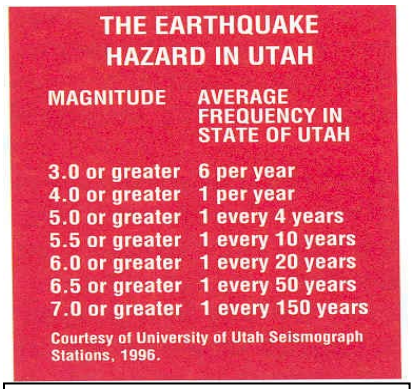
Earthquakes

Profiling Hazard Event

The 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.

An earthquake is the abrupt shaking of the earth caused by the sudden breaking of rocks, when they can no longer withstand the stresses, built up deep beneath the earth's surface. The rocks tend to rupture along weak zones referred to as faults. When rocks break, they produce seismic waves that are transmitted through the rock outward producing ground shaking. Earthquakes are unique multi-hazard events, with the potential to cause huge amounts of damage and loss. Secondary effects of a sudden release of seismic energy (earthquake) include: ground shaking, surface fault rupture, liquefaction, tectonic subsidence, slope failure, and various types of flooding.



THE EARTHQUAKE HAZARD IN UTAH

MAGNITUDE	AVERAGE FREQUENCY IN STATE OF UTAH
3.0 or greater	6 per year
4.0 or greater	1 per year
5.0 or greater	1 every 4 years
5.5 or greater	1 every 10 years
6.0 or greater	1 every 20 years
6.5 or greater	1 every 50 years
7.0 or greater	1 every 150 years

Courtesy of University of Utah Seismograph Stations, 1996.

Figure I-12 Earthquake Frequency

<u>The Intermountain Seismic Belt</u>

The Intermountain Seismic Belt (ISB), is a zone of pronounced earthquake activity up to 120 miles wide extending in a north south direction 800 miles from Montana to northern Arizona. The Utah portion of the ISB trends from the Tremonton Cache Valley area south through the center of the state, along the Wasatch Front, and the southwest through Richfield and Cedar City concluding in St. George. "The zone generally coincides with the boundary between the Basin and Range physiographic province to the west and the Middle Rocky Mountains and Colorado Plateau physiographic provinces to the east" (Eldredge 6).

Earthquake Threats

The major secondary effects of earthquakes include: ground shaking, surface fault rupture, liquefaction, tectonic subsidence, avalanches, rock fall, slope failure, and various types of flooding. Other sections discuss landslides and flooding therefore, they will not be discussed here as an effect of earthquakes yet importance needs to be given to the fact that earthquakes can increase the likelihood of flooding and landslides.

<u>Ground Shaking</u>

Ground shaking causes the most impact during an earthquake because it affects large areas and is the origin of many secondary effects associated with earthquakes. Ground shaking, which generally lasts 10 to 30 seconds in large earthquakes, is caused by the passage of seismic waves generated by earthquakes.

Earthquakes produce both vertical and horizontal ground shaking illustrated in figure I-13. The primary or P waves are compressional; the secondary or S waves have a shear

motion. These body waves radiate outwards from the fault to the ground surface where they cause ground shaking. The fast moving P waves are the first waves to cause the vibration of a building. The S waves arrive next often causing a structure to vibrate from side to side. Surface waves, characterized as Rayleigh (R) and Love (L) waves, arrive last, mainly causing low-frequency vibrations. Surface waves are more likely than P and S waves to cause tall buildings to vibrate.

Earthquake waves vary in both frequency and amplitude. High frequency low amplitude waves cause more damage to short stiff structures, were as low frequency high amplitude waves have a greater effect on tall (high-rise) structures. Ground shaking is measured using Peak Ground Acceleration (PGA). The PGA measures the rate in change of motion relative to the established acceleration due to gravity.

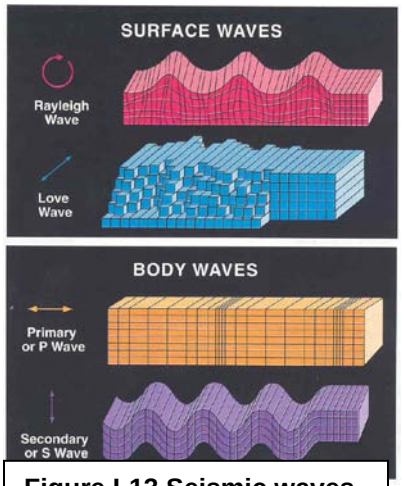


Figure I-13 Seismic waves

Local geologic conditions such as depth of sediment and sediment type, affect earthquake waves. Deep valley sediments, like those found in the Salt Lake Basin, increase the amplitude of seismic of certain frequencies relative to bedrock. In general, ground shaking increases with increased thickness of sediments" (Eldredge 8). Findings in recent geologic research done by Ivan Wong et al indicate an earthquake in Salt Lake County would produce higher PGA values than previously expected near faults and areas of near surface bedrock.

Surface Fault Rupture

During a large earthquake, fault movement may propagate along a fault plane to the surface, resulting in surface rupture along the fault. The Wasatch fault is a normal (mountain building) fault with regards to movement, meaning the footwall of the fault moves upward and the hanging wall moves in a down direction. Thus, faulting at the surface is on a steeply dipping plane, which results in the formation of large fault scarps. Surface fault rupture along the Wasatch fault is expected for earthquakes with magnitudes of 6.5 or larger. The largest probable earthquake that could strike Utah is anticipated to be an earthquake with an estimated magnitude between 7.0 and 7.5, and would most likely occur on the Wasatch Fault. An earthquake of this magnitude, based on current research, would create surface fault rupture with a displacement of around 6 to 10 feet in height and 20-40 miles long. In historic time surface fault rupture has only occurred once in Utah; the 1934 Hansel Valley earthquake with a magnitude 6.6 produced 1.6 feet of vertical offset.

