

HAZUS-MH: Earthquake Event Report

Region Name: Ogden Earthquake Mw 6.5 ShakeMap Scenario

Earthquake Scenario: Ogden Earthquake Mw 6.5 ShakeMap Scenario

Print Date: October 16, 2009

Totals only reflect data for those census tracts/blocks included in the user's study region.

Disclaimer:

The estimates of social and economic impacts contained in this report were produced using HAZUS loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.

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General Description of the Region

HAZUS is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of HAZUS is to provide a methodology and software application to develop earthquake losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from earthquakes and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 27 county(ies) from the following state(s):

Utah

Note:

Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 78,264.96 square miles and contains 476 census tracts. There are over 733 thousand households in the region and has a total population of 2,354,384 people (2005 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 616 thousand buildings in the region with a total building replacement value (excluding contents) of 125,439 (millions of dollars). Approximately 95.00 % of the buildings (and 0.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 52,143 and 8,878 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 616 thousand buildings in the region which have an aggregate total replacement value of 125,439 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 45% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

HAZUS breaks critical facilities into two (2) groups: essential facilities and high potential loss (HPL) facilities. Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 53 hospitals in the region with a total bed capacity of 6,535 beds. There are 1,021 schools, 319 fire stations, 128 police stations and 5 emergency operation facilities. With respect to HPL facilities, there are 571 dams identified within the region. Of these, 198 of the dams are classified as 'high hazard'. The inventory also includes 706 hazardous material sites, 0 military installations and 0 nuclear power plants.

Transportation and Utility Lifeline Inventory

Within HAZUS, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 61,021.00 (millions of dollars). This inventory includes over 8,325 kilometers of highways, 2,878 bridges, 228,205 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	2,878	3,345.60
	Segments	1,250	43,857.10
	Tunnels	4	2.00
		Subtotal	47,204.70
Railways	Bridges	33	3.90
	Facilities	12	32.00
	Segments	1,485	2,821.00
	Tunnels	0	0.00
		Subtotal	2,856.90
Light Rail	Bridges	0	0.00
	Facilities	24	63.90
	Segments	24	37.20
	Tunnels	0	0.00
		Subtotal	101.10
Bus	Facilities	10	10.70
		Subtotal	10.70
Ferry	Facilities	1	1.30
		Subtotal	1.30
Port	Facilities	0	0.00
		Subtotal	0.00
Airport	Facilities	28	298.20
	Runways	44	1,670.40
		Subtotal	1,968.60
		Total	52,143.30

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	2,771.90
	Facilities	2	65.30
	Pipelines	0	0.00
		Subtotal	2,837.10
Waste Water	Distribution Lines	NA	1,663.10
	Facilities	53	3,459.20
	Pipelines	0	0.00
		Subtotal	5,122.30
Natural Gas	Distribution Lines	NA	1,108.70
	Facilities	8	8.50
	Pipelines	954	2,010.00
		Subtotal	3,127.30
Oil Systems	Facilities	31	3.00
	Pipelines	465	733.60
		Subtotal	736.60
Electrical Power	Facilities	24	2,587.20
		Subtotal	2,587.20
Communication	Facilities	120	11.80
		Subtotal	11.80
		Total	14,422.30

Earthquake Scenario

HAZUS uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	Ogden Earthquake Mw 6.5 ShakeMap Scenario
Type of Earthquake	User-defined
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	NA
Latitude of Epicenter	NA
Earthquake Magnitude	6.50
Depth (Km)	NA
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	NA

Building Damage

Building Damage

HAZUS estimates that about 32,315 buildings will be at least moderately damaged. This is over 5.00 % of the total number of buildings in the region. There are an estimated 1,355 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the HAZUS technical manual. Table 3 below summaries the expected damage by general occupancy for the buildings in the region. Table 4 summaries the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	515	0.09	6	0.02	1	0.00	0	0.00	0	0.00
Commercial	18,889	3.45	599	1.67	550	2.50	317	3.53	58	4.27
Education	720	0.13	33	0.09	43	0.19	36	0.41	8	0.56
Government	1,588	0.29	42	0.12	62	0.28	63	0.70	14	1.04
Industrial	6,754	1.23	184	0.52	174	0.79	126	1.40	27	1.97
Other Residential	60,318	11.00	3,949	11.04	4,392	19.98	1,657	18.46	185	13.64
Religion	2,298	0.42	94	0.26	112	0.51	95	1.06	20	1.47
Single Family	457,171	83.39	30,864	86.28	16,650	75.74	6,682	74.44	1,045	77.06
Total	548,254		35,772		21,983		8,976		1,356	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	258,860	47.22	14522	40.60	1,329	6.05	420	4.68	98	7.25
Steel	5,316	0.97	121	0.34	200	0.91	204	2.27	56	4.12
Concrete	4,360	0.80	129	0.36	215	0.98	171	1.91	30	2.21
Precast	3,252	0.59	48	0.13	95	0.43	116	1.29	29	2.16
RM	107,620	19.63	4808	13.44	2,042	9.29	386	4.30	59	4.38
URM	150,149	27.39	14658	40.98	15,161	68.97	6,700	74.64	1,013	74.70
MH	18,697	3.41	1485	4.15	2,941	13.38	978	10.89	70	5.18
Total	548,254		35,772		21,983		8,976		1,356	

*Note:

RM Reinforced Masonry
 URM Unreinforced Masonry
 MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 6,535 hospital beds available for use. On the day of the earthquake, the model estimates that only 6,243 hospital beds (96.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 99.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

Table 5: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	53	0	0	49
Schools	1,021	0	0	1,021
EOCs	5	0	0	5
PoliceStations	128	0	0	128
FireStations	319	0	0	319

Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

Table 6: Expected Damage to the Transportation Systems

System	Component	Locations/ Segments	Number of Locations_			
			With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	1,250	0	0	1,250	1,250
	Bridges	2,878	67	0	2,811	2,839
	Tunnels	4	0	0	4	4
Railways	Segments	1,485	0	0	1,485	1,485
	Bridges	33	0	0	33	33
	Tunnels	0	0	0	0	0
	Facilities	12	0	0	12	12
Light Rail	Segments	24	0	0	24	24
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	24	0	0	24	24
Bus	Facilities	10	0	0	10	10
Ferry	Facilities	1	0	0	1	1
Port	Facilities	0	0	0	0	0
Airport	Facilities	28	0	0	28	28
	Runways	44	0	0	44	44

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, HAZUS performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.

Table 7 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	2	0	0	1	2
Waste Water	53	2	0	49	53
Natural Gas	8	0	0	8	8
Oil Systems	31	1	0	29	31
Electrical Power	24	0	0	24	24
Communication	120	7	0	120	120

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	138,593	985	461
Waste Water	83,156	779	364
Natural Gas	4,087	5	8
Oil	2,370	11	25

Table 9: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	733,390	52,187	32,129	8,289	0	0
Electric Power		0	0	0	0	0

Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. HAZUS uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 28 ignitions that will burn about 0.89 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 2,146 people and burn about 129 (millions of dollars) of building value.

Debris Generation

HAZUS estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 1.880 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 47.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 75,320 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Shelter Requirement

HAZUS estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 4,569 households to be displaced due to the earthquake. Of these, 3,524 people (out of a total population of 2,354,384) will seek temporary shelter in public shelters.

Casualties

HAZUS estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake

Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	11	2	0	1
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	12	2	0	1
	Industrial	28	7	1	2
	Other-Residential	387	77	9	18
	Single Family	1,059	201	24	46
	Total	1,496	290	35	67
2 PM	Commercial	677	155	22	44
	Commuting	1	1	3	0
	Educational	249	60	9	18
	Hotels	2	0	0	0
	Industrial	208	51	7	14
	Other-Residential	83	17	2	4
	Single Family	212	42	5	10
	Total	1,432	328	48	89
5 PM	Commercial	542	124	18	34
	Commuting	31	38	68	13
	Educational	31	8	1	2
	Hotels	3	1	0	0
	Industrial	130	32	4	9
	Other-Residential	151	31	4	7
	Single Family	424	82	10	19
	Total	1,314	316	106	84

Economic Loss

The total economic loss estimated for the earthquake is 2,889.91 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 2,747.54 (millions of dollars); 28 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 49 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	11.95	93.41	6.87	29.83	142.06
	Capital-Related	0.00	5.07	72.42	4.24	8.22	89.94
	Rental	40.29	45.97	50.40	2.27	9.68	148.60
	Relocation	147.54	33.59	80.37	11.44	106.71	379.65
	Subtotal	187.83	96.57	296.60	24.83	154.44	760.27
Capital Stock Losses							
	Structural	196.25	55.96	100.84	33.28	76.65	462.98
	Non_Structural	447.60	186.00	202.71	76.63	199.13	1,112.07
	Content	140.41	40.09	96.79	45.43	74.15	396.87
	Inventory	0.00	0.00	4.31	11.01	0.04	15.36
	Subtotal	784.26	282.05	404.65	166.35	349.97	1,987.28
	Total	972.09	378.63	701.25	191.17	504.40	2,747.54

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, HAZUS computes the direct repair cost for each component only. There are no losses computed by HAZUS for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

