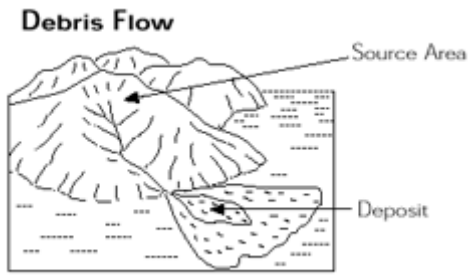
Landslides

Profiling Hazard Event

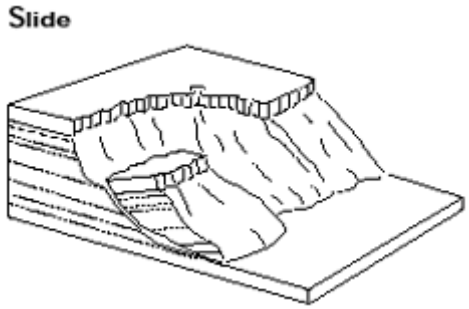
Requirement §201.4(c)(2)(i): [The State risk assessment shall include an overview of the] location of all natural hazards that can affect the State, including information on previous occurrences of hazard events, as well as the probability of future hazard events, using maps where appropriate … .

Landslides are a "down slope movement of a mass of rock, earth, or debris". Landslides, often referred to as mass wasting or slope failures, are one of the most common natural disasters. (Cruden 36). Slope failures can vary considerably in shape, rate of movement, extent, and impact on surrounding areas. Slope failures are classified by they're type of movement and type of material. The types of movement are classified as falls, slides, topples, and flows. "The types of material include rock, debris (coarse grained soil) and earth (fine grained soil)" (Eldredge 17). "Types of slope failures then are identified as rock falls, rock slides, debris flows, debris slides, and so on" (Eldredge 17). Slope failures occur because of either an increase in the driving forces (weight of slope and slope gradient) or a decrease in the resisting forces (friction, or the strength of the material making up a slope). "Geology (rock type and structure), topography (slope gradient), water content, vegetative cover, and slope aspect are important factors of slope stability" (Eldredge 18).

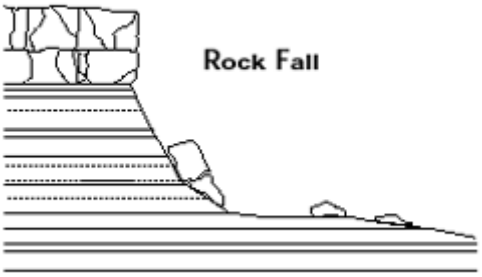
Figure I-24 Three Common Types of Landslides in Utah



Debris flows consist of sediment-water mixtures that flow down a streambed or hillside, commonly depositing sediment at canyon mouths in fan like deposits know as alluvial fans.



Slides are down slope movements of soil or rock on slopes.



Rock falls consist of rock(s) falling from a cliff or cut slope and are very common in the canyon country of southern Utah.

Conditions That Make Slopes More Susceptible to Landslides

- Discontinuities: faults, joints, bedding surfaces.
- Massive materials over soft materials.
- Orientations of dip slope: bedding planes that dip out of slope.
- Loose structure and roundness.
- Adding weight to the head of a slide such as: rain, snow, landslides, mine waste piles, buildings, leaks from pipes, sewers, and canals, construction materials fill materials.
- Ground shaking: earthquakes or vibrations.
- Increase in lateral spread caused by mechanical weathering.
- Removal of lateral support.
- Human activities: cut and fill practices, quarries, mine pits, road cuts, lowering of reservoirs.
- Removing underlying support: under cutting of banks in a river.
- Increase in pore water pressure: snow melt, rain, and irrigation.
- Loss of cohesion.