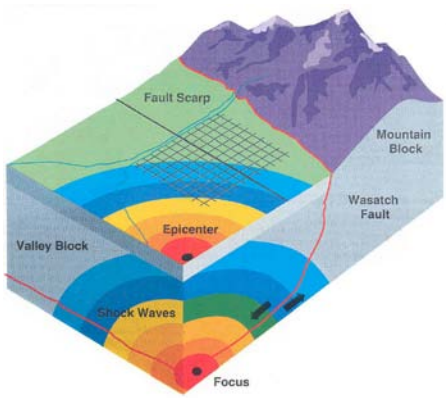


Figure I-14 Wasatch Fault block model

Surface fault rupture presents several hazards. Anything built on top of the fault or crossing the fault has a high potential of being destroyed by the event of displacement. Foundations will be cracked, building torn apart, and roads, utility lines, pipelines, or any other lifelines crossing the fault. It is almost impossible to design anything within reasonable cost parameters to withstand an estimated displacement of 6 to10 feet.

Figure I-15 Displacement in excavation

Surface fault rupture does not occur on a single distinct plane; instead, it occurs over a zone often several hundred feet wide known as the zone of deformation. The zone of deformation occurs mainly on the downthrown side of the main fault trace. Antithetic faults moving in the opposite direction of the main fault, create grabens (down dropped blocks) within the zone of deformation.

Liquefaction

Soil liquefaction occurs when water-saturated cohesionless sandy soils are subject to ground shaking. When liquefaction occurs soils behave more like a viscous liquid (quicksand) and lose their bearing capacity and shear strength. Two conditions must be met in order for soils to liquefy: (1) the soils must be susceptible to liquefaction (sandy, loose, water-saturated, soils typically between 0 and 30 feet below the ground surface) (2) ground shaking must be strong enough to cause susceptible soils to liquefy. The loss of shear strength and bearing capacity due to liquefaction causes buildings to settle or tip and light buoyant structures such as buried storage tanks and empty swimming pools to float upward. Liquefaction can occur during earthquakes of magnitude 5.0 or greater.

Lateral Spread

Soils, once liquefied, can flow on slopes with angles of .5 to 5 percent. This movement of liquefied soils is known as lateral spread. "The surficial soil layers break up and sections move independently, and are displaced laterally over a liquefied layer" (Eldredge 10). Liquefaction can cause damage in several way, with lateral spreading being one of the most common. Displacement of three (3) or more feet may occur and be accompanied by ground cracking and vertical displacement. Lateral spreading causes roads, buildings, buried utilities, and any other buried or surface structure to be pulled apart.

Various Flooding Issues Related to Earthquakes

Earthquakes could cause flooding due to regional lowering and tilting of the valley floor (tectonic subsidence), dam failure and seiches in lakes and reservoirs. Flooding can also result from the disruption of rivers and streams. Water tanks, pipelines, and aqueducts may be ruptured, or canals and streams altered by ground shaking, surface faulting, ground tilting, and landsliding.

RM	MMI	
2	I	NOT FELT EXCEPT BY A VERY FEW UNDER ESPECIALLY FAVORABLE CONDITIONS.
	II	FELT ONLY BY A FEW PERSONS AT REST, ESPECIALLY ON UPPER FLOORS OF BUILDINGS. DELICATELY SUSPENDED OBJECTS MAY SWING.
3	III	FELT QUITE NOTICEABLY BY PERSONS INDOORS, ESPECIALLY ON UPPER FLOORS OF BUILDINGS. MANY PEOPLE DO NOT RECOGNIZE IT AS AN EARTHQUAKE. STANDING MOTOR CARS MAY ROCK SLIGHTLY. VIBRATION SIMILAR TO THE PASSING OF A TRUCK. DURATION ESTIMATED.
4	IV	FELT INDOORS BY MANY, OUTDOORS BY A FEW DURING THE DAY. AT NIGHT, SOME AWAKENED. DISHES, WINDOWS, DOORS DISTURBED; WALLS MAKE CRACKING SOUND. SENSATION LIKE A HEAVY TRUCK STRIKING BUILDING. STANDING MOTOR CARS ROCKED NOTICEABLY.
	V	FELT BY NEARLY EVERYONE; MANY AWAKENED. SOME DISHES, WINDOWS BROKEN. UNSTABLE OBJECTS OVERTURNED. PENDULUM CLOCKS MAY STOP.
5	VI	FELT BY ALL, MANY FRIGHTENED. SOME HEAVY FURNITURE MOVED; A FEW INSTANCES OF FALLEN PLASTER. DAMAGE SLIGHT.
6	VII	DAMAGE NEGLIGIBLE IN BUILDINGS OF GOOD DESIGN AND CONSTRUCTION; SLIGHT TO MODERATE IN WELL-BUILT ORDINARY STRUCTURES; CONSIDERABLE DAMAGE IN POORLY BUILT OR BADLY DESIGNED STRUCTURES; SOME CHIMNEYS BROKEN.
	VIII	DAMAGE SLIGHT IN SPECIALLY DESIGNED STRUCTURES; CONSIDERABLE DAMAGE IN ORDINARY SUBSTANTIAL BUILDINGS WITH PARTIAL COLLAPSE. DAMAGE GREAT IN POORLY BUILT STRUCTURES. FALL OF CHIMNEYS, FACTORY STACKS, COLUMNS MONUMENTS, WALLS. HEAVY FURNITURE OVERTURNED.
7	IX	DAMAGE CONSIDERABLE IN SPECIALLY DESIGNED STRUCTURES; WELL-DESIGNED FRAME STRUCTURES THROWN OUT OF PLUMB. DAMAGE GREAT IN SUBSTANTIAL BUILDINGS, WITH PARTIAL COLLAPSE. BUILDINGS SHIFTED OFF FOUNDATIONS.
	X	SOME WELL-BUILT WOODEN STRUCTURES DESTROYED; MOST MASONRY AND FRAME STRUCTURES DESTROYED WITH FOUNDATIONS. RAILS BENT.
8	XI	FEW, IF ANY (MASONRY) STRUCTURES REMAIN STANDING. BRIDGES DESTROYED. RAILS BENT GREATLY.
	XII	DAMAGE TOTAL. LINES OF SIGHT AND LEVEL ARE DISTORTED. OBJECTS THROWN INTO THE AIR.