HAZUS estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

Table 12: Transportation System Economic Losses
(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	43,857.11	\$9.79	0.02
	Bridges	3,345.63	\$29.30	0.88
	Tunnels	1.96	\$0.00	0.00
	Subtotal	47204.70	39.10	
Railways	Segments	2,821.00	\$0.67	0.02
	Bridges	3.92	\$0.03	0.77
	Tunnels	0.00	\$0.00	0.00
	Facilities	31.96	\$2.73	8.53
	Subtotal	2856.90	3.40	
Light Rail	Segments	37.15	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	63.91	\$1.87	2.93
	Subtotal	101.10	1.90	
Bus	Facilities	10.68	\$0.71	6.64
	Subtotal	10.70	0.70	
Ferry	Facilities	1.33	\$0.00	0.11
	Subtotal	1.30	0.00	
Port	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Airport	Facilities	298.23	\$7.98	2.68
	Runways	1,670.42	\$0.21	0.01
	Subtotal	1968.60	8.20	
Total		52143.30	53.30	

Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	\$0.00	0.00
	Facilities	65.30	\$4.90	7.51
	Distribution Lines	2,771.90	\$6.58	0.24
	Subtotal	2,837.12	\$11.48	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	3,459.20	\$53.97	1.56
	Distribution Lines	1,663.10	\$5.20	0.31
	Subtotal	5,122.32	\$59.17	
Natural Gas	Pipelines	2,010.00	\$0.05	0.00
	Facilities	8.50	\$0.00	0.01
	Distribution Lines	1,108.70	\$5.56	0.50
	Subtotal	3,127.32	\$5.61	
Oil Systems	Pipelines	733.60	\$0.14	0.02
	Facilities	3.00	\$0.04	1.45
	Subtotal	736.60	\$0.18	
Electrical Power	Facilities	2,587.20	\$12.44	0.48
	Subtotal	2,587.20	\$12.44	
Communication	Facilities	11.80	\$0.20	1.66
	Subtotal	11.76	\$0.20	
	Total	14,422.31	\$89.07	

Table 14. Indirect Economic Impact with outside aid
 (Employment as # of people and Income in millions of \$)

	LOSS	Total	%
First Year			
	Employment Impact	40,471	5.43
	Income Impact	85	0.30
Second Year			
	Employment Impact	17,611	2.36
	Income Impact	8	0.03
Third Year			
	Employment Impact	428	0.06
	Income Impact	(55)	-0.20
Fourth Year			
	Employment Impact	21	0.00
	Income Impact	(73)	-0.26
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(74)	-0.26
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(74)	-0.26

Appendix A: County Listing for the Region

Beaver,UT

Box Elder,UT

Cache,UT

Carbon,UT

Daggett,UT

Davis,UT

Duchesne,UT

Emery,UT

Garfield,UT

Grand,UT

Iron,UT

Juab,UT

Millard,UT

Morgan,UT

Piute,UT

Rich,UT

Salt Lake,UT

San Juan,UT

Sanpete,UT

Sevier,UT

Summit,UT

Tooele,UT

Uintah,UT

Utah,UT

Wasatch,UT

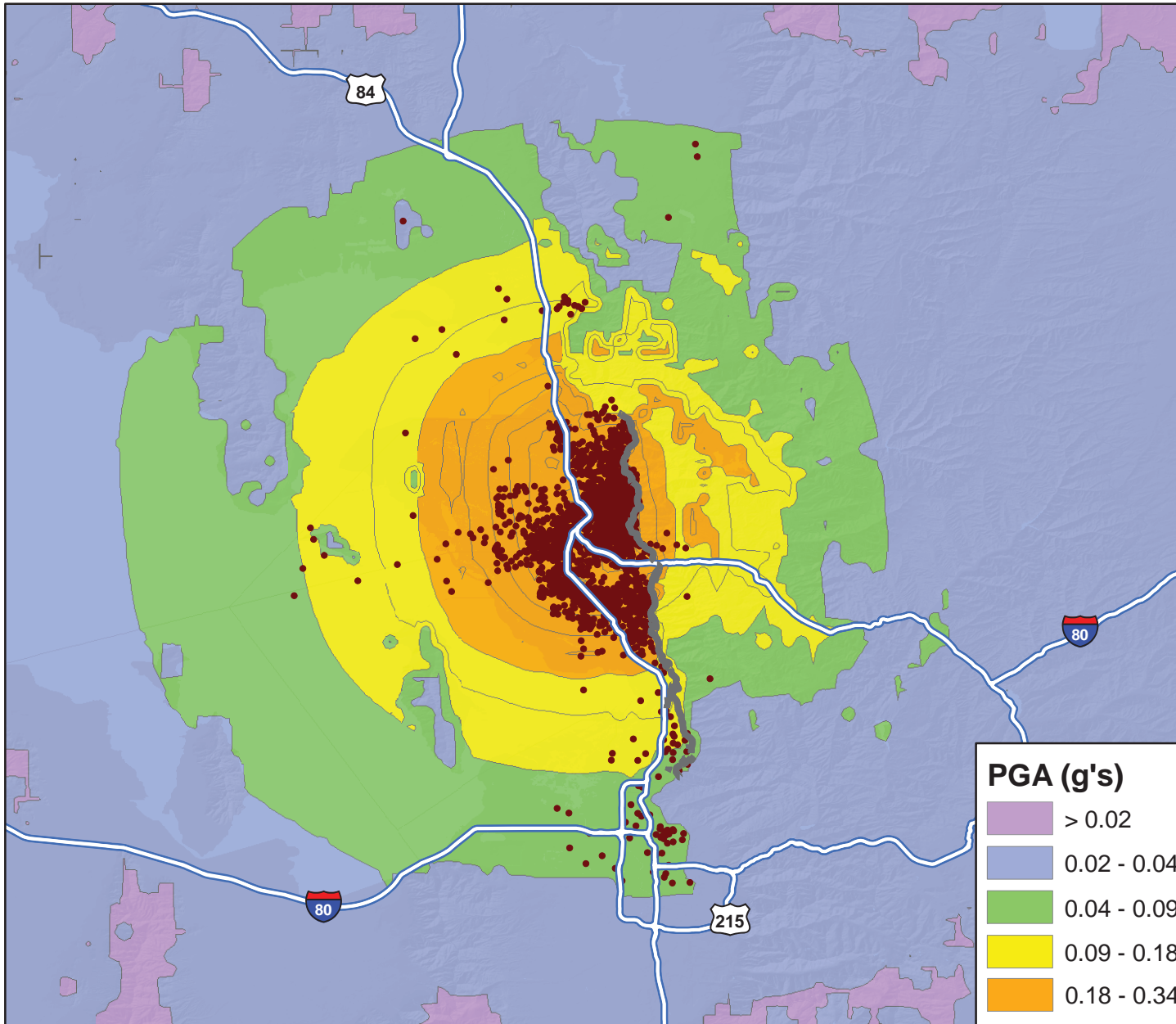
Wayne,UT

Weber,UT

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Utah	Beaver	6,295	252	89	341
	Box Elder	45,659	1,658	687	2,346
	Cache	100,585	3,382	1,703	5,085
	Carbon	19,947	825	395	1,220
	Daggett	884	74	18	92
	Davis	270,344	10,230	3,870	14,101
	Duchesne	15,233	496	248	744
	Emery	10,885	403	142	546
	Garfield	4,957	276	94	370
	Grand	8,891	350	195	546
	Iron	37,498	1,323	741	2,065
	Juab	9,240	291	190	481
	Millard	12,713	447	233	681
	Morgan	7,910	305	139	444
	Piute	1,439	69	24	93
	Rich	2,327	249	38	288
	Salt Lake	962,837	39,526	18,636	58,162
	San Juan	14,341	443	164	608
	Sanpete	24,037	708	387	1,095
	Sevier	19,623	697	315	1,013
	Summit	35,804	2,598	708	3,307
Tooele	50,184	1,782	564	2,347	
Uintah	26,973	851	460	1,312	
Utah	429,727	9,780	6,285	16,065	
Wasatch	18,879	0	89	89	
Wayne	2,590	115	38	154	
Weber	214,582	8,462	3,369	11,831	
Total State		2,354,384	85,592	39,821	125,426
Total Region		2,354,384	85,592	39,821	125,426

Direct Building Economic Loss - Earthquake Scenario: Ogden, UT



M 6.5 Ogden Earthquake

● 1 Dot = \$1,000,000

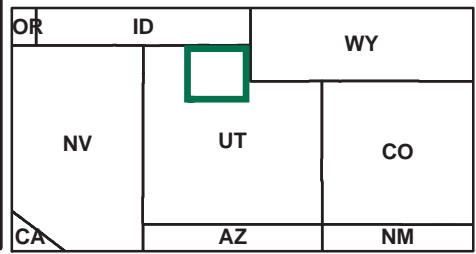
— Counties
 — Potential fault source

County	Cost Structural Damage	Cost Non-Structural Damage	Total Loss*
Box Elder	\$3 M	\$9 M	\$23 M
Cache	\$0 M	\$2 M	\$5 M
Davis	\$129 M	\$332 M	\$801 M
Salt Lake	\$7 M	\$26 M	\$61 M
Utah	\$0 M	\$1 M	\$2 M
Weber	\$323 M	\$741 M	\$1,856 M
Total	\$463 M	\$1,112 M	\$2,747 M

