

# HAZUS-MH: Earthquake Event Report

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**Region Name:** Cedar City Segment M66

**Earthquake Scenario:** Cedar City Segment M6.6

**Print Date:** December 10, 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 8 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 22,771.95 square miles and contains 39 census tracts. There are over 63 thousand households in the region and has a total population of 192,276 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 62 thousand buildings in the region with a total building replacement value (excluding contents) of 10,229 (millions of dollars). Approximately 97.00 % of the buildings (and 68.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 13,287 and 1,079 (millions of dollars) , respectively.

## Building and Lifeline Inventory

### **Building Inventory**

HAZUS estimates that there are 62 thousand buildings in the region which have an aggregate total replacement value of 10,229 (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 70% 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 8 hospitals in the region with a total bed capacity of 537 beds. There are 112 schools, 82 fire stations, 19 police stations and 2 emergency operation facilities. With respect to HPL facilities, there are 124 dams identified within the region. Of these, 44 of the dams are classified as 'high hazard'. The inventory also includes 8 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 14,366.00 (millions of dollars). This inventory includes over 2,523 kilometers of highways, 520 bridges, 58,288 kilometers of pipes.

**Table 1: Transportation System Lifeline Inventory**

<b>System</b>	<b>Component</b>	<b># locations/ # Segments</b>	<b>Replacement value (millions of dollars)</b>
<b>Highway</b>	Bridges	520	401.40
	Segments	255	12,083.90
	Tunnels	2	0.20
		<b>Subtotal</b>	<b>12,485.60</b>
<b>Railways</b>	Bridges	0	0.00
	Facilities	0	0.00
	Segments	103	238.30
	Tunnels	0	0.00
		<b>Subtotal</b>	<b>238.30</b>
<b>Light Rail</b>	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		<b>Subtotal</b>	<b>0.00</b>
<b>Bus</b>	Facilities	0	0.00
		<b>Subtotal</b>	<b>0.00</b>
<b>Ferry</b>	Facilities	1	1.30
		<b>Subtotal</b>	<b>1.30</b>
<b>Port</b>	Facilities	0	0.00
		<b>Subtotal</b>	<b>0.00</b>
<b>Airport</b>	Facilities	10	106.50
	Runways	12	455.60
		<b>Subtotal</b>	<b>562.10</b>
		<b>Total</b>	<b>13,287.20</b>

**Table 2: Utility System Lifeline Inventory**

<b>System</b>	<b>Component</b>	<b># Locations / Segments</b>	<b>Replacement value (millions of dollars)</b>
<b>Potable Water</b>	Distribution Lines	NA	726.00
	Facilities	0	0.00
	Pipelines	0	0.00
		<b>Subtotal</b>	<b>726.00</b>
<b>Waste Water</b>	Distribution Lines	NA	435.60
	Facilities	5	326.30
	Pipelines	0	0.00
		<b>Subtotal</b>	<b>761.90</b>
<b>Natural Gas</b>	Distribution Lines	NA	290.40
	Facilities	0	0.00
	Pipelines	6	212.10
		<b>Subtotal</b>	<b>502.50</b>
<b>Oil Systems</b>	Facilities	2	0.20
	Pipelines	0	0.00
		<b>Subtotal</b>	<b>0.20</b>
<b>Electrical Power</b>	Facilities	5	539.00
		<b>Subtotal</b>	<b>539.00</b>
<b>Communication</b>	Facilities	18	1.80
		<b>Subtotal</b>	<b>1.80</b>
		<b>Total</b>	<b>2,531.40</b>

## Earthquake Scenario

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

<b>Scenario Name</b>	Cedar City Segment M6.6
<b>Type of Earthquake</b>	User-defined
<b>Fault Name</b>	NA
<b>Historical Epicenter ID #</b>	NA
<b>Probabilistic Return Period</b>	NA
<b>Longitude of Epicenter</b>	NA
<b>Latitude of Epicenter</b>	NA
<b>Earthquake Magnitude</b>	6.60
<b>Depth (Km)</b>	NA
<b>Rupture Length (Km)</b>	NA
<b>Rupture Orientation (degrees)</b>	NA
<b>Attenuation Function</b>	NA