Landslide History

In the United States, it is estimated that the total dollar losses from landslides is between one and two billion dollars ($1.6 billion and $3.2 billion, year 2000 dollars). This figure is a conservative estimate, as there is no uniform method or overall agency that keeps track of or reports landslide losses. Landslides result in extremely high monetary losses in other countries, but there is no overall estimate as to the exact amount.

In Utah, the most current documented yearly losses from damaging landslides is from 2001which exceeded $3 million, including the costs to repair and stabilize hillsides along state and federal highway (Ashland, 2003). Total landslide dollar losses are hard to determine for past events because a standard for documenting them do not exist. Several state and local agencies track landslide losses with inconsistent formats often resulting in several different totals for a single event. The recurrent or ongoing movement at very slow rates, of some slides, results in widespread, but typically limited damage. This movement, cumulatively over several years, causes damage. Francis Ashland, of the Utah Geologic Survey discusses landslide damages in Utah as well as the difficulties of accruing accurate post movement loss numbers. His work “The Feasibility of Collecting Accurate Landslide-Loss Data in Utah, Open File Report 410” is found in appendix K of this plan.

Thistle Slide

In 1983, the town of Thistle was destroyed by floodwaters when the Thistle landslide created a natural dam and subsequent reservoir blocking roads and rail line. The Marysvale branch line, of the railroad was never reopened, leaving a large area of central Utah without rail service. Thistle resulted in Utah's first presidential disaster declaration and became the most costly landslide in United States history. Three reports have been issued estimating the cost of the landslide between $200 million and $337 million dollars.

Heather Drive Landslide

In 2001 this landslide destroyed three houses and forced the relocation of three others. Total dollar losses for this event have been estimated various sources between $519,800 and $1,092,000.

Santaquin Mollie Fire Debris Flow

In August of 2001, the 8,000+ acre Mollie Fire burned an area of the Wasatch Range known as Dry Mountain above the city of Santaquin. The bench development area of Santaquin City is located not more than 50 yards from the edge of the fire perimeter on an alluvial fan. The Mollie wildfire, caused watershed damaged elevated the debris flow risk. At approximately 6:45 p.m. on Thursday, September 12, 2002, after nearly a week of intense thunderstorms, the charred earth of the ironically named Dry Mountain produced 10 debris flows. These flows did major damage to several houses and resulted in significant cleanup costs.

Buckley Draw—Springville Fire

The Springville fire started on June 30, 2002 at 7:19 p.m. and burned a total of 2,207 acres above dozens of homes. This burned area heightened the debris flow risk to those homes on the alluvial fans below. At the April 29, 2003 neighborhood meeting, the debris flows in Santaquin were contrasted with the conditions at the Buckley Draw. Plans for trench construction were discussed. A flag notification system and evacuation plan was put in place. A web link with updated hazard information, a phone 'hot line' with an updated message, and a notification procedure alerting the Neighborhood Chair of any changes in the hazard level were implemented. A practice evacuation drill was held on Saturday, May 10, 2003.

The 1,500 feet long trench/deflection dike was completed on July 28, 2003, by Provo City in conjunction with the NRCS and their Emergency Watershed Protection program. At approximately 3:00 a.m. on September 10, 2003, four separate debris flows were triggered. The newly finished trench routed the second largest flow. The trench finished "in a nick of time" worked as designed preventing property loss and potentially life loss. It is difficult to predict total amount of damage prevented by the trench, but at a minimum the deflection dike prevented damage equal to its construction cost. The spreader fences in the debris runout field distributed the runoff materials and completely contained this debris flow.

Kanab Creek Landslide

On March 12, 2005 at approximately 5:30 p.m., a 100 ft. long by 60 ft. high vertical stream-cut along Kanab Creek failed. This rock fall occurred within the city limits of

Kanab, killing one boy and partially burying two children. This earth-fall-type landslide was most likely the result of long-term gravitational effects on over-steepened, unconsolidated material in the arroyo walls. (Lund, 2005)

Provo Rock Fall

On May 12, 2005 at 5:00 p.m., a rock fall destroyed a guest house located in Provo. No fatalities resulted from the rock fall. The rock measured 7 x 5.1 x 4.5 feet and weighed approximately 13 tons. The rock fall is believed to have resulted from a series of significant storms that passed through the Prove area between May 10-12, in which approximately 3.7 inches of mixed rain and snow fell on the area. It was raining at the time of the rock fall (Giraud, 2005).