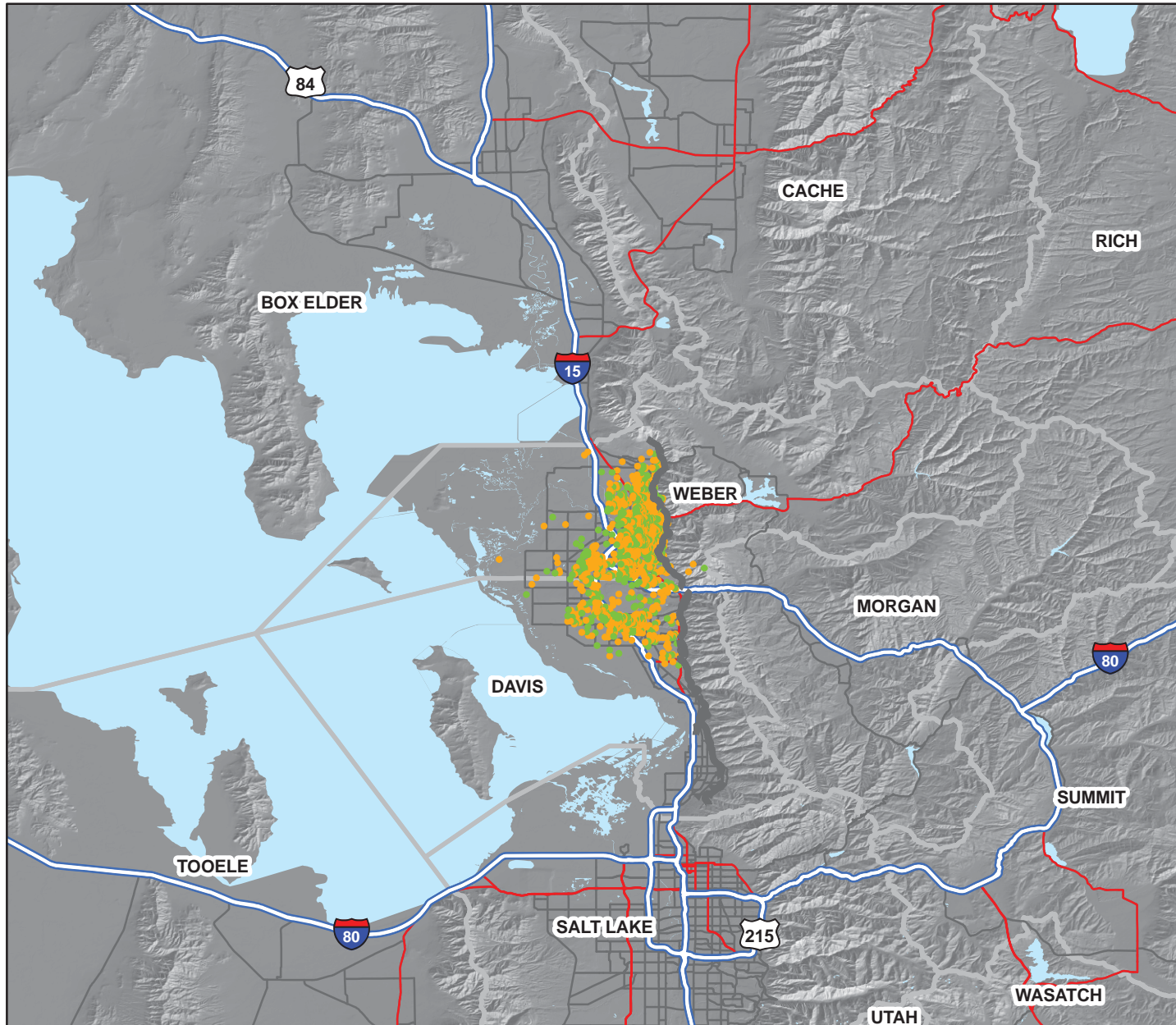
All values are millions of dollars
 * Total loss = structural, nonstructural, contents, and inventory damage, as well as income losses resulted from relocation, capital related losses, wage loss, and rental income loss

PGA (g's)

	> 0.02
	0.02 - 0.04
	0.04 - 0.09
	0.09 - 0.18
	0.18 - 0.34



Estimated Displaced Households & Short Term Public Shelter Needs - Earthquake Scenario: Ogden, UT



M 6.5 Ogden Earthquake

	Total #
Public Shelter Needs (Individuals)	3,524
Displaced Households	4,570

- 1 Dot = 5 Displaced Households*
 - 1 Dot = 5 Public Shelter Needs (Individuals)*
- * delineated by census tract

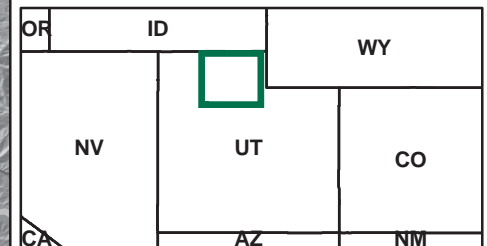
Roads

- Interstate
- Highway
- Major Road

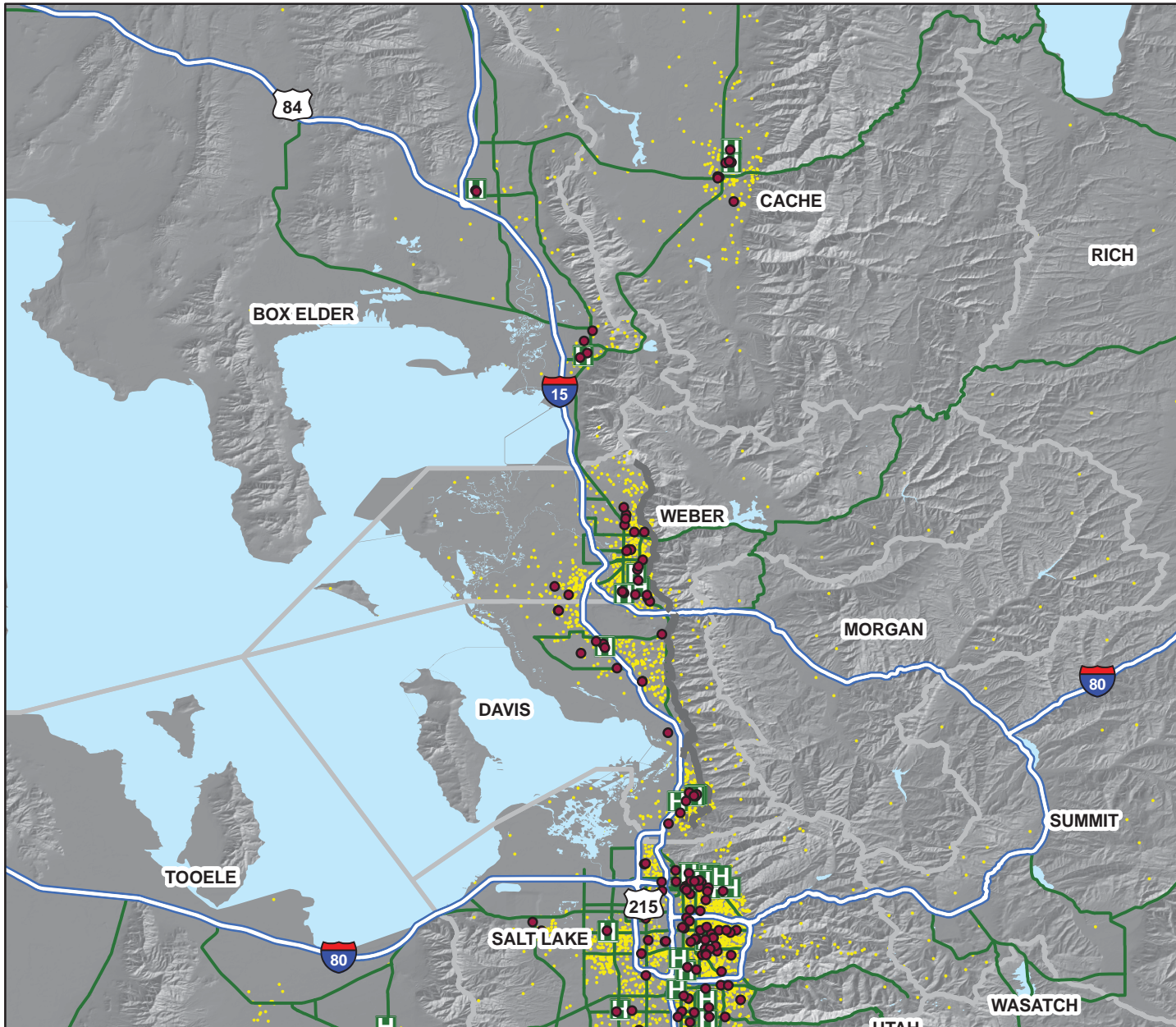
- Counties
- Potential fault source



10-22-09 FEMA & URS Corporation



Distribution of Elderly, Impaired Hospitals (Day 1), & Hospital Bed Availability - Earthquake Scenario: Ogden, UT



M 6.5 Ogden Earthquake

Highway Impacts

Damage is expressed as the probability that a given highway or bridge segment will realize at least moderate damage.