## Building Damage

### Building Damage

HAZUS estimates that about 975 buildings will be at least moderately damaged. This is over 2.00 % of the total number of buildings in the region. There are an estimated 9 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	(%)
<b>Agriculture</b>	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
<b>Commercial</b>	979	1.65	49	2.36	50	6.28	15	8.31	1	10.41
<b>Education</b>	87	0.15	3	0.14	3	0.42	2	0.92	0	1.56
<b>Government</b>	255	0.43	10	0.48	8	1.07	1	0.80	0	0.30
<b>Industrial</b>	210	0.35	10	0.50	12	1.57	4	2.04	0	2.21
<b>Other Residential</b>	8,307	14.02	434	21.12	307	38.80	70	40.10	5	50.47
<b>Religion</b>	272	0.46	13	0.64	12	1.52	3	1.64	0	1.54
<b>Single Family</b>	49,144	82.94	1,535	74.77	398	50.33	81	46.19	3	33.50
<b>Total</b>	<b>59,255</b>		<b>2,054</b>		<b>790</b>		<b>176</b>		<b>9</b>	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
<b>Wood</b>	42,038	70.95	1400	68.15	128	16.17	1	0.61	0	0.06
<b>Steel</b>	507	0.86	23	1.13	33	4.13	12	7.04	1	14.85
<b>Concrete</b>	441	0.74	27	1.31	28	3.48	7	4.09	0	4.76
<b>Precast</b>	238	0.40	9	0.46	14	1.82	6	3.38	0	4.28
<b>RM</b>	8,080	13.64	209	10.19	270	34.19	78	44.66	3	27.00
<b>URM</b>	1,128	1.90	74	3.62	53	6.67	13	7.60	1	12.18
<b>MH</b>	6,823	11.51	311	15.13	265	33.54	57	32.62	3	36.88
<b>Total</b>	<b>59,255</b>		<b>2,054</b>		<b>790</b>		<b>176</b>		<b>9</b>	

\*Note:

RM Reinforced Masonry  
 URM Unreinforced Masonry  
 MH Manufactured Housing



## **Essential Facility Damage**

Before the earthquake, the region had 537 hospital beds available for use. On the day of the earthquake, the model estimates that only 471 hospital beds (88.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 91.00% of the beds will be back in service. By 30 days, 99.00% 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	8	1	0	7
Schools	112	0	0	109
EOCs	2	0	0	2
PoliceStations	19	0	0	17
FireStations	82	0	0	82

## 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	255	0	0	255	255
	Bridges	520	10	0	510	520
	Tunnels	2	0	0	2	2
Railways	Segments	103	0	0	103	103
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	1	0	0	1	1
Port	Facilities	0	0	0	0	0
Airport	Facilities	10	0	0	10	10
	Runways	12	0	0	12	12

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	0	0	0	0	0
Waste Water	5	0	0	4	5
Natural Gas	0	0	0	0	0
Oil Systems	2	0	0	2	2
Electrical Power	5	0	0	5	5
Communication	18	0	0	18	18

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	36,298	462	116
Waste Water	21,779	366	91
Natural Gas	211	0	0
Oil	0	0	0

**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	63,223	19	0	0	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 1 ignitions that will burn about 0.08 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 128 people and burn about 5 (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 0.060 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 26.00% 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 2,360,000 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

## Social Impact

### **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 73 households to be displaced due to the earthquake. Of these, 63 people (out of a total population of 192,276) 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
<b>2 AM</b>	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	10	1	0	0
	Single Family	10	1	0	0
	<b>Total</b>	<b>21</b>	<b>3</b>	<b>0</b>	<b>0</b>
<b>2 PM</b>	Commercial	8	1	0	0
	Commuting	0	0	0	0
	Educational	9	1	0	0
	Hotels	0	0	0	0
	Industrial	2	0	0	0
	Other-Residential	1	0	0	0
	Single Family	1	0	0	0
	<b>Total</b>	<b>22</b>	<b>3</b>	<b>0</b>	<b>1</b>
<b>5 PM</b>	Commercial	10	1	0	0
	Commuting	1	2	3	1
	Educational	3	0	0	0
	Hotels	0	0	0	0
	Industrial	2	0	0	0
	Other-Residential	4	1	0	0
	Single Family	4	0	0	0
	<b>Total</b>	<b>23</b>	<b>5</b>	<b>3</b>	<b>1</b>