South Weber Landslide

Around 9:30 p.m. on Sunday, April 9, 2006 a rapidly moving landslide in South Weber broke through the back wall of a house at 7687 South 1650 East, injuring a child inside. e landslide started on a steep slope near a pond in a gravel pit atop a bluff behind the house. Subsequent investigation found evidence of subsurface water flow from the pond to the slope.

Water seepage and saturation of materials on the bluff top likely triggered the landslide, but the steep slope, the weight of fill placed on the top of the slope, and weak underlying geologic materials were contributing factors.

Also, a major rain and snow storm on April 4 through 6 dropped approximately 2 inches of water, likely causing surface and subsurface water levels to rise. After the landslide, the pond was drained to reduce further landsliding.

The 1650 East landslide and a nearby similar one that demolished a barn and blocked South Weber Drive (State Route 60) in 2005, demonstrate the destructive nature of rapidly moving landslides and the risk of building at the base of steep slopes.

The rapidly moving landslide that slammed into this house at 7687 South 1650 East, South Weber, broke through the back wall and injured a child inside.

Sunset Drive and Beechwood Drive Landslides

Homeowners along Sunset Drive in Layton recognized in mid-April that the Sunset Drive landslide had reactivated. In 1998, landslide movement damaged seven lots and resulted in a house having to be condemned and demolished. The 2006 movement affected six lots, including two houses. The house at 1843 East Sunset Drive straddles the main scarp, and landslide movement has removed support from beneath part of the foundation. Layton City building inspectors found the house unsafe for occupancy due to structural damage, and it may be moved off the landslide to another location. UGS geologists measured a 4- to 8-foot increase in ground-water levels in and near the landslide between

March 16 and April 17, which apparently triggered movement. The 2006 peak ground-water level is a threshold that can be used to predict future landslide movement.

The Beechwood Drive landslide is a quarter-mile south of the Sunset Drive landslide and reactivated at about the same time. The Beechwood Drive landslide is a reactivation of a pre-existing landslide with no documented historical movement.
The landslide main scarp cuts across the back of five lots and has damaged landscaping in backyards. The landslide also affected the upper part of the proposed Beechwood subdivision phase 6 development. Both the Sunset and Beechwood Drive landslides show how prone some slopes in Layton are to landslide movement.

Creekside Drive Landslide

In 2005, three landslides formed in the Creekside Drive area of Mountain Green in Morgan County, in a northeast-facing slope underlain by pre-existing landslide deposits. In 2006, the three landslides reactivated, and two new landslides formed nearby.

Continued movement of the largest of the five landslides forced the evacuation of a severely damaged house at the top of the slide, and damaged two others.

Damage also occurred to Creekside Drive and utilities beneath the road, disrupting the power and water to the affected subdivision.

Landslide movement left this concrete driveway slab suspended in the air in the Creekside Drive area, Mountain Green.

Despite favorable subdivision-wide and lot-specific geotechnical studies, landsliding occurred within only a few years of development on the pre-existing landslide deposits. Stabilization of the landslides, particularly the largest one, will likely prove costly and technically challenging.

Sherwood Hills Landslide

The Sherwood Hills landslide in northern Provo is one of several in northern Utah that has undergone repeated movement over the past 25 years. Damage to houses and roads caused by renewed landslide movement was first documented in the early 1980s. The landslide has been systematically monitored since May 1999 when Provo City established survey points on the slide and began using high-precision Global Positioning System survey techniques to measure movement. The survey results suggest that the landslide remained active even during the drought years between 1999 and 2004.