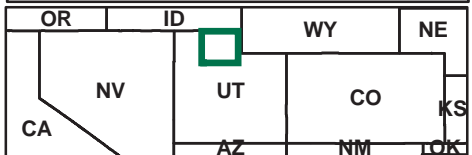
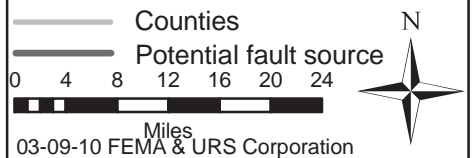
- 1 Dot = 30 People over 65
- Nursing Home
- Highway
 - high
 - moderate
 - low

Impaired Hospitals at Day 1

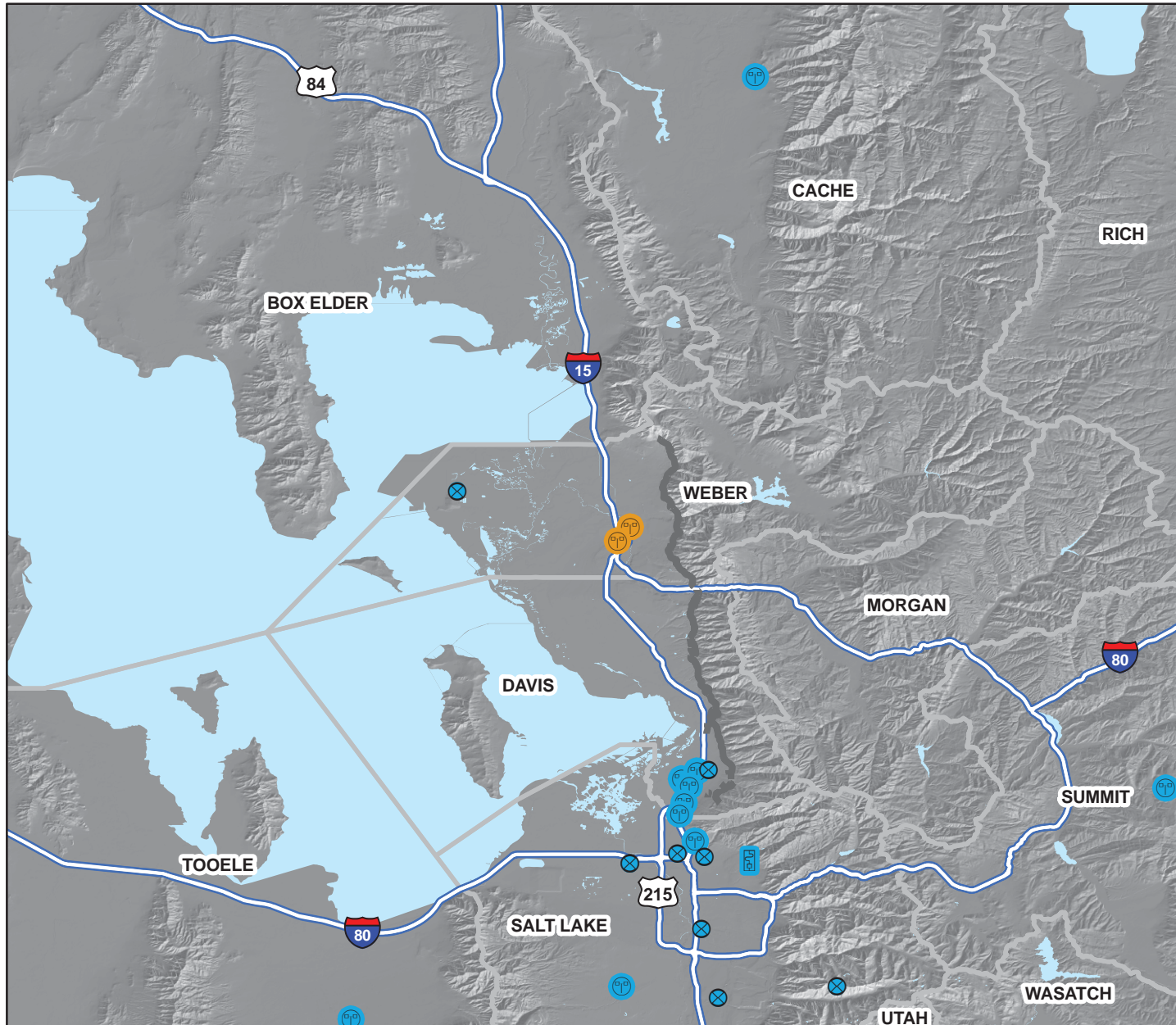
Damage is expressed as the probability that a given hospital will realize at least moderate damage.

County	Total # Hospital Beds	Hospital Beds Available	Injuries Requiring Hospital Treatment 2pm*
Box Elder	107	102	5
Cache	158	158	1
Davis	468	400	392
Salt Lake	3,440	3,437	12
Utah	1,013	1,012	0
Weber	655	287	1399
Total	5,841	5,396	1,809

* Injuries of severity 1,2, and 3.



Electrical, Natural Gas, and Oil Facility Damage - Earthquake Scenario: Ogden, UT



M 6.5 Ogden Earthquake

Utility Damage (at least moderate)

Damage is expressed as the percentage chance that a given Utility System will realize at least moderate damage.

Oil Facility

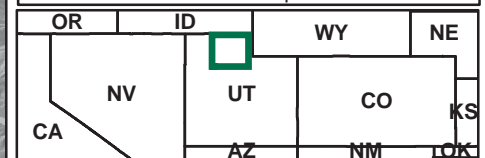
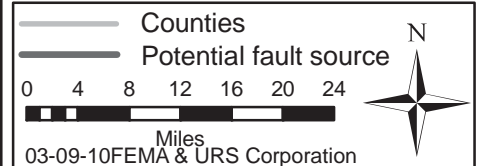
- low
- moderate
- high