Figure I-16 Comparison between MMI and RM

Seiches

Standing bodies of water are susceptible to earthquake ground motion. Water in lakes and reservoirs may be set in motion and slosh from one end to the other, much like in a bathtub. This motion is called a seiche (pronounced "saysh"). A seiche may lead to dam failure or damage along shorelines.

Earthquake Measurement

An earthquake's size is measured in two ways. One is by their magnitude, which is a measure of the amplitude of the seismic waves, the second is by their intensity, a measure of the damaged caused by the quake. The Richter Magnitude scale, a logarithmic scale where every whole number increase represents a ten-fold increase in recorded ground motion, is used to measure magnitude. The Modified Mercalli Intensity Scale (MMI) is used to measure intensity. Developed in 1902 by an Italian scientist named G. Mercalli this scale is based on observations of damage.

Significant Earthquakes:

Every year, seismograph stations record about 700 earthquakes occurring in Utah. Most of these are too small to even be felt. Figure I-17 demonstrates the average frequency of earthquakes in Utah. Utah has numerous active faults throughout the state, capable of causing

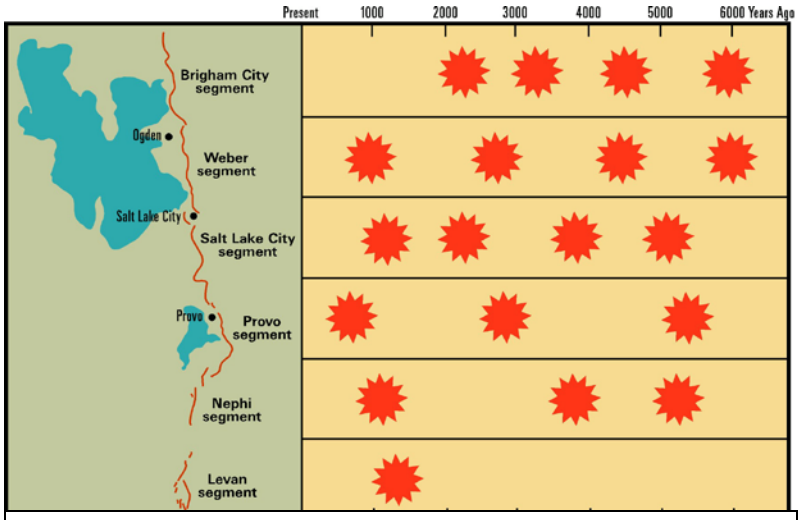


Figure I-17 Movement along each segment of the Wasatch Fault

damage, but due to the number of people residing along the Wasatch Front and the amount of infrastructure, an event on the Wasatch Fault would cause the most damage. The last known movement of each segment of the Wasatch Fault is shown in figure I-1. Table I-14 provides a timeline of all earthquakes larger then 5.0 magnitude, occurring in Utah from 1876 to present.

Illustrated in Figures I-18, 19, and 20 are the location of earthquakes from 1962 through 1992 larger than 3.0, while slightly dated these maps provide spatial reference to seismically active areas.

Table I-14 Significant Utah Earthquakes

Date	Name	Magnitude
March 22, 1876	Moroni	5.0
December 5, 1887	Kanab	5.7
April 20, 1891	St. George	5.0
July 18, 1894	Ogden	5.0
August 1, 1900	Eureka	5.0 +/- .5
November 13, 1901	Southern Utah	6.0 +/- .5
November 17, 1902	Pine Valley	6.0
April 15, 1908	Milford	5.0
October 5, 1909	Hansel Valley	6.0
January 10, 1910	Elsinore	5.0
May 22, 1910	Salt Lake City	5.5
May 13, 1914	Ogden	5.0 +/- .5
July 15, 1915	Provo	5.0
September 29, 1921	Elsinore	6.0
January 20, 1933	Parowan	5.0
March 12, 1934	Hansel Valley	6.6
August 30, 1942	Cedar City	5.0
September 26, 1942	Cedar City	5.0
February 22, 1943	Magna	5.0
November 17, 1945	Glenwood	5.0
March 6, 1949	Salt Lake City	5.0
February 13, 1958	Wallsburg	5.0
February 27, 1959	Panquitch	5.0
July 21, 1959	Southwest	5.7
April 15, 1961	Ephraim	5.0
August 30, 1962	Cache Valley	5.7
September 5, 1962	Magna	5.2
October 4, 1967	Marysvale	5.2
August 14, 1988	San Rafael Swell	5.3
January 29, 1989	Wasatch Plateau	5.4
September 2, 1992	St. George	5.8

*Occurred in Idaho felt in throughout northern Utah

Table derived form information provided by the University of Utah Seismograph Stations.