## Economic Loss

The total economic loss estimated for the earthquake is 133.84 (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 115.09 (millions of dollars); 34 % 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 34 % 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
<b>Income Losses</b>							
	Wage	0.00	0.45	5.71	0.28	2.08	8.53
	Capital-Related	0.00	0.19	5.50	0.17	0.70	6.56
	Rental	0.63	1.64	2.83	0.10	0.87	6.06
	Relocation	2.29	1.31	4.14	0.54	9.31	17.59
	<b>Subtotal</b>	<b>2.92</b>	<b>3.59</b>	<b>18.17</b>	<b>1.09</b>	<b>12.96</b>	<b>38.73</b>
<b>Capital Stock Losses</b>							
	Structural	3.05	2.21	4.16	1.09	4.09	14.60
	Non_Structural	11.78	8.48	8.60	2.36	12.25	43.48
	Content	5.04	2.13	4.07	1.48	5.01	17.74
	Inventory	0.00	0.00	0.15	0.39	0.00	0.54
	<b>Subtotal</b>	<b>19.87</b>	<b>12.82</b>	<b>16.98</b>	<b>5.32</b>	<b>21.36</b>	<b>76.35</b>
	<b>Total</b>	<b>22.79</b>	<b>16.42</b>	<b>35.15</b>	<b>6.40</b>	<b>34.32</b>	<b>115.09</b>

## 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	12,083.95	\$0.00	0.00
	Bridges	401.43	\$3.84	0.96
	Tunnels	0.20	\$0.00	0.00
	<b>Subtotal</b>	<b>12485.60</b>	<b>3.80</b>	
Railways	Segments	238.26	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	<b>Subtotal</b>	<b>238.30</b>	<b>0.00</b>	
Light Rail	Segments	0.00	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	<b>Subtotal</b>	<b>0.00</b>	<b>0.00</b>	
Bus	Facilities	0.00	\$0.00	0.00
	<b>Subtotal</b>	<b>0.00</b>	<b>0.00</b>	
Ferry	Facilities	1.33	\$0.00	0.00
	<b>Subtotal</b>	<b>1.30</b>	<b>0.00</b>	
Port	Facilities	0.00	\$0.00	0.00
	<b>Subtotal</b>	<b>0.00</b>	<b>0.00</b>	
Airport	Facilities	106.51	\$2.93	2.75
	Runways	455.57	\$0.00	0.00
	<b>Subtotal</b>	<b>562.10</b>	<b>2.90</b>	
<b>Total</b>		<b>13287.20</b>	<b>6.80</b>	



**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	0.00	\$0.00	0.00
	Distribution Lines	726.00	\$2.08	0.29
	<b>Subtotal</b>	<b>725.97</b>	<b>\$2.08</b>	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	326.30	\$6.13	1.88
	Distribution Lines	435.60	\$1.65	0.38
	<b>Subtotal</b>	<b>761.92</b>	<b>\$7.77</b>	
Natural Gas	Pipelines	212.10	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Lines	290.40	\$1.76	0.61
	<b>Subtotal</b>	<b>502.51</b>	<b>\$1.76</b>	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.20	\$0.00	0.87
	<b>Subtotal</b>	<b>0.20</b>	<b>\$0.00</b>	
Electrical Power	Facilities	539.00	\$0.31	0.06
	<b>Subtotal</b>	<b>539.00</b>	<b>\$0.31</b>	
Communication	Facilities	1.80	\$0.06	3.46
	<b>Subtotal</b>	<b>1.76</b>	<b>\$0.06</b>	
	<b>Total</b>	<b>2,531.35</b>	<b>\$11.99</b>	

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

	LOSS	Total	%
<b>First Year</b>			
	Employment Impact	0	0.00
	Income Impact	(1)	-0.07
<b>Second Year</b>			
	Employment Impact	0	0.00
	Income Impact	(2)	-0.21
<b>Third Year</b>			
	Employment Impact	0	0.00
	Income Impact	(3)	-0.27
<b>Fourth Year</b>			
	Employment Impact	0	0.00
	Income Impact	(3)	-0.27
<b>Fifth Year</b>			
	Employment Impact	0	0.00
	Income Impact	(3)	-0.27
<b>Years 6 to 15</b>			
	Employment Impact	0	0.00
	Income Impact	(3)	-0.27