Electric Power Facility

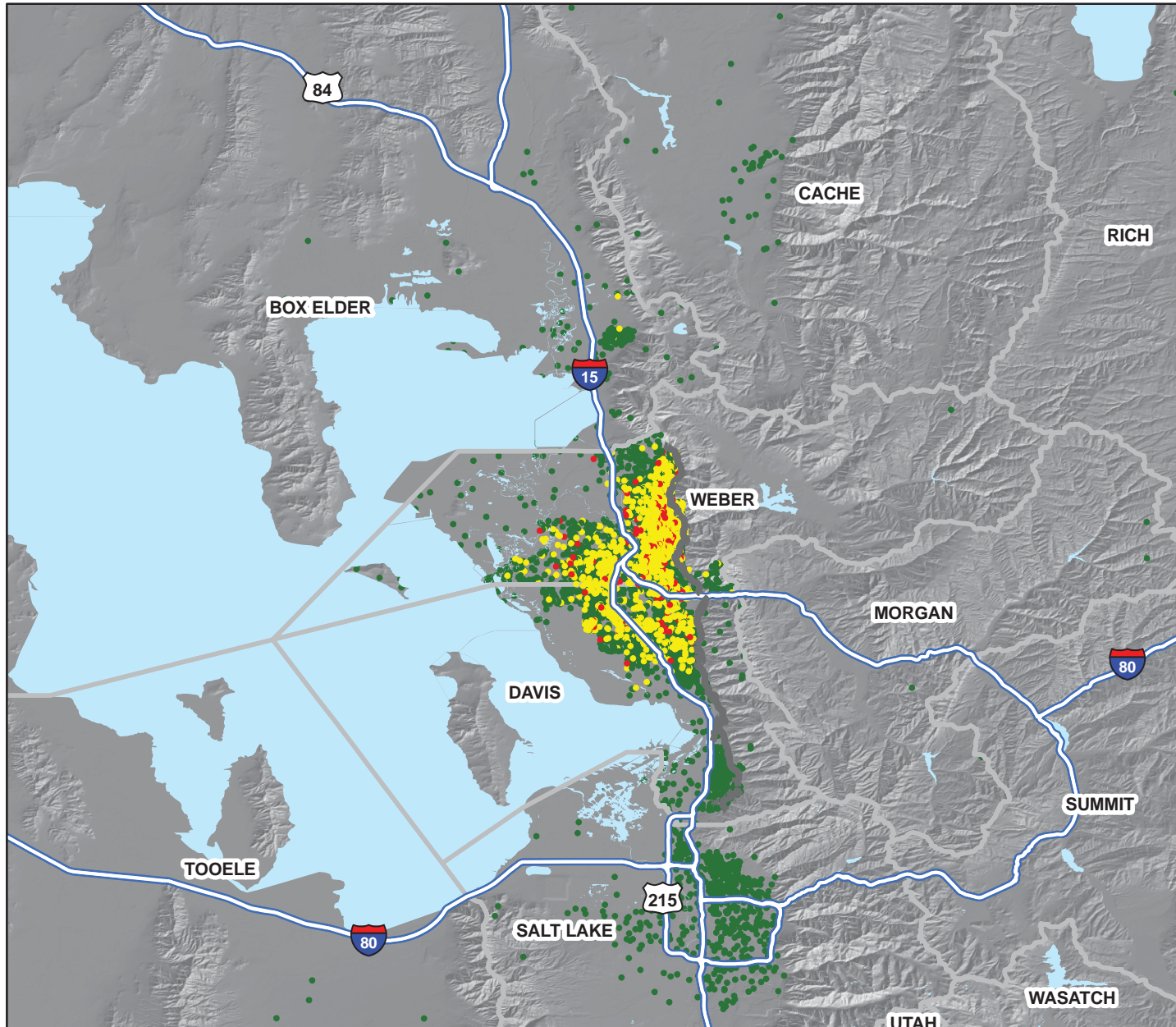
- low
- moderate
- high

Natural Gas Facility

- low
- moderate
- high



Estimated Building Inspection Needs - Earthquake Scenario: Ogden, UT

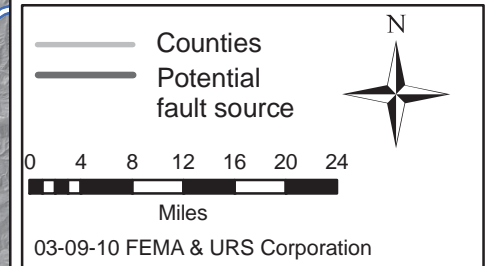


M 6.5 Ogden Earthquake

	Estimated # of Structures	Estimated # of Inspectors Needed
Red (Complete)	1,356	9
Yellow (Extensive)	8,976	120
Light Green (Slight/Moderate)	57,746	385
Total	68,078	514

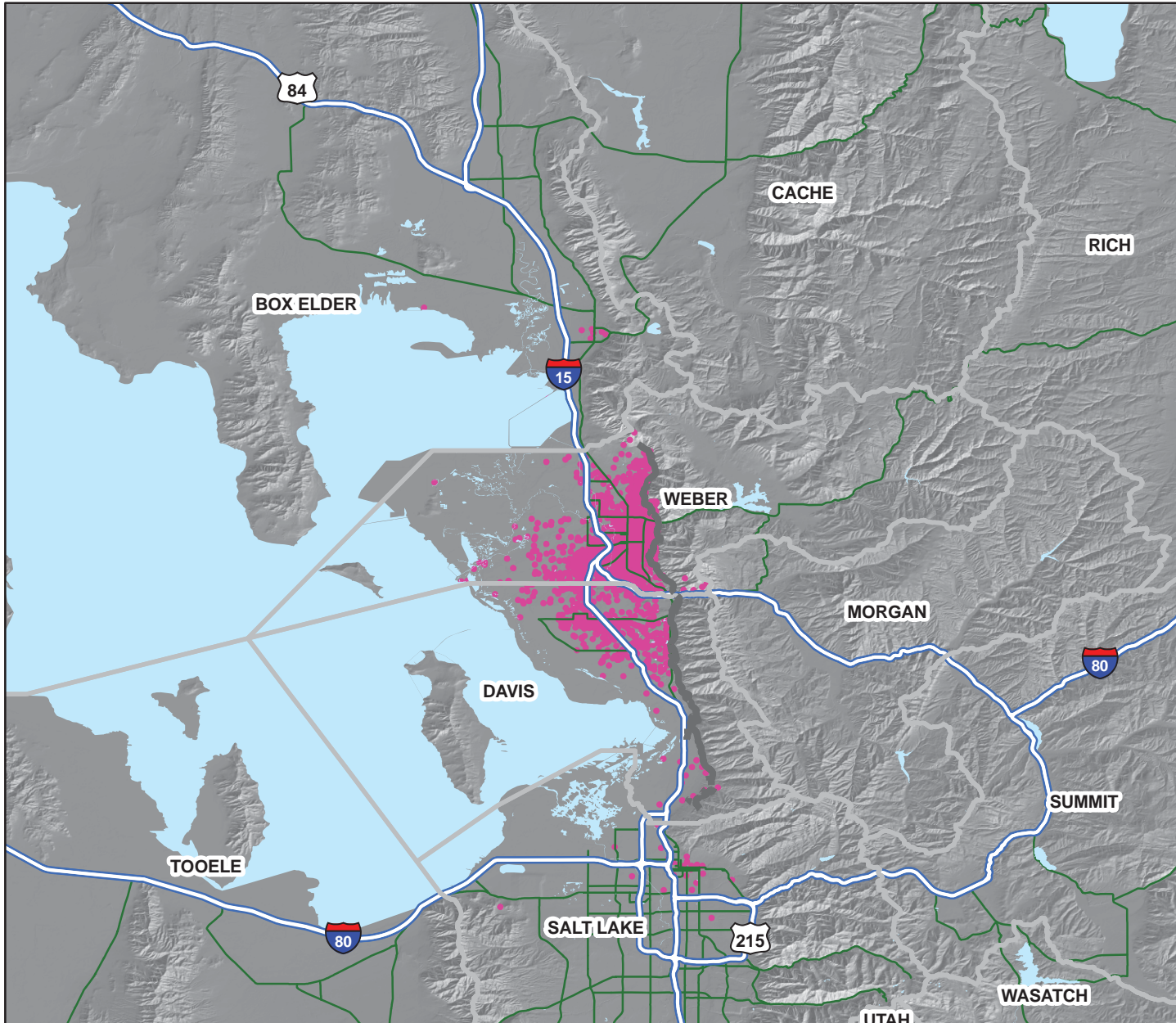
*Estimated number of inspectors needed to complete inspections in 30 days.

- 1 Dot = 10 (by census tract)
- Red Tag (Complete Damage)
- Yellow Tag (Extensive Damage)
- Green Tag (Slight/Moderate Damage)



OR	ID	WY
NV	UT	CO
CA	AZ	NM

Estimated Debris and Highway Impacts - Earthquake Scenario: Ogden, UT



M 6.5 Ogden Earthquake

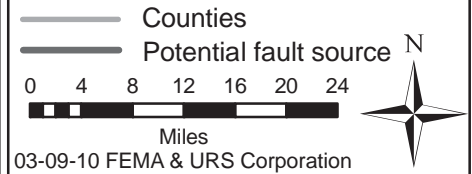
• 1 Dot = 1 thousand tons of
Total Debris
(by census tract)

Highway Impacts (at least moderate)

— low Damage is expressed as the
 probability that a given
 highway or bridge
— moderate segment will realize at
 least moderate damage.
— high

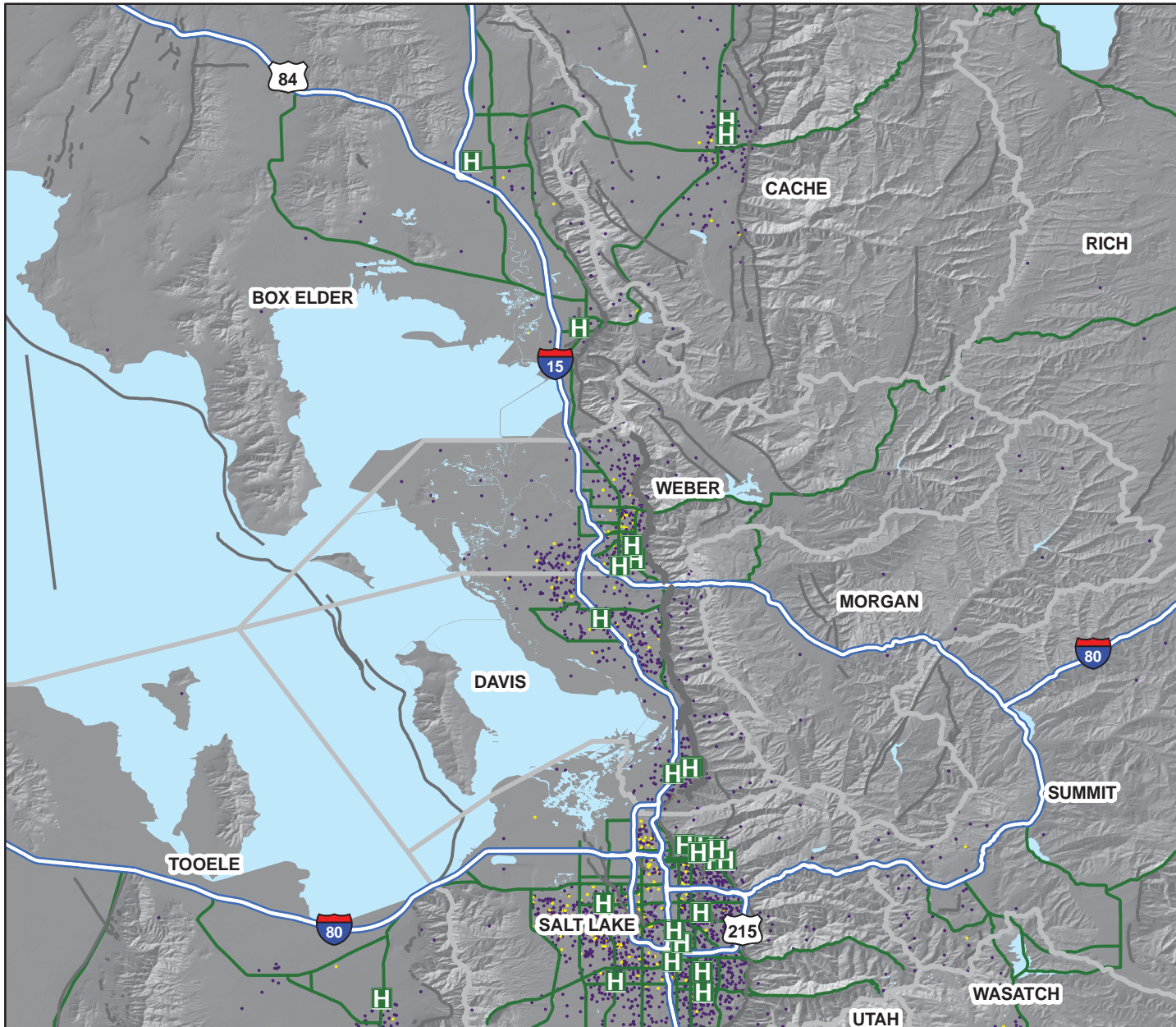
County	Brick and Wood (tons)	Concrete and Steel (tons)	Estimated Truck Loads*
Box Elder	9,000	4,000	520
Cache	2,000	0	80
Davis	196,000	279,000	19,000
Salt Lake	43,000	3,000	1,840
Weber	629,000	717,000	53,840
Total	879,000	1,003,000	75,280

