAKE COUNTY, UTAH—AN EVALUATION OF THREATS POSED BY GROUND-WATER DEVELOPMENT AND DROUGHT

by Sandow M. Yidana, Mike Lowe, and Richard L. Emerson

http://geology.utah.gov/online/ri/ri-268.pdf

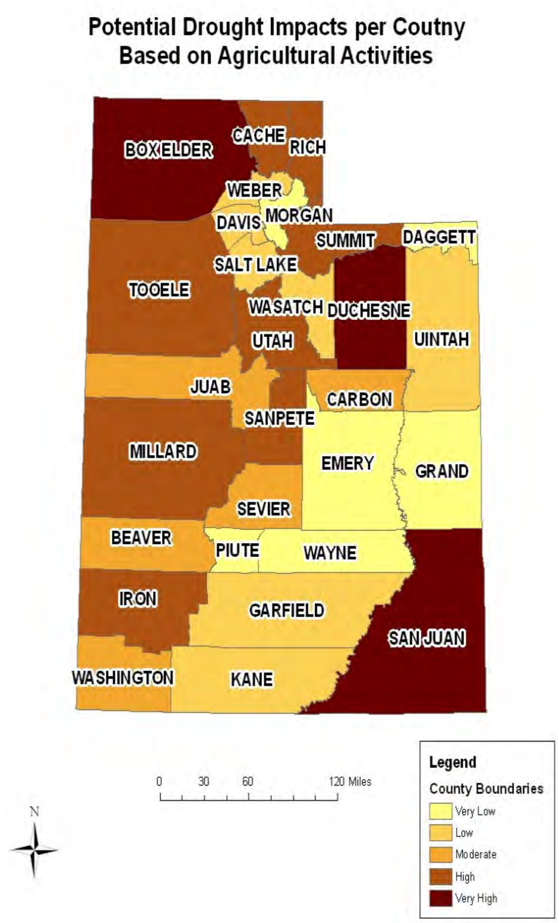
4.3.9.5 Vulnerability Assessment:

Due to the unpredictability of drought, it is difficult to identify the areas most threatened and to provide loss estimate values. Utah is currently experiencing drought conditions, yet reports are not yet available on the impact of the current drought. However, historical drought records demonstrate that agriculture is typically the economic sector most impacted by drought (UHMP). The 2003 Economic Report to the Governor discusses some of the statewide economic impacts of a drought beginning in 1999. Since it is not known what the local impacts of the current drought will be, this report will serve as the best available loss estimate. It is expected droughts in the future will have similar losses.

The 2003 Economic Report to the Governor suggests the drought has contributed to job change. "During 2002, job change was -1.0%. Without the drought, job change might have been -0.6%, 0.4% higher than what actually occurred. The hardest hit sector was agriculture, where 2,600 jobs and almost $40 million in income were lost." Livestock sales were estimated as down $100 million and hay sales down $50 million due to the drought. Drought related fires are believed to contribute to a decline in tourism sales, also down $50 million. The combined effects of the drought in these three sectors resulted in a loss of over 6,100 jobs and $120 million in lost income during 2002. Construction, manufacturing, and wholesale trade were also impacted by drought.

The Utah Division of Water Resources mentions in their drought report that large and significant data gaps hinder the quantification of drought impacts in all sectors of the economy and society. They suggest that tax revenues and other potential economic indicators of drought impacts be monitored at all levels of government in order to improve evaluation methods and to better understand drought impacts (UHMP).

The 2011 Utah Hazard Mitigation Plan conducted drought vulnerability rankings based on agricultural information. Economic indicators include cash receipts per county, personal income from farming, number of acres of farmland per county, number of acres of cropland per county, and the number of cattle per county were used to determine a county's vulnerability to drought. This vulnerability assessment resulted in a ranking by county of the potential drought impacts based on Agriculture activities. Salt Lake County was given a moderate ranking.



Map 18

Water supply and water storage in reservoirs is another important indicator of current drought conditions. Salt Lake County receives regular updates on the current water supply and future outlook from the Colorado Basin River Forecast Center.

4.3.10 Infestation

Infestation is caused when a parasite or pest over-populates in quantities large enough to be destructive, threatening or obnoxious. Past infestation events have been devastating enough to lead to presidential disaster declarations because of the destruction to food supplies that affect wildlife, livestock and agricultural lands. Crickets, katydids, grasshoppers, and worms tend to be the most damaging and affect rural areas the most. Drought may exacerbate infestations by resulting in a decrease in predators. Drought also affects food supplies, which may cause insects to begin to search over a wider area for food.

4.3.10.1 Location and Extent:

Insect infestation has been largely kept at bay due to the ongoing efforts of the Utah Department of Agriculture and Food (Table 8-3). Several threats still exist in the Wasatch Front study area, particularly from Cereal Leaf beetles, Japanese beetles, Gypsy moths, Mormon Crickets, grasshoppers and various woodborers and bark beetles.

Infestation Hazard Profile

<table>
<tr><td rowspan="4">Potential Magnitude</td><td></td><td>Catastrophic (>50%)</td><td rowspan="4">Probability</td><td></td><td>Highly Likely</td></tr>
<tr><td></td><td>Critical (25-50%)</td><td>X</td><td>Likely</td></tr>
<tr><td>X</td><td>Limited (10-25%)</td><td></td><td>Possible</td></tr>
<tr><td></td><td>Negligible (< 10%)</td><td></td><td>Unlikely</td></tr>
<tr><td>Location</td><td colspan="5">Dependent on vegetation and climate preference of individual insect species.</td></tr>
<tr><td>Seasonal Pattern</td><td colspan="5">Typically spring and summer months.</td></tr>
<tr><td>Conditions</td><td colspan="5">Varies with insect species.</td></tr>
<tr><td>Duration</td><td colspan="5">Months, years.</td></tr>
<tr><td>Secondary Hazards</td><td colspan="5">Wildfire, dust storms, landslides due to dead vegetation.</td></tr>
<tr><td>Analysis Used</td><td colspan="5">Utah Department of Agriculture and Food (UDAF), United States Forest Service (USFS), Utah Division of Forest, Fire, and State Lands (UDFFSL).</td></tr>
</table>

Profile 9

The Cereal Leaf beetle first appeared in Utah in 1984 in Morgan County. The beetle is currently found in all Wasatch Front Counties. Cereal Leaf beetles feed on grains and can cause much damage to these crops. To combat the spread of the Cereal Leaf beetle, the Utah Department of Agriculture and Food (UDAF) has introduced a parasitic wasp (UDAF 2007a).

Africanized Honey Bee	European Corn Borer[3]	Grasshopper*[2]
Apple Maggot[1]	Egyptian Cottonworm[2]	Red Imported Fire Ant
Cherry Fruit Fly[1]	Silver Y Moth[2]	Black Imported Fire Ant
Asian Gypsy Moth[1]	False Codling Moth[1]	Mosquito/West Nile Virus*[2]
Rosy (Pink) Gypsy Moth[1]	North American Gypsy Moth*[2]	Woodwasp[4]
Siberian Silk Moth[1]	Japanese Beetle[4]	Exotic Woodborers
Nun Moth[1]	Mormon Cricket*[2]	Exotic Bark Beetles
Cereal Leaf Beetle*[2]	* Detected in Wasatch Front study area, 2007	

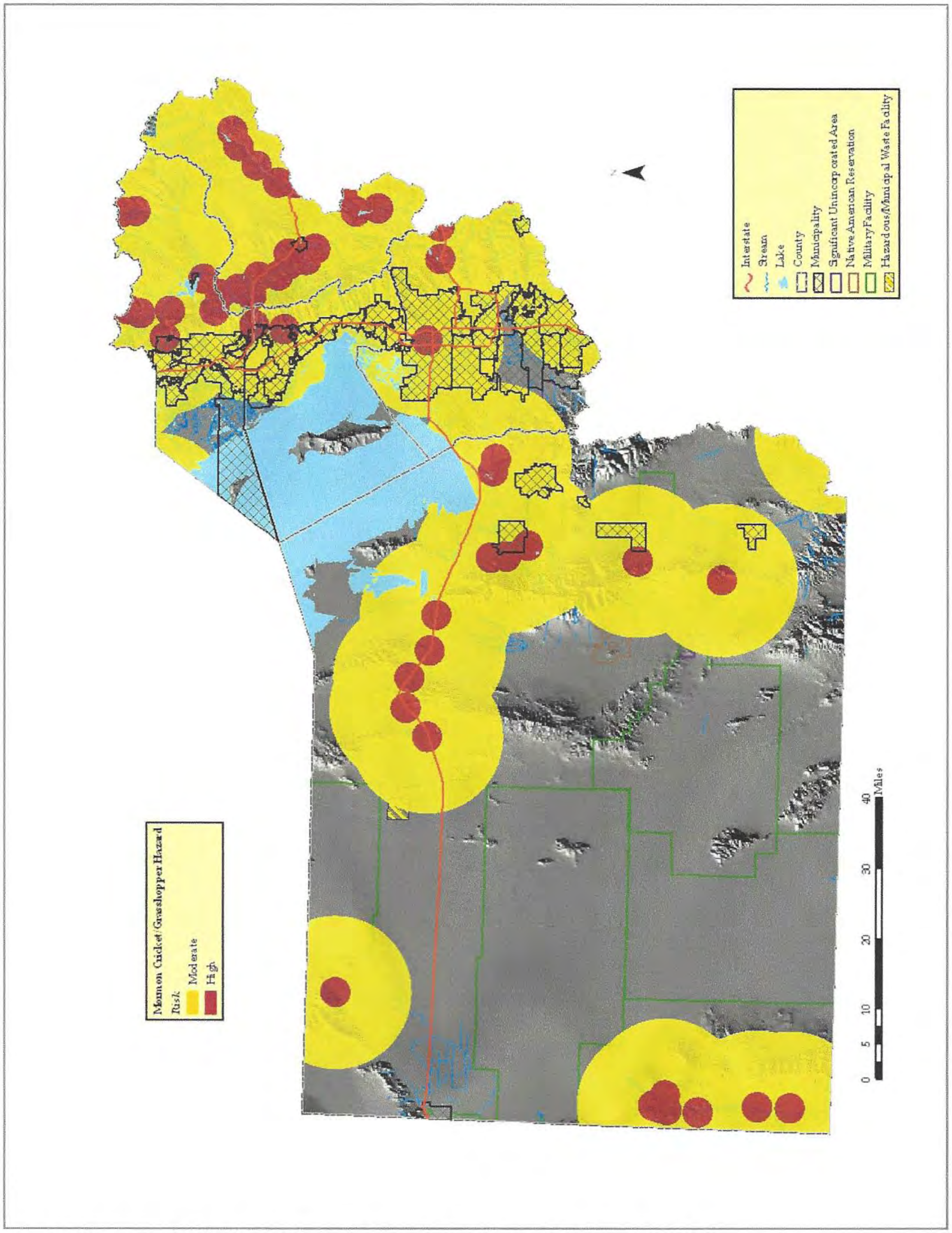
[1] Traps in all Wasatch Front counties except Morgan County
[2] Traps in all Wasatch Front counties
[3] Traps in Davis and Weber counties only
[4] Traps in Davis, Salt Lake and Weber counties only

Table 33. Insects Currently Monitored by Utah Department of Agriculture and Food (UDAF 2007a)

Mormon Crickets and grasshoppers are regularly found in the Wasatch Front study area. In small numbers, these insects do not cause much of a problem—but when their populations explode, great hordes can devastate crops. The following except from the 2007 Annual Insect Report by UDAF outlines how these populations can explode:

> "Often the damage done to agricultural commodities is increased by the effects of warmer weather and drought. Mild winters and hot, dry weather speed up the maturation process of these insects and allow more of them and their eggs to survive the cold. Drought also cuts into the population of birds and rodents that prey on them, and the fungal diseases that decrease insect numbers".

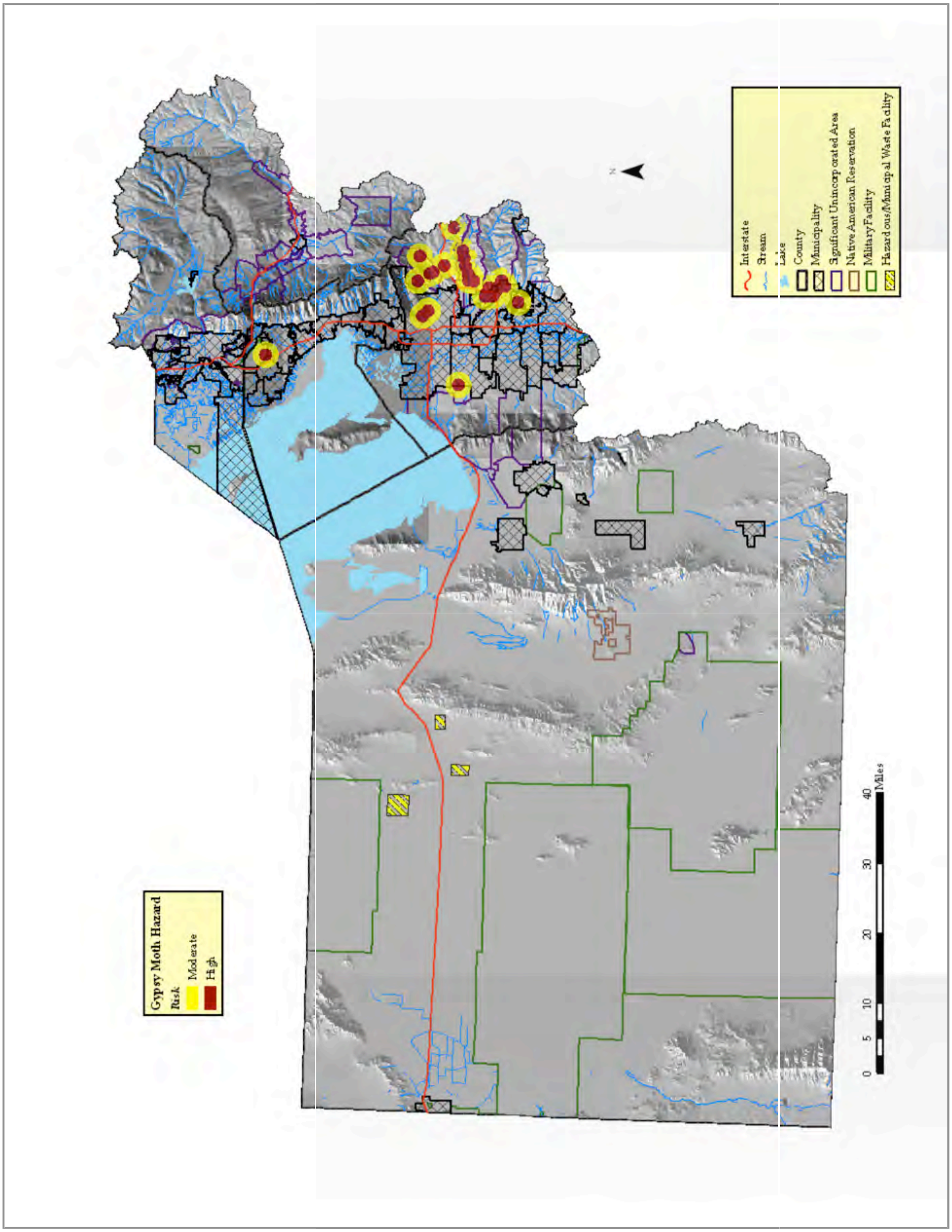
UDAF has used aerial treatment and ground baiting to manage populations of Mormon Crickets and grasshoppers with success. Due to this success, no treatment is planned for 2008 (UDAF 2007a). See Map 19 for the Mormon cricket and grasshopper hazard potential.


Mormon Cricket/Grasshopper Hazard
Risk
Moderate
High
Interstate
Stream
Lake
County
Municipality
Significant Unincorporated Area
Native American Reservation
Military Facility
Hazardous/Municipal Waste Facility
0 5 10 20 30 40
Miles

Map 19

Another insect of concern in the region is the North American Gypsy moth. Utah is an ideal breeding ground for the Gypsy Moth with an “arid climate, mountainous terrain, and lack of effective natural predators” (Watson 2007). The moths can be very destructive through the defoliation of tree leaves (UDAF 2007a). The Gypsy Moth was first found in the state in 1988 with the population rapidly growing the following year.

Treatment programs administered by UDAF using natural bacteria have proven very effective in controlling populations. Less than 3 moths per year have been caught in UDAF traps since 2000 in the entire state. The two moths in 2007 were found in separate locations in Salt Lake County (Watson 2007). See Map 20 for Gypsy moth hazard potential.



Map 20–Gypsy Moth Hazard Potential (Source: Utah Department of Agriculture and Food)

Example of Bark Beetle Infestation – Before and After (UDFFSL 2003)

Woodborers and Bark beetles are a distinct problem for all trees in the Wasatch Front area. Like many other insect hazards in the area, drought has helped Woodborer and Bark beetle populations to grow and expand due to stressed trees (Matthews, et al. 2005). Likewise, overall warming trends in the western United States have allowed these insects to survive the winters promoting multiple reproduction cycles. Insecticides and general thinning of trees has proven to be the most effective methods of control (UDFFSL 2003). See Map 21 for damages caused by Woodborers, Bark beetles, and other insects.

4.3.10.2 Range of Magnitude:

Year	Acres Infested
1997	1,180
1998	509,800
1999	758,000
2000	658,500
2001	1,894,500
2002	2,450,650

4.3.10.3 History:

Mormon Crickets increase during drought years according USDA –APHIS survey.

Left unchecked, grasshoppers may destroy rangeland and compete with livestock and wildlife for food. Ranchers and land managers need to first determine if there really is an infestation. The definition of an infestation, though this is not an exact science, is “eight or more grasshoppers per square yard”. If there is an infestation, a control plan needs to be devised. The best and most economical way to control infestations on rangeland is aerial spraying. Some years there are government cost share programs to help spray large acres of rangeland. Usually, the land needs to border adjacent to federal or state lands to qualify for government aid.

The insecticides most commonly used on rangelands are Malathion ULV and Dimilin. Dimilin spray is proving to be the least expensive and environmentally safe alternative. It is important that spraying takes place early in the grasshoppers' lives. The younger the grasshoppers and Mormon Crickets are, the higher the kill rate. The best time to spray rangeland is usually during the first three stages of the insects' lives.
http://extension.usu.edu/files/publications/publication/pub__6510916.pdf

4.3.10.4 Future Occurrence – There is no current prediction of insect infestation. However, noxious weeds are an increasing threat and reduce crop yields, destroy native plant and animal habitat, damage recreational opportunities, lower land values, create erosion problems and fire hazards and poisons humans and livestock. Salt Lake County has a Weed Control Board that has been established to mitigate this problem.

4.3.10.5 Vulnerability Assessment:
There is currently no study being performed in Salt Lake County to determine the economic cost or vulnerability for the county as a stand-alone entity. However, the extension team of Mark Nelson, Matt Palmer, Michael Pace, Jeff Banks and Jay Karren received a grant to study the Economic Impact of Mormon Crickets on Agronomic Crops and Rangeland in Western Utah. The goals are:

- To determine the economic impact that Mormon Crickets have on alfalfa, small grains and rangeland vegetation in Beaver, Millard, Juab and Tooele Counties
- To develop a fact sheet outlining the economic damage caused by Mormon Crickets on the study crops
- To educate farmers, Extension agents and other interested agencies on the importance of looking at anticipated damage and costs when deciding what control measures to take or recommend

4.3.11 Problem Soils

Problem soils are soils that present problems for engineered structures. Problem soils include expansive soils, collapsible (hydro compactable) soil, limestone and karst terrain, gypsiferous soil, soils subject to piping, active sand dunes, peat, underground mines subject to subsidence, ad sodium sulfate-rich soil. These geologic materials are susceptible to volumetric changes, collapse, subsidence, or other problems, which can damage structures built on top of problem soils. Human activities such as adding water and/or loading can aggravate potentially unstable conditions that induce the majority of damage to structures (UNHH 2008, SHMP 2011).

Most of the hazards created by problem soil and rock can be reduced or avoided if they are understood and their extent is known. Recognizing where problem soil and rock are found and taking precautions to minimize their effects can reduce the need for costly corrective measures after damage to structures and roads has occurred. The majority of damage to structures results from human activities, usually through addition of water or by loading or excavation, which aggravate potentially unstable conditions. (UNHH 2008, SHMP 2011).

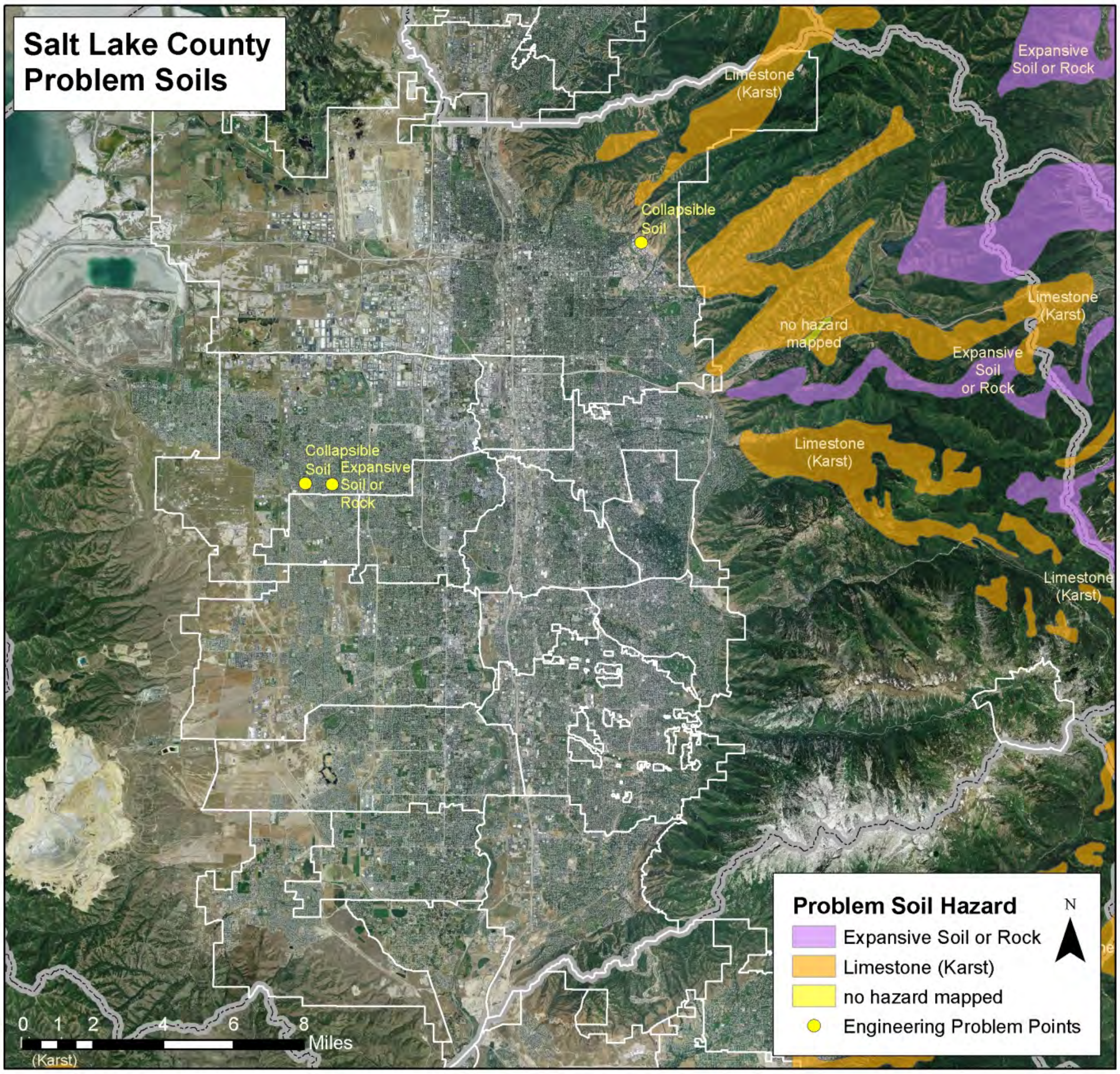
Problem Soil Hazard Profile:

Potential Magnitude		Catastrophic (>50%)	Probability		Highly Likely
		Critical (25-50%)			Likely
	X	Limited (10-25%)		X	Possible
		Negligible (< 10%)			Unlikely
Location	Wasatch Mountains (Map 19).				
Frequency	Continuous.				
Conditions	Conditions vary by geologic formation.				
Duration	Minutes to Years.				
Secondary Hazards	Flooding (broken water pipes), fire (broken gas pipes).				
Analysis Used	Utah Geological Survey.				