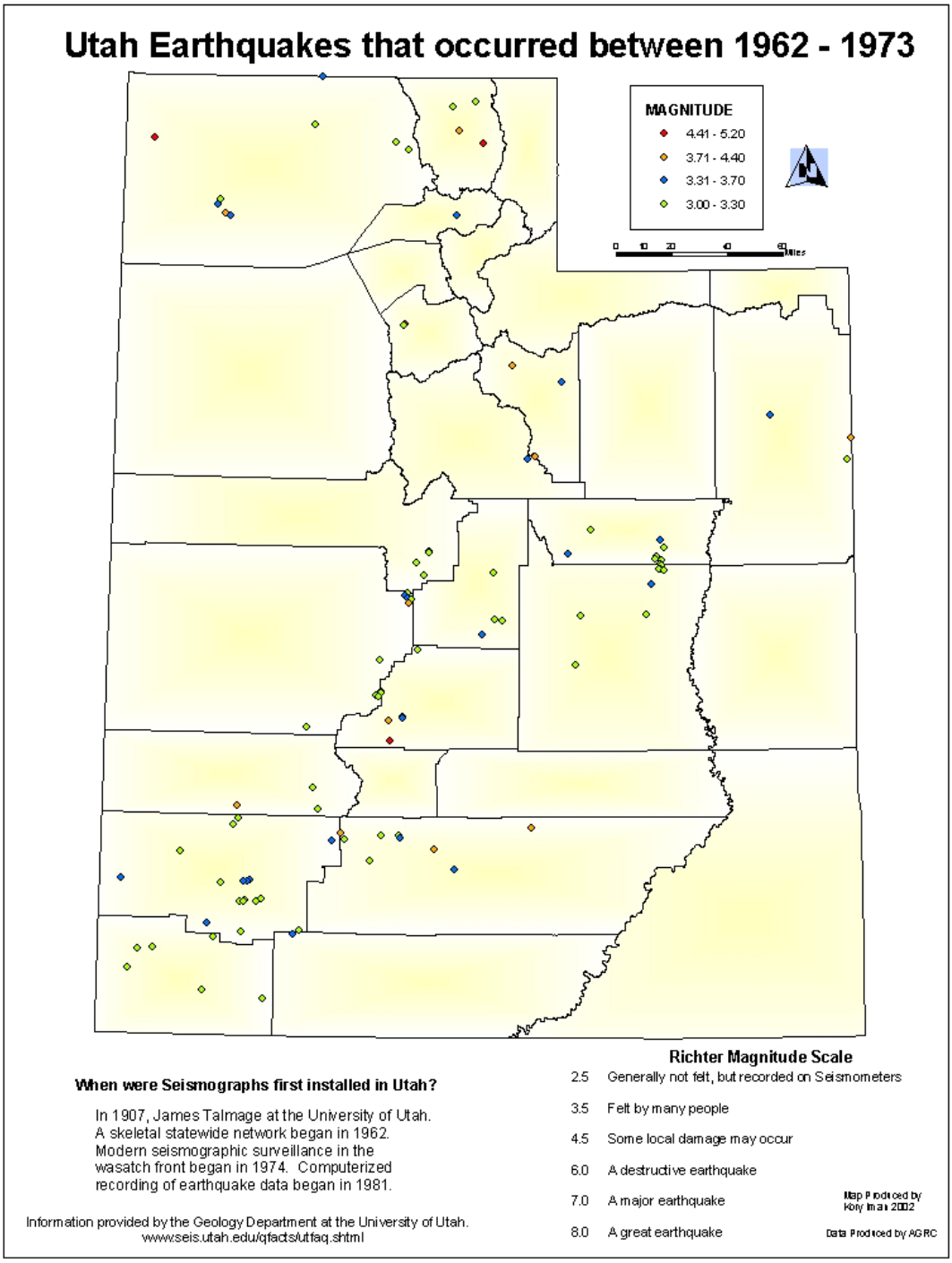
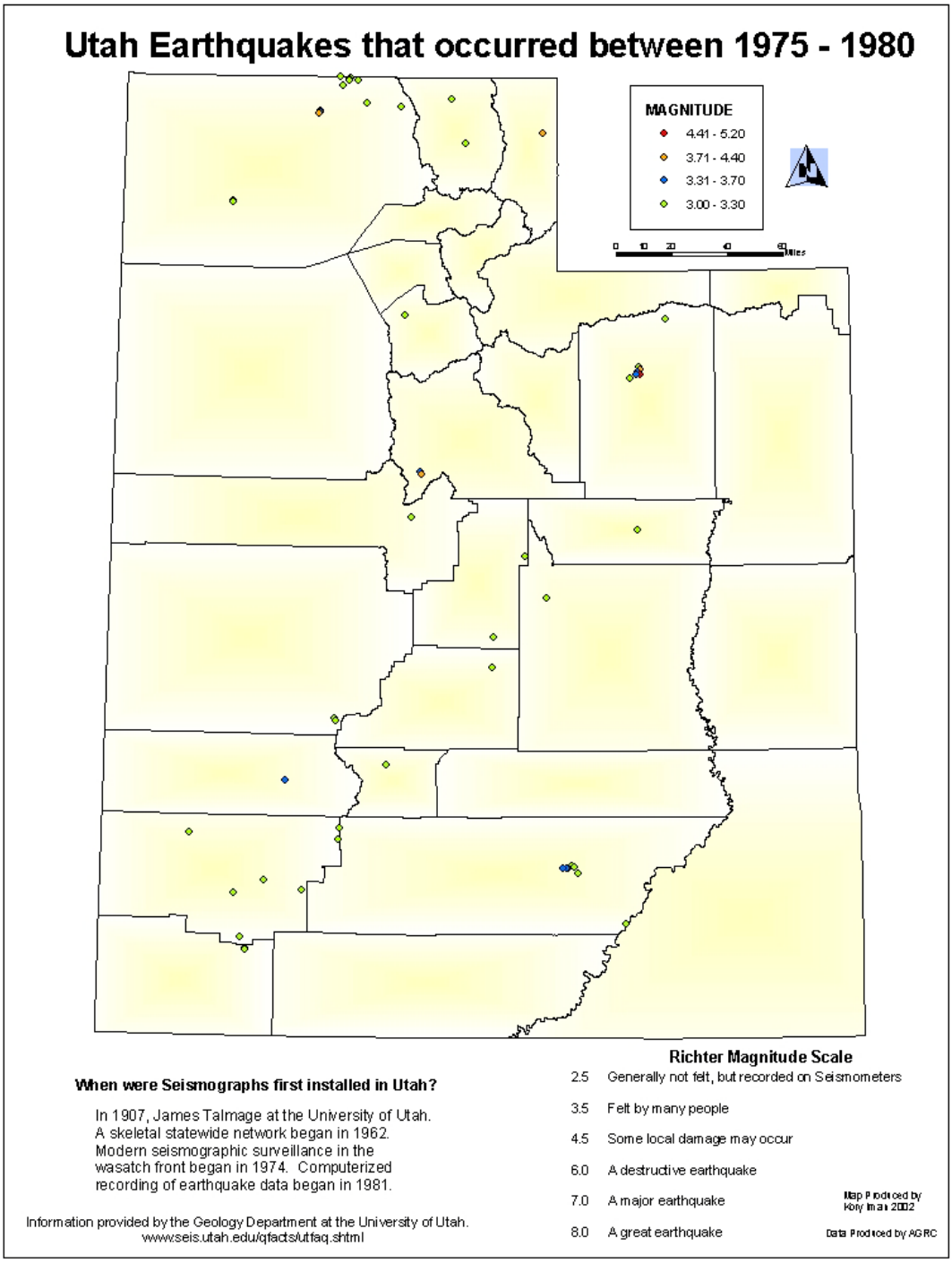