* Truck loads estimated at 25 tons per truck



OR	ID	WY
NV	UT	CO
CA	AZ	NM

Demographic Distribution and Highway Impacts - Earthquake Scenario: Ogden, UT



M 6.5 Ogden Earthquake

Highway Impacts

Damage is expressed as the probability that a given highway or bridge segment will realize at least moderate damage.

Highway

- low
- moderate
- high

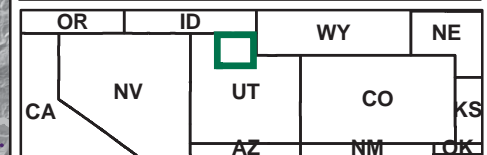
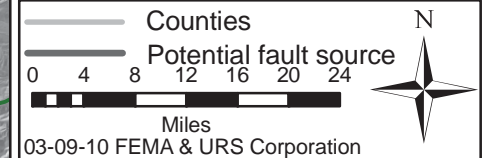
Demographics

1 Dot = 500 People (by census tract)

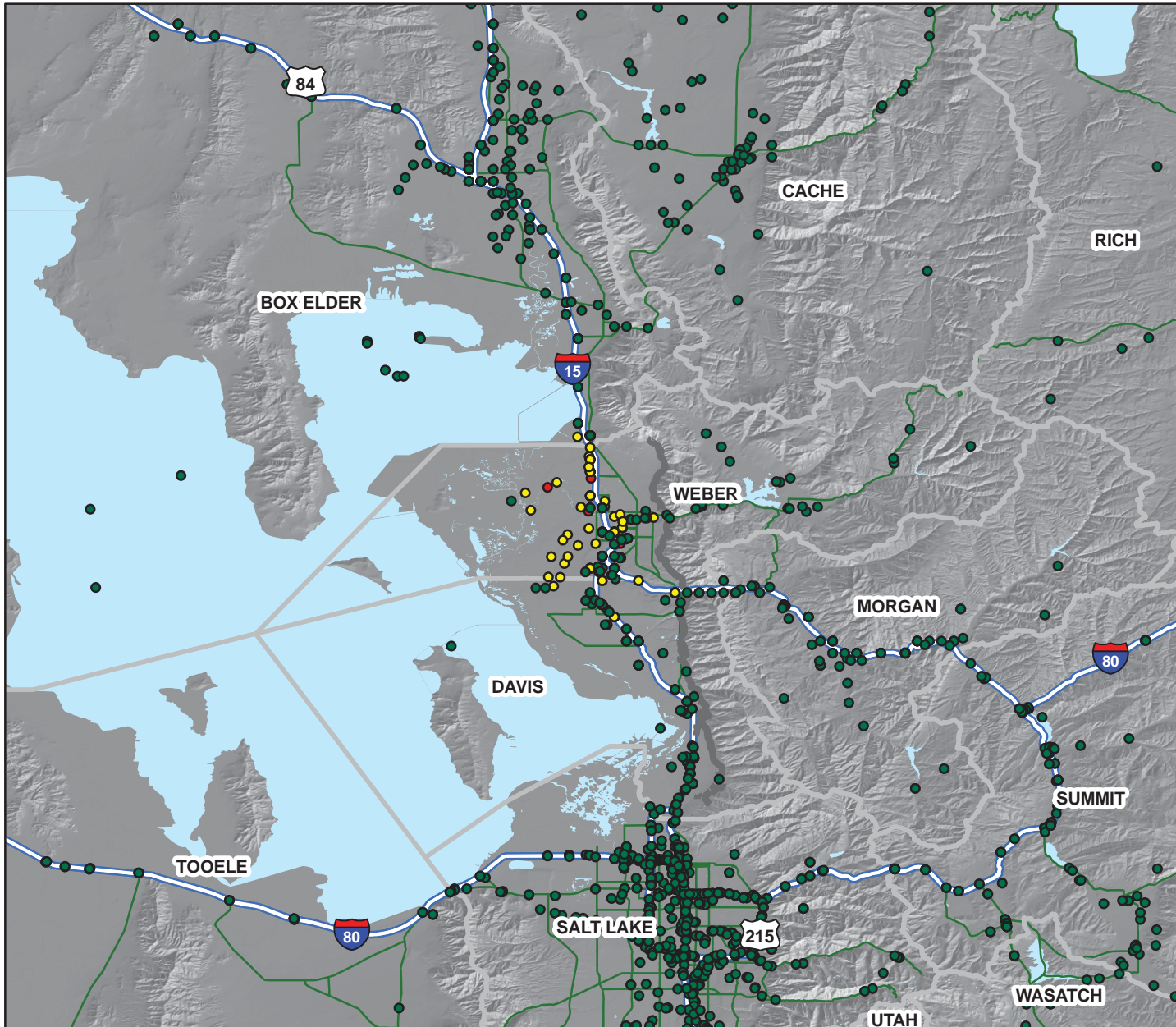
- English Speaking
- Potentially Non-English Speaking

Impaired Hospitals (Day1)

- high
Damage is expressed as the probability that a given hospital will realize at least moderate damage.
- moderate
- low



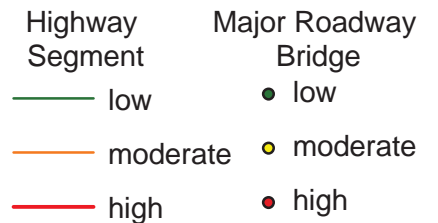
Estimated Highway Infrastructure Impacts - Earthquake Scenario: Ogden, UT



M 6.5 Ogden Earthquake

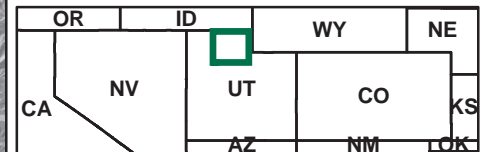
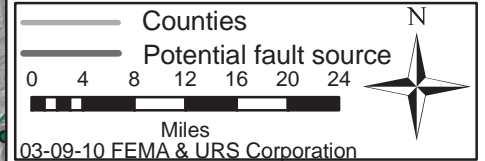
Highway Impacts (at least moderate)

Damage is expressed as the probability that a given highway or bridge segment will realize at least moderate damage.