Profile 10

4.3.11.1 Location and Extent:

Two types of problem soils are present in Salt Lake County—limestone and expansive soils. Both of these hazards are primarily found in the Wasatch Mountains in the Eastern part of the County. See Map 21.



Map 21

4.3.11.2 Range of Magnitude:
Illustrated on Map 21

Limestone karst structures are easily eroded by water and therefore often form caverns and crevices. If these caverns become large enough, the overlying ground can give way causing sinkholes and other forms of subsidence. Structures directly over the karst structure have a high potential for collapse. Ground water contamination is also possible (Mulvey 1992). Fortunately, many of the areas affected by karst structures in Salt Lake County are undeveloped.

Expansive soils can absorb large quantities of water. When a home or road is placed on top of these soils, normal evaporation cannot take place. The clay begins to absorb more water than is evaporated and expands, causing heaving. During especially dry periods, these soils can contract significantly causing subsidence and ground cracking. Residents already living in these areas should avoid excessive watering, make sure sufficient water drainage is in place around the home, and ensure plumbing and irrigation pipes and fixtures are well protected from breakage or leaks (Kaliser 1972).

4.3.11.3 History:

No historical data on impacts of problems soils within Salt Lake County were available at the time of this draft.

4.3.11.4 Future Occurrence:

As illustrated in the recent occurrence in North Salt Lake City the increasing development of our county will continue to put pressure on jurisdictions to allow developers to construct buildings in problem soil areas. It is imperative that building ordinances and inspectors maintain close surveillance to prevent an increase of construction in problem soil areas.

4.3.11.5 Vulnerability Assessment:

Table 34 estimates infrastructure vulnerable to problem soils in Salt Lake County. Provided are the number of units or total length of infrastructure vulnerable and the estimated replacement costs as provided by HAZUS-MH lost estimation software. Table 35 and Table 36 estimate the total area, population and buildings vulnerable to problem soils.

Item	Length (Miles) or Number of Units	Replacement Cost
Highways/Interstates	4.81 miles	$37,544,750
Highway Bridges	8 bridges	$10,166,037
Railway Segments	0 miles	$0
Railway Bridges	0 bridges	$0
Water Distribution Lines	75.86 miles	$2,441,550
Gas Lines	30.34 miles	$976,619
Sewer Lines	45.51 miles	$1,464,931
Total Estimated Infrastructure Replacement Cost		$52,593,887

Table 34. Infrastructure Vulnerable to Problem Soils, Salt Lake County

Incorporated Areas	Acres Affected	Population Affected	Structures in Hazard Areas	
			Residential (Replacement Value)	Commercial (Annual Sales)
Alta	0	0	0	0
Bluffdale	0	0	0	0
Cottonwood Heights	0	0	0	0

Draper	0	0	0	0
Herriman	0	0	0	0
Holladay	0	0	0	0
Midvale	0	0	0	0
Murray	0	0	0	0
Riverton	0	0	0	0
Salt Lake City	3,783	1,707	634 $129,716,400	0
Sandy City	0	0	0	0
South Jordan	0	0	0	0
South Salt Lake	0	0	0	0
Taylorsville	0	0	0	0
West Jordan	0	0	0	0
West Valley City	0	0	0	0

Table 35. Vulnerability Assessment for Problem Soils, Incorporated Salt Lake County

Unincorporated Areas	Acres Affected	Population Affected	Structures in Hazard Areas	
			Residential (Replacement Value)	Commercial (Annual Sales)
Big Cottonwood Canyon	8,574	41	16 $3,273,600	0
Camp Williams	0	0	0	0
Canyon Rim	0	0	0	0
Copperton	0	0	0	0
East Millcreek	0	0	0	0
Emigration Canyon	9,373	1,329	520 $106,392,000	20 $10,270,878
Granite	0	0	0	0
Kearns	0	0	0	0
Magna	0	0	0	0
Millcreek	0	0	0	0
Mount Olympus	15,714	516	175 $35,805,000	0
Parley’s Canyon	19,814	1,447	557 $113,962,200	0
Sandy Hills	0	0	0	0
Southwest	0	0	0	0
Willow Canyon	0	0	0	0

Table 36. Vulnerability Assessment for Problem Soils, Unincorporated Salt Lake County (2006 socioeconomic projections)

4.3.12 Radon

Radon is a radioactive gas released from the nuclear decay process of uranium and radium, which are trace elements of many soils. As radon moves up through the ground it can enter a home through cracks and gaps in walls and floors, cavities inside walls, gaps around service pipes and water supply connections. Though relatively harmless at low levels, radon is classified by the EPA as a known human carcinogen and is considered the leading cause of non-smoking lung cancer in the United States. Because radon is tasteless, odorless, and invisible, it presents unique challenges in minimizing our daily exposure to this naturally occurring radiation (UNHH 2008).

Radon can be detected through an inexpensive test and can be mitigated through proper ventilation of excessive radon and installation of systems to prevent radon from entering the home.

Radon Hazard Profile:

Potential Magnitude		Catastrophic (>50%)	Probability		Highly Likely
		Critical (25-50%)			Likely
	X	Limited (10-25%)		X	Possible
		Negligible (< 10%)			Unlikely
Location	Region wide				
Frequency	Year-round, continuous				
Conditions	Buildings over top of soils containing high amounts of decaying uranium, which is commonly found in Utah.				
Duration	Years				
Secondary Hazards	Unknown				
Analysis Used	Information and maps provided by the Utah Geological Survey and the Utah Division of Radiation Control.				

Profile 11

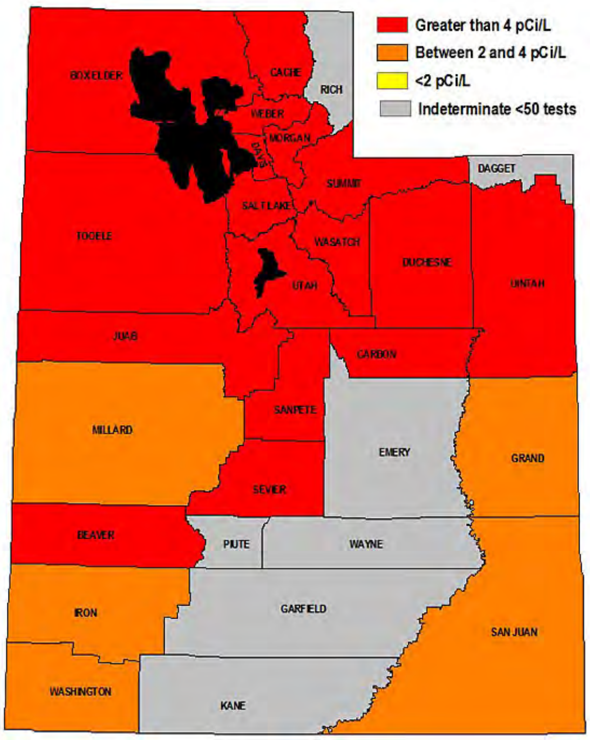
4.3.12.1 Location and Extent:

Radon gas can be found in most Utah homes. The gas comes from the small particles of uranium in rocks and soil, which decays into radium. In turn, the radium breaks down further into radon. As the radon moves up through the ground, it can enter a home through cracks and gaps in walls and floors if not properly vented.

Due to the types of geologic formations found in Salt Lake County, radon gas is likely present in higher concentrations in homes in the Wasatch and Oquirrh Mountains and their foothills. Sites further from the mountains and foothills generally have lower concentrations of radon. Radon does not pose a threat to infrastructure.

4.3.12.2 Range of Magnitude:

Through collections of tests performed by various households in the county, households containing higher levels of radon were found to roughly follow the patterns predicted by geologic formation. One exception is the area just South of Interstate 80 in Western Salt Lake City



History:

The danger of high exposure to radon in mines was known back in the 1500s. Yet, the presence of radon in indoor air was not documented until 1950. Finally in 1970, research was initiated to address sources of indoor radon, determinants of concentration, health effects and approaches to mitigation. In 1984, a widely publicized incident in Salt Lake County escalated the problem of indoor radon and investigation intensified, with the EPA taking a strong lead to educate states via its State Indoor Radon Grant (SIRG).

EPA's grant has been partially funding the Utah Division of Radiation Control's (DRC) Indoor Radon Program that enables the Division to respond to a continuous stream of public telephone and email inquiries, provide education to homeowners and professionals, conduct "target area" indoor radon assistance and surveys and offer individualized assistance to homeowners and public agencies concerning all aspects of the indoor radon hazard problem.

"The Division's primary goal is to assure that radiation exposure to individuals is kept to the lowest practical level," said Lundberg. "A vital mechanism in reducing radiation exposure and potentially saving lives is our Indoor Radon Program."

Radiation risk to the American public from radon gas is undisputed. According to William Field (2011), radon is the leading environmental cause of cancer mortality in the United States and the seventh leading cause of cancer mortality overall. The Harvard School of Public Health in the Center for Risk Analysis has ranked radon as the highest of ten risks of death in homes in the United States, ahead of falls and home fires.

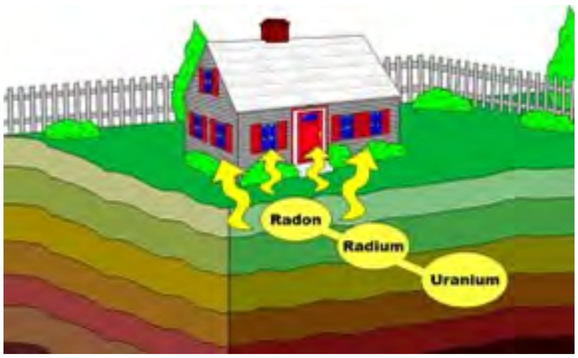
"Radon awareness in Utah has grown steadily the past decade," said Keyser. "Already this year, we have seen the number of radon tests conducted in Utah triple from the previous year."

4.3.12.3 Past Occurrence:

There is currently no database of past radon readings for Salt Lake County.

4.3.12.4 Future Occurrence:
The Salt Lake County Board of Realtors is currently maintaining a database of Radon readings in residential homes. County Ordinances require homes with unacceptable radon levels to undergo mitigation procedures prior to sale. This should eventually make all homes safe.

4.3.12.5 Vulnerability Assessment:
Radon is a radioactive gas created by the breakdown of Uranium and is considered radiation.



Uranium is found naturally in soil and rocks. Normally, radon emits into the atmosphere and is harmless. Radon is:

- Odorless
- Colorless
- Tasteless

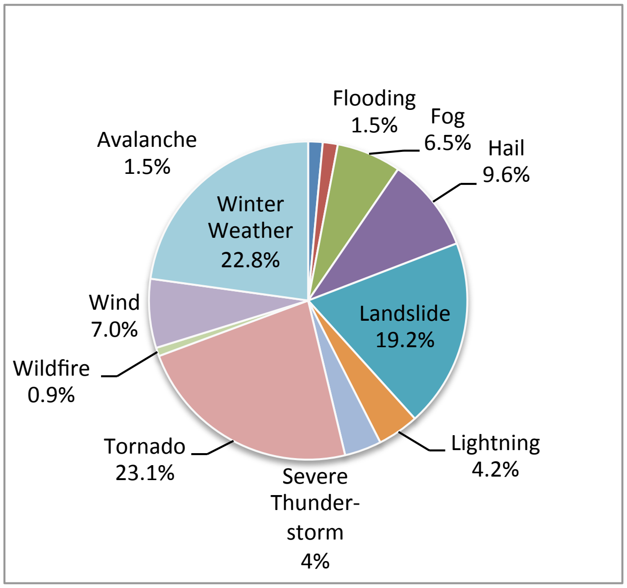
When radon is released, it goes into the atmosphere or seeps into homes and buildings through cracks in the structure of the house. When this happens, the gas becomes trapped due to poor circulation of indoor and outdoor air. Radiation is measured in curies. A curie is a rate of disintegration of 1 gram of radium. Radon is measured in picocuries per liter, shown as pCi/L.

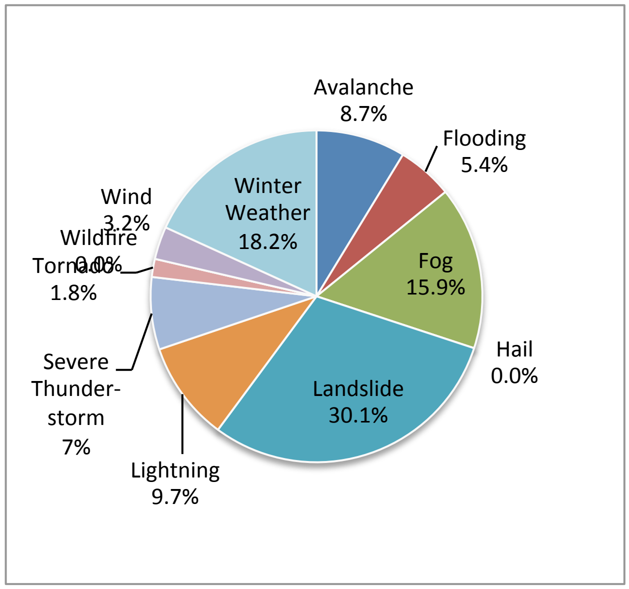
Radon Risks:
Radon decays into radioactive particles that can be trapped in the lungs when inhaled. These particles release small bursts of energy that damage lung tissue and may lead to lung cancer. Radon is the second leading cause of lung cancer in the United States. Only smoking causes more lung-cancer deaths, and smoking combined with radon is a particularly serious health risk. Chances of getting lung cancer are higher from the combination of smoking and radon than from either source alone. Not everyone who is exposed to radon develops the disease, but the chances increase with increasing levels of radon and length of exposure. The amount of time between exposure and onset of the disease is usually many years.

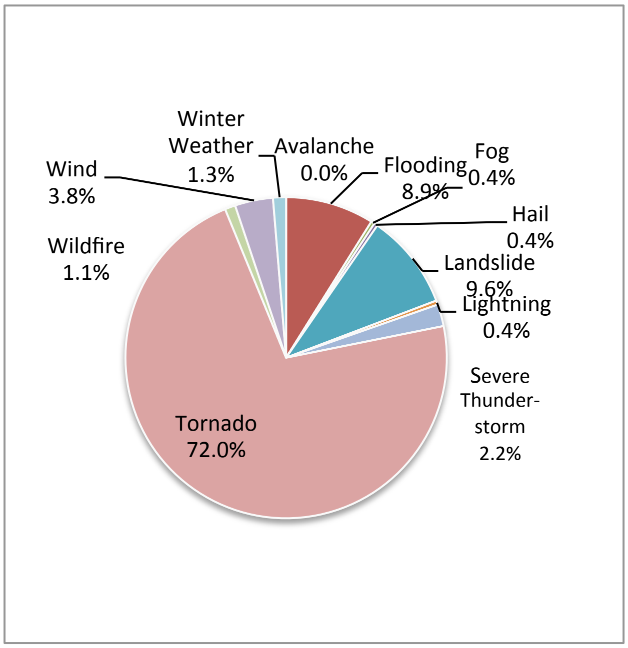
4.4 Hazard Vulnerability Summary

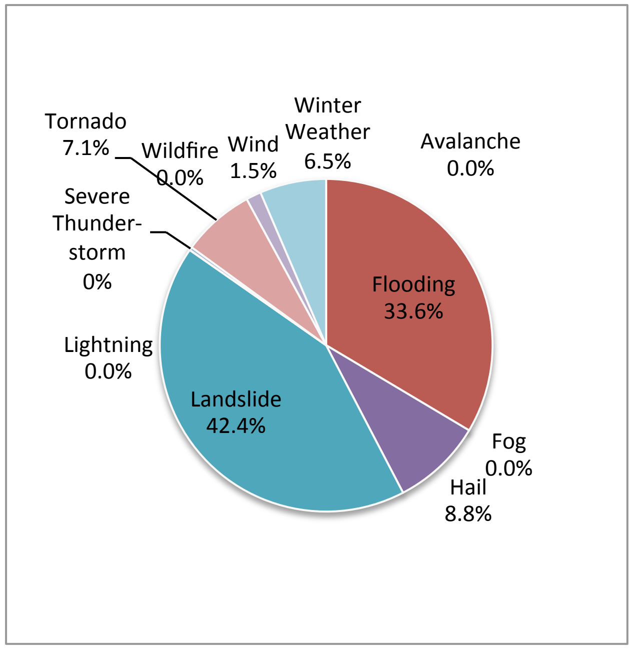
4.4.1 History:
Identifying past hazard events provides a starting point for predicting where future events could potentially occur. The following historical hazard event statistics for Salt Lake County were consolidated from the Spatial Hazard Events and Losses Database for the United States (SHELDUS) of the Hazards and Vulnerability Research Institute (HVRI). These charts, tables and graphs give a comparison of the past impacts of various hazards. This database records reported natural hazard events, which cause greater than $50,000 in damage. Monetary figures were not adjusted for inflation.

4.4.2 Ranking Results:



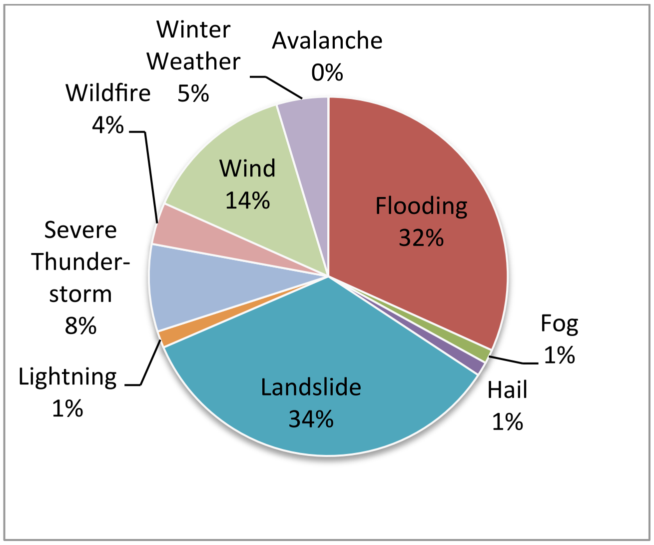




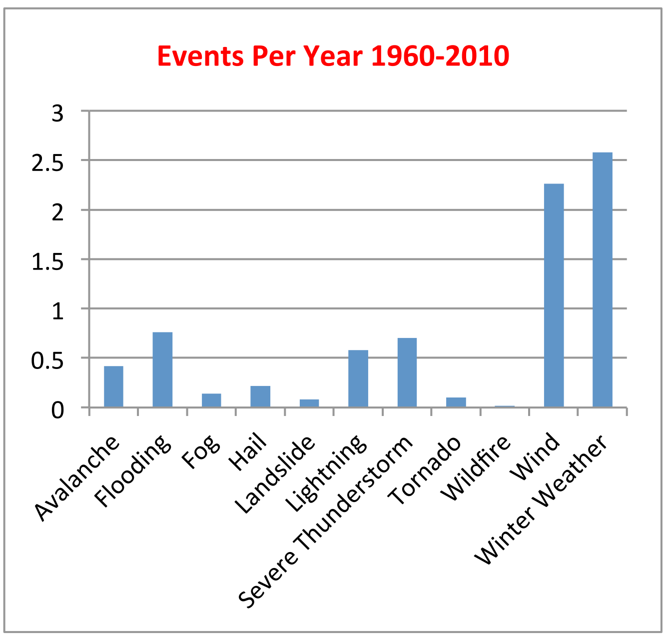


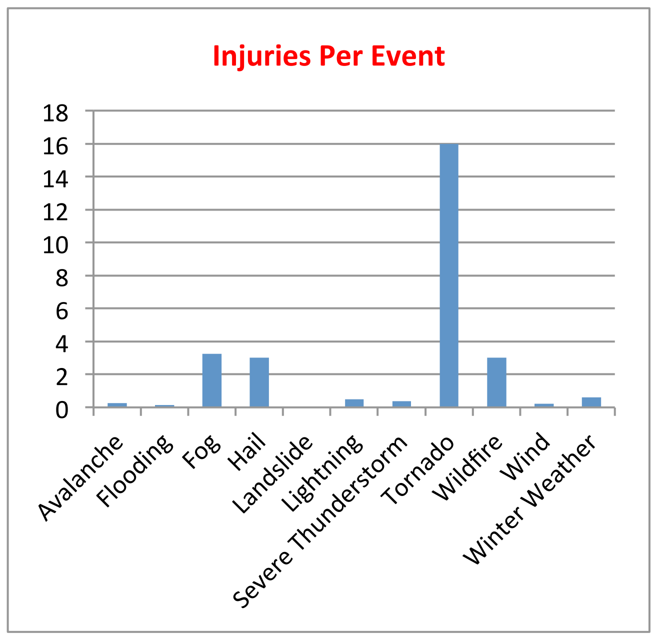
Percent of Total Property Damage

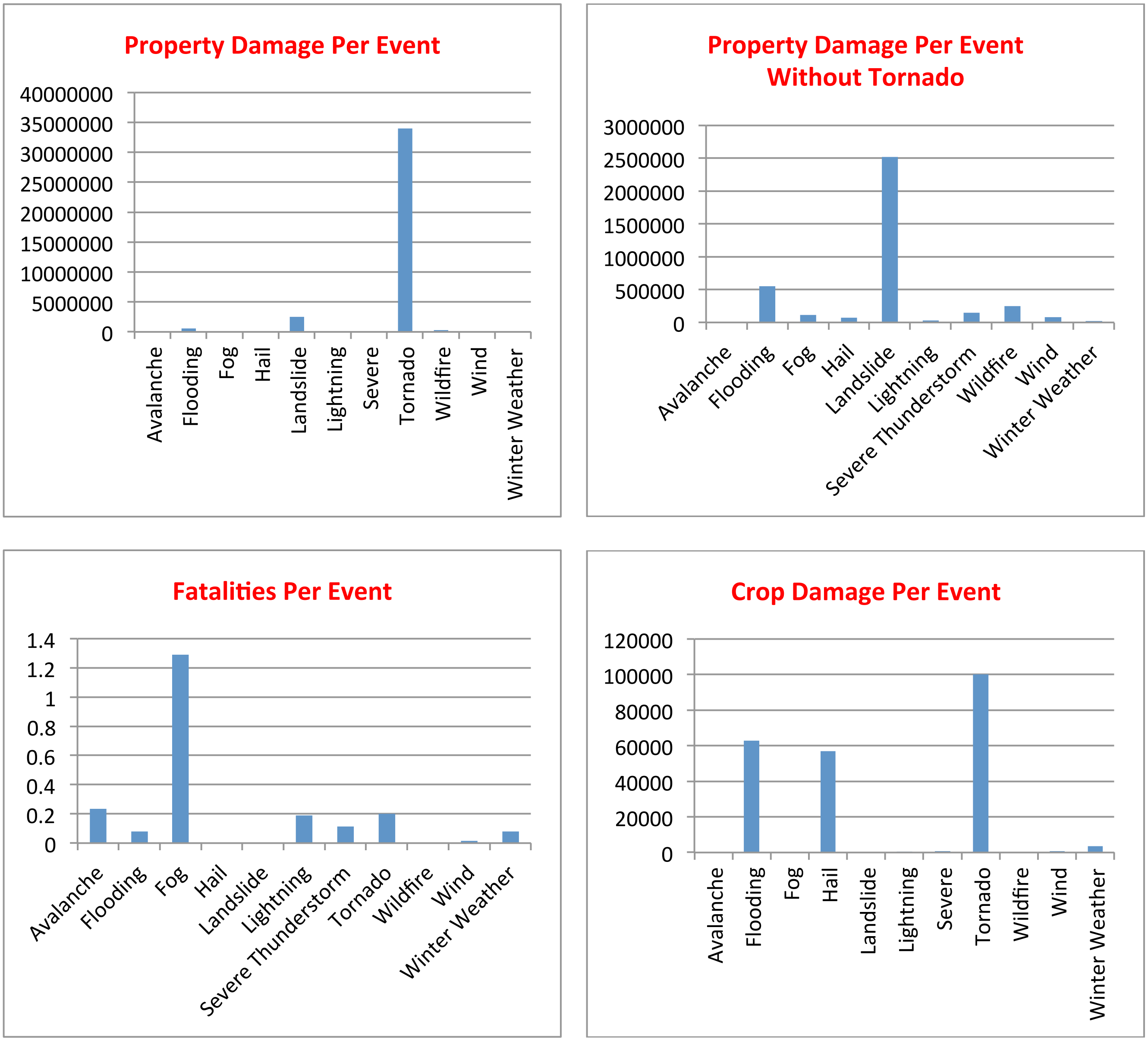
Percent of Total Crop Damage



Percent of Total Property Damage without Tornado







Major Event Annual and Per Event Averages 1960-2010, Salt Lake County (HVRI 2012)