Utah Earthquakes that occurred between 1962 - 1973
MAGNITUDE
4.41 - 5.20
3.71 - 4.40
3.31 - 3.70
3.00 - 3.30
When were Seismographs first installed in Utah?
In 1907, James Talmage at the University of Utah.
A skeletal statewide network began in 1962.
Modern seismographic surveillance in the
wasatch front began in 1974. Computerized
recording of earthquake data began in 1981.
Information provided by the Geology Department at the University of Utah.
www.seis.utah.edu/qfacts/utfaq.shtml
Richter Magnitude Scale
2.5 Generally not felt, but recorded on Seismometers
3.5 Felt by many people
4.5 Some local damage may occur
6.0 A destructive earthquake
7.0 A major earthquake
8.0 A great earthquake
Map Produced by
Kory Imai 2002
Data Produced by AGRC

Figure I-18


Utah Earthquakes that occurred between 1975 - 1980
MAGNITUDE
4.41 - 5.20
3.71 - 4.40
3.31 - 3.70
3.00 - 3.30
0 10 20 40 60 Miles
When were Seismographs first installed in Utah?
In 1907, James Talmage at the University of Utah.
A skeletal statewide network began in 1962.
Modern seismographic surveillance in the
wasatch front began in 1974. Computerized
recording of earthquake data began in 1981.
Information provided by the Geology Department at the University of Utah.
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Richter Magnitude Scale
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6.0 A destructive earthquake
7.0 A major earthquake
8.0 A great earthquake
Map Produced by
Kory Imai 2002
Data Produced by AGRC