With the return of wetter-than-normal conditions in 2005, the rate and area of landslide movement increased. By 2006, three houses in the upper part of the landslide had been abandoned, including one built in 2000, and a road had been severely damaged. Some data suggest that landslide movement is continuous, slowing in the summer to an undetectable rate, and increasing in the late winter and early spring as groundwater levels

rise during the snowmelt. The continuing losses due to movement illustrate the potential high costs, both public and private, associated with development on large pre-existing landslides.

City Creek Canyon Landslides

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

Landsliding in Northern Utah

Local wet conditions in northern Utah have caused some landslides to reactivate along with other types of shallow slope failures. Areas with active landslides in early 2009 include Ogden Valley in eastern Weber County, western Morgan County, southeastern Davis County, and Spanish Fork Canyon in Utah County. Examples include: reactivation or acceleration of persistently moving historical landslides, minor movement of landslides in highway cut slopes, local highway embankment and rock-wall failures, and local shallow slides on steep slopes in pre-existing landslides.

Above-normal precipitation in southeastern Davis County has caused an increase in the rate of movement of the Springhill landslide in North Salt Lake, resulting in additional damage to houses, roads, and buried utilities. The landslide has moved persistently since the late 1990s, severely damaging three houses since 1998. Damaging landsliding has also occurred in Ogden Valley and the Snowbasin area of eastern Weber County.

Snowmelt-induced landsliding occurred in the front yard of a house in the foothills of Ogden Valley, where saturated fill soil slid onto a driveway that crossed the slope.
Reactivation of pre-existing landslides crossed by State Route 226 (near Snowbasin ski resort) is causing minor damage to the highway in several locations. In addition, embankment failures along the edge of the highway are causing road cracks and pavement settlement.

Landsliding coincident with the snowmelt was detected at several other sites this year including minor movement of the Frontier Drive landslide in Morgan County, a small landslide in a highway cut slope in Spanish Fork Canyon, Utah County and a new small slide in a local steep slope in the head of the Sage Vista Lane landslide in Cedar Hills, Utah County. Several landslides that occurred in generally south-facing slopes, including an embankment failure along US-6/89 in Spanish Fork Canyon, may have been caused by relatively rapid snowmelt. For the most part, no damage has resulted from these landslides.

Provo Rockfall

Around 11:30 a.m. on April 11, 2009, a rock fall impacted the area of 1500 North and 1550 East in Provo, Utah.

Boulder that damaged the vacant house at 1496 North 1550 East, Provo. Boulder is estimated to be 4x5x4 feet. Photo courtesy of the Provo Fire Department.

One rock-fall boulder damaged the outside of a playhouse located at 1522 North 1550 East, and another, larger boulder severely damaged a vacant house at 1496 North 1550 East.

The April 11, 2009 rock fall occurred one lot north of the May 12, 2005 "Y" Mountain rock fall. The rock fall occurred shortly after a storm on April 8-9 that dropped 1.5 inches of precipitation in less than 18 hours at the Cascade Mountain Snotel site, 3 miles southeast of the rock-fall source area. Impact craters (bounce marks) evident on the slope above the houses indicate several rocks traveled downslope. The rocks traveled an estimated one mile downslope, and likely achieved high velocities as they bounced and rolled.

At 1496 North 1550 East, a boulder bounced over the back fence and into the back of the house. Inside the house, the boulder damaged the ceiling and crashed through a wall, before falling through the floor and into the garage door.

The source for the rock fall in both 2005 and 2009 is a cliff band in the Mississippian Deseret Limestone on "Y" Mountain about 2,600 vertical feet above the houses.

Numerous large rocks from prehistoric and historical rock-fall events are scattered throughout the neighborhood and on the hillside above, indicating these lots are in a high rock-fall hazard area. Although the occurrence of this rock fall does not necessarily indicate a heightened rock-fall hazard under present conditions, rock falls are possible in this area at any time and typically occur with no warning, often during and following storms, periods of snowmelt, and earthquakes.