Salt Lake County has included a vulnerability assessment in each hazard identification using best available data. Data used to support this assessment included the following:

- FEMA's HAZUS-MH MR3 GIS-based inventory data (January 2005)
- Written descriptions of inventory and risks provided by participating jurisdictions
- Existing plans and studies
- Personal interviews with planning team members and staff from the county and participating jurisdictions

4.4.3 Salt Lake County Vulnerability and Assets at Risk

Number of Structures with Moderate or Greater Vulnerability (% of Total)								
Critical Facilities	Total	Dam Failure	Flood	Ground Shaking	Liquefaction	Problem Soils	Slope Failure	Wildfire
Amateur Radio Repeaters	64	2 (3%)	0 (0%)	64 (100%	5 (8%)	0 (0%)	5 (8%)	10 (16%)
Public Safety Repeaters	11	0 (0%)	0 (0%)	11 (100%	5 (46%)	0 (0%)	3 (33%)	5 (46%)
Electric Generation Facilities	5	2 (40%)	1 (20%)	5 (100%	2 (40%)	0 (0%)	1 (20%)	0 (0%)
Emergency Operations Centers	15	1 (7%)	1 (7%)	15 (100%	10 (67%)	0 (0%)	0 (0%)	0 (0%)
Fire Stations	57	4 (7%)	3 (5%)	57 (100%	26 (46%)	0 (0%)	2 (4%)	1 (2%)
Hospitals	30	2 (7%)	0 (0%)	30 (100%	12 (40%)	0 (0%)	2 (7%)	0 (0%)
Oil Facilities	2	0 (0%)	0 (0%)	2 (100%	2 (100%	0 (0%)	0 (0%)	0 (0%)
Police Stations	25	5 (20%)	1 (4%)	25 (100%	19 (76%)	0 (0%)	0 (0%)	0 (0%)
Schools	246	25 (10%)	0 (0%)	246 (100%	108 (44%)	0 (0%)	0 (0%)	1 (1%)
Water Treatment Facilities	7	2 (29%)	2 (29%)	7 (100%	2 (29%)	1 (14%)	2 (29%)	1 (17%)

Table 37. Critical Facilities Vulnerability Matrix for Local Hazards, Salt Lake County NA=Not Applicable

Salt Lake County development trends have recently slowed with many new developments stalled. Development that is still occurring will be in the Southern and Western portions of the county because housing and land values are slightly lower. Development is tending to occur on agricultural lands. The Wasatch Mountain Range and the Great Salt Lake prohibit development in the Northern and Eastern reaches of Salt Lake County.

4.4.4 Hazards and Future Development:

Population Estimates									
County	2000 Pop (July 1)	2011 Pop (est.)	Absolute Change 2000-2011	% Change 2000-2011	AARC 2000-2011	Rank by 2011 Pop	Rank by Absolute Change	Rank by % Change	Rank by AARC
Salt Lake	902,777	1,045,82	143,052	15.85%	1.4%	1	1	19	13

County		9							
Population by County and Multi-County District									
MCD/ County	1990	2000	2010	2020	2030	2040	2050	2060	AARC 2000-2050
Wasatch Front	1,107,570	1,389,210	1,640,814	1,883,072	2,147,752	2,429,672	2,702,404	2,979,319	1.9%
Salt Lake County	728,298	902,777	1,053,274	1,180,859	1,340,665	1,507,997	1,659,566	1,812,819	1.7%
Households by County and Multi-County District									
MCD/ County	1990	2000	2010	2020	2030	2040	2050	2060	AARC 2000-2050
Wasatch Front	360,125	449,359	539,595	645,014	784,829	907,753	1,019,448	1,133,023	2.5%
Salt Lake County	242,401	296,710	343,828	413,941	499,959	574,647	638,950	704,429	2.3%

Table 38. Demographic and Economic Projections (UPEC 2011, all statistics are based on July 1 snapshot.)

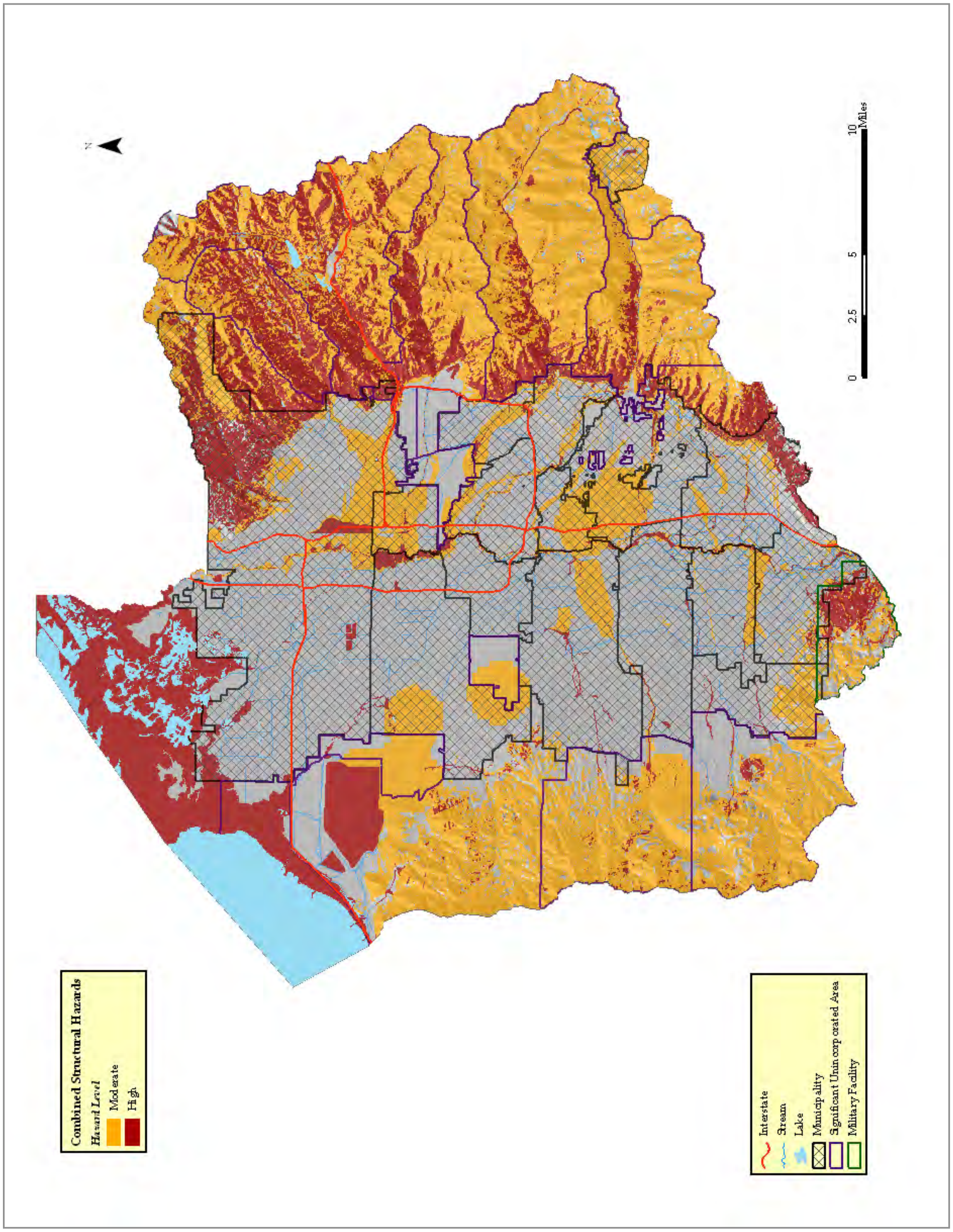
Those portions of the county near the Great Salt Lake and the Jordan River are subject to high liquefaction in the event of an earthquake and therefore pose a risk to incoming residents and new structures. Jurisdictions may mitigate the earthquake threat and its secondary risks through the use of zoning ordinances and building codes that will recognize the threat and reduce its impact. Examples of more appropriate forms of land use along fault lines include “farms, golf courses, parks, and undeveloped open space” (UGS 1996).

Flooding is also possible along the Jordan River. Many new homes have been built along the river’s banks in areas that flooded in 1983-84. Zoning restrictions on building location and building codes preventing basements would be well suited in these areas.

Wildfire risk is most severe in the foothills of the Wasatch Mountain Range. These areas, known as Wildland-Urban Interface (WUI) zones, are most vulnerable due to the amount and types of vegetation and new structures that act as fuel to a burning fire. This threat may be mitigated by encouraging communities to become “Fire Wise Communities”, continued use of building and zoning codes and increase the public’s awareness.

Landslide/slope failure is another threat near the foothills of the Wasatch Mountains. Many new developments can be found near areas of current landslides. More detailed landslide studies and zoning appropriate for high hazard areas will decrease the likelihood of landslides injuring persons or damaging property.

Map 22 shows the combined risk of nine structural-threatening hazards (dam failure, earthquake, flood, landslide, lightning, problem soils, tornado, wildland fire and wind) in Salt Lake County. The areas of high hazard (red) are areas of high landslide and flood risk as well as the “extreme” risk wildland fire areas. These areas are best preserved as open space to protect citizens from almost certain disasters. The moderate areas of the map (orange) are those areas having moderate or greater risk from five (5) or more structural-threatening hazards. These areas should be preserved as open space if not already developed or hazard-appropriate development encouraged. If already developed, these areas should be the initial focus of education campaigns and for regulatory requirements of hazard mitigation techniques by residents.



Map 22 Salt Lake County's

Capability Assessment

5.1 Update Process Summary

The purpose of conducting a capability assessment is to determine the ability of the County to implement a comprehensive mitigation strategy, and to identify potential opportunities for establishing for enhancing specific mitigation policies, programs or projects. The assessment has two primary components: an inventory of the County's relevant plans, laws regulations and policies and/or programs already in place and an analysis of its capacity to carry them out. A careful examination of capabilities will detect any existing gaps, shortfalls or weaknesses associated with ongoing government activities that could hinder proposed mitigation activities and possibly exacerbate hazard vulnerability. The capability assessment also provides an opportunity to highlight the positive mitigation measures already in place or being implemented throughout the County, which should continue to be supported and enhanced if possible through future mitigation efforts.

This section provides an assessment of county hazard mitigation capabilities. At the county level, a summary of the jurisdiction's tools available for pre- and post-disaster hazard mitigation is provided as well as development management. The 2014 HMP expands this assessment to comprehensively describe other tools available related to hazard mitigation and development in hazard-prone areas. A comprehensive list of existing planning policies, programs, and capabilities which support hazard mitigation activities is included in each jurisdiction's plan. This assessment was prepared based on information gathered from the jurisdiction's staff. Opportunities to review draft information were provided to the jurisdiction's staff and people who attend the public forums.

5.2 County Capability Assessment

As explained in several areas of the plan, the County has robust mitigation capabilities at both the jurisdictional level and the County level. The County Staff that is responsible for the unincorporated sections of the County also serves as source for individual jurisdictions in assistance at many levels. Below is a list of the County's mitigation capabilities, which is also included in the Unincorporated County Annex. Salt Lake County Emergency Management, while having responsibility for creating this plan and assisting jurisdictions in creating their plans, relies on Salt Lake County's staff for creating and managing mitigation capabilities in both the Jurisdictions and the unincorporated sections of the County.

5.2.1 Capability Assessment

Please refer to the Capability's Assessment provided in Annex K Salt Lake County—Unincorporated.

Salt Lake County Emergency Management Agency Staff

SLCo EM coordinates county agency response to support county and local governments in the areas of civil defense, disaster mitigation and preparedness, planning, and response to and recovery from natural disasters. Figure 5.2.1-1 provides an overview of SLCo EM's organizational structure and the current staffing.

Salt Lake County Emergency Management Bureau:

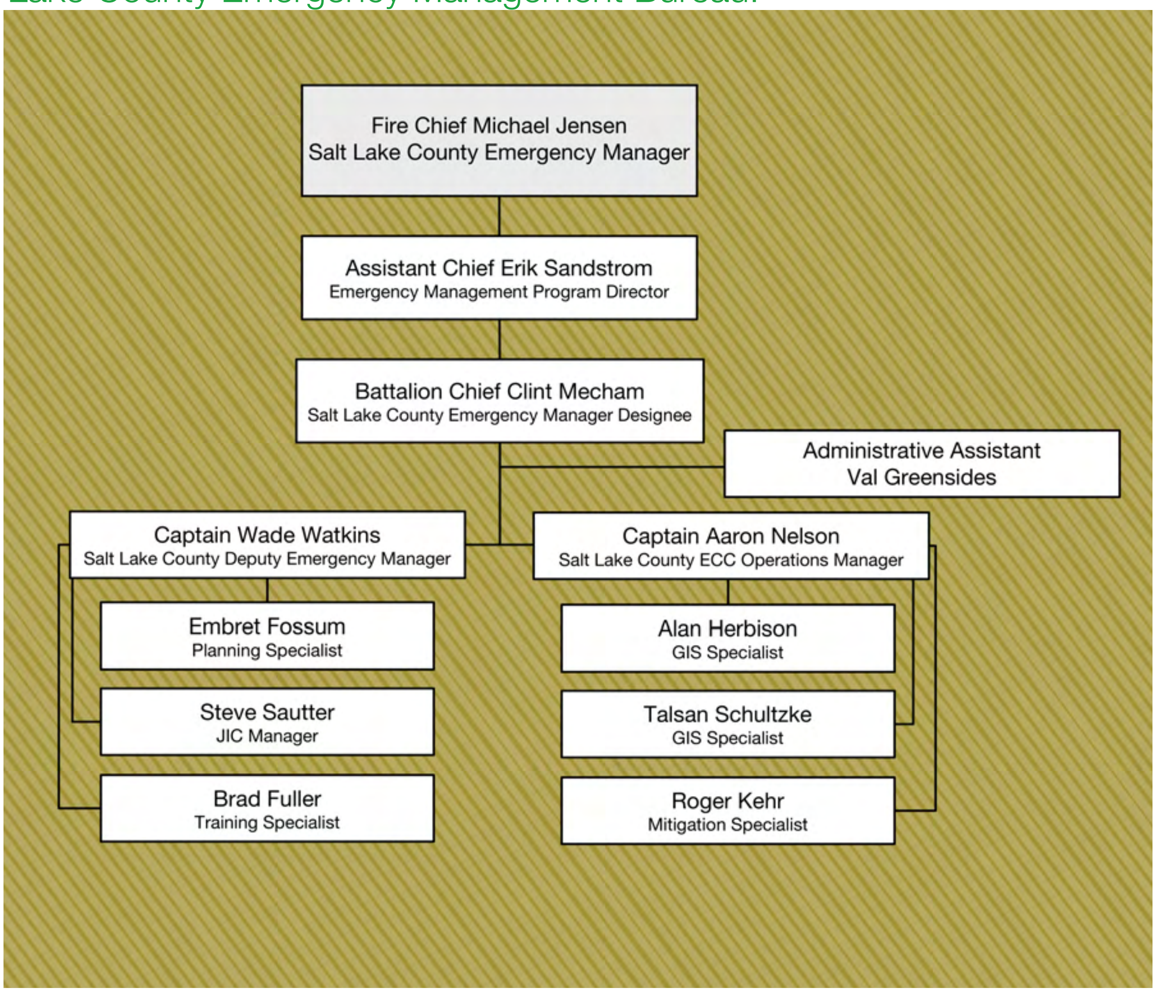


Figure 5.1 Organizational structure for the Salt Lake County Emergency Management Agency, October 2014

Salt Lake County Emergency Management Webpage

A webpage is maintained by SLCo EM that provides timely information to local community officials and citizens throughout the County. Information provided through the webpage includes, but is not limited to:

- Advisories and alerts
- Upcoming meeting and training announcements

SLCo EM staff attends conference to continue to build relationships through the county that will be effective in implementing mitigation activities. SLCo EM regularly presents at many state, county and jurisdictional meetings.

5.2.2 Be Ready Utah:

Be Ready Utah is the State of Utah's official emergency preparedness campaign managed by the Division of Homeland Security and under the direction of Lt. Governor Greg Bell. It is designed as a bottom-up approach for preparedness with the focus on every individual's personal responsibility in preparedness first. The BeReady Utah campaign was officially launched in April 2005 at the annual League of Cities and Towns conference in St. George, Utah following the devastating floods in January 2005.

Be Ready Utah provides valuable information for individuals and families, communities, public safety professionals, business and civic leaders, school administrators and volunteers. We believe that preparedness leads to prosperity. Every community has the opportunity to provide resources to prepare its citizens and BeReady Utah can help prepare Utah.

Post-Disaster Capability

Salt Lake County's post-disaster capability is also built on staff and the training they receive to know and practice their post-disaster responsibilities. Salt Lake County and SLCo EM staff have access to multiple technical and communication tools, including the Salt Lake County Emergency Operations Center, that supports their ability to respond effectively in post-disaster situations. The Public Safety Emergency Telephone Act supports identification of disaster needs to emergency responders and managers.

SLCo EM staff is cross-trained so that they can fulfill multiple roles in the post-disaster environment. The most prominent emerging policy or program impacting post-disaster capability is the program to regularly host training and exercises of post-disaster capability.

Technical and Communication Tools

Salt Lake County Emergency Management is capable of assisting all levels of government in post-disaster situations. The agency has technical expertise and communication tools to provide disaster-related coordination.

HAZUS, Geographic Information Systems, a 24-hour call center, WebEOC, and video telecommunication are all used in post-disaster situations. Within SLCo EM, all staff are cross-trained and capable of performing multiple tasks depending on the status of the Emergency Operations Center. In addition to pre-disaster responsibilities discussed in Section 5.2.1, the SLCo EM staff also performs several post-disaster activities:

- Emergency Coordination Center (ECC) duties – SLCo EM staff provide infrastructure and human services support in the event the Emergency Operations Center is activated.
- Field duties - SLCo EM staff are trained and have safety equipment to perform fieldwork after a disaster. They often assess locations that were heavily impacted by a disaster and identify opportunities for mitigation. SLCo EM staff also may be called upon to staff disaster assistance centers in the field.
- Field briefings – SLCo EM staff will conduct field briefings to jurisdictions on Salt Lake County disaster funding, how it can be used and how municipalities can fund eligible projects.
- Continuity of Operations duties - SLCo EM staff maintains their regular pre-disaster duties during a disaster to maintain continuity of operations.

Salt Lake County Emergency Coordination Center (ECC)

The County ECC is a technologically advanced facility staffed and operated 24-hours a day by highly trained personnel. Each of the fifteen Emergency Support Function (ESF) agencies is required to send a representative to the ECC during emergencies and exercises. During emergencies, personnel from other county agencies staff the ECC. At the county and local levels, ECCs are also the central coordination point for response and recovery efforts. These facilities range from large and highly sophisticated to small and simple.

Public Safety Emergency Telephone Act

Act 78 (i.e. the *Public Safety Emergency Telephone Act, 1990-78*), as amended, is designed to provide a toll-free standard number (911) accessible from both land and cellular phones for any individual in the county to gain rapid, direct access to emergency services. The act places responsibility for developing a 911 system on county government. It provides for user contributions based on the number of lines of telephone service. These contributions are administered at the county level. Act 78 establishes technical, training and certification guidelines, and minimum standards to be met in developing the county 911 plan. It encourages the development of enhanced 911 systems and constant improvement of existing systems.

Hazard Mitigation Grant Program Administrative Plans

In the event of a presidential disaster declaration, a Hazard Mitigation Grant Program Administrative Plan is edited and updated. Edits may be extensive and may require new sections to be developed depending on the regulatory changes between disaster declarations. Administrative Plans document the process for the administration of HMGP and the project management of the mitigation measures to be funded under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988. They set forth agency guidance for the eligibility, development, submission, review, and recommendation of HMGP applications relative to federal disaster declarations. Topics including responsibilities and staffing, identification and evaluation of mitigation projects, application procedures, and financial management are addressed.

Hazard Mitigation Grant Program Community Outreach

SLCo EM will provide quarterly information sessions for municipal officials on the post-disaster grant funding application process.

Repetitive Loss and Severe Repetitive Loss Capability

As stated in Section 5.2.1, SLCo EM staff will have a continuous twelve-month approach to mitigating repetitive loss and severe repetitive loss properties. This continuous approach supports both pre- and post-disaster grant funding streams. Specifically in the post-disaster situation, mitigating RL and SRL properties is a criterion used by the state committee that reviews the HMGP applications. For instance, if all items in an HMGP were equal an application for an RL or SRL property would be prioritized over a non-RL or SRL property.

5.2.3 Development Management Capability

In Salt Lake County, local municipalities regulate development. They do this by adopting zoning ordinances, floodplain ordinances, and subdivision and land development ordinances—and grant building permits by verifying that development proposals are consistent with these documents. Local municipalities have several effective tools at their disposal to address development in hazard prone area. These tools are discussed below.

Zoning ordinances allow for local communities to regulate the use of land in order to protect the interest and safety of the general public. Zoning ordinances can be designed to address unique conditions or concerns within a given community. They may be used to create buffers between structures and high-risk areas, limit the type or density of development and/or require land development to consider specific hazard vulnerabilities.

Subdivision and land development ordinances are intended to regulate the development of housing, commercial, industrial or other uses, including associated public infrastructure, as land is subdivided into buildable lots for sale or future development. Within these ordinances, guidelines on how land will be divided, the placement and size of roads and the location of infrastructure can reduce exposure of development to hazard events

To protect people and structures from flood hazards, FEMA administers the National Flood Insurance Program that has an objective to guide development away from high-flood risk areas. Local municipalities participate through ordinance adoption and floodplain regulation and as a condition of community participation in the NFIP structures built within the Special Flood Hazard Area must adhere to the floodplain management regulations.

Through administration of floodplain ordinances, municipalities can ensure that all new construction or substantial improvements to existing structures located in the floodplain are flood-proofed, dry-proofed, or built above anticipated flood elevations. Floodplain ordinances may also prohibit development in certain areas altogether.

Municipalities can also participate in the NFIP's CRS program. Community participation in this program can provide premium reductions for properties located outside of Special Flood Hazard Areas of up to 10-percent and reductions for properties located in Special Flood Hazard Areas of up to 45-percent. These discounts can be obtained by undertaking public information, mapping and regulations, flood damage reduction and flood preparedness activities.