## **Appendix A: County Listing for the Region**

Beaver,UT

Garfield,UT

Iron,UT

Kane,UT

Piute,UT

Sevier,UT

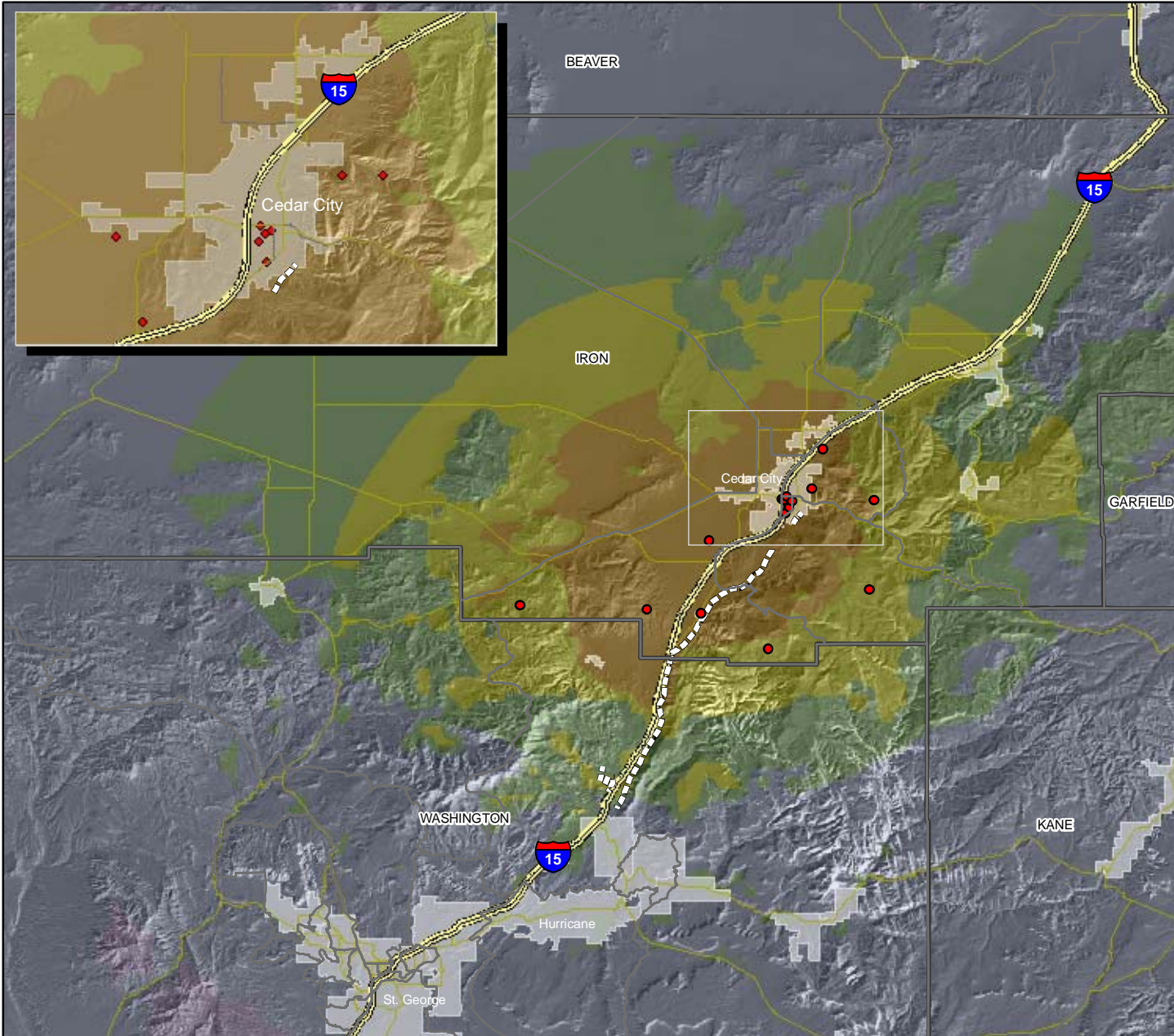
Washington,UT

Wayne,UT

**Appendix B: Regional Population and Building Value Data**

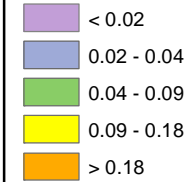
State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Utah	Beaver	6,295	252	89	341
	Garfield	4,957	276	94	370
	Iron	37,498	1,323	741	2,065
	Kane	6,385	323	127	450
	Piute	1,439	69	24	93
	Sevier	19,623	697	315	1,013
	Washington	113,489	3,900	1,839	5,739
	Wayne	2,590	115	38	154
<b>Total State</b>		<b>192,276</b>	<b>6,955</b>	<b>3,267</b>	<b>10,225</b>
<b>Total Region</b>		<b>192,276</b>	<b>6,955</b>	<b>3,267</b>	<b>10,225</b>