Rockville Rockfall

The rock, estimated to be about 21 x 17 x 17 feet and weighing about 450 tons, slid and fell from the upper slope of Rockville Bench, began to roll downslope, collided with a large stationary boulder at the base of the slope, and shattered into numerous smaller fragments that damaged several outbuildings, two cars, and a house. Although people were home at the time, no one was injured. The rock fall occurred shortly after a protracted storm event on February 5-9, 2010 that produced 1.38 inches of rain at the Zion Canyon RAWS station, 4.5 miles northeast of Rockville.

The rock fell/rolled 280 vertical feet and a slope distance of 500 feet before colliding with the other boulder. Debris ejected from the impact measured up to 9 feet in long dimension and traveled an additional 180 feet. The rock fall originated from the Shinarump Conglomerate Member of the Triassic Chinle Formation that caps Rockville

Bench, although the event occurred in two stages. The rock originally detached from the Shinarump ledge, traveled about 40 feet, and came to rest on a steep slope formed on the upper red member of the Moenkopi Formation, where it remained high on the slope for at least 17 years.

The rainstorm prior to the rock fall likely caused material beneath the rock to erode and caused the rock to slide, and then fall over a 12-foot ledge and roll down the remainder of the slope. This rock fall occurred less than 2000 feet west of where another large rock fall severely damaged a home in Rockville in October 2001. A second large talus (rock already detached from its source area) boulder remains high on the slope and appears to be analogous to the boulder that moved. Numerous large boulders from prehistoric and historical rock falls are present along the base of Rockville Bench, indicating several homes there are in a high-rock-fall hazard area. Although the occurrence of this rock fall does not necessarily indicate a heightened rock-fall hazard under present conditions, rock falls are possible in this area at any time and typically occur with no warning, often during and following storms, periods of freeze-thaw, and earthquakes.

Springhill Landslide

The Utah Geological Survey (UGS) has been monitoring conditions at the Springhill landslide in North Salt Lake, Davis County since 1998. In the late 1990s, residents in the Springhill area of North Salt Lake, Davis County began noticing cracking and other distress related to relatively minor movement of the landslide. By 1998, a house at 160 Springhill Drive that straddled the northern boundary of the landslide was severely damaged and condemned. Relatively severe distress also occurred to several houses along Valley View Drive (formerly 350 E) and Springhill Circle. *(UGS Aerial Springhill Landslide)*

Little movement or damage occurred during a dry period between 1999 and 2004, but the rate of movement accelerated during the 2005 wet year. Since 2005, the amount of movement each year has increased, except in 2007 (a dry year), resulting in an increased amount of damage and distress, particularly to houses in the upper and lower parts of the landslide and to Springhill Drive.

The Springhill landslide is about 720 feet long and about 290 feet wide where it is crossed by Springhill Drive. The local relief (change in elevation) is about 150 feet and the average slope of the landslide is approximately 21 percent (the ground rises 21 feet over a distance of 100 feet). The depth of the landslide varies along its length. Along the north edge of Springhill Circle, the landslide is about 48 feet deep and likely deeper than

70 feet beneath Springhill Drive. The landslide is shallower along its southern edge, and in the head and toe.

Assessing Vulnerability by Jurisdiction

Requirement §201.4(c)(2)(ii): [The State risk assessment shall include an] overview and analysis of the State's vulnerability to the hazards described in this paragraph (c)(2), based on estimates provided in local risk assessments as well as the State risk assessment. The State shall describe vulnerability in terms of the jurisdictions most threatened by the identified hazards, and most vulnerable to damage and loss associated with hazard events. State owned critical or operated facilities located in the identified hazard areas shall also be addressed … .