Figure I-19

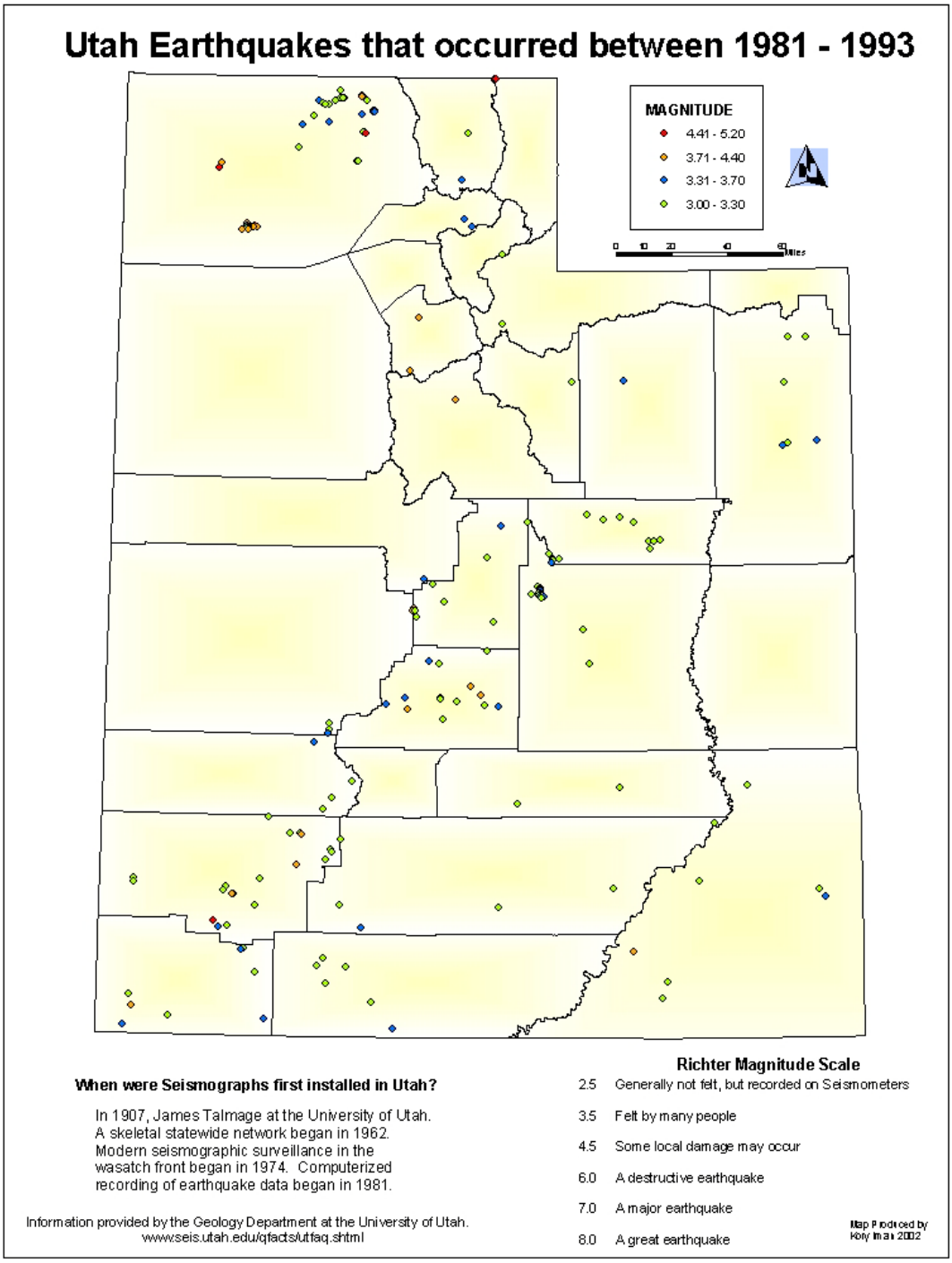
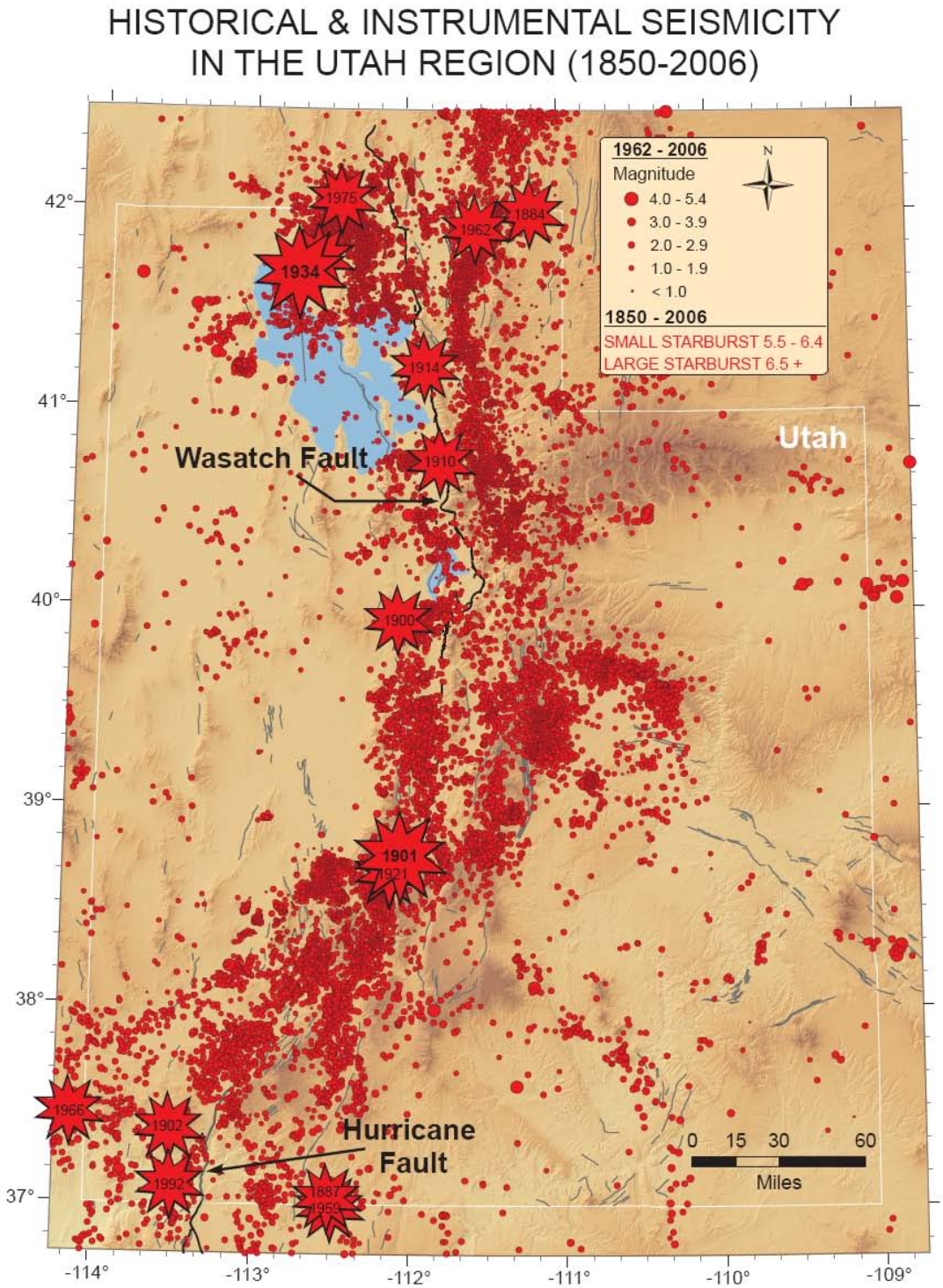

Utah Earthquakes that occurred between 1981 - 1993
MAGNITUDE
4.41 - 5.20
3.71 - 4.40
3.31 - 3.70
3.00 - 3.30
When were Seismographs first installed in Utah?
In 1907, James Talmage at the University of Utah.
A skeletal statewide network began in 1962.
Modern seismographic surveillance in the
wasatch front began in 1974. Computerized
recording of earthquake data began in 1981.
Information provided by the Geology Department at the University of Utah.
www.seis.utah.edu/qfacts/utfaq.shtml
Richter Magnitude Scale
2.5 Generally not felt, but recorded on Seismometers
3.5 Felt by many people
4.5 Some local damage may occur
6.0 A destructive earthquake
7.0 A major earthquake
8.0 A great earthquake

Figure I-20



*Source: University of Utah Seismograph Stations earthquake catalog
(number of earthquakes = 39,058)

Figure I-21

Assessing Vulnerability by Jurisdiction

> ***[The 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... 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…***

County vulnerability ranking is solely based on the total building related economic loss that would occur from a 2500-year seismic event in each county.