# Direct Building Economic Loss - Earthquake Scenario: Cedar City Segment, UT



## M 6.6 Cedar City Segment Earthquake

### PGA (% g's)

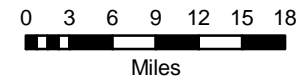


1 Dot =  
\$1,000,000

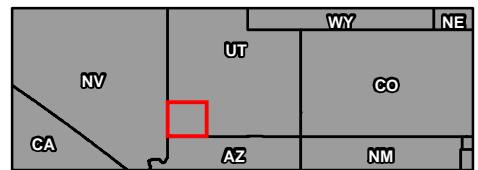
County	Cost Structural Damage	Cost Non-Structural Damage	Total Loss (Including Contents)
Piute	1	7	14
Sevier	0	0	0
Kane	0	9	17
Washington	77	721	1365
Beaver	2	28	53
Wayne	0	0	0
Iron	14508	42651	113525
Garfield	7	60	113
<b>Total</b>	<b>\$14,595</b>	<b>\$43,478</b>	<b>\$115,087</b>

\* All values are thousands of dollars

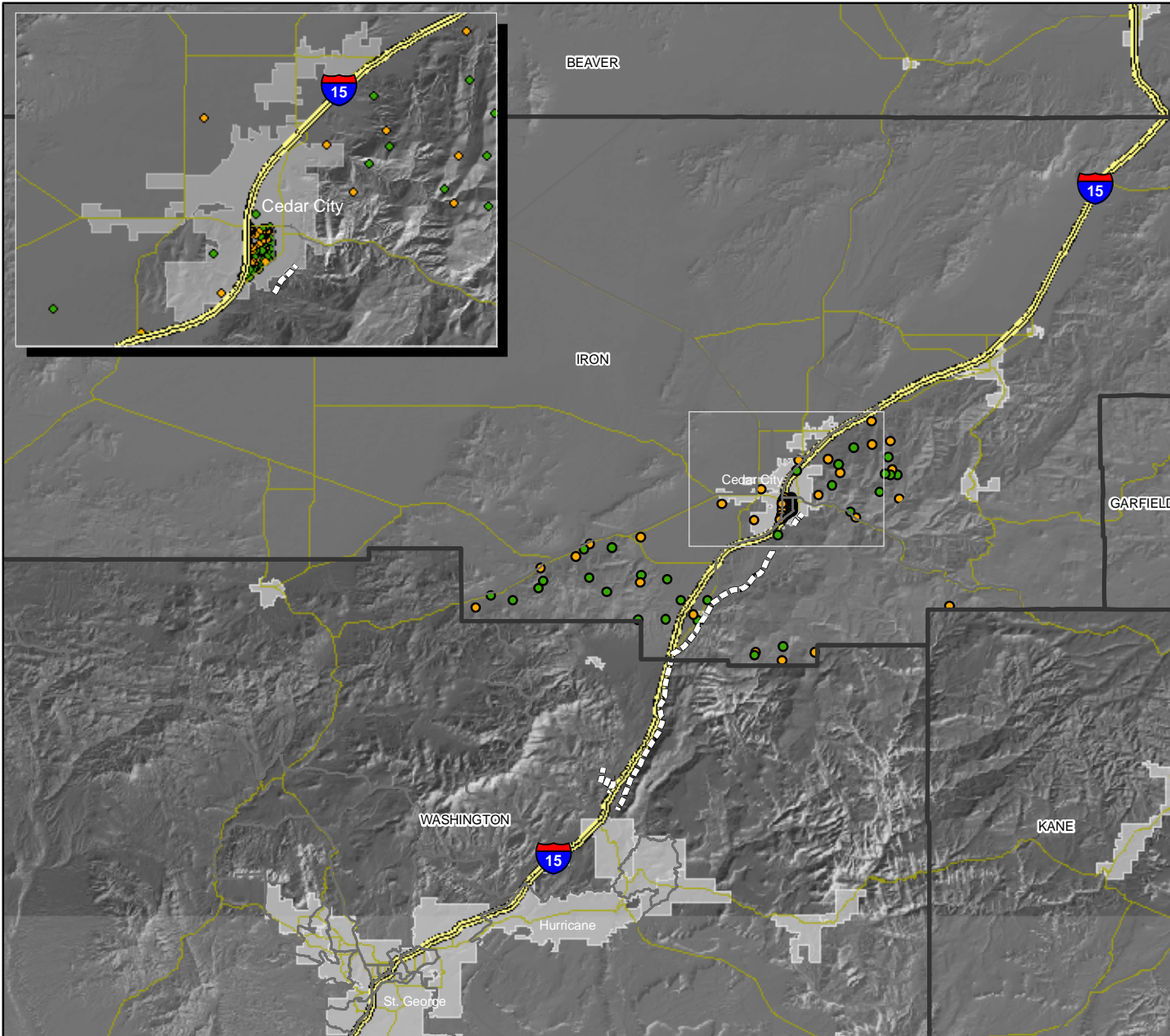
- Hurricane Fault: Cedar City Segment
- ▭ Counties
- ▬ Interstate
- Major Roads
- ▭ City Boundaries