The County also has policies to regulate construction standards for new construction and substantially renovated buildings. Building codes regulate construction standards for new construction and substantially renovated buildings. Standards can be adopted that require resistant or resilient building design practices to address hazard impacts common to a given community.

5.3 Local Capability Assessment

5.3.1 Status of Local Hazard Mitigation Plans

Local plans in Salt Lake County have typically been developed at the county level with participation by the jurisdictions within the county limits.

6 Mitigation Strategies

This section describes the mitigation strategy process and mitigation action plan for the Salt Lake County Multi-Jurisdiction Multi-Hazard Mitigation Plan.

6.1 Update Process Summary:

The results of the planning process, the risk assessment, the goal setting, the identification of mitigation actions, and the hard work of the team led to the action plan in Section 5.3 Mitigation Action Plan. The following overall mitigation strategies have been created:

- **Share** all of the information gathered with the public in as many venues as possible. Also share the information with other jurisdictions and all emergency management personnel.
- **Follow-up** on all stated actions to make sure all jurisdictions are following through on their mitigation plans.
- **Since** 90% of all hazard funds are related to flooding we will make sure that all jurisdictions are applying the NFIP guidelines in all areas.
- **Follow** mitigation grant offerings and make sure all jurisdictions apply for funds.

6.2 Goals & Objectives

The Mitigation Planning Team has organized resources, assessed hazards, risks and documented mitigation capabilities. The resulting goals, objectives, and mitigation actions were developed based on these tasks. The team held a series of meetings designed to develop mitigation strategies as described further throughout this section.

Goals for this mitigation plan are statements that:

- Represent the desires of the entire community
- Include all members of the community both public and private
- Can be accomplished in the future whether near-term or long-term

Goals form the basis for objectives and actions that will be taken and are not dependent on feasibility of implementation. Objectives—which are different than goals—define strategies that will accomplish the goals and are specific and measurable.

The following are the goals in a non-prioritized fashion:

Goal 1: Provide Protection for People's Lives from Hazards
Element 1.1: Provide timely notification to all citizens of potential and imminent hazards

Element 1.2: Protect public health and safety by preparation, response, recovery and resilient actions related to natural disasters

Element 1.3: Improve community communications so that they are interoperable and robust

Goal 2: Reduce exposure to natural hazards
Element 2.1: Wildfires are an increasing threat to our communities. We should use best practices already in place in neighboring communities to reduce our communities' exposure.

Element 2.2: Reduce exposure to losses from landslides. With the increased effect of sudden rainfall events, ground shaking, and mining, we need to increase our awareness of areas prone to landslides.

Element 2.3: Reduce Spring flood and storm-related losses

Element 2.4: Reduce the impact to the communities due to drought

Goal 3: Improve Community awareness to hazards and their potential to create long term effects both for the public and the business community.
Element 3.1: Continue to use all avenues such as TV, print, and social media to educate the public about hazards, what the public and business can do to diminish their effects, and encourage communities to practice responding to potential hazards.

Element 3.2: Use Volunteer Organizations Active in Disaster (VOADS) to enlist and educate the public and business partners.

Goal 4: Provide Protection for Critical Facilities, Utilities, and Services from Hazard Impacts

Goal 5: Maintain Coordination of Disaster Planning
Element 5.1: Coordinate with changing U.S. Department of Homeland Security/FEMA needs

Element 5.2: Coordinate with other community plans

Element 5.3: Maximize the use of shared resources between jurisdictions and special districts for mitigation/communication

Element 5.4: Standardize systems among agencies to provide for better interoperability

Goal 6: Maintain/Provide for FEMA Eligibility and Work to Position Jurisdictions for Grant Funding.
Element 6.1: Provide County departments and other jurisdictions with information regarding mitigation opportunities

Element 6.2: As part of plan implementation, review actions in this plan on an annual basis to be considered for annual FEMA Pre-Disaster Mitigation grant allocations or after a presidential disaster declaration.

6.3 Identification and Analysis of Mitigation Actions:

In order to identify and select mitigation actions to support the mitigation goals, each hazard identified in Section 4.1 Identifying Hazards: Natural Hazards was evaluated. Only those hazards that were determined to be a priority hazard were considered further in the development of hazard-specific mitigation actions.

These priority hazards encompassing all the jurisdictions in the county are listed below. The Mitigation Actions for that Jurisdiction are specified, prioritized and a rough cost-benefit analysis performed and is found within each respective jurisdiction's annex.

6.4 Mitigation Action Plan:

Each Jurisdiction has included in their plan the description of mitigation action plans, their prioritization and implementation. A brief cost-benefit analysis has also been completed for each action plan for the jurisdictions to decide which mitigation factors they will proceed with first.

Salt Lake County's Mitigation Actions are designed to encourage monthly conversations on each of the county's identified hazards. Each month a hazard will be discussed in detail, each jurisdiction will distribute their best practices for mitigating that hazard and all jurisdictions will create a new mitigation strategy for dealing with the specific hazard being discussed. This new strategy will be added to the jurisdictions plan as detailed in plan maintenance.

6.4.1 Emergency Managers Mitigation Schedule:

Action Lead—Salt Lake County Emergency Management
Multi-Hazard Mitigation Actions
January 2015 Emergency Manager's Meeting/Planning Team Earthquake Mitigation Review (Each Jurisdiction will bring their best mitigation practice and update progress on plans to date. Special emphasis will be based on cost/benefit reviews.)

February 2015	Emergency Manager’s Meeting/Planning Team Flood Mitigation Review (Each Jurisdiction will bring their best mitigation practice and update progress on plans to date. Special emphasis will be based on cost/benefit reviews.)
March 2015	Emergency Manager’s Meeting/Planning Team Wildland Fire Mitigation Review (Each Jurisdiction will bring their best mitigation practice and update progress on plans to date. Special emphasis will be based on cost/benefit reviews.)
April 2015	Emergency Manager’s Meeting/Planning Team Slope Failure Mitigation Review (Each Jurisdiction will bring their best mitigation practice and update progress on plans to date. Special emphasis will be based on cost/benefit reviews.)
May 2015	Emergency Manager’s Meeting/Planning Team Severe Weather Mitigation Review (Each Jurisdiction will bring their best mitigation practice and update progress on plans to date. Special emphasis will be based on cost/benefit reviews.)
June 2015	Emergency Manager’s Meeting/Planning Team Dam Failure Mitigation Review (Each Jurisdiction will bring their best mitigation practice and update progress on plans to date. Special emphasis will be based on cost/benefit reviews.)
July 2015	Emergency Manager’s Meeting/Planning Team Avalanche Mitigation Review (Each Jurisdiction will bring their best mitigation practice and update progress on plans to date. Special emphasis will be based on cost/benefit reviews.)
August 2015	Emergency Manager’s Meeting/Planning Team Pandemic Mitigation Review (Each Jurisdiction will bring their best mitigation practice and update progress on plans to date. Special emphasis will be based on cost/benefit reviews.)
September 2015	Emergency Manager’s Meeting/Planning Team Drought Mitigation Review (Each Jurisdiction will bring their best mitigation practice and update progress on plans to date. Special emphasis will be based on cost/benefit reviews.)
October 2015	Emergency Manager’s Meeting/Planning Team Infestation Mitigation Review (Each Jurisdiction will bring their best mitigation practice and update progress on plans to date. Special emphasis will be based on cost/benefit reviews.)

November 2015 Emergency Manager's Meeting/Planning Team Radon Mitigation Review (Each Jurisdiction will bring their best mitigation practice and update progress on plans to date. Special emphasis will be based on cost/benefit reviews.)	
December 2015 Emergency Manager's Meeting/Planning Team Problem Soils Mitigation Review (Each Jurisdiction will bring their best mitigation practice and update progress on plans to date. Special emphasis will be based on cost/benefit reviews.)	

Table 6.1.1

6.4.1.2 The cost for this mitigation effort is minimal.
6.4.1.3 The benefit will range from hundreds of thousands of dollars to millions of dollars.
6.4.1.4 The benefit to cost ratio is almost infinite

6.4.2 Firewise:

About the Firewise Communities Program
Brush, grass and forest fires don't have to be disasters. NFPA's Firewise Communities Program encourages local solutions for safety by involving homeowners in taking individual responsibility for preparing their homes from the risk of wildfire. Firewise is a key component of Fire Adapted Communities – a collaborative approach that connects all those who play a role in wildfire education, planning and action with comprehensive resources to help reduce risk.

The program is co-sponsored by the USDA Forest Service, the US Department of the Interior, and the National Association of State Foresters. To save lives and property from wildfire, NFPA's Firewise Communities program teaches people how to adapt to living with wildfire and encourages neighbors to work together and take action now to prevent losses. We all have a role to play in protecting ourselves and each other from the risk of wildfire.

About the National Fire Protection Association (NFPA)
NFPA is a worldwide leader in fire, electrical, building, and life safety. The mission of the international nonprofit organization founded in 1896 is to reduce the worldwide burden of fire and other hazards on the quality of life by providing and advocating consensus codes and standards, research, training, and education. NFPA develops more than 300 codes and standards to minimize the possibility and effects of fire and other hazards. All NFPA codes and standards can be viewed at no cost at www.nfpa.org/freeaccess.

Community Wildfire Protection Plan (CWPP)
A CWPP is a document produced in effort to mitigate the risk of wildfire in at-risk communities. The plan is developed by a community-based citizen group in conjunction with subject matter experts such as local fire departments, State of Utah Wildland/Urban Interface coordinators and partners from the BLM and USFS.

Typically CWPP development entails 4-6 weekly meetings that address the following:

- Community make-up (infrastructure, access & egress, population, # of homes, etc.). This group is made of citizen volunteers who have recognized the need for a plan. We like to get city or community leaders involved as often as possible.
- Areas that pose a risk to the community
- Projects to mitigate the above risk(s)
- Community education
- Needs for local responders (to address wildfire threats; i.e. New PPE, engines, staffing etc.)
- Ongoing maintenance

Every few years it should be revisited and updated as necessary.

One thing unique to Utah, is the CWPP ties in with communities becoming Firewise, which is a prestigious national award given to communities whom have been proactive and taken steps to address and mitigate the issue of wildfire. Something Interesting is Salt Lake County has 19 high risk wildland fire communities, and most are within UFA's response area. Salt Lake County is currently working with each community to develop CWPP and work towards Firewise recognition where applicable. Once the CWPP is complete, grants are applied for on their behalf by the SMEs involved and most communities will typically receive a monetary reward to complete the projects identified in the CWPP.

Below are the Salt Lake County Areas participating in the Firewise Program.

Community Number	Community Name	County	Lat	Long	Fire Occurrence	Fuels Hazards	Values Protected	Fire Protection Capability	Overall Score	Notes
277	Salt Lake City	Salt Lake	40.7627769	-111.8874988	2	3	2	1	8	
278	Sandy	Salt Lake	40.5710733	-111.792188	2	3	2	1	8	
279	Alta	Salt Lake	40.5853222	-111.6518986	1	1	2	2	6	
280	Big Cottonwood	Salt Lake	40.6344202	-111.7083822	1	1	3	2	7	Canyon is designated
281	Bluffdale	Salt Lake	40.4736108	-111.9533369	2	3	2	1	8	
282	Brighton	Salt Lake	40.6013883	-111.5805566	1	1	3	2	7	
283	Copperton	Salt Lake	40.5636127	-112.0977772	2	2	2	1	7	
284	Cottonwood Heights	Salt Lake	40.6073088	-111.7902819	1	2	3	1	7	Renamed from Granit
285	Dimple Dell	Salt Lake	40.5619452	-111.8150019	2	3	3	1	9	
286	Draper	Salt Lake	40.4909247	-111.8540225	2	2	3	1	8	
287	Emigration Canyon	Salt Lake	40.77	-111.7591669	2	3	3	2	10	
288	Herriman	Salt Lake	40.4920486	-112.0380213	2	3	2	1	8	
289	High Country Estates	Salt Lake	40.5008358	-112.087225	2	3	3	1	9	
290	Holladay	Salt Lake	40.674568	-111.7824641	1	2	1	1	5	
291	Lambs Canyon	Salt Lake	40.7084747	-111.6158605	2	2	2	3	9	
292	Little Cottonwood	Salt Lake	40.5738511	-111.6987175	1	1	2	2	6	Canyon is designated
293	Mount Aire	Salt Lake	40.7258336	-111.7169436	2	2	2	3	9	
294	Olympus Cove	Salt Lake	40.6457619	-111.8058963	2	3	2	1	8	

6.4.2.2 The cost for this mitigation effort is minimal.
6.4.2.3 The benefit will range from hundreds of thousands of dollars to millions of dollars.
6.4.2.4 The benefit to cost ratio is almost infinite

6.4.3 Earthquake

6.4.3.1 Problem Statement

Salt Lake County's large number of unreinforced brick residences poses a large problem in the event of a major earthquake. Salt Lake County Emergency Management will help county jurisdictions present the "Fix the Bricks" program. This program is part of the Salt Lake City and State of Utah effort to mitigate the effects of a large-scale earthquake by minimizing post-earthquake personal injury and requirement for outside assistance.

6.4.3.2 The cost for this mitigation effort is minimal.
6.4.3.3 The benefit will range from hundreds of thousands of dollars to millions of dollars.
6.4.3.4 The benefit to cost ratio is almost infinite

6.4.4 Flood

6.4.4.1 Mitigation Action

Salt Lake County Emergency Management will help county jurisdictions procure grants for flood mitigation assistance through a presentation at a special emergency managers' meeting. As each jurisdiction has already identified their flood prone areas through HAZUS and RiskMAP we will utilize existing reports to help all jurisdictions prepare plans for mitigation and application for funding.

Canal Mapping will be discussed at the 2015 Emergency Managers Meeting and a subcommittee will be formed.

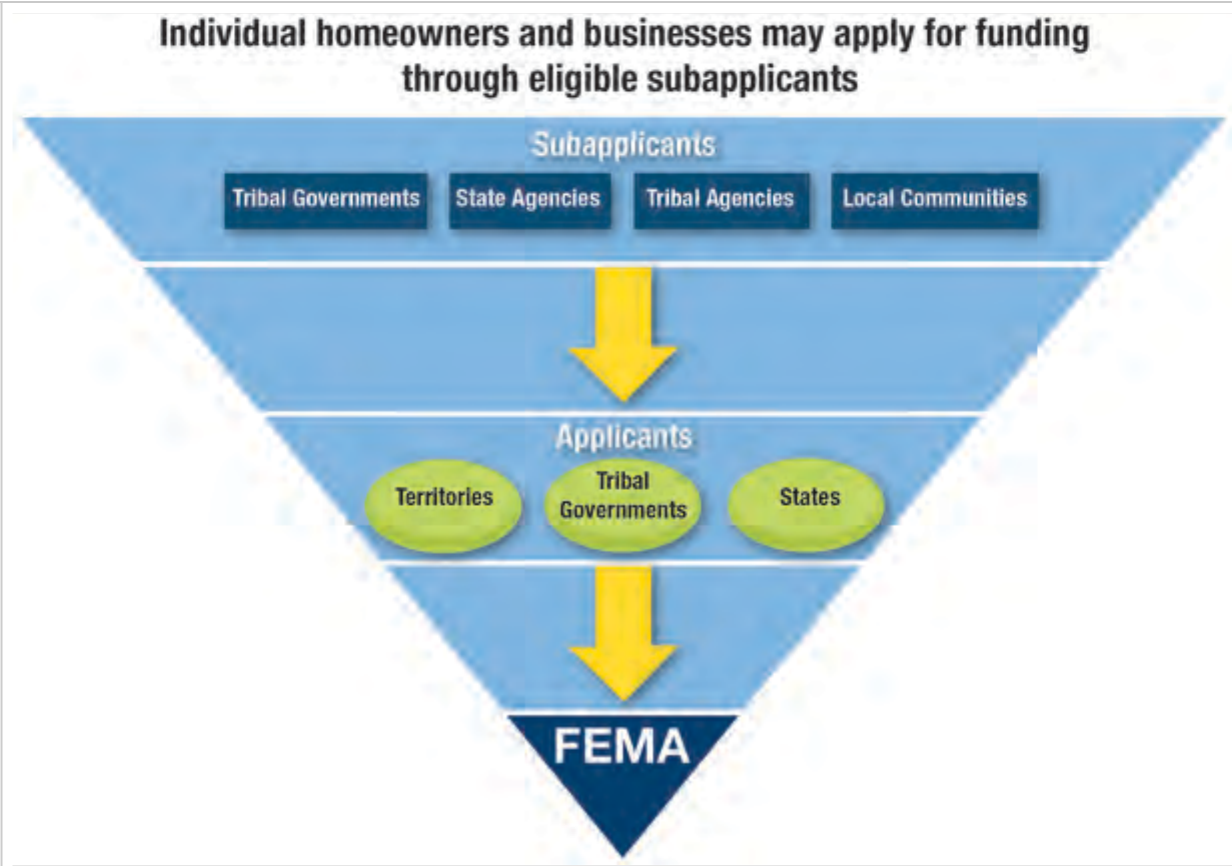
Flood Mitigation Assistance Program

The Flood Mitigation Assistance (FMA) program provides funds for projects to reduce or eliminate risk of flood damage to buildings that are insured under the National Flood Insurance Program (NFIP) on an annual basis.

There are three types of FMA grants available to applicants:

- **Planning Grants** - to prepare flood mitigation plans
- **Project Grants** - to implement measures to reduce flood losses, such as elevation, acquisition or relocation of NFIP-insured structures
- **Management Cost Grants** - for the grantee to help administer the FMA program and activities

Please see the chart below for information on how to apply to the FMA program.



FEMA pyramid flow chart Flood Mitigation Assistance.

6.4.4.2 The cost for this mitigation effort is minimal.
6.4.4.3 The benefit will range from hundreds of thousands of dollars to millions of dollars.
6.4.4.4 The benefit to cost ratio is almost infinite.

6.4.5 Slope Failure:

6.4.5.1 Soil slopes

As seen in the massive slope failure in North Salt Lake City the Wasatch Front is prone to slope failure due to the close proximity of construction to the Wasatch and Oquirrh Mountains. The county will hold a special conference for emergency managers to go over detection of probable slope failure areas and best practices for mitigation efforts.

Geometry modification

The operation of re-profiling a slope with the aim of improving its stability, can be achieved through various procedures:

- Lowering the slope

- Positioning infill at the foot of the slope

Slopes can be reduced by digging out the brow of the slope. This is effective for correcting shallow forms of instability, where movement is limited to layers of ground near to the surface and when the slopes are higher than 15 ft. Moreover, the steps created in this way and suitably achieved also reduce surface erosion.

However, caution should be exercised to avoid the onset of local breakage following the cuts made. Infill at the foot of the slope, instead, has a stabilising effect in the case of translational or deep rotational landslide, in which the landslide surface at the top submerges and describes a sub-vertical surface that re-emerges in the area at the foot of the slope. The choice of reducing the slope and infilling at the foot is rarely a problem since there are generally specific constraints to be respected at the top or at the foot of the slope.

Generally in slope stabilization where there are no constraints (often this occurs for natural slopes) a combination of slope reduction and infilling at the foot of the slope is adopted to avoid heavy work of just one type. Included among work at the foot of the slope are the berm and some gravitational structures like gabions or reinforced ground, that is, concrete blocks. In the case of natural slopes the choice of re-profiling scheme is not so clear as in the case of artificial slopes. Often the profile is highly irregular with large areas of not recent natural creep, so that its shallow development can make some areas unserviceable as a cutting or infill point.
Where the buried shape of the old landslide is complicated, depositing of infill material in one area can lead to destabilising another.

When planning this type of work the stepping effect of the cuts and infill should be taken into account: their beneficial influence on the increase in Safety Factor will be reduced in relationship to the size of the landslide under examination. Moreover, it is very important to ensure that neither the cuts nor the infill mobilise the existing or potential creep plane of the landslide. Generally, infilling at the foot of the landslide should be preferred to cutting at the top (to reduce weight at the top of the slope), since the latter solution proves to be often more expensive than the former. Moreover, in complex and compound landslides, infill at the foot of the slope, at the tip of the foot itself, has a lesser probability of interfering with the interaction of the individual landslide elements.

An important aspect of stabilization work that changes the morphology of the slope is that, in more precisely mechanical terms, effecting cuts and infill generates non-drained charge and discharge stresses. In fact, in the case of positioning infill, the safety factor SF, will be less in the short term than in the long term. In the case of effecting a cut in the slope, SF will be less in the long term rather than in the short term. therefore in both cases it is opportune to calculate the SF both in the short and the long term.

Finally, it should be remembered that the effectiveness of infill increases with time on condition that it is associated with an appropriate infill drainage system, obtained through an underlying drainage cover or appropriate shallow drainage. More generally therefore re-profiling systems are associated with and integrated by surficial protection of the slope against erosion and by regulation of meteoric waters through drainage systems made up of ditches and small channels (clad or unclad and prefabricated) to run off the water collected.

These surficial water regulation systems are obtained by modeling the land itself around the body of the landslide large ground ditches in the case of incoherent material landslides) or by means of flexible suitably placed drainage pipes able to collect the water.

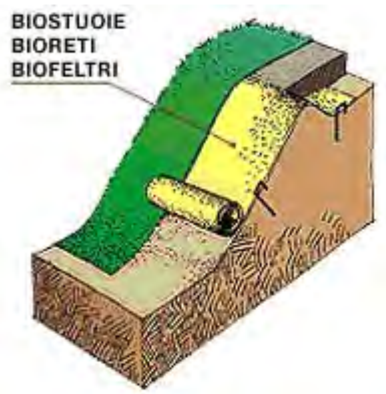
Surface water run off system by prefabricated channels

Micro-perforated flexible drainage tubes

These provisions will serve the purpose of avoiding penetration of the landslide body by circulating water or into any cracks or fissures, further decreasing ground shear strength. A problem that could be caused by water near the surface of the hillside is the erosion of surface material due to water runoff. This proves hazardous in terms of stability since it tends to weaken the slope by removing material as well as triggering excess pressure due to the water flow. For defense against erosion, a series of solutions can be used, such as:

- Geomats
- Geogrids
- Brushwood mats

These measures share the superficial character of their installation given their low environmental impact. Geomats or rather anti-eroding biomats or bionets are purpose-made synthetic products for the protection and grassing of slopes subject to surface wash through two main erosion control mechanisms: the containment and reinforcement of the surficial ground; the protection from the impact of the raindrops.



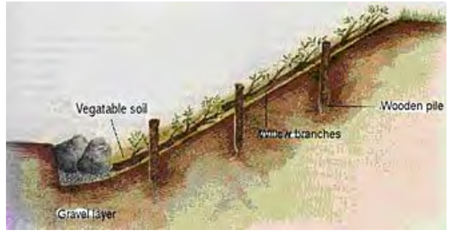
Anti-erosion solutions with the use of bionets: typical scheme

Anti-erosion solutions with the use of bionets: types of bionets

Typical anti-erosion solutions with geomats

Geogrids

Wicker or brushwood mats are made of vegetal material. Very long and flexible willow branches can be used, which are then covered with infill soil. Alternating stakes of different woody species are used and they are woven to form a barrier against the downward drag of the material eroded by the free water on the surface



Geogrids

Draining techniques

Drainage systems are adopted to reduce the neutral stresses in a potentially unstable hillside. In terms of safety for global stability, these measures translate into the lowering of the water level inside the mass, which consequently leads to reduction in pore-pressure in the ground and an increase in the shear strength available in particular along the potential creep surface. In relation to hillside morphology, the kinematics of movement predicted and to the depth of the creep surfaces, the reduction in pore-pressure by drainage can be obtained using shallow and deep drains.