1. Salt Lake
2. Utah
3. Davis
4. Weber
5. Washington
6. Cache
7. Summit
8. Tooele
9. Box Elder
10. Iron
11. Uintah
12. Carbon
13. Sanpete
14. Sevier
15. Wasatch
16. Duchesne
17. San Juan
18. Millard
19. Emery
20. Grand
21. Kane
22. Garfield
23. Juab
24. Morgan
25. Beaver
26. Rich
27. Wayne
28. Piute
29. Daggett

Estimating Potential Losses by Jurisdiction

> ***[The risk assessment shall include an] overview and analysis of potential losses to identified vulnerable structures, based on estimates provided in local risk assessments…***

HAZUS MH, a model developed by FEMA to replicate earthquake loss, was used to estimate vulnerability. HAZUS MH was used to model ground-shaking levels with a 2500-year return period for each county. Compiled in table I-15 are some of the more pertinent loss values, from the HAZUS MH runs.

Table I-15 County Earthquake Loss Value from HAZUS MH

County Name	Building Related Economic Losses Residential in Millions	Building Related Economic Losses Non-Residential in Millions	Total Casualties Estimates for 2AM	Fatalities 2AM	Total Building Related Economic Losses in Millions
Beaver	$56.63	$14.08	51	2	$70.71
Box Elder	$413.68	$134.7	514	25	$548.37
Cache	$641	$340.27	816	39	$981.26
Carbon	$121.15	$46.2	3	0	$167.35
Daggett	$6.38	$0.67	2	0	$7.06
Davis	$3,009.21	$1,036.15	3680	183	$4,045.36

County Name	Building Related Economic Losses Residential in Millions	Building Related Economic Losses Non-Residential in Millions	Total Casualties Estimates for 2AM	Fatalities 2AM	Total Building Related Economic Losses in Millions
Duchesne	$40.56	$11.52	35	1	$52.09
Emery	$78.24	$25.43	88	3	$103.67
Garfield	$65.97	$40.51	54	2	$106.48
Grand	$14.16	$6.84	1	0	$21
Iron	$349.54	$139.43	370	17	$488.96
Juab	$45.03	$25.96	54	3	$70.98
Kane	$41.75	$17.29	34	1	$59.04
Millard	$46.69	$21.5	48	2	$68.19
Morgan	$38.7	$20.4	41	2	$59.09
Piute	$18.31	$5.48	15	1	$23.78
Rich	$34.05	$3.36	14	1	$37.41
Salt Lake	$12,978.45	$7,252.62	15310	756	$20,231.07
San Juan	$10.18	$2.38	8	0	$12.57
Sanpete	$132.25	$87.6	153	7	$181.49
Sevier	$124.92	$50.91	127	5	$175.83
Summit	$374.94	$136.76	209	10	$511.7
Tooele	$236.74	$76.01	258	11	$312.75
Uintah	$72.38	$33.42	60	2	$105.8
Utah	$3,491.86	$1,568.72	168	11	$5,060.58
Wasatch	$96.68	$33.23	75	3	$129.91
Washington	$613.58	$279.54	621	25	$893.12
Wayne	$13.31	$3.54	8	0	$16.85
Weber	$2,451.35	$1,004.53	2957	149	$3,455.87
Total	$25,617.69	$12,419.05	25774	1261	$37,998.34

Assessing Vulnerability by State Facilities

> [The 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 …the State risk assessment. …State owned critical or operated facilities located in the identified hazard areas shall also be addressed…

When assessing the vulnerability of state owned facilities, or all facilities for that matter, an understanding of the building code, to which the building was designed, is of extreme importance. Utah building codes began to address seismic design as early as 1976 although the state did not adopt building codes fully addressing seismic safety until 1989. It is a fairly safe assumption that buildings constructed prior to 1976 will not perform in an earthquake as well as those building constructed following 1976. An increased understanding of seismic events coupled with advances in building design has greatly increased our ability to design and construct buildings, which perform better in earthquakes. Safer buildings are a result of scientific gains in the fields of geoscience and structural engineering, being accepted and put in practice through building codes. Thus, buildings constructed today will have a superior performance in an earthquake than those constructed in the past.

Earthquakes are regional hazards effecting multi-county areas, and because almost the entire state could experience a seismic event, all of the state owned buildings exhibit some degree of risk due to the event. The degree of risk is determined by several factors none more important than the likelihood and potential magnitude of the earthquake, although when discussing potential building damage regardless of location, building design is a key factor. Vulnerability of state owned facilities was determined through age of construction with those buildings built before 1976 considered having a higher risk. Shown in table I-16 is the number of state buildings in each county built prior to1976 and those built post 1976.

Table I-16 Number of State Owned Facilities per County Built pre and post 1976

County Name	Number of state owned buildings consider high risk pre 1976 construction date	Number of state owned buildings consider to have a lower risk post 1976 construction date
Beaver	17	27
Box Elder	53	71
Cache	245	270
Carbon	54	82
Daggett	10	19
Davis	74	136
Duchesne	29	64
Emery	34	51
Garfield	28	32
Grand	29	37
Iron	57	127
Juab	17	45
Kane	17	37
Millard	24	56
Morgan	22	36
Piute	9	16
Rich	14	26
Salt Lake	571	924
San Juan	29	77
Sanpete	38	125
Sevier	36	74
Summit	17	96
Tooele	23	64
Uintah	42	71
Utah	165	279
Wasatch	38	102
Washington	39	112
Wayne	20	14
Weber	151	147
Total	1,902	3217

Estimating Potential Losses by State Facilities

[The risk assessment shall include the following:]…[a]n overview and analysis of potential losses to identified vulnerable structures, based on estimates provided in …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.