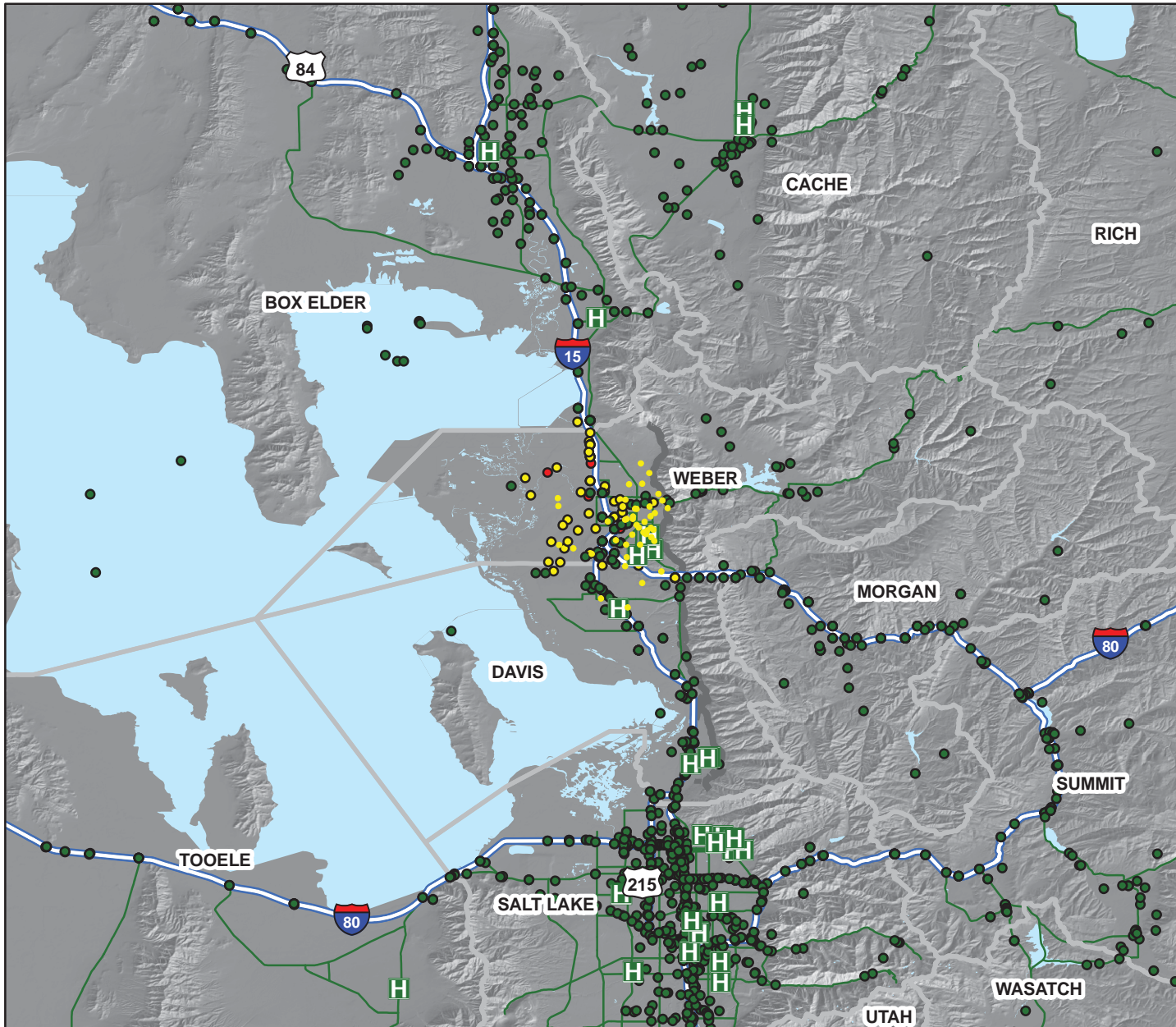


County	# of Bridges Needing Inspection	# of Bridges Needing Priority Inspection	# of Bridge Engineers Needed*
Box Elder	230	0	0
Cache	62	0	0
Davis	131	3.93	1
Morgan	80	0	0
Rich	23	0	0
Summit	155	0	0
Weber	141	9.87	1
Total	822	14	2

* For priority inspections only, assuming that 2 engineers can inspect 5 bridges a day for 3 days



Impaired Hospitals (Day 1), Hospital Bed Availability, & Highway Impacts - Earthquake Scenario: Ogden, UT



M 6.5 Ogden Earthquake

Highway Impacts

Damage is expressed as the probability that a given highway or bridge segment will realize at least moderate damage.

Bridge Seg.	Highway
● high	— high
● moderate	— moderate
● low	— low

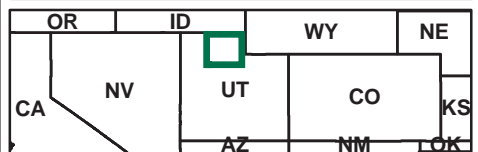
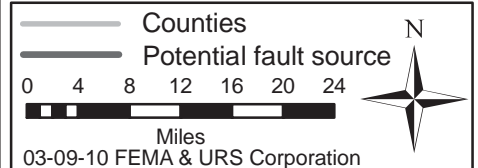
Impaired Hospitals (Day 1)

Damage is expressed as the probability that a given hospital will realize at least moderate damage.

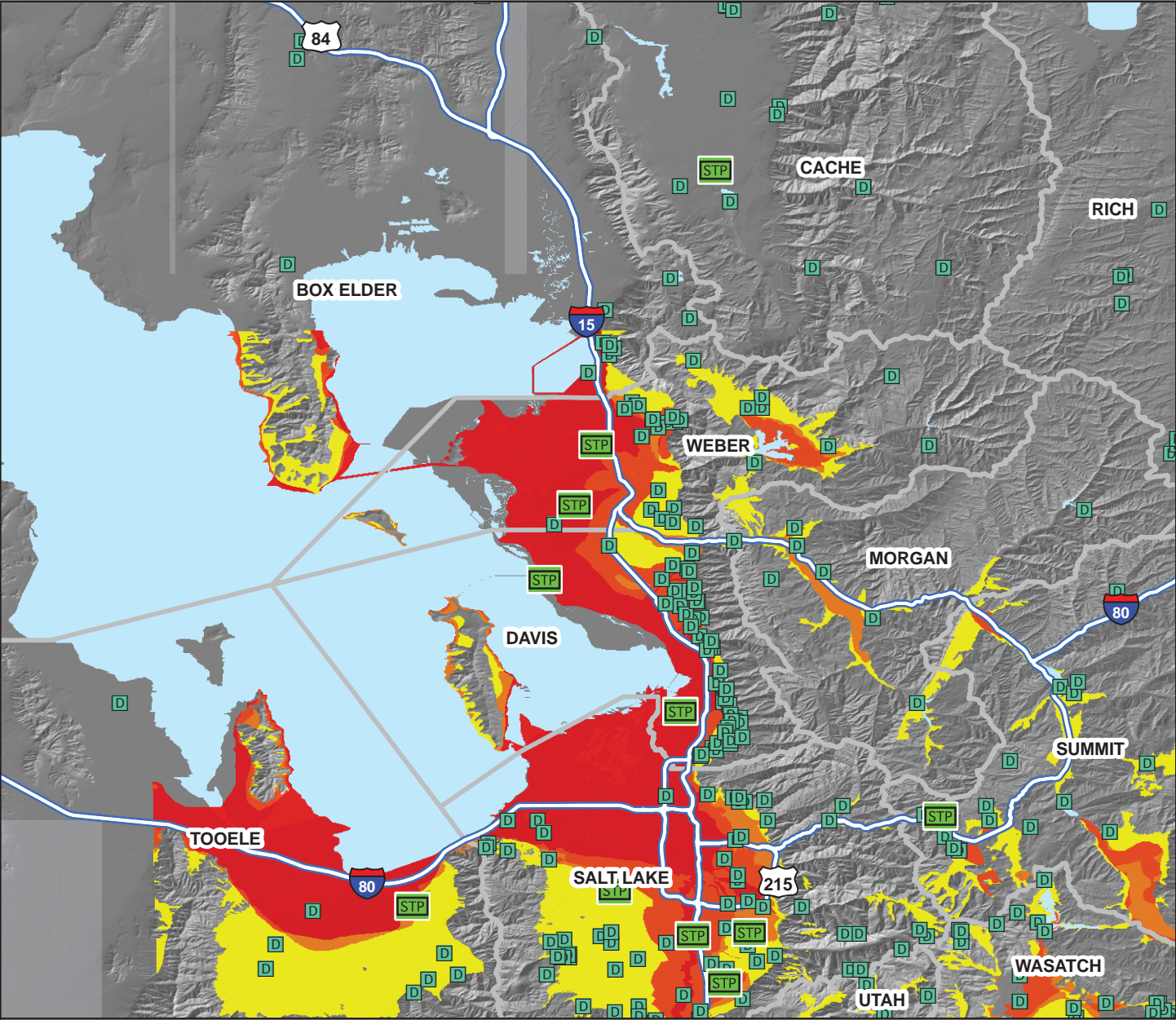
1 Dot = 1 Life Threatening Injury (Severity Level 3 by census tract)

County	Total # Hospital Beds	Hospital Beds Available	Injuries Requiring Hospital Treatment 2pm*
Box Elder	107	102	5
Cache	158	158	1
Davis	468	400	392
Salt Lake	3,440	3,437	12
Utah	1,013	1,012	0
Weber	655	287	1399
Total	5,841	5,396	1,809

* Injuries of severity 1, 2, and 3.



Water Line, Sewage Treatment Facility Distribution and Liquefaction Susceptibility - Earthquake Scenario: Ogden, UT



M 6.5 Ogden Earthquake

Liquefaction Susceptibility

- Low
- Medium
- High
- Very High

STP Sewage Treatment Facilities

D Dams

County	# Households without Potable Water (at Day 1)	Daily Potable Water Needs Per Person (Gallons/day)	Number of Truckloads needed Daily
Davis	18,556	55,668	12
Weber	33,631	100,893	21

* Based on U.S. Army Corp Mission Guidebook (Daily water is based on an estimated 3 people per household. One truck can transport an estimated 5000 gallons of water.)