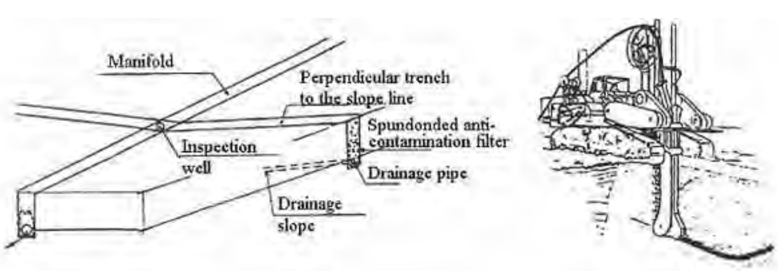
Usually, shallow drainage is adopted when the potential hillside movement is foreseen as shallow landslide affecting the ground to a depth of about 5-6m. When there is deeper surface slipping, deep drainage has to be introduced, but shallow drainage systems can be provided anyway with the aim of running off that aliquot of surficial water directly connected to seasonal rainfall.

Shallow drainage

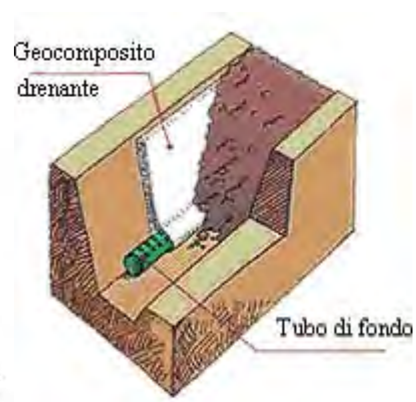
There are two types of shallow drainage solution:

- Shallow drainage trenches

Traditional drainage trenches are cut in an unbroken length and filled with highly permeable granular draining material;



Typical shallow drainage trenches



Shallow drainage trenches equipped with geocomposites: typical scheme

- Shallow drainage trenches equipped with geocomposites

These systems consist of unbroken trenches with scarped sides covered with geocomposites, generally with 25m. Long panels, having draining characteristics. The bottom of the trench houses a drainage tube with the task of bottom discharge placed in continuity to the geocomposite canvas.

Deep drainage

Deep drainage acts by modifying the filtration routes in the ground. Often they are more expensive than shallow drains, but they are usually more effective because they remove the quantity of water that induces instability in the hillside, from within the ground and diminish the neutral stresses directly where necessary. Deep drainage in earth slopes can be obtained by means of the following works: large diameter drainage wells equipped with sub-horizontal drains. These systems can have just a structural function, just a draining function or both. The draining elements are the microdrains, perforated and positioned sub-horizontally and fanned out, oriented uphill to favor water discharge by gravity.

The size of the wells is chosen with the aim of allowing the insertion and functioning of the perforation equipment for the microdrains. Generally, the minimum internal diameter to be adopted must be greater than 3.5 m, for drains with a length of 20 to 30 m.

Longer drains require wells with a diameter of up to 8–10 m. To determine the network of microdrains planners have to take into consideration the makeup of the subsoil and the hydraulic regime of the slope, to provide for the correct number and distribution of the microdrains.
The drainage in these wells is passive, realised by linking the bottom of adjacent wells by sub-horizontal perforations (provided with temporary sheathing pipes) in which the microdrains are placed at a gradient of about 15-20° and are equipped with microperforated PVC pipes, protected by non-filtering fabric along the draining length.

Once all the drain is inserted in the hole and having embedded the latter in the ground, the temporary sheathing is completely removed and the head of the drain is cemented to the well. In this way a discharge line is created linking all the wells emerging to the surface downhill, where the water is discharged naturally without the help of raising pumps.

The wells are placed at such a distance apart that the individual collecting areas of the microdrains, appertaining to each well, are overlaid. In this way all the volume of the slope involved with the water table is drained. Medium-diameter drainage wells linked at the bottom. The technique involves the dry cutting with temporary sheathing pipes, of aligned drainage wells, with a diameter of 1200–1500 mm., positioned at an interaxis of 6–8 m., their bottoms linked together to a bottom tube for the discharge of drained water. In this way the water discharge takes place passively, due to gravity by perforated pipes with mini-tubes, positioned at the bottom of the wells themselves. The linking pipes, generally made of steel, are blind in the linking length and perforated or windowed in the length corresponding to the well.

The wells have a concrete bung at the bottom and are filled, after withdrawal of the temporary sheathing pipe, with dry draining material and are closed with an impermeable clay bung.
In normal conditions, these wells reach a depth of 20–30 m, but, in especially favorable cases, a depth of even 50 m can be reached. Some of these wells have drainage functions across their whole section and others can be inspected. The latter serve for maintenance of the whole drainage screen. Such wells that can be inspected are also a support point for the creation of new drainage wells and access for the installation, also on a later occasion, for a range of sub-horizontal drains at the bottom or along the walls of the wells themselves, with the purpose of increasing the drainage capacity of the well.

The following references were used in section 6.4.5

Bomhad E. N. (1986). *Stabilità dei pendii,* Dario Flaccovio Editore, Palermo.

Cruden D. M. & Varnes D. J. (1996). Landslide types and process. In "Landslides - Investigation and Mitigation", Transportation Research Board special Report n. 247, National Academy Press, Washington DC, 36-75.

Fell R. (1994). Landslide risk assessment and acceptable risk, Can. Geotech. J., vol. 31, 261-272.

Giant G. (1997). *Caduta di massi - Analisi del moto e opere di protezione,* Hevelius edizioni, Naples.

Hunge O. (1981). Dynamics of rock avalanches and other types of mass movements. PhD Thesis, University of Alberta, Canada.

Peck R.P. (1969). Advantages and limitations of the observational method in applied soil mechanics, *Geotechnique* 19, n. 2, 171-187.

Tambura F. (1998). Stabilizzazione di pendii - Tipologie, tecnologie, realizzazioni, Hevelius edizioni, Naples.

Tanzini M. (2001). *Fenomeni franosi e opere di stabilizzazione,* Dario Flaccovio Editore, Palermo

Terzaghi K. & Peck R. B. (1948). *Soil mechanics in engineering practice,* New York, Wiley.

6.4.5.2 The cost for this mitigation effort is minimal.
6.4.5.3 The benefit will range from hundreds of thousands of dollars to millions of dollars.
6.4.5.4 The benefit to cost ratio is almost infinite

6.4.6 Severe Weather

Problem Statement – Severe weather is inevitable. The best mitigation practice is the timely communication of the event and actions that can be taken to minimize the effects. The biggest threat of severe weather is winter storms. Winter storms usually cause power outages that can last up to several days. Home heating becomes a major problem. Each year Salt Lake County has several devastating fires from homeowners using unsafe heating units. The county will help jurisdictions communicate proper heating methods during power outages using the "Fire is Everyone's Fight" program.

Fire Is Everyone's Fight™

Fire Is Everyone's Fight™ is a national effort led by the U.S. Fire Administration (USFA) to lower the number of home fires and home fire injuries in America. Along with USFA and partner organizations across the country, the fire community is speaking out with a unified message of fire prevention and safety to the public. The goal is to change how people think about fire and fire prevention using social marketing strategies to address the broadest possible audience.

The fire problem in the United States is an ongoing and continuous battle for the fire service and the public alike. Eighty-one percent of all fire deaths and 76 percent of all fire injuries occur in residential buildings.

Each year there is an estimated:

- 365,500 residential building fires
- 2,560 deaths
- 13,275 injuries
- $6.6 billion in property loss

A call to action

This is a call to action for the USFA, fire and life safety partner organizations and the American public. We must join together to help reduce the number of home fires, and the resulting deaths, injuries and loss of property. We rely on the fire service to fight fires once they occur; however, the prevention of fires is up to all of us. Fire Is Everyone's Fight™. Fire is Everyone's Fight™ is a national effort led by the U.S. Fire Administration (USFA) to lower the number of home fires and home fire injuries in America. Along with USFA and partner organizations across the country, the fire community is speaking out with a unified message of fire prevention and safety to the public. The goal is to change how people think about fire and fire prevention using social marketing strategies to address the broadest possible audience.

As firefighters and emergency responders, you work every day to keep our families and homes safe. Fire is Everyone's Fight™ not only supports your vital mission to protect lives and property, but it also seeks to keep you and the men and women you serve with safer as well. As you and thousands of other members of the fire and emergency services community across the country spread Fire is Everyone's Fight™ to your communities, people will begin to recognize and understand the importance of taking small steps to make their homes and families safer from fire.

There are dozens of ways you can use Fire is Everyone's Fight™ to help teach people in your city or town to be safer. This guide shares just a few ideas to help you get started. It offers suggestions for engaging people in the community. This guide will help you:

- Integrate Fire is Everyone's Fight™ content into your existing media and community outreach programs.
- Reach out to organizations to arrange speaking opportunities.
- Use social media to get the word out about fire safety and prevention.
- Know what to say and how to say it simply and effectively.
- Put together an event that attracts the audience you want to inform.
- Create opportunities to get the word out.

6.4.6.2 The cost for this mitigation effort is minimal.
6.4.6.3 The benefit will range from hundreds of thousands of dollars to millions of dollars.
6.4.6.4 The benefit to cost ratio is almost infinite

6.4.7 Dam Failure

6.4.7.1 Problem Statement

Salt Lake County's dams present a serious hazard to citizens in the event of a major earthquake. Salt Lake County Emergency Management will hold a special meeting of emergency managers to instruct them in how to use FEMA's compendium of dam incidents and failures. This information is presented through FEMA's Lessons Learned Information Sharing website.

https://www.llis.dhs.gov/sites/default/files/Regular%20operation%20maintenance%20and%20inspection%20of%20dams%20is%20important%20to%20the%20early%20detection%20and%20prevention%20of%20dam%20failure_1.pdf

Regular operation, maintenance, and inspection of dams is important to the early detection and prevention of dam failure.

Abstract:

This interactive PDF was developed to supplement the Dam Incidents and Failures Lessons Learned Information Sharing webpage and contains information regarding how regular operation, maintenance, and inspection of dams is important to the early detection and prevention of dam failure. A brief description of this lesson learned, a list of case studies describing dam incidents or failures from which the lesson was learned, as well as photographs and videos related to the subject can be found in within this document. Also presented in the file are the best practice documents for guidance on averting dam disasters through regular operation, maintenance, and inspection in the future.

6.4.7.2 The cost for this mitigation effort is minimal.
6.4.7.3 The benefit will range from hundreds of thousands of dollars to millions of dollars.
6.4.7.4 The benefit to cost ratio is almost infinite

6.4.8 Avalanche

6.4.8.1 Problem Statement –
Salt Lake County is the gateway to the most avalanche prone road in the United States. Although the costs of avalanches are not dramatic in the financial sense the loss of live in Utah from Avalanches outranks any other natural cause. Salt Lake County Emergency Management will hold a special meeting for emergency managers to help them use the Utah Avalanche Center's robust multi-platform messaging system to keep their citizens aware of times to stay out of avalanche prone terrain.

Get real time Utah Avalanche Center info on your phone

By Jared Hargrave • December 1, 2010

> Imagine you're skinning up for some backcountry skiing in Days Fork near Alta. You checked the avalanche report in the morning and feel good to go as the day is forecast to be a moderate, level 2 rating. Just as you enter avalanche terrain in a high elevation area, your phone chirps with a new text message that reads: "11am, Days Fork, skier caught, uninjured, soft slab, 2'x100'x500'." Wouldn't you be glad to have this information before dropping into Days Fork yourself? Then sign up to receive text messages from the Utah Avalanche Center.

Utah Avalanche Center

Avalanche conditions are constantly in flux, and that avalanche report you read hours ago may be irrelevant by late afternoon. With real-time avalanche info coming in on your phone, you can stay up to date on current conditions and be better informed to make the right decisions in any terrain.

Here are some other examples of text messages sent out by the Utah Avalanche Center last season:

•HS-NC-3 radar love 200′ wide step down to near ground….ran near end if storm.
•Large natural spotted by solitude patrol in meadow chutes.
•Avalanche Warning issued with dangerous conditions expected through the week.
•Fatality yesterday near Francis Peak. Reported 42 yr. old male snowmobiler. Issued Avalanche Watch for today with forecasted storm.
•Highway control-work in LCC cancelled.

6.4.8.2 The cost for this mitigation effort is minimal.
6.4.8.3 The benefit will range from hundreds of thousands of dollars to millions of dollars.
6.4.8.4 The benefit to cost ratio is almost infinite

6.4.9 Pandemic

Salt Lake County, being the home of the Church of Jesus Christ of Latter-day Saints (the Mormons), is uniquely situated to have citizens returning from almost every country in the world. With their return is the inevitable increase in probability of the introduction of illnesses from these countries. Salt Lake County is the home of both the University of Utah's Medical Facilities and the Intermountain Healthcare's facilities possessing state of the art infectious disease physicians and treatment facilities. Salt Lake County Emergency Management will host presentations from these facilities and the County Health Department to the County's emergency managers to assist them in designing their mitigation programs for dealing with pandemics.

> "The Salt Lake County Health Department (SLCo HD) continues to improve its emergency response capacity by planning, training, exercising and working with partners and municipalities throughout the county.
> The SLCoHD Emergency Management Bureau takes the lead within the department and involves all health department staff through planning, training, drills and exercises.
> The health department follows the principles of Emergency Management: to plan for, respond to, recover from, and mitigate natural and manmade emergencies and disasters.
> **Our goal is to do the most good for the most people in the shortest amount of time. "**

6.4.9.2 The cost for this mitigation effort is minimal.
6.4.9.3 The benefit will range from hundreds of thousands of dollars to millions of dollars.
6.4.9.4 The benefit to cost ratio is almost infinite

6.4.10 Drought

6.4.10.1 Problem Statement

Salt Lake County is prone to cyclical droughts. These droughts have been severe enough to require mandatory water rationing. Salt Lake County Emergency Management will conduct a special presentation on "Slow the Flow" for County Emergency Managers to help them encourage their residents to take advantage of the free "Water Check" program.

What is a water check?

A water check analyzes the efficiency of your automated sprinkler system. Trained workers will perform the water check at your home and provide you with a customized watering schedule.
The tests that will be performed include soil type, grass root depth, sprinkler distribution uniformity and water pressure. The entire process will take approximately one hour.

How much does it cost?

The water check program is a free service sponsored by your water provider.

How do I sign up?

The SL County program will be open until further notice. You can schedule an appointment by signing up using the form below or by calling 877-728-3420. This program is sponsored by: Jordan Valley Water Conservancy District, Central Utah Water Conservancy District, Washington County Water Conservancy District, Sandy City, Murray City, Salt Lake City, Metropolitan Water District of Salt Lake and Sandy, Central Iron County Water Conservancy District and Utah State University.

6.4.10.2 The cost for this mitigation effort is minimal.
6.4.10.3 The benefit will range from hundreds of thousands of dollars to millions of dollars.
6.4.10.4 The benefit to cost ratio is almost infinite

6.4.11 Infestation

6.4.11.1 Problem Statement

The history of insect infestation in Utah has been so dramatic that it is the subject of movies and even the naming of a certain type of cricket the "Mormon Cricket". The cost to agriculture can run into the millions of dollars. Today, with the development of residential areas overtaking previous agricultural areas the danger has diminished but is not totally eradicated. Salt Lake County Emergency Management will conduct a special educational program for jurisdiction emergency managers to introduce them to the State and Federal officials who stand ready to assist them with infestation problems. Keynote speakers from the US Department of Agriculture will explain best practices for mitigating infestation that the emergency managers can incorporate into their

emergency mitigation strategies.

By John Hollenhorst

Taken from KSL.com May 29th, 2012 @ 8:06pm

> A single Mormon cricket is not really a problem. But by the billions, they'll eat anything. They'll eat anything. Grass, crops, sagebrush - even laundry on the clothesline. A few years ago, there were infestations of crickets so dense, they made the land crawl, and your flesh along with it. That's what portions of Central Utah had a few weeks ago. "It was the worst infestation we've had since 2004," said Greg Abbott with the U.S. Dept. of Agriculture. "We were afraid they were going to get away from us." Curt Gentry has been riding the range in Beaver County, spreading poison baited with apple pulp. It's to protect ranches and farms from the crickets' voracious appetite. "The farmers are very happy when we keep it away out of their hay fields," Gentry said. "Especially if it's been fresh planted. Like oats, for example. They're very tender and that's just like ice cream to the crickets." Within minutes, the poison bait has the crickets in their death throes. This method is being used on the margins of the infestation. But the most effective battle tactic has been aerial spraying over the last month. That's happened over 56,000 acres that were hardest hit by the infestation. It's hard to find a live cricket there now.

6.4.11.2 The cost for this mitigation effort is minimal.
6.4.11.3 The benefit will range from hundreds of thousands of dollars to millions of dollars.
6.4.11.4 The benefit to cost ratio is almost infinite

6.4.12 Radon

6.4.12.1 Problem Statement

- Radon kills 21,000 people per year. (American Lung Association)
- Radon is the #1 cause of lung cancer for nonsmokers.
- A radon level of 15 pCi/L is equivalent in lung damage to each person living within a household smoking a pack of cigarettes per day. (Radon Measurement & Elimination Services)
- Utah has one of the lowest rates of smoking in the country, but lung cancer is still the leading cause of cancer death.

When radon becomes trapped in buildings and homes, people breath the radon into their lungs and the gas becomes trapped. The Environmental Protection Agency (EPA) has determined that a level of 4.0 piC/L action level of radon is dangerous for human health. Utah Radon Levels are at or above this level on average. Radon continues to break down over time because of environmental interactions with other chemicals. When radon breaks down it releases harmful cancer causing chemicals into the lungs. The chemicals wear down the lungs over time and cause lung cancer. At a 4.0 piC/L action level or above, the risk increases because of the high concentration of cancer causing chemicals in the home for people to breath in. However, radon exposure is preventable.

Salt Lake County Emergency Management will conduct a half day seminar to help emergency managers educate their citizens in procuring radon testing kits. A presentation from the Salt Lake County Health department will be made. The course will cover the steps for citizens when they purchase the radon test kit:

Step 1: Purchase a radon test kit. You can purchase a kit from:

- Hardware stores (may have additional lab fee; read label carefully)
- Online from the Utah Department of Environmental Quality

Step 2: Follow the instructions. Place kit in lowest level of your home that you live in.
Close windows and doors for 12 hours before test and limit traffic in the room.
Do not place in rooms like bathrooms, play rooms, kitchens, or laundry rooms.
Step 3: Mail kit to the lab. Please be aware that some kits charge a lab fee. Read the instructions and disclaimer before purchasing.
Step 4: Interpret your results. A level of 4.0 pCi/L or higher is considered harmful to your health. Consult a mitigation professional for prices and ways to fix the problem. The Utah Department of Environmental Quality has this list.

6.4.12.2 The cost for this mitigation effort is minimal.
6.4.12.3 The benefit will range from hundreds of thousands of dollars to millions of dollars in the potential reduction of healthcare costs.
6.4.12.4 The benefit to cost ratio is almost infinite

6.4.13 Problem Soils

6.4.13.1 Problem Statement

Salt Lake County is prone to areas of collapsible soil.
Salt Lake County Emergency Management will conduct a half-day seminar with the authors of the book *Geologic Hazards of the Magna Quadrangle, Salt Lake County, Utah,* authored Jessica J. Castleton, Ashley Elliott, Greg N. McDonald for emergency managers to determine testing and mitigation techniques that can be implemented.

6.4.13.2 The cost for this mitigation effort is minimal.
6.4.13.3 The benefit will be approximately hundreds of thousands of dollars.
6.4.13.4 The benefit to cost ratio is almost infinite

6.5 Technological Hazards

Used in conjunction and with permission from the State of Utah

6.5.1 Technological Hazards Profile

Technological hazards are those caused by tools, machines, and substances that are used every day. The major technological hazards that will be discussed in this section are Hazardous Materials and Radiological Accidents.

Hazardous Materials refers generally to hazardous substances: petroleum, natural gas, synthetic gas, and acutely toxic chemicals. The term Extremely Hazardous Substance (EHS) is used in Title III of the Superfund Amendments and Reauthorization Act of 1986 to refer to those chemicals that could cause serious health effects following short-term exposure from accidental releases.
With the passage of the Federal Emergency Planning and Community Right-To-Know Act (EPCRA) in 1986, the division began implementation of a statewide Hazardous Materials Emergency Planning Program. For the first time, passage of the Emergency Planning and Community Right-to-Know Act allowed emergency planners, responders, and the public access to facility-specific information regarding the identification, location, and quantity of particular hazardous materials at fixed sites.

The law requires facilities with threshold quantities of federally mandated substances to report annually to State and local emergency officials. In addition, facilities must immediately notify officials of any releases of harmful chemicals that have the potential to result in offsite consequences. This information is utilized to prepare emergency plans for hazardous materials incidents, to allow responders to receive training based on specific known threats, and to inform and educate the public regarding the chemicals present in their communities.
Salt Lake County has more than 320 fixed facility (2014) locations that report the presence of an Extremely Hazardous Substance in federally mandated threshold amounts. (Utah DEQ, Environmental and Remediation Response)

Currently, Salt Lake County does not have nuclear power generating facilities. However, radiological accidents can still occur through the transportation of radioactive material.

6.5.1.1 Previous Occurrences

In 2009, approximately 212 incidents in Utah involving hazardous materials reported occurred, according to the U.S. DOT's Pipeline and Hazardous Materials Safety Administration. Highway incidents accounted for 193 reported incidents. Utah ranked 42nd in number of incidents reported in 2009. The following table shows the year (2005-2009), number of incidents, and the State's ranking. The number of events and the State's ranking has remained consistent since 2000. We were unable to separate this strictly into Salt Lake County incidents and ranking.

Year	Number of Incidents	State Ranking
2005	218	26th
2006	312	24th
2007	338	23rd
2008	274	25th
2009	212	42nd

Table 6.5.1 Hazardous Materials Reports – Utah – 2005 - 2009
***http://www.phmsa.dot.gov/portal/site/PHMSA*.**

6.5.1.2 Current and Future Exposures

Hazardous Materials

Major disasters like that in Bhopal, India, in December 1984, which resulted in 2,000 deaths and over 200,000 injuries, are rare. Reports of hazardous material spills and releases, however, are increasingly commonplace. Thousands of new chemicals are developed each year. Major chemicals spills can occur at any facility that produces, uses, or stores chemicals. These include chemical manifesting plants, laboratories, shipyards, railroad yards, warehouses, or chemical disposal areas. Illegal dumpsites can appear anywhere. Recent evidence shows that hazardous materials incidents may be the most significant threat facing local jurisdictions.

Radiological Accidents

The transportation and disposal of radioactive materials and waste creates problems because of the long life of radioactive materials.

6.6 Man-made Hazards Profile

Other manmade hazards include those hazards caused by direct human intervention and create a potential threat to the health, safety, and welfare of citizens. The major manmade hazards that will be discussed in this section are civil disturbances, mass immigration, and terrorism.

6.6.1 Civil Disturbances

Civil disturbances are public crises that occur with or without warning and that may adversely impact significant portions of the population. These disturbances may be the actions of any number of persons causing disruption of the populace.

6.6.2 Mass Casualty Incidents

Mass Casualty Incidents occur as the result of injuries or death to numerous individuals at the same time. Examples include massive building structural failure, airplane crashes, bus crashes, train derailments, and multiple collisions on interstate highways.

6.6.2.1 Current and Future Exposure

Human-caused hazards can and do occur anywhere and at any time. In most cases they result in injuries, possible loss of life, and the threat of further violence or consequences. Because of the importance of international tourism and trade to Salt Lake County's economy and central office of the LDS Church, the threats of manmade hazards in Salt Lake County will continue to exist. Local, State, and Federal law enforcement officials continually monitor suspended terrorists and threats of mass immigration and civil disturbances.

6.6.3 Terrorism

Terrorism is defined in the Code of Federal Regulations as "the unlawful use of force and violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives." It is the use of force or violence against persons or property in violation of the criminal laws of the United States for purposes of intimidation, coercion, or ransom.