Requirement §201.4(d): Plan must be reviewed and revised to reflect changes in development…

According to the USGS, landslides are a widespread geologic hazard that can occur in all 50 states. On average, landslides cause $1-2 billion annually in damages and claim 25 lives per year. Urban development in and along hillside areas increase the number of people threatened by landslide events each year. Many factors contribute to overall landslide vulnerability; including local weather, soil moisture, duration and intensity of precipitation, wildfire history, and development pressure. Typically, landslides result from other natural disasters such as earthquakes, volcanoes, wildfires, and floods. Table I-22 illustrates how many square miles per county are in high or moderate landslide susceptible areas. Data for assessing landslide vulnerability was provided by the Utah Geological Survey.

Table I-22 Area of square miles per county with high or moderate landslide risk

County	Areas within High or Moderate Landslide Susceptibility Areas (square miles)
Beaver	625.6
Box Elder	1010.8
Cache	563.5
Carbon	818.4
Daggett	312.2
Davis	104
Duchesne	104.6
Emery	128.02
Garfield	197.5
Grand	1537.9
Iron	758.7
Juab	803.6
Kane	1680.5
Millard	1187.8
Morgan	449.3

Piute	361.7
Rich	263.9
Salt Lake	321.63
San Juan	2512.3
Sanpete	783.6
Sevier	587.4
Summit	1035.8
Tooele	938.3
Uintah	1367.1
Utah	1076.7
Wasatch	717.91
Washington	1108
Wayne	785.4
Weber	261.8
Total	**23,815.66**

Table I-23 Summary of Landslide Susceptibility per County by Hazard Category

County Name	High Hazard (square miles)	Moderate Hazard (square miles)	Low Hazard (square miles)	Extremely Low Hazard (square miles)
Beaver	46.6	579	236.1	1365.4
Box Elder	46.6	579	236.1	1365.4
Cache	10.8	552.7	161.2	365.3
Carbon	7.1	811.3	219.4	407.3
Daggett	8.7	303.5	165.5	195.7
Davis	15.4	89	14.6	16.9
Duchesne	15.4	89.2	14.6	167.6
Emery	2.02	126	143.1	175.3
Garfield	3.7	193.8	223.5	1763.1
Grand	17.2	1520.7	547.9	1508.6
Iron	20.5	738.2	333	1906.5
Juab	15.2	788.4	211.4	1999.5
Kane	42	1638.5	672.9	1530.9
Millard	13.1	1174.7	396.9	4524.1
Morgan	25.7	423.6	92.3	46.7
Piute	65.9	295.8	121.6	211.7
Rich	1.2	262.7	227.3	449.4
Salt Lake	1.63	320	25	373.9
San Juan	102.6	2409.7	1287.8	3765.9
Sanpete	100.9	682.7	254.8	463.1
Sevier	149.7	437.7	317.2	458.5
Summit	80.1	955.7	417.9	348.1
Tooele	1.3	937	233.2	5396.4
Uintah	32.4	1334.7	906.2	2068.1
Utah	21.1	1055.6	195	591.3
Wasatch	9.51	708.4	247.3	160.1
Washington	28.1	1079.9	423.2	792.9
Wayne	48.7	736.7	323.6	1239.9
Weber	15	246.8	61.9	237.2

Estimating Potential Losses by Jurisdiction

Requirement §201.4(c)(2)(iii): [The State risk assessment shall include an] overview and analysis of potential losses to the identified vulnerable structures, based on estimates provided in local risk assessments as well as the State risk assessment. The State shall estimate the potential dollar losses to State owned or operated buildings, infrastructure, and critical facilities located in the identified hazard areas.

Requirement §201.4(d): Plan must be reviewed and revised to reflect changes in development…

The following table was developed using information and data from local hazard mitigation plans. Counties are ranked by number of structure in counties and the replacement costs.