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# Estimated Displaced Households & Short Term Public Shelter Needs - Earthquake Scenario: Cedar City Segment, UT

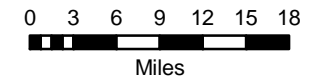


## M 6.6 Cedar City Segment Earthquake

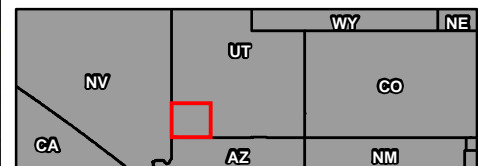
	Total #
Public Shelter Needs (Individuals)	63
Displaced Households	73

- 1 Dot = 1 Public Shelter Need (Individuals)\*
  - 1 Dot = 1 Displaced Household\*
- \* delineated by census tract*

- Hurricane Fault: Cedar City Segment
- ▭ Counties
- ==== Interstate
- Major Roads
- ▭ City Boundaries

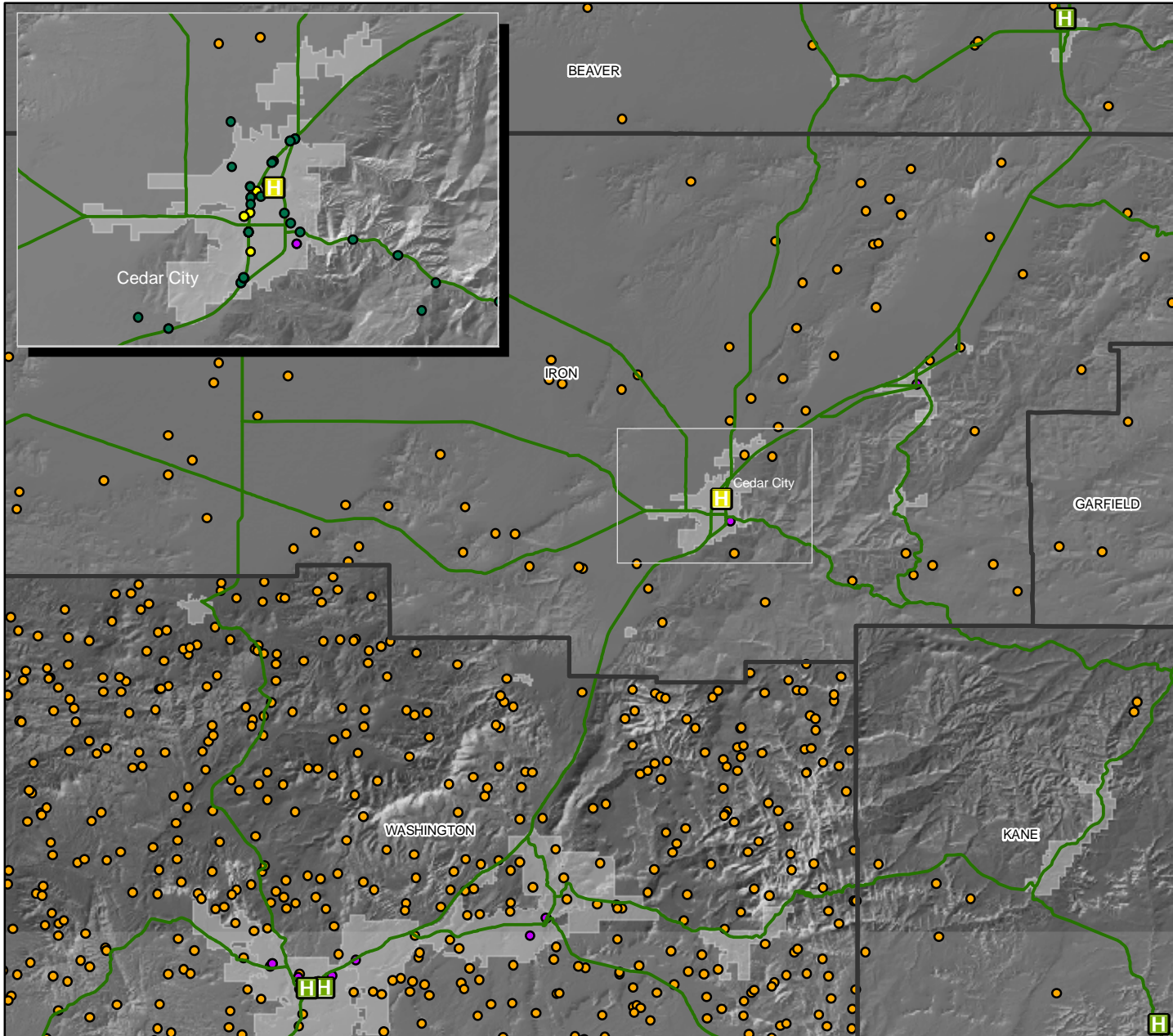


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# Estimated Displaced Households & Short Term Public Shelter Needs - Earthquake Scenario: Cedar City Segment, UT



## M 6.6 Cedar City Segment Earthquake

### Highway Damage

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

Highway Segment Impact	Major Roadway Bridge Impact
<span style="color: green;">—</span> Low	<span style="color: green;">●</span> Low
<span style="color: orange;">—</span> Moderate	<span style="color: orange;">●</span> Moderate
<span style="color: red;">—</span> High	<span style="color: red;">●</span> High

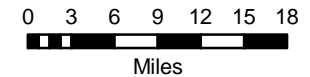
### Impaired Hospitals at Day 1

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

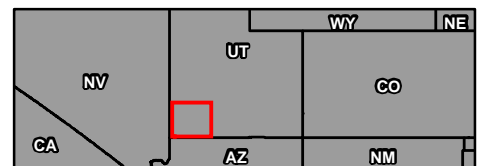
<span style="color: green;">H</span> Low
<span style="color: orange;">H</span> Moderate
<span style="color: red;">H</span> High

County	Total # Hospital Beds	Hospital Beds Available	Injuries Requiring Hospital Treatment 2pm
Beaver	70	70	0
Garfield	44	44	0
Iron	48	1	3
Kane	37	37	0
Sevier	42	42	0
Washington	296	295	0
<b>Total</b>	<b>537</b>	<b>489</b>	<b>3</b>