If a terrorist incident occurs in a city or county, communities may receive assistance from both State and federal agencies under the existing Integrated Emergency Management System.
The U.S. Department of Homeland Security (DHS) is the lead federal agency for supporting State and local response to the consequences of terrorist attacks. Terrorism is often categorized as "domestic" or "international."

Domestic terrorism involves groups or individuals whose terrorist activities are directed at elements of our government or populations without foreign direction.

International terrorism involves groups or individuals whose terrorist activities are foreign-based and/or directed by countries or groups outside the United States or whose activities transcend national boundaries.

This distinction refers not to where the terrorist act takes place, but rather to the origin of the individuals or groups responsible. For example, the 1995 bombing of the Murrah Federal Building in Oklahoma City was an act of domestic terrorism, but the attacks of September 2001 were international in nature.

For the purposes of consequence management, the origin of the perpetrator(s) is of less importance than the impacts of the attack on life and property; thus, the distinction between domestic and international terrorism is less relevant for the purposes of mitigation, preparedness, response, and recovery than for understanding the capabilities of terrorist groups and how to respond to the impacts they generate.

Before the September 11, 2001, attacks in New York, the Pentagon, and Pennsylvania, most terrorist incidents in the United States had been bombing attacks, involving detonated and un-detonated explosive devices, tear gas, and pipe and fire bombs. The effects of terrorism can vary significantly from loss of life and injuries to property damage and disruptions in services such as electricity, water supply, public transportation, and communications. One way governments attempt to reduce vulnerability to terrorist incidents is by increasing security at airports and other public facilities that could be considered potential targets.

While we can never predict what target a terrorist will choose, we do know some of the factors they use when selecting one. Terrorists want to achieve one or more of the following:

- Produce a large number of victims
- Attack places that have symbolic value

- Get the greatest possible media attention
- Produce mass panic

Terrorists also select targets best suited for the type of weapon being used. For example, some biological agents are not effective in sunlight. Most chemical agents are more effective indoors with limited airflow. Radioactive material will be most effective where large numbers of people will pass close by without detecting it. Terrorists are likely to target heavily populated, enclosed areas like stadiums, government buildings, sporting events, airport terminals, subways, shopping malls, and industrial manufacturing facilities.

A terrorist attack can take several forms, depending on the technological means available to the terrorist, the nature of the political issue motivating the attack, and the points of weakness of the terrorist's target. Other possibilities include an attack at transportation facilities, an attack against utilities or other public services, or an incident involving chemical or biological agents.
As part of a terrorism risk assessment we can assume the results can be:

- Disruption of government and private industry operations and impact our economy and society
- Large-scale human casualties, property destruction, and damage to national prestige and public confidence

6.6.3.1 Terrorism in Utah

As with most states, Utah considers itself to be vulnerable to terrorism because the chief objective of a terrorist is to spread fear and create economic damage.

The open availability of basic shelf-type chemicals and mail order biological research materials, coupled with access to even the crudest laboratory facilities, could enable the individual extremist or an organized terrorist faction to manufacture highly lethal substances or to fashion less sophisticated weapons of mass destruction. The use of such weapons could result in mass casualties and long-term contamination, and could wreak havoc to both the State and national economies.

Unlike natural disasters, there are relatively few methods to predict the time or place of a Weapon of Mass Destruction (WMD)/terrorist event. This fact negates the "watch" and "warning" time phases. The action phases for a WMD/terrorist event will be Mitigation, Prevention, Response, and Recovery.

- Prevention Phase:
    - The actions during this phase are those taken by local, State, and federal law enforcement agencies to monitor and coordinate intelligence and other potential indicators to prevent, defend against, prepare for, and mitigate the impacts of terrorist attacks against our nation.
    - The State utilizes intelligence provided by Fusion Centers, Joint Terrorism Taskforces, and Regional Domestic Security Taskforces.

- Mitigation Phase:

  - The actions during this phase are those that require time to carry out. They include mitigation, training, planning, public awareness, and any activities that require long-term programs to accomplish their objectives.
  - These pre-disaster activities take place in the normal living and working environments of the participants.

- Response Phase:
  - The actions taken during this phase are those emergency response activities that must take place during the first 72 hours to a few weeks after the incident.
  - These actions have the major goal of saving lives, alleviating suffering, and preventing further disaster.
  - When responding to disaster events, the National Incident Management System (NIMS) will be used by trained/qualified staff to manage the response actions.

- Recovery Phase:
  - The actions during this phase are those taken during the first one to two months after the incident.
  - These actions, which begin immediately after the emergency response operations, have the goal of returning the State and citizens to normal conditions.
  - The emphasis will pass from life-saving to cleanup of the affected areas and a return to normal activities.

The Utah Statewide Information & Analysis Center (SIAC) is a public safety partnership designed to appropriately collect, analyze, and disseminate intelligence to enhance the protection of Utah's and Salt Lake County's citizens, communities, and critical infrastructure. SIAC is located within Salt Lake County.

The SIAC is the State's and County's intelligence fusion center: a collaborative effort of two or more agencies that provide resources, expertise and information for analysis, with the goal of maximizing their ability to detect, prevent, investigate, and respond to criminal and terrorist activity.
The SIAC has three major operational areas:

- Intelligence Analysis and Investigative Case Support
- The Intelligence Liaison Officer Program
- Critical Infrastructure Protection

The SIAC keeps a list of State Critical Infrastructure and Key Resource (CI/KR) locations within the State that they determine to be a credible target of a terrorist event. The data and details of these structures cannot be provided within the mitigation plan due to the sensitivity of the data. Structures selected to the CI/KR list are eligible for additional government grant funding to increase their security against a terrorist event. One example of funding for which CI/KR sites qualify is the Buffer Zone Protection Program (BZPP).

6.6.3.2 Weapons of Mass Destruction (WMD)

Nuclear, Biological, and Chemical

Weapons of mass destruction are defined as (1) Any destructive device as defined in 18 U.S.C., Section 2332a, which includes any explosive, incendiary, or poison gas, bomb, grenade, or rocket having a propellant charge of more than four ounces, missile having an explosive or incendiary charge of more than one quarter ounce, mine or device similar to the above; (2) Poison gas; (3) Any weapon involving a disease organism; or (4) Any weapon that is designed to release radiation or radioactivity at a level dangerous to human life.

Although bombs are still the weapon of choice for most terrorists, many are beginning to use nuclear, biological, and chemical weapons for their terrorist acts. The ways they spread these contaminants vary by the type used. For an attack on a wider area, terrorists may use crop dusting techniques or introduce the agent into the heat and air conditioning system of a building. They may use an explosive device, breaking device, or fan. The terrorist's goal is to reach the maximum number of people with the minimum amount of nuclear, biological, or chemical material.

6.6.3.3 Weapons of Mass Destruction-Nuclear

Man-made radiation comes from medical devices, like x-ray machines, and also from nuclear power plants. There are low levels of radiation exposure present in the everyday environment, but the danger in a nuclear terrorist attack comes with the amount and type of radiation given off.
Effects
The effects of a nuclear attack depend on how much radiation is received, how long someone is exposed to the radiation, and how the radiation entered the body. For example, there would be a difference in the effects if someone drank radiation-contaminated water or if they were in the path of a nuclear explosion.

How radiation enters the body:

- Breathing it in.
- Swallowing contaminated food or water.
- Absorbed through the skin.
- Penetrating radiation that affects organs and blood.

Symptoms

Signs and symptoms of radiation exposure depend on the amount of radiation received and the length of exposure. Victims exposed to deadly or extremely high doses of radiation in a short period of time – seconds to minutes – will display symptoms you can recognize.

- Burned, reddened skin.
- Nausea, vomiting, diarrhea.
- Hair loss.
- Convulsions and unconsciousness.
- Death.

Exposure to non-deadly doses may produce similar symptoms but may take longer to show up. Exposure to low doses of radiation will take 15 – 20 years for the medical effects, such as vision loss and cancer, to appear. Radiation also affects people differently depending on their age, gender, and overall health. Other health effects include:

- Brain swelling.
- Blood chemistry changes.
- Internal organ and tissue damage

Indicators of a Nuclear Attack

Nuclear attacks are very dangerous because radiation is invisible and odorless, and requires special devices for detection. Unless a sign saying radioactivity is present or a nuclear explosion is witnessed, it is almost impossible to know that radiation is present or that people may have been exposed. Victims of this type of attack can often survive, provided they are quickly decontaminated (washed or cleaned off) and medically treated as soon as possible.

6.6.3.4 Weapons of Mass Destruction—Biological

Biological agents are actually living organisms or the products of living organisms and they can be deadly. Biological agents can go undetected for hours to days. Signs and symptoms might initially look like a bad cold, flu, or other common illness. Some agents can be extremely lethal in very small quantities. Biological weapons fall into three categories: bacteria, viruses, and toxins with bacteria. All three types can potentially be deadly.

Effects

Bacteria and viruses cause diseases such as anthrax, smallpox, and cholera. Toxins are poisonous products of living organisms. Examples include snake and scorpion venom and food poisoning, which are caused by a bacteria-produced toxin.

How biological agents enter the body:

- Breathing it in.
- Breaks in the skin.
- Injection.
- Eating or drinking

Symptoms

Signs and symptoms are different for each agent, and each agent will affect people differently. Young children, elderly, and chronically ill victims are more likely to be severely affected by these agents. Some common general symptoms may include:

- Coughing and flu-like symptoms.
- Shortness of breath.
- Weakness or fatigue.
- Vomiting.
- Diarrhea.

Indicators of a Biological Attack

Biological agents can take hours or days to produce an effect and make people sick. If the agent is contagious and the victims are experiencing flu symptoms, those people could infect others without knowing they had been exposed. Victims can survive in most cases, as long as they are identified in time and medically treated.

6.6.3.5 Weapons of Mass Destruction—Chemical

Chemical warfare agents are substances specifically designed to kill, seriously injure, or disable people. They can be similar to many household chemicals such as insect killers, but are hundreds of times more hazardous. In general, terrorists use chemical agents because they are relatively easy and cheap to make. They work very fast – within minutes – and will cause mass injury, panic, and death using very small amounts. These agents were originally designed for military use as weapons of war. Their use in World War I and other combat situations proved their effectiveness, which is what attracts terrorists.

Effects

Most chemical agents, depending on their type, concentration, and length of exposure, can be deadly. Some attack the central nervous system, like nerve gas and incapacitating agents. Some, such as blood and choking agents, attack the respiratory system. Blistering agents and riot control agents affect the skin, eyes, and mucous membranes by direct contact. Blister and riot control agents such as tear gas, mace, and pepper sprays can also affect the respiratory system. Some of these chemical agents, with slight modifications, have industrial or commercial applications. For example, the same chlorine used to disinfect swimming pools was the first chemical warfare agent used in World War I as a choking agent.

How chemical agents enter the body:

Breathing it in.

- Direct contact with skin and eyes.
- By eating or drinking.
- Symptoms

Each chemical agent has different effects on people depending on the amount and duration of exposure, how it gets into the body, and its concentration. However, in general, people exposed to these chemical agents will share common physical signs and symptoms.

- Red or irritated eyes and skin.
- Choking and coughing.
- Shortness of breath or tightening of the chest.
- Vomiting and nausea.
- Runny nose.
- Dizziness or loss of consciousness.
- Convulsions or seizures.
- Pinpointed pupils and dimness of vision.

Unlike nuclear and biological materials, some chemical agents tend to cause symptoms in people in seconds to minutes. Some of these symptoms are similar to a heart attack or other illness. However, if you see several people in an area with the same signs and symptoms, it is highly unlikely that they are all having a heart attack. It is possible they have been exposed to a chemical agent.

6.6.4 Previous Domestic Terrorism Occurrences

6.6.4.1 Eco-Terrorism

Eco-terrorism usually refers to acts of terrorism, violence or sabotage committed in support of ecological, environmental, or animal rights causes against persons or their property.
Under the Animal Enterprise Protection Act of 1992 it became a federal crime to "cause more than $10,000 in damage while engaged in "physical disruption to the functioning of an animal enterprise by intentionally stealing, damaging, or causing the loss of any property…used by the animal enterprise." In 2006, this was updated and renamed the Animal Enterprise Terrorism Act by the 109th congress. The updated act included causing personal harm and the losses incurred on "secondary targets" as well as adding to the penalties for these crimes.

In 2009 two animal rights activists were arrested under the Animal Enterprise Terrorism Act in connection to the release of mink from Utah fur farms. The crimes are attributed to the Animal Liberation Front, which the FBI labels the "number one domestic terrorism threat". There have been several documented occurrences of Eco Terrorism in Salt Lake County with at least one occurrence in South Jordan Utah in 2008, and one in Unincorporated Salt Lake County in 2009.

6.6.4.2 Probability of Future Terrorism Events

There is no sure way to predict future terrorism events. The probability of a major terrorist event in Salt Lake County is perceived to be low, but planning must be done as part of the larger national Homeland Security initiatives. The SIAC and local government play a large role in providing the State and County with critical intelligence and serve as a prevention measure to the State.

6.6.4.3 Other Hazard Vulnerability Analysis for State Facilities and Assets

In 2010 the SHMPAT provided the following details analyzing other hazards for vulnerability to State facilities and assets.
Utah recognizes that it is vulnerable to other hazards, such as terrorism and technological and man-made events. A high-level detailed risk assessment was not completed due to the low level of risk and lack of information for these compared to other hazards (earthquake and flood).
In a broad based analysis, the following state assets have been identified as potentially vulnerable to terrorism:

- Water: such as lakes and reservoirs;
- Dams (federal, state and privately owned)
- Canals, pipelines, and levees
- Highways, airports, public roads, and bridges
- Agriculture: farms
- Finance: commercial banks; credit unions

- Oil and Natural Gas; hazardous liquid pipelines, refineries and terminal facilities
- Electrical Power: private and local power plans; and
- Chemical "high risk" facilities

Hazard	Application Mode	Hazard Duration	Extent of Effects: Static/Dynamic	Mitigating and Exacerbating Conditions
Conventional Bomb	Detonation of explosive device on or near target; delivery via person, vehicle, or projectile	Instantaneous; additional secondary devices may be used lengthening the time duration of the hazard until the attack site is determined to be clear	Extent of damage is determined by type and quantity of explosive. Effects generally static other than cascading consequences, incremental structural failure, etc.	Energy decreases logarithmically as a function of distance from seat of blast. Terrain, forestation, structures, etc can provide protection by absorbing and/or deflecting energy and debris. Exacerbating conditions include ease of access to target; lack of barriers/shielding poor construction; and ease of concealment of device.
Chemical Agent	Liquid/aerosol contaminants can be dispersed using sprayers or other aerosol generators; liquids vaporizing from puddles/containers; or munitions	Chemical agents may pose viable threats for hours to weeks depending on the agent and the conditions in which it exists.	Contamination can be carried out of the initial target area by persons, vehicles, water, and wind. Chemicals may be corrosive or otherwise damaging over time if not remediated.	Air temperatures can affect evaporation of aerosols. Ground temperatures affect evaporation of liquids. Humidity can enlarge aerosol particles, reducing inhalation hazard.

				Precipitation can dilute and disperse agents, but disperse vapors can also enlarge target area. The micro-meteorological effects of buildings and terrain can alter travel and duration of agents. Shielding in the form of sheltering in place can protect people and property from harmful effects.
Biological Agent	Liquid or solid contaminants can be dispersed using sprayers/aerosol generators or by point or line sources such as munitions, covert deposits and moving sprayers.	Biological agents may pose viable threats for hours to years depending on the agent and the conditions in which it exists.	Depending on the agent used and the effectiveness with which it is deployed, contamination can be spread via wind and water. Infection can also be spread via human or animal vectors.	Altitude of release agent used and the effectiveness with which it is deployed, contamination can above ground can affect dispersion; sunlight is destructive to many bacteria and viruses; light to moderate winds can break up aerosol clouds; the micro-meteorological effects of buildings and terrain can influence

				aerosolization and travel of agents.
Radiological Agent	Radioactive contaminants can be dispersed using sprayers/aerosol generators, or by point of line sources such as munitions, covert deposits and moving sprayers.	Contaminants may remain hazardous for seconds to years depending on material used.	Initial effects will be localized to site of attack; depending on meteorological conditions, subsequent behavior or radioactive contaminants may be dynamic.	Duration of exposure, distance from source or radiation, and the amount of shielding between source and target determine exposure to radiation.
Nuclear Bomb	Detonation of nuclear device underground, at the surface, in the air or at high altitude.	Light/heat flash and blast/shock wave lasts for seconds; nuclear radiation and fallout hazards can persist for years. Electromagnetic pulse from a high-altitude detonation lasts for seconds and affects only unprotected electronic systems.	Initial light, heat, and blast effects of a subsurface, ground or air burst are static and are determined by the device's characteristics and employment; fallout of radioactive contaminants may be dynamic depending on meteorological conditions.	Harmful effects of radiation can be reduced by minimizing the time of exposure. Light, heat, and blast energy decreases logarithmically as a function of distance from seat of blast. Terrain, forestation, structures, etc. can provide shielding by absorbing and/or deflecting radiation and radioactive contaminants.

Table 6.6.4 Assessing Vulnerability –Hazard

6.6.5 Technological and Man-made Strategies

The State of Utah, SLCo EM and partners in the terrorism and response sector worked together to develop strong, yet realistic mitigation strategies for technological and man-made disasters. The effects of terrorism can vary significantly from loss of life and injuries to property damage and disruptions in services such as electricity, water supply, public transportation, and communications. In that respect, preparation for terrorist events is similar to any other disaster. Mitigation efforts for other hazards will also help to prevent damage from terrorist incidents as well. This "all-hazards" mitigation approach builds upon existing programs that mitigate other natural and technological hazards while focusing on security of the public. With this "all-hazards" approach in mind, the State and communities can and should:

#1 Priority Goal: Recognize facility vulnerabilities throughout the State
A. Objective: Establish ways to identify and fund structural mitigation measures.

Possible projects:
1. Provide SIAC information and data supporting all-hazard mitigation efforts in for their assessment software
2. Encouraging tying into PDM funds to enhance structural mitigation measures on vulnerable State and local facilities.
Responsible agencies:
State government to identify structural mitigation measures
Local and State government to apply for grant opportunities
B. Objective: Assess and enhance security measures at critical facilities
Possible Projects:
1. All-hazard risk assessment information when updating security measures
2. Provide funding through Homeland Security grants to fund projects
Responsible agencies:
State government to identify structural mitigation measures
Local and State government to apply for grant opportunities

#2 Priority Goal: Reduce risk from bomb blast and nuclear, biological, and chemical attacks to critical state facilities and population.
A. Objective: Review state and local technological manmade response and recovery plans
Possible Projects:
1. Encourage local governments to review technological manmade hazards plans and include risk analysis and mitigation measures in their regional/local hazard mitigation plans
Responsible agencies:
State government to identify mitigation measures
Local and State government to apply for grant opportunities
B. Objective: Identify other plans and studies to assist with risk assessment

Possible Projects:
1. Develop a secure technological and manmade library for plans
2. Work with private sector to gather risk assessment date
Responsible agencies:
State government to identify plans
Local and State government to apply for grant opportunities

#3 Priority Goal: Enhance outreach and partnerships with state and local agencies
A. Objective: Include non-traditional institutions, agencies, commissions, etc., that are impacted by technological and manmade hazard in state and local mitigation plan development
Possible Projects:
1. Include private sector representative on the State Hazard Mitigation Team
2. Include higher education on the State Hazard Mitigation Team
Responsible agencies:
State government to identify outreach and partnership opportunities
Local and State government to apply for grant opportunities
Possible funding will be evaluated at the local level with support from State and federal government programs.

6.6 Action Plan Progress from the 2009 Wasatch Front Plan

Each Jurisdiction has reviewed the mitigation strategies and plans from the 2009 Wasatch Front Plan. Their individual actions as to whether the plans were completed, still in need of action and included in this plan's mitigation strategies, or irrelevant are located in each jurisdiction's annex. The table was devised by South Jordan's Emergency Manager Dustin Lewis to review the progress on the 2009 plans for each jurisdiction.

7 Plan Implementation & Maintenance

7.1 Update Process Summary

Evaluating, updating and monitoring this plan are critical to maintaining its value and success in the County's hazard mitigation efforts. Salt Lake County has made dramatic strides in moving from a Wasatch Front Hazard Centric effort to a county and jurisdiction specific hazard centric format.

The basis for the initial review of this updated plan was the Wasatch Front Natural Hazards Pre-Disaster Mitigation Plan December 2009. The plan, although approved, did not align with FEMA's desired format and its structure did not encourage each jurisdiction to evaluate the problems created by their unique hazards. Nor did it encourage each jurisdiction to evaluate its mitigation capabilities.

With the updated and completely reformatted approach in this 2014 plan both the County and the individual jurisdictions are taking a much greater ownership of their mitigation strategies and the time frame in which they must be accomplished.

Beginning in the Spring of 2015 Salt Lake County Emergency Management will take a much more proactive approach to mitigation and will be presenting monthly meetings for the dissemination of best mitigation practices. Along with these educational courses the County will be conducting a grant-writing program. Finally the County will maintain and update a monthly status table of each jurisdictions mitigation activities.

In addition the county looks forward to working with the State of Utah's mitigation team in designing a statewide program for the implementation of the best mitigation practices as listed under mitigationguide.org. This way we will be able to focus more energy over a longer period of time to accomplish far more mitigation projects.

7.2 Maintenance

7.2.1 Maintenance Schedule

Periodic monitoring and updates of this Plan are required to ensure that the goals and objectives for the Region are kept current and that local mitigation strategies are being carried out. This Plan has been designed to be user-friendly in terms of maintenance and implementation. This portion of the Plan outlines the procedures for completing revisions and updates. The Plan will also be revised to reflect lessons learned or to address specific hazard incidents arising out of a disaster.

Annual Review Procedures

County jurisdictions will be responsible to annually review the mitigation strategies described in this Plan, as required by the Utah Division of Emergency Management (UDEM), or as situations dictate such as following a disaster declaration. The process will include the county organizing a Mitigation Planning committee comprised of individuals from organizations responsible to implement the described mitigation strategies. Progress toward the completion of the strategies will be assessed and revised as warranted. Each county Emergency Manager will regularly monitor the Plan and is responsible to make revisions and updates. If the participating jurisdictions or UDEM determines that a modification of the Plan is warranted, an amendment to the Plan may be initiated as described below.

Five-Year Plan Review

The entire plan including any background studies and analysis shall be revised and updated every five years by the participating jurisdictions to determine if there have been any significant changes in the region that would affect the plan. Increased development, increased exposure to certain hazards, the development of new mitigation capabilities or techniques and changes to Federal or state legislation are examples of changes that may affect the condition of the plan.

The Natural Hazard Pre-Disaster Mitigation Planning Team, with a potential membership representing every jurisdiction in Salt Lake County, will be reconstituted for the five-year review/update process. Typically, the same process that was used to create the original plan will be used to prepare the update.

Plan Amendments

The SLCo EM Hazard Mitigation Officer, Local Mitigation Committee, or Mayor/City Manager of an affected community will initiate amendments and updates to the Plan.

Upon initiation of an amendment to the plan, SLCo EM will forward information on the proposed amendment to all interested parties including but not limited to; all affected city or county departments, residents and businesses. Depending on the magnitude of the amendment, the full planning committee may be reconstituted.

At a minimum, the information will be made available through public notice in a newspaper of general circulation or on the Salt Lake County website www.slcoem.org. The review and comment period for the proposed Plan amendment will last for not less than thirty (30) days.

At the end of the comment period, the proposed amendment and all review comments will be forwarded to participating jurisdictions for consideration. If no comments are received from the reviewing parties within the specified review period, such will be noted accordingly. SLCO EM will review the proposed amendment along with comments received from other parties and submit a recommendation to the SHMO and FEMA within sixty (60) days of the end of the comment period.