Utah Statewide County Landslide Risk 2010		
Counties	**Number of Structures in Areas of Moderate or Greater hazard**	**Replacement Costs of Residential Units and Annual Sales of Commercial Units**
Salt Lake	30388	$6,262,887,678
Weber	17609	$3,926,990,975
Davis	11839	$2,278,993,977
Utah	11753	$1,762,950,000
Washington	2823	$905,279,402
Summit	3054	$540,713,300
Morgan	1356	$276,841,812
Kane	881	$213,301,739
Cache	1099	$209,087,058
Iron	881	$194,175,540
Wasatch	757	$96,240,000
Tooele	391	$57,315,737
Sevier	553	$49,770,000
Garfield	182	$42,959,231
Box Elder	441	$39,042,354
Beaver	285	$22,354,233
Duchesne	253	$20,240,000
Grand	97	$12,003,847
Carbon	97	$7,627,789
Piute	92	$6,900,000
Uintah	66	$5,280,000
Wayne	17	$1,275,000
Daggett	13	$960,000
Juab	1	$95,000

Sanpete	1	$95,000
Emery	0	$0
Millard	0	$0
Rich	0	$0
San Juan	0	$0
State Total	84929	$16,933,379,672

Figures from the latest Local Hazard Mitigation Plan

Wasatch and Summit Counties did not have replacement costs or annual sales

Assessing Vulnerability by State Facilities

Requirement §201.4(c)(2)(ii): [The State risk assessment shall include an] overview and analysis of the State's vulnerability to the hazards described in this paragraph (c)(2), based on estimates provided in local risk assessments as well as the State risk assessment. The State shall describe vulnerability in terms of the jurisdictions most threatened by the identified hazards, and most vulnerable to damage and loss associated with hazard events. State owned critical or operated facilities located in the identified hazard areas shall also be addressed … .

Requirement §201.4(d): Plan must be reviewed and revised to reflect changes in development…

State facilities data updated in November 2010 was provided by the Utah Division of Risk Management. The data presented in this shape file was complied with the help of several state agencies and entities. The state-owned facilities shape file was overlaid on top of the 2006 Utah Geological Survey landslide susceptibility shape file. Using ArcView 9.3, landslide susceptibility areas were clipped from a county shape files for each Utah County. The "select by location" option was then utilized in order to determine how many vulnerable state facility structures exist per county.

Table I- 24 Total Number of State Owned Facilities in Landslide Susceptibility Areas

County Name	Count Facilities	Insured Value
Beaver	43	$59,658,705
Box Elder	135	$384,071,542
Cache	586	$1,520,883,525
Carbon	135	$208,266,895
Daggett	29	$15,121,339
Davis	352	$1,473,229,390
Duchesne	102	$162,843,693
Emery	111	$111,498,739
Garfield	75	$56,085,456
Grand	79	$49,168,990
Iron	230	$542,074,952

Juab	73	$86,657,955
Kane	71	$59,766,836
Millard	85	$151,693,827
Morgan	67	$71,260,550
Piute	24	$17,118,968
Rich	63	$22,581,600
Salt Lake	2221	$9,243,977,141
San Juan	104	$155,374,819
Sanpete	189	$400,181,595
Sevier	127	$194,770,108
Summit	143	$286,656,757
Tooele	94	$325,264,444
Uintah	131	$232,447,687
Utah	625	$2,874,167,305
Wasatch	156	$178,608,368
Washington	252	$814,071,164
Wayne	36	$17,077,394
Weber	398	$1,595,063,587
OVERALL TOTAL	**6736**	**$21,309,643,331**

Estimating Potential Losses by State Facilities

Requirement §201.4(c)(2)(iii): [The State risk assessment shall include an] overview and analysis of potential losses to the identified vulnerable structures, based on estimates provided in local risk assessments as well as the State risk assessment. The State shall estimate the potential dollar losses to State owned or operated buildings, infrastructure, and critical facilities located in the identified hazard areas.