To estimate the potential losses a seismic event would cause to state owned facilities, age of construction was again a central element. This time the construction date of a building was utilized to determine the value or expected damage as based on the building's insured value. To determine the value of vulnerable state-owned facilities, the state-owned building database was queried to identify the number of buildings, age of building construction, and insured value of those buildings for each county. The insured value was then used to determine estimated building damage that would result from an event with ground motion of 0.25 and 0.55 PGA. Loss estimation tables from FEMA publication 386-2 "Understanding Your Risk - identifying hazards and estimating losses" were utilized to obtain the percentage of damage expected at the two different PGA values. Rather than determine the building type of all 5119 state-owned facilities the values in Table E-4 are for reinforced masonry structures. We assumed moderate building code construction for those structures built after 1976 and pre-code construction for those structures build before 1976. Values in table E-4, assume damage estimates of 3.9 and 12.4 percent at 0.25 PGA and 27.7 and 53.1 at 0.55 PGA. Content values were not figured into table I-17, as they are most likely included in the insured value. This may have slightly increased the expected damage because as a rule content valued is one half of the expected building damage.

For example, building damage for pre-code construction with a ground motion event of 0.55 PGA has an estimated percent damage of 53.1. One would estimate that the contents damage would be 26.55 percent of the building's replacement value.

Table I-17 Potential Damage to State Owned Facilities

County Name	Insured value	Expected building damage at 0.25 PGA (g)	Expected building damage at 0.55 PGA (g)
Beaver	$26,371,416	$ 1,028,485.22	$ 7,304,882.23
Pre 1976	$13,328,034	$1,652,676.22	$7,077,186.05
Box Elder	$75,837,338	$2,957,656.18	$21,006,942.63
Pre 1976	$135,870,891	$16,847,990.48	$72,147,443.12
Cache	$371,855,177	$14,502,351.90	$103,003,884.03
Pre 1976	$630,778,131	$78,216,488.24	$334,943,187.56
Carbon	$4,068,120	$158,656.68	$1,126,869.24
Pre 1976	$83,112,148	$10,305,906.35	$44,132,550.59
Daggett	$5,034,836	$196,358.60	$1,394,649.57
Pre 1976	$4,068,120	$504,446.88	$2,160,171.72
Davis	$366,764,486	$14,303,814.95	$101,593,762.62
Pre 1976	$473,752,182	$58,745,270.57	$251,562,408.64
Duchesne	$34,473,051	$1,344,448.99	$9,549,035.13
Pre 1976	$67,816,647	$8,409,264.23	$36,010,639.56

County Name	Insured value	Expected building damage at 0.25 PGA (g)	Expected building damage at 0.55 PGA (g)
Emery	$33,360,826	$1,301,072.21	$9,240,948.80
Pre 1976	$35,387,341	$4,388,030.28	$18,790,678.07
Garfield	$19,465,471	$759,153.37	$5,391,935.47
Pre 1976	$17,178,095	$2,130,083.78	$9,121,568.45
Grand	$15,553,531	$606,587.71	$4,308,328.09
Pre 1976	$22,634,276	$2,806,650.22	$12,018,800.56
Iron	$199,172,583	$7,767,730.74	$55,170,805.49
Pre 1976	$110,866,683	$13,747,468.69	$58,870,208.67
Juab	$40,790,927	$1,590,846.15	$11,299,086.78
Pre 1976	$6,999,201	$867,900.92	$3,716,575.73
Kane	$20,349,221	$793,619.62	$5,636,734.22
Pre 1976	$15,707,794	$1,947,766.46	$8,340,838.61
Millard	$65,663,568	$2,560,879.15	$18,188,808.34
Pre 1976	$21,777,721	$2,700,437.40	$11,563,969.85
Morgan	$15,202,016	$592,878.62	$4,210,958.43
Pre 1976	$15,632,939	$1,938,484.44	$8,301,090.61
Piute	$3,878,328	$151,254.79	$1,074,296.86
Pre 1976	$9,939,684	$1,232,520.82	$5,277,972.20
Rich	$5,407,528	$210,893.59	$1,497,885.26
Pre 1976	$7,546,201	$935,728.92	$4,007,032.73
Salt Lake	$2,681,862,908	$104,592,653.41	$742,876,025.52
Pre 1976	$2,363,165,497	$293,032,521.63	$1,254,840,878.91
San Juan	$42,398,548	$1,653,543.37	$11,744,397.80
Pre 1976	$48,655,744	$6,033,312.26	$25,836,200.06
Sanpete	$171,819,118	$6,700,945.60	$47,593,895.69
Pre 1976	$45,630,073	$5,658,129.05	$24,229,568.76
Sevier	$71,018,002	$2,769,702.08	$19,671,986.55
Pre 1976	$40,432,040	$5,013,572.96	$21,469,413.24
Summit	$158,254,746	$6,171,935.09	$43,836,564.64
Pre 1976	$7,114,282	$882,170.97	$3,777,683.74
Tooele	$80,451,484	$3,137,607.88	$22,285,061.07
Pre 1976	$80,169,143	$9,940,973.73	$42,569,814.93
Uintah	$71,050,468	$2,770,968.25	$19,680,979.64
Pre 1976	$46,996,482	$5,827,563.77	$24,955,131.94
Utah	$869,253,106	$33,900,871.13	$240,783,110.36
Pre 1976	$566,049,306	$70,190,113.94	$300,572,181.49
Wasatch	$43,178,642	$1,683,967.04	$11,960,483.83
Pre 1976	$35,694,869	$4,426,163.76	$18,953,975.44
Washington	$291,174,090	$11,355,789.51	$80,655,222.93
Pre 1976	$89,817,438	$11,137,362.31	$47,693,059.58
Wayne	$2,105,608	$82,118.71	$583,253.42
Pre 1976	$8,099,647	$1,004,356.23	$4,300,912.56
Weber	$338,871,627	$13,215,993.45	$93,867,440.68
Pre 1976	$643,544,568	$79,799,526.43	$341,722,165.61
Total	$11,772,451,947	$939,185,665.98	$4,695,501,544.28

Damage estimates utilized tables from FEMA 386-2. Values following the county name are for buildings constructed post 1976.