In determining whether to recommend approval or denial of a Plan amendment request, the following factors will be considered:

- There are errors or omissions made in the identification of issues or needs during the preparation of the Plan; and/or
- New issues or needs have been identified which were not adequately addressed in the Plan; and/or
- There has been a change in information, data or assumptions from those on which the Plan was based.
- The nature or magnitude of risks has changed.
- There are implementation problems, such as technical, political, legal or coordination issues with other agencies.

Upon receiving the recommendation of SLCo EM, a public hearing will be held. SLCo EM will review the recommendation (including the factors listed above) and any oral or written comments received at the public hearing. Following that review, SLCO EM will take one of the following actions:

1. Adopt the proposed amendment as presented.
2. Adopt the proposed amendment with modifications.
3. Defer the amendment request for further consideration and/or hearing.
4. Reject the amendment request.

Implementation through Existing Programs

Once the Mitigation Plan is promulgated, participating cities and counties will be able to include this plan's information in existing programs and plans. These could include the General or Master Plan, Capital Improvements Plan, Emergency Operations Plan, State Mitigation Plan, City Mitigation Plans. Many of the mitigation actions developed by the cities and counties have elements of mitigation implementation including the National Flood Insurance Program (NFIP), the Utah Wildland-Urban Interface Code, the Building Code Effectiveness Grading System (BCEGS), and Community Rating System (CRS), all of which have been implemented.

7.2.2 Maintenance Evaluation Process

It will be the responsibility of the administration of each jurisdiction, as they see fit, to ensure these actions are carried out no later than the target dates unless reasonable circumstances prevent their implementation (i.e. lack of funding availability).

Funding Sources

Although all mitigation techniques will likely save money by avoiding losses, many projects are costly to implement. Salt Lake County jurisdictions shall continue to seek outside funding assistance for mitigation projects in both the pre- and post-disaster environment. This portion of the Plan identifies the primary Federal and State grant programs for participating jurisdictions to consider, and also briefly discusses local and non-governmental funding sources.

Federal Programs

The following federal grant programs have been identified as funding sources which specifically target hazard mitigation projects:

Title: Pre-Disaster Mitigation Program
Agency: Federal Emergency Management Agency
Through the Disaster Mitigation Act of 2000, Congress approved the creation of a national program to provide a funding mechanism that is not dependent on a Presidential Disaster Declaration. The Pre-Disaster Mitigation (PDM) program provides funding to states and communities for cost-effective hazard mitigation activities that complement a comprehensive mitigation program and reduce injuries, loss of life, and damage and destruction of property.

The funding is based upon a 75% Federal share and 25% non-Federal share. The non-Federal match can be fully in-kind or cash, or a combination. Special accommodations will be made for "small and impoverished communities", who will be eligible for 90% Federal share/10% non-Federal. FEMA provides PDM grants to states that—in turn—can provide sub-grants to local governments for accomplishing the following eligible mitigation activities:

- State and local Natural Hazard Pre-Disaster Mitigation Planning
- Technical assistance (e.g. risk assessments, project development)
- Mitigation Projects
- Acquisition or relocation of vulnerable properties
- Hazard retrofits
- Minor structural hazard control or protection projects
- Community outreach and education (up to 10% of State allocation)

Title: Flood Mitigation Assistance Program
Agency: Federal Emergency Management Agency
FEMA's Flood Mitigation Assistance program (FMA) provides funding to assist states and communities in implementing measures to reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes and other structures insurable under the National Flood Insurance Program (NFIP). FMA was created as part of the National Flood Insurance Reform Act of 1994 (42 USC 4101) with the goal of reducing or eliminating claims under the NFIP.

FMA is a pre-disaster grant program and is available to states on an annual basis. This funding is available for mitigation planning and implementation of mitigation measures only and is based upon a 75% Federal share/25% non-Federal share. States administer the FMA program and are responsible for selecting projects for funding from the applications submitted by all communities within the state. The state then forwards selected applications to FEMA for an eligibility determination. Although individuals cannot apply directly for FMA funds, their local government may submit an application on their behalf.

Title: Hazard Mitigation Grant Program
Agency: Federal Emergency Management Agency
The Hazard Mitigation Grant Program (HMGP) was created in November 1988 through Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistant Act. The HMGP assists states and local communities in implementing long-term mitigation measures following a Presidential disaster declaration.

To meet these objectives, FEMA can fund up to 75% of the eligible costs of each project. The state or local cost-share match does not need to be cash; in-kind services or materials may also be used. With the passage of the Hazard Mitigation and Relocation Assistance Act of 1993, federal funding under the HMGP is now based on 15% of the federal funds spent on the Public and Individual Assistance programs (minus administrative expenses) for each disaster.

The HMGP can be used to fund projects to protect either public or private property, so long as the projects in question fit within the state and local governments overall mitigation strategy for the disaster area, and comply with program guidelines. Examples of projects that may be funded include the acquisition or relocation of structures from hazard-prone areas, the retrofitting of existing structures to protect them from future damages, and/or the development of state or local standards designed to protect buildings from future damages.

Eligibility for funding under the HMGP is limited to state and local governments, certain private nonprofit organizations or institutions that serve a public function, Indian tribes and authorized tribal organizations. These organizations must apply for HMPG project funding on behalf of their citizens. In turn, applicants must work through their state, since the state is responsible for setting priorities for funding and administering the program.

Title: Public Assistance (Infrastructure) Program, Section 406
Agency: Federal Emergency Management Agency
FEMA's Public Assistance Program, through Section 406 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, provides funding to local governments following a Presidential Disaster Declaration for mitigation measures in conjunction with the repair of damaged public facilities and infrastructure.

The mitigation measures must be related to eligible disaster related damages and must directly reduce the potential for future, similar disaster damages to the eligible facility. These opportunities usually present themselves during the repair/replacement efforts.

Proposed projects must be approved by FEMA prior to funding. They will be evaluated for cost effectiveness, technical feasibility and compliance with statutory, regulatory and executive order requirements. In addition, the evaluation must ensure that the mitigation measures do not negatively impact a facility's operation or risk from another hazard.

Public facilities are operated by state and local governments, Indian tribes or authorized tribal organizations and include:

- Roads, bridges & culverts
- Draining & irrigation channels
- Schools, city halls & other buildings
- Water, power & sanitary systems
- Airports & parks

Private nonprofit organizations are groups that own or operate facilities that provide services otherwise performed by a government agency and include, but are not limited to the following:

- Universities and other schools
- Hospitals & clinics
- Volunteer fire & ambulance
- Power cooperatives & other utilities
- Custodial care & retirement facilities
- Museums & community centers

Title: Small Business Administration (SBA) Disaster Assistance Program
Agency: U.S. SBA
The SBA Disaster Assistance Program provides low-interest loans to businesses following a Presidential disaster declaration. The loans target businesses to repair or replace uninsured disaster damages to property owned by the business, including real estate, machinery and equipment, inventory and supplies. Businesses of any size are eligible, along with non-profit organizations. SBA loans can be utilized by their recipients to incorporate mitigation techniques into the repair and restoration of their business.

Title: Community Development Block Grants
Agency: US Department of Housing and Urban Development
The Community Development Block Grant (CDBG) program provides grants to local governments for community and economic development projects that primarily benefit low- and moderate-income people. The CDBG program also provides grants for post-disaster hazard mitigation and recovery following a Presidential disaster declaration.

Funds can be used for activities such as acquisition, rehabilitation or reconstruction of damaged properties and facilities and for the redevelopment of disaster areas.

State Programs

Local
Local governments depend upon local property taxes as their primary source of revenue. These taxes are typically used to finance services that must be available and delivered on a routine and regular basis to the general public. If local budgets allow, these funds are used to match Federal or State grant programs when required for large-scale projects.

Non-Governmental

Another potential source of revenue for implementing local mitigation projects are monetary contributions from non-governmental organizations, such as private sector companies, churches, charities, community relief funds, the American Red Cross, hospitals, land trusts and other non-profit organizations.

Paramount to having a Plan deemed to be valid is its implementation. There is currently no new fiscal note attached to the implementation of this Plan.

7.3 Continued Public Involvement

Throughout the planning process, public involvement has been and will be critical to the development of the Plan and its updates. The Plan will be available on the Unified Fire Authority and Salt Lake County Emergency Management websites to provide opportunities for public participation and comment. The Plan will also be available for review at the offices of Salt Lake County Emergency Management.

Salt Lake County Emergency Management has been designated as the lead agency in preparing and submitting the Salt Lake County Natural Hazards Pre-Disaster Mitigation Plan, which includes coverage for all incorporated cities and counties within Salt Lake County in addition to unincorporated areas of Salt Lake County. With limited resources, however, it becomes difficult to both identify and to individually contact the broad range of potential agencies that may stand to benefit from the Plan. This being the case, we have established the following course of action

STEP 1

SLCo EM will publicly advertise all hearings, requests for input and meetings directly related to the Natural Hazard Pre-Disaster Mitigation Planning process. Meetings of the Mitigation Planning Team where plan items are discussed and where actions are taken will not receive special notifications as they are already advertised according to set standards. All interested parties are welcome and invited to attend such meetings and hearings, as they are public and open to all.

STEP 2

The AOG has established a mailing list of many local agencies and individuals that may have an interest in the Natural Hazard Pre-Disaster Mitigation Plan. Each identified agency or person will be mailed a notice of the hearings and open houses.

STEP 3

Comments, both oral and written, will be solicited and accepted from any interested party. Comments, as far as possible, will be included in the final draft of the Plan— however SLCo EM reserves the right to limit comments that are excessively long due to the size of the plan.

STEP 4
Specific to risk assessment and hazard mitigation, needs analysis, and capital investment strategies, SLCo EM will make initial contact and solicitation for input from each incorporated jurisdiction within the region. All input is voluntary. Staff time and resources do not allow personal contact with other agencies or groups, however, comments and strategies are welcomed as input to the planning process from any party via regular mail, FAX, e-mail, phone call, etc. In addition, every public jurisdiction advertises and conducts public hearings on their planning, budget, etc. where most of these mitigation projects are initiated. Input can be received from these prime sources by the region as well.

STEP 5
The following policies will guide SLCo EM staff in making access and input to the Natural Hazard Pre-Disaster Mitigation Plan as open and convenient as possible:

Participation
All citizens of the region are encouraged to participate in the planning process, especially those who may reside within identified hazard areas. SLCO EM will take whatever actions possible to accommodate special needs of individuals including the impaired, non-English speaking, persons of limited mobility, etc.

Access to Meetings
Adequate and timely notification to all area residents will be given as outlined above to all hearings, forums, and meetings.

Access to Information
Citizens, public jurisdictions, agencies and other interested parties will have the opportunity to receive information and submit comments on any aspect of the Natural Hazards Pre-Disaster Mitigation Plan, and/or any other documents prepared for distribution by SLCo EM that may be adopted as part of the Plan by reference. SLCo EM may charge a nominal fee for printing of documents that are longer than three pages.

Technical Assistance
Residents as well as local jurisdictions may request assistance in accessing the program and interpretation of mitigation projects. SLCo EM staff will assist to the extent practical, however, limited staff time and resources may prohibit staff from giving all the assistance requested. SLCo EM will be the sole determiner of the amount of assistance given all requests.

Public Hearings
The AOG will plan and conduct public hearings according to the following priorities:

- Hearings will be conveniently timed for people who might benefit most from mitigation programs

- Hearings will be accessible to people with disabilities (accommodations must be requested in advance according to previously established policy)
- Hearings will be adequately publicized. Hearings may be held for a number of purposes or functions including: Identification and profile of hazards; developing mitigation strategies; and reviewing Mitigation Plan goals, performance and future Plans.

Future Revisions

Future revisions of the Plan shall include:

- Expanded vulnerability assessments to include flood and dam failure inundation
- Continuation of the search for more specific mitigation actions
- An analysis of progress of the plan as it is revised.
- An expanded look into how the identified natural hazards will affect certain populations including the young and elderly.

8 Plan Adoption

Each county and participating jurisdiction must adopt an updated hazard mitigation plan within five years of the previous plan approval date. This process must be thoroughly documented. Communities maintain access to all hazard mitigation grant streams by following the five-year update schedule and meeting plan adoption requirements.

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Appendix A—Glossary

Abutment (dam) – the valley side against which a dam is constructed.

Acre-foot of water – approximately 326,000 gallons of water, or approximately a football field covered by one foot of water.

Active Faults – An active fault is defined as a fault displaying evidence of displacement along one or more of its traces during Holocene time (about the last 11,000 years).

Aftershocks – earthquakes during the seconds, hours, days to months following a larger earthquake (main shock) in the same general region.

Alluvial fan – a cone-shaped deposit of stream sediments, generally deposited at the base of a mountain where a stream encounters flatter terrain.

Amplitude (seismic waves) - the maximum height of a wave crest or depth of a trough. Amount the ground moves as a seismic wave passes, as measured from a seismogram.

ATV – All Terrain Vehicle

Avalanche path – the area in which a snow avalanche runs; generally divided into starting zone, track, and runout zone.

Basin and Range physiographic province – consists of north-south-trending mountain ranges separated by valleys, bounded by the Rocky Mountains and the Colorado Plateau to the east and the Sierra-Cascade Mountains to the west (includes western Utah).

Bearing capacity – the load per unit area, which the ground can safely support without excessive yield.

Bedrock – solid in-place rock sometimes exposed and sometimes concealed beneath the soil.

Block faulting – see **normal fault**

Collapsible soil (hydrocompaction) – loose, dry, low-density soil that decreases in volume or collapses when saturated for the first time following deposition.

Critical Areas – Environmentally sensitive areas that include wetlands fish and wildlife habitat conservation areas; geologically hazardous areas; areas with a critical recharging effect on aquifers used for potable water; and frequently flooded areas. Critical areas have measurable characteristics which, when combined, create a value for or potential risk to public health, safety and welfare.

Critical/Essential Facilities – Structures meeting one or more of the following criteria:

- Fire stations, police stations, storage facilities for vehicles/equipment needed after a hazard event, and emergency operation centers.
- Hospitals, nursing homes, and housing which is likely to contain occupants who may not be sufficiently mobile to avoid injury or death as a result of a hazardous event
- Public and private utility facilities, which are vital to maintaining or restoring normal services to, damaged areas after a hazardous event.
- Structures or facilities that produce, store, or use highly flammable, explosive, volatile, toxic and/or water reactive materials

Debris flow – involves the relatively rapid, viscous flow of surficial material that is predominantly coarse grained.

Debris slide – involves predominantly coarse-grained material moving mainly along a planar surface.

Drought (Agricultural) – lack of water for crop production in a given area

Drought (Hydrologic) – lack of water in the entire water supply for a given area.

Drought (Meteorological) – lack of precipitation compared to an area’s normal

Drought (Socioeconomic) – lack of water sufficient to support an area’s population

Earth flow – Involves fine-grained material that slumps away from the top or upper part of a slope, leaving a scarp, and flows down to form a bulging toe.

Earthquake – a sudden motion or trembling in the earth as fracture and movement of rocks along a fault release stored elastic energy.

Earthquake fault zone – earthquake fault zones are regulatory zones around active faults. The zones are used to prohibit the location of critical facilities and structures designed for human occupancy from being built astride an active fault. Earthquake Fault Zones are plotted on topographic maps at a scale of 1-inch equals 2,000 feet. The zones vary in width, but average about one-quarter mile wide.

Earthquake-induced seiche – Earthquake generated water waves causing inundation around shores or lakes and reservoirs.

Epicenter – the point on the earth's surface directly above the focus of an earthquake.

Epoch – geologic time unit lasting more than an age but shorter than a period (Epoch 2008).

Erosion – the removal of earth or rock material by many types of processes, for example, water, wind, or ice action.

Expansive soil and rock – soil and rock that contain clay minerals that expand and contract with changes in moisture content.

Fault – a break in the earth along which movement occurs.

Fault segment – section of a fault that behaves independently from adjacent sections.

Fault zone – an area containing numerous faults.

Federal Emergency Management Agency (FEMA) – authorized under Section 404 of the Stanford Act. Provides funding for hazard mitigation projects that are cost-effective and comply with existing post-disaster mitigation programs and activities. These projects cannot be funded through other programs to be eligible.

Fill – material used to raise the surface of the land generally in a low area.

Fire-resistant vegetation – plants that do not readily ignite and burn when subjected to fire because of inherent physiological characteristics of the species such as moisture content, fuel loading, and fuel arrangement.

Floodplain – an area adjoining a body of water or natural stream that has been or may be covered by floodwater.

Floodplain (100-year/500-year) – Floodplains that have the potential to flood once every 100 or 500 years or that has a 1% (100-year) or 0.2% (500-year) chance of flooding equal to or in excess of that in any given year.

Floodway – An area of land immediately adjacent to a stream or river channel that, in times of flooding, becomes an enlarged stream or river channel and carries the floodwater with the highest velocity.

Fluvial – concerning or pertaining to rivers or streams.

Focus – the point of origin of an earthquake within the earth, and the origin of the earthquake's seismic waves.

Formation (geologic) – a mappable rock unit consisting of distinctive features/rock types separate from units above and below.

Frequency (seismic waves) – the number of complete cycles of a seismic wave passing a point during one second.

Fuel (fire) – vegetation, building material, debris, and other substances that will support combustion.

Fuel break – a change in fuel continuity, type of fuel, or degree of flammability of fuel in a strategically located strip of land to reduce or hinder the rate of fire spread.

Fuel type – a category of vegetation used to indicate the predominate cover of an area.

Glacial moraine – debris (sand to boulders) transported and deposited by glacial ice along a glacier's sides or terminus.

Graben – a block of earth down dropped between two faults.

Gradient (slope) – a measure of the slope of the land surface.
Ground failure – a general term referring to any type of ground cracking or subsidence, including landslides and liquefaction-induced cracks.

Ground shaking – the shaking or vibration of the ground during an earthquake.

Ground water – that portion of subsurface water that is in the zone of saturation.

Gypsiferous deposits – soil or rock containing gypsum, which can be subject to dissolution.

Gypsum – a mineral composed of hydrated calcium sulfate. A common mineral of evaporates.

Hazard Mitigation Plan – The Plan resulting from a systematic evaluation of the nature and extent of vulnerabilities posed by a hazard present in society that includes the strategies needed to minimize future vulnerability to hazards.

Hazard Mitigation – Any action taken to reduce or permanently eliminate the long-term risk to human life and property and the environment posed by a hazard.

HAZUS-MH – Hazards United States – Multi-hazards; Earthquake loss estimation software using GIS databases developed by FEMA.

Head (landslide) – the upper parts of the slide material along the contact between the disturbed material and the main scarp.

Holocene – geologic epoch covering the last 10,000 years (after the last Ice Age).

Igneous rocks – rocks formed by cooling and hardening of hot liquid material (magma), including rocks cooled within the earth (for example, granite) and those that cooled at the ground surface as lavas (such as basalt).

Impermeable – materials having a texture that does not permit water to move through.

Interfluve – land between two streams in the same drainage basin (Interfluve 2004)

Intermountain Seismic Belt (ISB) – zone of pronounced seismicity, up to 120 miles wide and 800 miles long, extending from Arizona through central Utah to northwestern Montana.

Lacustrine – concerning or pertaining to lakes.

Lake Bonneville – a large, ancient lake that existed 30,000 to 12,000 years ago and covered nearly 20,000 square miles in Utah, Idaho, and Nevada. The lake covered many of Utah's valleys, and was almost 1,000 feet deep in the area of the present Great Salt Lake.

Lake Bonneville sediments – sediments deposited by Lake Bonneville, found in the valleys, which range from gravels and sands to clays.

Landslide – a general term for a mass of earth or rock, which moves down slope by flowing, spreading, sliding, toppling, or falling (see slope failure).

Lateral spread – lateral down slope displacement of soil layers, generally several feet or more, above a liquefied layer.

Levee (flood) – a berm or dike used to contain or direct water, usually without an outlet or spillway.

Liquefaction – sudden large decrease in shear strength of a cohesionless soil (generally sand or silt) caused by collapse of soil structure and temporary increase in pore-water pressure during earthquake ground shaking.

Magnitude (earthquake) – a quantity characteristic of the amplitude of the ground motion of an earthquake. The most commonly used measurement is the Richter magnitude scale; a logarithmic scale based on the motion that would be measured by a standard type of seismograph 60 miles from the earthquake's epicenter.

Metamorphic rocks – rocks formed by high temperatures and/or pressures (for example, quartzite formed from sandstone).

Mitigation – the act of reducing or preventing hazards that affect society or those things deemed important to society

Modified Mercalli Intensity (MMI) – the most commonly used intensity scale in the U.S.; it is a measure of the severity of earthquake shaking at a particular site as determined from its effect on the earth's surface, man, and man's structures.

Montmorillonite – a clay mineral characterized by expansion upon wetting and shrinking upon drying.

Natural vegetation – native plant life existing on a piece of land before any form of development.

Normal fault (block faulting) – fault caused by crustal extension in which relative movement on opposite sides is primarily vertical; for example, the Wasatch fault.

Oolite – spherical grains of carbonate sand with a brine shrimp fecal pellet nucleus.

Outlet (dam) - a conduit through which controlled releases can be made from the reservoir.

Palmer Drought Severity Index (PDSI) – developed by Wayne Palmer in the 1965; measures drought severity using temperature, precipitation and soil moisture (Utah Division of Water Resources 2007)

Peat – unconsolidated surficial deposit of partially decomposed plant remains.

Period (geologic) – a standard (world-wide) geologic time unit.

Permeability – the capacity of a porous rock or soil for transmitting a fluid.

Physiographic province – a region whose pattern of relief features or landforms differs significantly from that of adjacent regions.

Piping (problem soil and rock) – a weak incoherent layer in unconsolidated deposits that acts as a channel directing the movement of water. As the layer becomes saturated it conducts water to a free face (cliff or stream bank for example) that intersects the layer, and material exits out a "pipe" formed in the free face. Piping can occur in a dam as the result of progressive development of internal erosion by seepage.

Pore space – the open spaces in a rock or soil between solid grains. The spaces may be filled with gas (usually air) or liquid (usually water).

Porosity – the ratio of the volume of pore space in rock or soil to the volume of its mass, expressed as percentage.

Probable Maximum Flood (PMF) – a flood that would result from the most severe combination of critical meteorological and hydrologic conditions possible in a region.

Probable Maximum Precipitation (PMP) – the maximum amount and duration of precipitation that can be expected to occur on a drainage basin.

Problem soil and rock – geologic materials that are susceptible to volumetric changes, collapse, subsidence, or other engineering geologic problems.

Project Impact – An initiative of the Federal Emergency Management Agency intended to modify the way in which the United States handles natural disasters. The Goal of Project Impact from a Federal Government perspective is to reduce the personal and economic costs of hazard events by bringing together the private and public sector to better enable the citizens of a community to protect themselves from natural hazards.

Quaternary – a geologic time period covering the last 1.6 million years.

Recurrence interval – the length of time between occurrences of a particular event (an earthquake, for example).

Rock fall – abrupt free fall or down slope movement, such as rolling or sliding, of loosened blocks or boulders from an area of bedrock. The rock-fall runout zone is the area below a rock-fall source that is at risk from falling rocks.

Rock topple – forward rotation movement of a rock unit(s) about some pivot point.

Runout zone (avalanche) – where a snow avalanche slows down and comes to rest (deposition zone). For large avalanches, the runout zone can include a powder- or wind-blast zone that extends far beyond the area of snow deposition.

Sand blow (earthquake) – deposit of sandy sediment ejected as water and sand to the surface, formed when ground shaking has caused liquefaction at depth.

Scarp – a relatively steeper slope separating two more gentle slopes. Scarps can form as result of earthquake faulting.

Sediment – material that is in suspension, is being transported, or has been moved from its site of origin by water, ice, or wind, and has come to rest on the earth's surface either above or below the sea level.

Sedimentary rocks – rocks formed from loose sediment such as sand, mud, or gravel deposited by water, ice, or wind, and then hardened into rock (for example, sandstone); or formed by dissolved minerals precipitating out of solution to form rock (for example, tufa).