— Counties

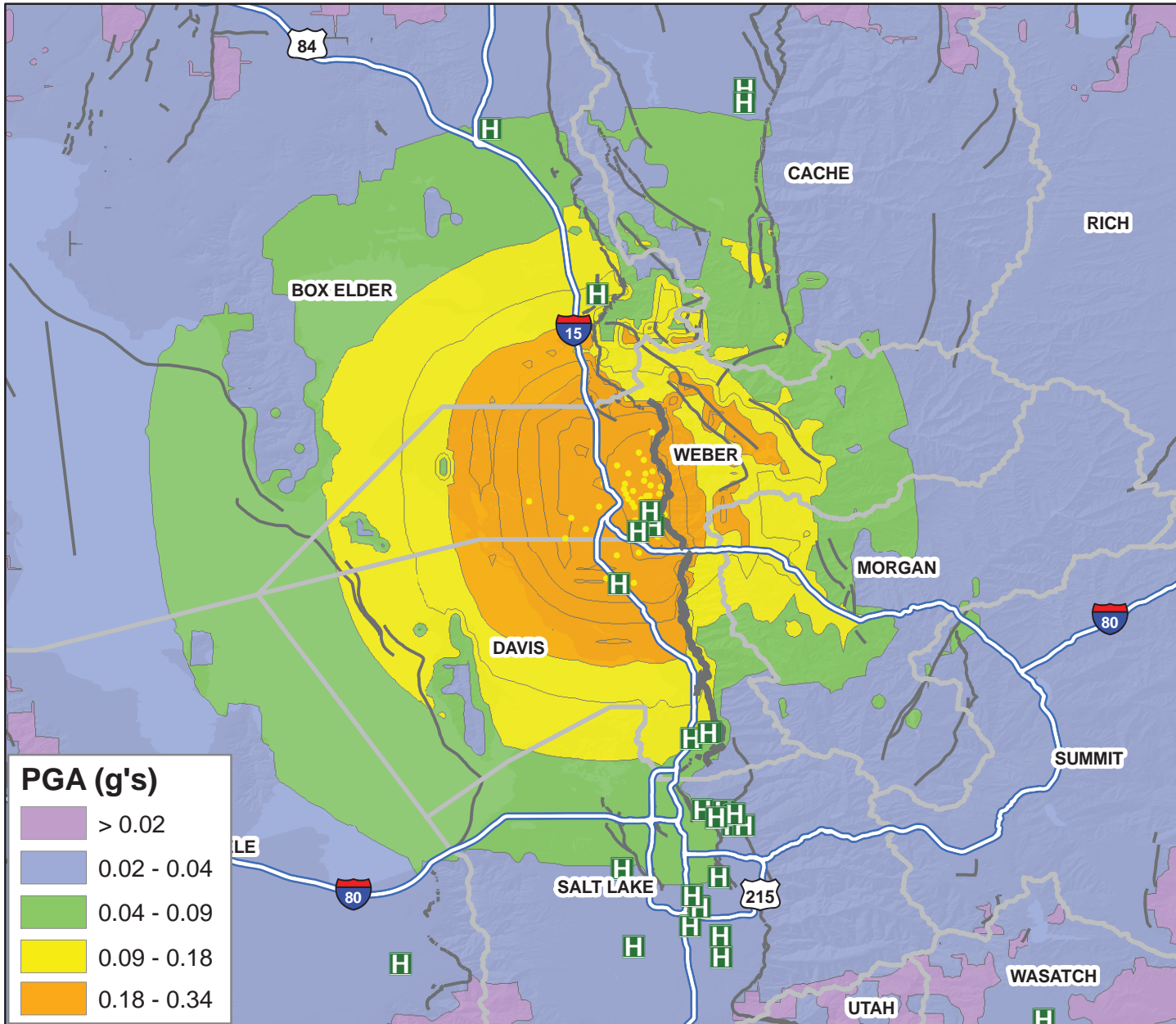
— Potential fault source

0 5 10 15 20 25 30 Miles

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OR	ID	WY	
NV	UT	CO	
CA	AZ	NM	

Potential Search and Rescue Needs - Earthquake Scenario: Ogden, UT



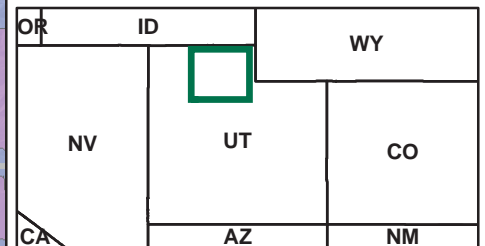
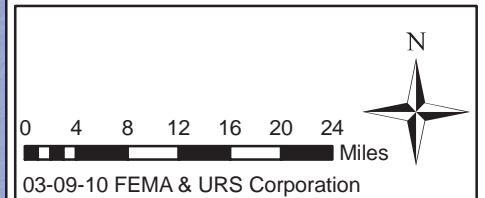
M 6.5 Ogden Earthquake

Impaired Hospitals (Day1)

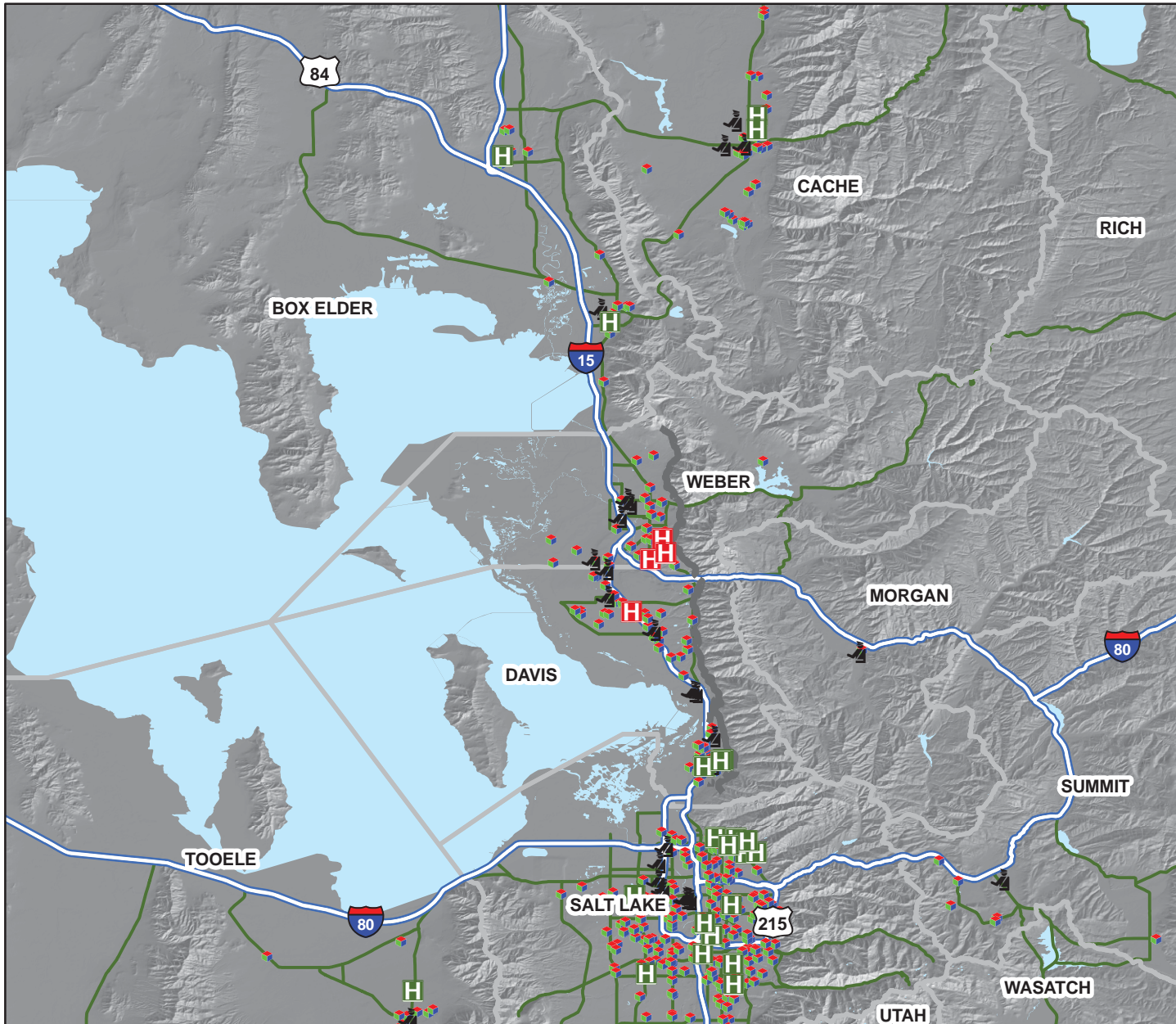
- high Damage is expressed as the probability that a given hospital will realize at least moderate damage.
- moderate
- low
- 1 Dot = 1 Life Threatening Injury (Severity Level 3 by census tract)

Structure Type	Red (Complete)	Collapse Rates for Complete Damage	Total Collapse
Wood	98	3%	3
Steel	56	6%	3
Concrete	30	10%	3
Precast Reinforced Masonry	29	13%	4
Unreinforced Masonry	59	10%	6
Manufactured Housing	1,013	15%	152
Total	70	3%	2
	1,355		173

- Counties
- Potential fault source



Correctional and Daycare Facilities, Impaired Hospitals (Day 1), and Highway Impacts - Earthquake Scenario: Ogden, UT



M 6.5 Ogden Earthquake

Highway Impacts

Damage is expressed as the probability that a given highway segment will realize at least moderate damage.

Highway

— high

— moderate

— low

Impaired Hospitals (Day 1)

Damage is expressed as high the probability that a given moderate hospital will realize at least low moderate damage.



Correctional Facilities



Daycare Facilities

— Counties

— Potential fault source

0 4 8 12 16 20 24



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