Requirement §201.4(d): Plan must be reviewed and revised to reflect changes in development…

Approximate current values for state owned facilities were provided by the Utah Division of Risk Management. Current values of the state owned facilities were updated in 2010. ArcView 9.3 was used to determine which state-owned facilities are within high or moderate landslide susceptibility areas. The current values of those facilities within high or moderate landslide susceptibility areas were then summed in order to determine the total estimated current value of at-risk facilities for each county.

Table I- 25 Total Insured Value of State Owned Facilities in Landslide Susceptibility Areas

County Name	Facilities in Landslide Areas (Low, Mod, High)	Insured Value of Facilities in Landslide Areas
Beaver	20	$22,547,849
Box Elder	11	$3,154,798
Cache	432	$1,217,183,163

Carbon	93	$117,719,052
Daggett	18	$2,676,364
Davis	30	$19,478,664
Duchesne	27	$30,014,571
Emery	77	$37,139,744
Garfield	32	$14,061,916
Grand	49	$45,724,073
Iron	8	$25,391,460
Juab	33	$13,960,246
Kane	38	$12,909,612
Millard	7	$677,562
Morgan	39	$22,461,151
Piute	7	$3,394,643
Rich	21	$5,509,206
Salt Lake	93	$630,522,528
San Juan	85	$86,836,813
Sanpete	154	$306,749,356
Sevier	98	$178,895,927
Summit	57	$126,632,635
Tooele	2	$88,242
Uintah	104	$185,812,189
Utah	94	$46,680,140
Wasatch	115	$82,158,395
Washington	161	$481,748,330
Wayne	19	$3,105,294
Weber	22	$64,488,059
OVERALL TOTAL	**1946**	**$3,787,721,982**

The number of people per three arc-seconds (approximately 90m x 70 m) within either high hazard or moderate hazard landslide susceptible areas was calculated to estimate the possible number of people that could be affected by landslides. The "select by location" feature found in the ArcView 9.3 software package was used to determine how many people are located within a high or moderate hazards zones. The UGS provided the landslide shape file. This shape file contains information about the location of landslide hazard areas and categories ranging from minimal risk to high risk to express how susceptible areas locations are to a landslide. LandScan provided population location data for daytime and nighttime hours.

The Landscan data set was derived by the Oak Ridge National Laboratory utilizing a combination of information such as 2000 census data, proximity of population to roads, slopes, land cover, night-time lights, and other information that is then apportioned to each three second arc-second grid areas. An arc-second is a measure of latitude and longitude used by geographers that equates to
approximately 90 meters by 70 meters in area. It is important to note that when working with population density data points, a 90m X 70m resolution is at a finer scale than

census block data. This is the most current data for both population and landslide susceptibility.

Table I-26 Total Daytime Population per County within High or Moderate Landslide Susceptibility Areas

County	Total Daytime Population
Beaver	130
Box Elder	1,051
Cache	6,873
Carbon	1,101
Daggett	263
Davis	390
Duchesne	9,348
Emery	305
Garfield	652
Grand	840
Iron	509
Juab	147
Kane	570
Millard	225
Morgan	803
Piute	53
Rich	27
Salt Lake	23,573
San Juan	782
Sanpete	562
Sevier	942
Summit	5,817
Tooele	405
Uintah	412
Utah	12,943
Wasatch	793
Washington	7,844
Wayne	66
Weber	9,220

I-27 Total Night-time Population per County within High or Moderate Landslide Susceptibility Areas

County	Total Night-time Population within High or Moderate Landslide Susceptibility Areas
Beaver	90
Box Elder	1,742
Cache	5,745
Carbon	887
Daggett	86
Davis	390

Duchesne	20,454
Emery	217
Garfield	39
Grand	671
Iron	633
Juab	338
Kane	444
Millard	19
Morgan	1,590
Piute	22
Rich	35
Salt Lake	24,443
San Juan	304
Sanpete	291
Sevier	230
Summit	7,502
Tooele	329
Uintah	427
Utah	12,252
Wasatch	719
Washington	6,226
Wayne	75
Weber	16,421