Seiche – a standing wave generated in a closed body of water such as a lake or reservoir. Ground shaking, tectonic tilting, sub aqueous fault rupture, or landslides into water can all generate a seiche.

Seismic waves – vibrations in the earth produced during earthquakes.

Seismicity – seismic or earthquake activity.

Sensitive clay – clay soil that experiences a particularly large loss of strength when disturbed. Deposits of sensitive clay are subject to failure during earthquake ground shaking.

Shear strength – the internal resistance that tends to prevent adjacent parts of a solid from "shearing" or sliding past one another parallel to the plane of contact. It is measured by the maximum shear stress that can be sustained without failure.

Shear stress - a stress causing adjacent parts of a solid to slide past one another parallel to the plane of contact.

Slope failure – a general term referring to any type of natural ground movement on a sloping surface (see landslide).

Slump – a slope failure that slides along a concave rupture surface. Generally slumps do not move very far from the source area.

Snow avalanche – a rapid down slope movement of a mass of snow, ice, and debris.

Spectral Acceleration – measurement for approximate horizontal force experienced in a model earthquake. Measurements are specific to the frequency of shaking found to affect buildings during and earthquake. A 0.2-second period affects primarily one- and two-story buildings while 1.0- second period of spectral acceleration affects buildings approximately 10 stories in height.

Stafford Act – Robert T. Stafford Disaster Relief and emergency Assistance Act, PL 100-707, signed into law November 23 1988: amended the Disaster Relief Act of 1974, PL 93-288

Starting zone (avalanche) – where the unstable snow or ice breaks loose and starts to slide.

Subsidence – a settling or sinking of the earth's crust.

Sunny-day failure –

Surface fault rupture (surface faulting) – propagation of an earthquake-generated fault rupture to the ground surface, displacing the surface and forming a scarp.

Tectonic subsidence – subsidence (down dropping) and tilting of a basin on the down dropped side of a fault during an earthquake.

Toe (landslide) – the margin of disturbed material most distant from the main scarp.

Track (avalanche) – the slope or channel down which a snow avalanche moves at a fairly uniform speed.

Unconsolidated basin fill – un-cemented and non-indurated sediment, chiefly clay, silt, sand, and gravel, deposited in basins.

Urban area – a geographical area, usually of incorporated land, covered predominately by engineered structures including homes, schools, commercial buildings, service facilities, and recreational facilities.

Velocity (ground motion) – the rate of displacement of an earth particle caused by passage of a seismic wave.

Wasatch fault – a normal fault that extends over 200 miles from Malad City, Idaho to Fayette, Utah, and trends along the western front of the Wasatch Range.

Watershed – the area of land above a reference point on a stream or river, which contributes runoff to that stream.

Weathering – a group of processes (such as the chemical action of air, rain water, plants, and bacteria and the mechanical action of temperature changes) whereby rocks on exposure to the weather change in character, decay, and finally crumble into soil.

Wildfire – uncontrolled fire burning in vegetation.

Wildland area – a geographical area of unincorporated land covered predominately by natural vegetation.

Wildland Urban Interface (WUI) – Wildland vegetation and forested areas adjacent to or intermingled with residential developments.

Zone of deformation (earthquake) – the width of the area of surface faulting over which earth materials have been disturbed by fault rupture, tilting, or subsidence.

Appendix B— List of Acronyms

AARC	Average Annual Rate of Change
AGRC	Automated Geographic Reference Center
APHIS	Animal and Plant Health Inspection Service
AOG	Association of Governments
BCEGS	Building Code Effectiveness Grading System
BOR	Bureau of Reclamation
cal yr B.P.	Calendar Years Before Present
CDBG	Community Development Block Grant
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CERT	Certified Emergency Response Team
CFR	Code of Federal Regulations
CFS	Cubic Feet per Second
CRS	Community Rating System
DB	Detention Basin
DFIRM	Digital Flood Insurance Rate Map
DHLS	Division of Homeland Security
DMA 2000	Disaster Mitigation Act of 2000
EAP	Emergency Action Plan
EGSLFZ	East Great Salt Lake Fault Zone
EM	Emergency Management/Manager
EOC	Emergency Operations Center
EOP	Emergency Operations Plan
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance
G	Gravity
GIS	Geographic Information Systems
GOPB	Governor's Office of Planning and Budget
GPS	Geographic Positioning System
GSL	Great Salt Lake

HAM	Handheld Amateur Radio
HAZMAT	Hazardous Materials
HAZUS-MH	Hazards United States – Multi-Hazards
HGMP	Hazard Mitigation Grant Program
LEPC	Local Emergency Planning Committee
LUST	Leaking Underground Storage Tank
M	Magnitude
MSL	Mean Sea Level
MOU	Memoranda Of Understanding
NCDC	National Climatic Data Center
NFIP	National Flood Insurance Program
NIMS	National Incident Management System
NWS	National Weather Service
PDM	Pre-Disaster Mitigation
PDSI	Palmer Drought Severity Index
piC/L	picoCuries per Liter
PL	Public Law
PSC	Public Safety Communications
RCRA	Resource Conservation and Recovery Act
SA	Spectral Acceleration
SBA	Small Business Administration
SHELDUS	Spatial Hazard Events and Losses Database for the United States
SLC	Salt Lake City
SPI	Standardized Precipitation Index
SR	State Route
STAPLEE	Social, Technical, Administrative, Political, Legal, Economic, Environmental
SWSI	Surface Water Supply Index
TAZ	Transportation Analysis Zone
TRAX	Transit Express
TRI	Toxic Release Inventory
UCAN	Utah Communication Agency Networks
UDAF	Utah Department of Agriculture and Food
UDOT	Utah Department of Transportation
UEDV	Utah Economic Data Viewer
UFFSL	Utah Division of Forestry, Fire, and State Lands
UGS	Utah Geological Survey
USGS	United States Geological Survey

USACE	United States Army Corps of Engineers
USC	United States Code
USDA	United States Department of Agriculture
USFS	United States Forestry Service
USU	Utah State University
UUSS	University of Utah Seismic Stations
WFRC	Wasatch Front Regional Council
WFZ	Wasatch Fault Zone
WUI	Wildland-Urban Interface

Appendix C—Works Cited

Black, Bill. 1993. *Radon Hazard Potential Map of Utah*. Map 149. Salt Lake City: Utah Geological Survey. http://geology.utah.gov/maps/geohazmap/pdf/m-149.pdf (Accessed 16 April 2008).

Brough, Clayton, Dan Brown, David James, Dan Pope and Steve Summy, eds. 2007. *Utah's Tornado's and Waterspouts – 1847 to Present*. National Weather Service – Salt Lake City Weather Forecast Office, National Weather Service, National Oceanic and Atmospheric Administration, Salt Lake City, UT. http://www.wrh.noaa.gov/slc/climate/tornado.php (Accessed 16 April 2008)

Bureau of Economic Analysis (BEA). 2007. Personal Income and Per Capita Personal Income by County for Utah 2003-2005. U.S. Department of Commerce. http://www.bea.gov/bea/regional/reis/scb.cfm (Accessed 16 April 2008).

Bureau of Economic and Business Research (BEBR). 2007. Utah Construction Information Database. http://www.bebr.utah.edu/CIDB.html (Accessed 16 April 2008).

Christenson, Gary, and Lucas Shaw. 2008. Geographic Information Database Showing Geologic-Hazards Special-Study Areas, Wasatch Front, Utah. Circular 106. Salt Lake City: Utah Geological Survey.

Critchfield, Howard. 1974. *General Climatology*. 3rd edition. Englewood Cliffs, NJ: Prentice Hall.

Dai, Aiguo, Kevin E. Trenberth, and Taotao Qian. 2004. A global data set of Palmer Drought Severity Index for 1870-2002: Relationship with soil moisture and effects of surface warming. *Journal of Hydrometeorology* 5:1117-1130. *Dai Palmer Drought Severity Index data provided by the NOAA* Earth System Research Laboratory at *http://www.cdc.noaa.gov/.*

Davis County. 2003. *Davis County Emergency Operations Plan*. Davis County, UT.

Dinter, D. A., and J. C. Pechmann. 2005. Segmentation and Holocene displacement history of the Great Salt Lake fault, Utah, in Proceedings Volume, *Basin and Range Province Seismic Hazards Summit II*, W.L. Lund, ed., Utah Geological Survey, Misc. Publication 05-2.

Dunn, Lawrence B., and Steven V. Vasiloff. 2001. Tornadogenesis and operational considerations of the 11 August 1999 Salt Lake City tornado as seen from two different Doppler radars. ***Weather Forecasting16:***377–398.

Elliot, Ashley. 2007a. *The 2001 Heather Drive Landslide, Layton, Davis County, Utah*. Public Information Series 88. Salt Lake City: Utah Geological Survey. http://www.geology.utah.gov/online/pi/ pi-88.pdf (Accessed 16 April 2008).

_____. 2007b. *The 2005-06 Creekside Drive Area Landslides – Mountain Green, Morgan County, Utah.* Public Information Series 91. Salt Lake City: Utah Geological Survey. http://geology.utah.gov/online/pi/pi-91.pdf (Accessed 16 April 2008).

Environmental Protection Agency (EPA). 2006. *Excessive Heat Events Guidebook*. http://www.epa.gov/ heatisland/about/pdf/EHEguide_final.pdf (Accessed 16 April 2008).

Epoch. Merriam-Webster.com. 2008. *Merriam-Webster Online Dictionary.* Merriam-Webster, Inc. http://www.merriam-webster.com/info/copyright.htm (Accessed 16 April 2008).

Federal Emergency Management Agency. 1995. *Seismic Considerations for Communities at Risk*. FEMA Publication 83. Washington, D.C.: Building Seismic Safety Council.

_____. 2002. *State and Local Mitigation Planning, How to Guide: Understanding you Risks*. FEMA 386-1. Washington, D.C.: Federal Emergency Management Agency.

_____*. 2006. Multi-Jurisdictional Mitigation Planning*. FEMA 386-8. Washington, D.C.: Federal Emergency Management Agency. http://www.fema.gov/library/viewRecord.do?id=1905 (Accessed 16 April 2008).

Federal Insurance and Mitigation Administration (FIMA). 2002. Digital Flood Insurance Map Database, Salt Lake County, Utah. Washington, D.C.: Federal Emergency Management.

_____. 2005. Digital Flood Insurance Map Database, Weber County, Utah. Washington, D.C.: Federal Emergency Management.

_____. 2007. Digital Flood Insurance Map Database, Davis County, Utah (and Incorporated Areas). Washington, D.C.: Federal Emergency Management.

Forest Health Protection (FHP). 2008. Aerial Detection Survey-GIS. U.S. Department of Agriculture Forest Service. http://www.fs.fed.us/r1-r4/spf/fhp/aerial/gisdata.html (Accessed 16 April 2008).

Giraud, Richard, and Lucas Shaw. 2007. Landslide Susceptibility Map of Utah. Utah Geological Survey Map 228DM. http://geology.utah.gov/online/m/m-228.pdf (Accessed 16 April 2008).

Hazards & Vulnerability Research Institute (HVRI). 2007. The Spatial Hazard Events and Losses Database for the United States, Version 5.1. Columbia, SC: University of South Carolina. http://www.cas.sc.edu/geog/hrl/sheldus.html (Accessed 16 April 2008)

Hecker, Suzanne. 1993. *Quaternary tectonics of Utah with emphasis on earthquake-hazard characterization*.
Utah Geological Survey, Bulletin 127, 257 p.

Hill, Geoffrey E. 1987. Fog Effect of the Great Salt Lake. *Journal of Applied Meteorology* 27:778-783.

Hydrometeorological Design Studies Center (HDSC). 2007. NOAA Atlas 14 Precipitation Frequency Estimates in GIS Compatible Formats. National Weather Service. http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_gis.html (Accessed 11 November 2007).

Interfluve. Dictionary.com. 2004. *The American Heritage® Dictionary of the English Language, Fourth*
Edition. Houghton Mifflin Company. http://dictionary.reference.com/browse/Interfluve (Accessed: 16 April 2008).

Kaliser, B.N. 1972. *Geologic Hazards in Morgan County with Applications to Planning*. Bulletin 93. Salt
Lake City: Utah Geological and Mineralogical Survey.

Lips, Elliot. Personal Communication. 1999.
Lund, William R. 2005. *Consensus Preferred Recurrence-Interval and Vertical Slip-Rate Estimates – Review*
of Utah Paleoseismic-Trenching Data. Utah Geological Survey, Bulletin 134, Utah Quaternary Fault Parameters Working Group.

Matthews, K., V. DeBlander, L. Pederson, P.Mocettini and D. Halsey, eds. 2005. United States Department of Agriculture, United States Forest Service and Utah Division of Forestry, fire and State Lands. http://www.fs.fed.us/r1-r4/spf/fhp/conditions/2002-2004%20UTcondrpt.pdf (Accessed 16 April 2008).

McCalpin, J.P., and S.P. Nishenko. 1996. Holocene probability, temporal clustering, and probabilities
of future large (M>7) earthquakes on the Wasatch fault zone, Utah. *Journal of Geophysical Research*, 101:6233-6253.

Morgan County. 2003. *Morgan County Emergency Operations Plan*. Morgan County, UT.

Mulvey, W.E. 1992. *Soil and Rock Causing Engineering Problems in Utah*. Utah Geological Survey

Special Study 80. http://geology.utah.gov/maps/geohazmap/pdf/probsoils.pdf (Accessed 16 April 2008).

National Climatic Data Center (NCDC). 2005. Climate Atlas of the Contiguous United States. National Oceanic and Atmospheric Administration. http://cdo.ncdc.noaa.gov/cgi-bin/climaps/ climaps.pl (Accessed 16 April 2008).

National Drought Mitigation Center (NDMC). 2006. What is Drought? 15 April 2008. http://drought.unl.edu/whatis/what.htm.

National Flood Insurance Program (NFIP). 1990a. Flood Insurance Rate Map, Morgan County, Utah (and Unincorporated Areas). Washington, D.C.: Federal Emergency Management Agency.

_____. 1990b. Flood Insurance Rate Map, Tooele County, Utah (and Unincorporated Areas). Washington, D.C.: Federal Emergency Management Agency.

National Seismic Hazard Mapping Program (NSHMP). 2002. 2002 NSHMP Hazard Mapping. U.S. Geological Survey, Earthquake Hazards Program. http://earthquake.usgs.gov/research/hazmaps/interactive/cmaps/custom2002_2006.php (Accessed 16 April 2008).

National Weather Service (NWS). 1999. *Thunderstorms…Tornadoes…Lightning…Natures Most Violent Storms*. National Oceanic and Atmospheric Administration Public Awareness Brochure 99050. http://www.nws.noaa.gov/om/brochures/ttl.pdf (Accessed 16 April 2008)

_____. 2001. *Winter Storms – The Deceptive Killers*. National Oceanic and Atmospheric Administration Public Awareness Brochure 200160. http://www.weather.gov/om/winterstorm/winterstorms.pdf (Accessed 16 April 2008)

_____. 2008. Utah's Most Dangerous Weather! Salt Lake City Weather Forecast Office, National Weather Service, National Oceanic and Atmospheric Administration, Salt Lake City, UT. http://www.wrh.noaa.gov/slc/climate/DangerousWeather.php (Accessed 16 April 2008)

Peterson, Kristina J. 2005. Recovery by Design: The Ongoing Challenges Presented by Katrina and Rita. *Natural Hazards Observer*, vol. 30, 2:10-11.

Salt Lake County. 2003. *Salt Lake County Emergency Operations Plan*. Salt Lake County, UT.

Scholastic Inc. 2008. All About Winter Storms. http://teacher.scholastic.com/activities/wwatch/winter/index.htm (Accessed 16 April 2008).

Solomon, Barry, Neil Storey, Ivan Wong, Walter Silva, Nick Gregor, Douglas Wright, and Greg McDonald. 2004. *Earthquake-Hazards Scenario for a M7 Earthquake on the Salt Lake City Segment of the Wasatch Fault Zone, Utah*. Special Study 111 DM. Salt Lake City: Utah Geological Survey.

Storm Prediction Center. 2007b. The Enhanced Fujita Scale (EF Scale). National Weather Service, National Oceanic and Atmospheric Administration. http://www.spc.noaa.gov/efscale/ (Accessed 16 April 2008).

_____. 2007b. Severe Weather Database Files (1950-2006). National Weather Service. http://www.spc.noaa.gov/wcm/ (Accessed 11 November 2007).

Tooele County. 2001. *Tooele County Emergency Operations Plan*. Tooele County, UT.

United States. 1970. *Clean Air Act*. 42 United States Code. s/s 7401 et seq. 1970. http://www.access.gpo.gov/uscode/title42/chapter85_.html. (Accessed 16 April 2008)

_____. 1973. *Endangered Species Act*. 16 United States Code 1531. http://www.access.gpo.gov/uscode/title16/chapter35_.html (Accessed 16 April 2008).

_____. 1977a. *Clean Water Act*. 33 USC s/s 121 et seq. 1977. Public Law 95-217. http://www.access.gpo.gov/uscode/title33/chapter26_.html (Accessed 16 April 2008).

_____. 1977b. *Floodplain Management Executive Order No. 11988*. 42 Code of Federal Regulations 26951.
http://www.fema.gov/plan/ehp/ehplaws/attachments-laws/eo11988.pdf (Accessed 15 April 2008).

_____. 2000. *National Historic Preservation Act of 1966*. Amended 2000 [with annotations]. Pub. L. 89-665; 16 United States Code 470 et seq. http://www.access.gpo.gov/uscode/title16/ chapter1a_subchapterii_.html (Accessed 16 April 2008).

_____. *2000. Disaster Mitigation Act of 2000.* Public Law 106-390; 42 USC 5121 note. http://www.fema.gov/library/viewRecord.do?id=1935 (Accessed 16 April 2008)

_____. 2002. *Hazard Mitigation Planning and Hazard Mitigation Grant Program*. 44 Code of Federal
Regulations. Parts 201 and 206. , Federal Register Interim Final Rule. Federal Emergency Management Agency. 26 February 2002.

United States Census Bureau (USCB). 2004. Residence County to Workplace County Flows for Utah. http://www.census.gov/population/www/cen2000/commuting.html#UT (Accessed 16 April 2008).

United States Geological Survey (USGS). 1999. Geologic Time: Major Divisions of Geologic Time. http://pubs.usgs.gov/gip/geotime/divisions.html (Accessed 16 April 2008).

_____. 2006. Utah Interactive State Basins Map. http://ut.water.usgs.gov/Basins/index.html (Accessed 16 April 2008).

University of Utah Seismograph Stations (UUSS). 2007. Utah Region Earthquake Listings, 1962-Present. http://www.quake.utah.edu/EQCENTER/LISTINGS/utahregion.htm (Accessed 16 April 2008).

Utah Avalanche Center (UAC). 2008. Frequently Asked Questions. U.S. Forestry Service. http://www.avalanche.org/~uac/ed-faq.htm (Accessed 15 April 2008).

Utah Department of Agriculture and Food (UDAF). 2007a. *2007 Insect Report*. http://ag.utah.gov/plantind/2007InsectReport.pdf (Accessed 16 April 2008).

_____. 2007c. Grasshopper/Mormon Cricket Data. Salt Lake City: UDAF.

_____. 2007b. Gypsy Moth Trap Data. Salt Lake City: UDAF.

Utah Department of Transportation (UDOT). 2006. Traffic Volume Maps - Traffic Maps for 2005. Utah
Department of Transportation: Data Analysis Unit. http://www.udot.utah.gov/main/f?p=100:pg:4873862879722483966:::1:T,V:1616, (Accessed 16 April 2008).

Utah Department of Workforce Services (UDWS). 2006. Utah Economic Data Viewer – County and Statewide Information. http://jobs.utah.gov/jsp/wi/utalmis/gotoCounties.do (Accessed 16 April 2008).

_____. 2007a. Davis County Largest Employers – Annual Average 2006. Workforce Information. http://jobs.utah.gov/opencms/wi/regions/northern/davis/davisme.pdf (Accessed 16 April 2008).

_____. 2007b. Morgan County Largest Employers – Annual Average 2006. Workforce Information. http://jobs.utah.gov/opencms/wi/regions/northern/morgan/morganme.pdf (Accessed 16 April 2008).

Utah Division of Comprehensive Emergency Management (UDCEM). 1991. *Utah Natural Hazards Handbook*. Utah Natural Hazards Training Workshop, July 1991.

Utah Division of Forestry, Fire and State Lands (UDFFSL). 2003. *Forest Health in Utah*. Utah Department of Natural Resources, June 2003. http://www.ffsl.utah.gov/foresthealth/fhgov4a.pdf (Accessed 16 April 2008).

_____. 2007. Northern Utah Regional Wildfire Protection Plan. http://www.utahfireinfo.gov/CWPP/northernutah/FINAL_Northern_UT%20RWPP.pdf (Accessed 16 April 2008)

Utah Division of Radiation Control (UDRC). 2006. Test Results by ZIP code – Long Term Results by ZIP Code. http://www.radon.utah.gov/test_results.htm (Accessed 16 April 2008).

_____. 2008a. Radon Overview. http://www.radon.utah.gov/ (Accessed 16 April 2008).

_____. 2008b. Radon Techniques for New Home Construction. http://www.radon.utah.gov/builder.htm (Accessed 16 April 2008).

Utah Division of Water Resources. 2007. *Drought in Utah: Learning from the Past – Preparing for the Future*. Utah State Water Plan. April 2007.

_____. 2007b. Great Salt Lake Pumping Project. http://www.water.utah.gov/construction/gsl/gslpage.htm (Accessed 16 April 2008).

Utah Division of Water Rights. 2007. WRDAMS - Point Shapefile of Dam database. http://utstnrwrt6.waterrights.utah.gov/Downloads/wrdams.exe (Accessed 16 April 2008)

Utah Geological Survey (UGS). 1996. *The Wasatch Fault*. Public Information Series 40. http://geology.utah.gov/online/pdf/pi-40.pdf (Accessed 16 April 2008).

_____. 2002. Utah Quaternary Fault and Fold Map – 2002. http://geology.utah.gov/maps/geohazmap/qfaults/imagemap2/ (Accessed 16 April 2008)

_____. 2004. Massive Rock Fall Near Devil's Slide, Morgan County, March 22, 2004. http://geology.utah.gov/utahgeo/hazards/landslide/morgan032204.htm (Accessed 16 April 2008).

_____. 2008. Earthquake Ground Shaking Levels for the Wasatch Front. http://ugs.utah.gov/utahgeo/hazards/eqfault/ibcshake/index.htm (Accessed 16 April 2008).

Utah Population Estimates Committee (UPEC). 2007. Demographics – Population Estimates, The State of Utah and Counties 1940-2007. Utah Governor's Office of Planning and Budget. http://governor.utah.gov/dea/UPEC/ AllUPECData071115.xls (Accessed 16 April 2008).

_____. 2008. Demographic and Economic Projections – 2008 Baseline Projections. http://governor.utah.gov/dea/ERG/ERG2008/2008ERGProjectionsTables.xls (Accessed 16 April 2008).

Utah Transit Authority (UTA). 2007. *Comprehensive Annual Financial Report for Fiscal Year Ended December 31, 2006*. http://www.rideuta.com/files/CAFR2006.pdf (Accessed 16 April 2008).

Vaisala, Inc. 2006. 1996-2005 Flash Density Map. National Weather Service. http://www.lightningsafety.noaa.gov/pdfs/Vaisala_96-05_Flash_Map.pdf (Accessed 16 April 2008).

Wasatch Front Regional Council (WFRC). 2007. Population Estimates, July 1, 2006. http://wfrc.org/resources/sedata/Surv06.xls (Accessed 15 April 2008).

Watson, Kris. 2007. *2007 Utah Cooperative Gypsy Moth Program Report*. Salt Lake City: Utah Department of Agriculture and Food.

Weber County. 2000. *Weber County Emergency Operations Plan*. Weber County, UT.

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