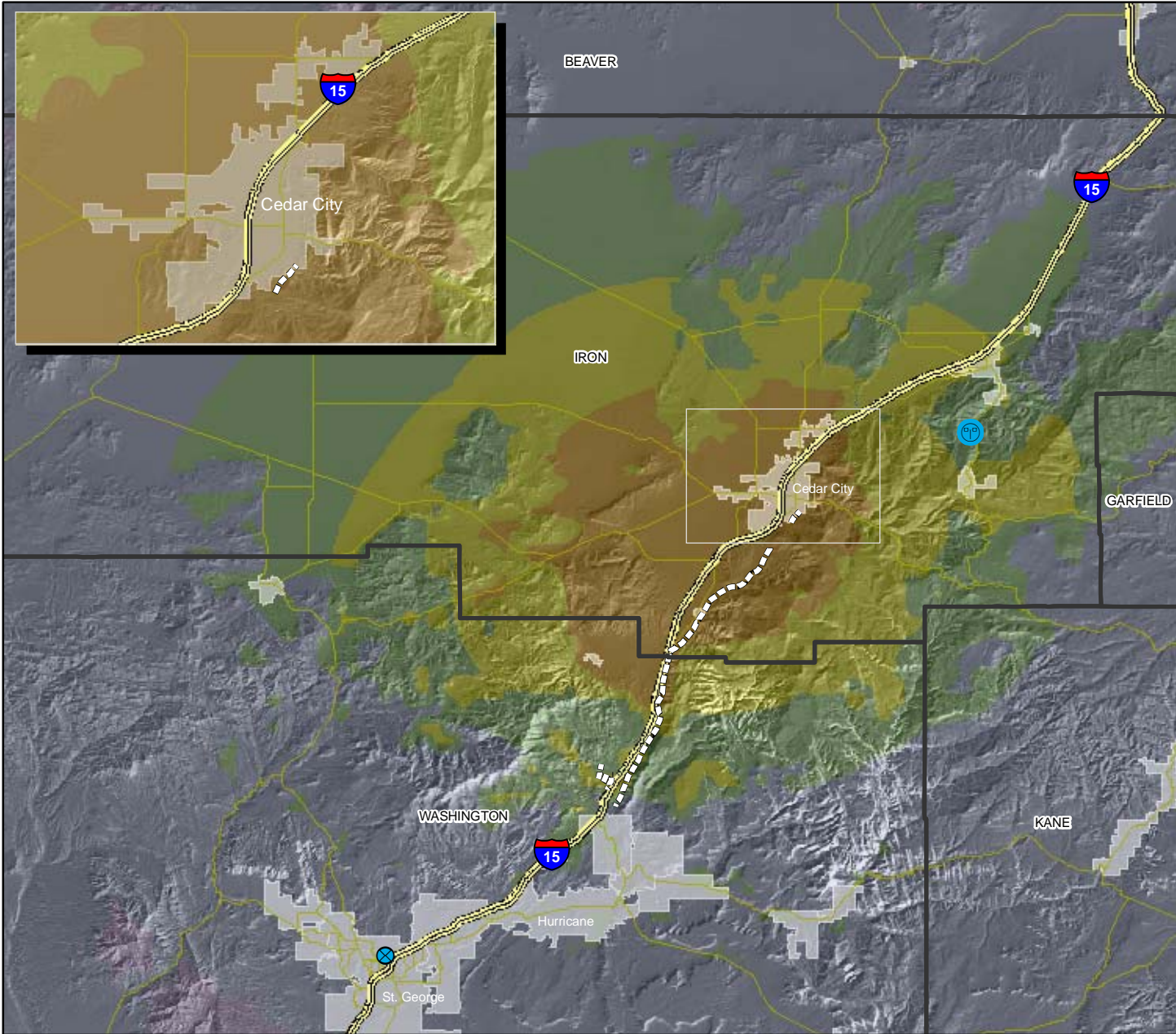
● 1 Dot = 30 People Over 65      ● Nursing Home



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# Electrical, Natural Gas and Oil Facility Damage- Earthquake Scenario: Cedar City Segment, UT



## M 6.6 Cedar City Segment Earthquake

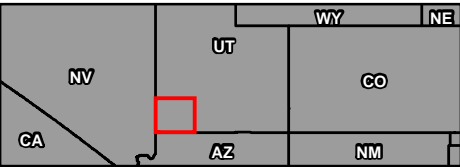
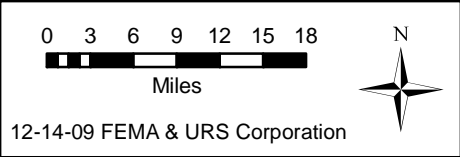
**Utility Damage  
(at least moderate)**

*Damage is expressed as the probability chance that a given utility system will realize at least moderate damage.*

Electric Power Facility	Oil Facility
⊗ Low	⊗ Low
⊗ Moderate	⊗ Moderate
⊗ High	⊗ High

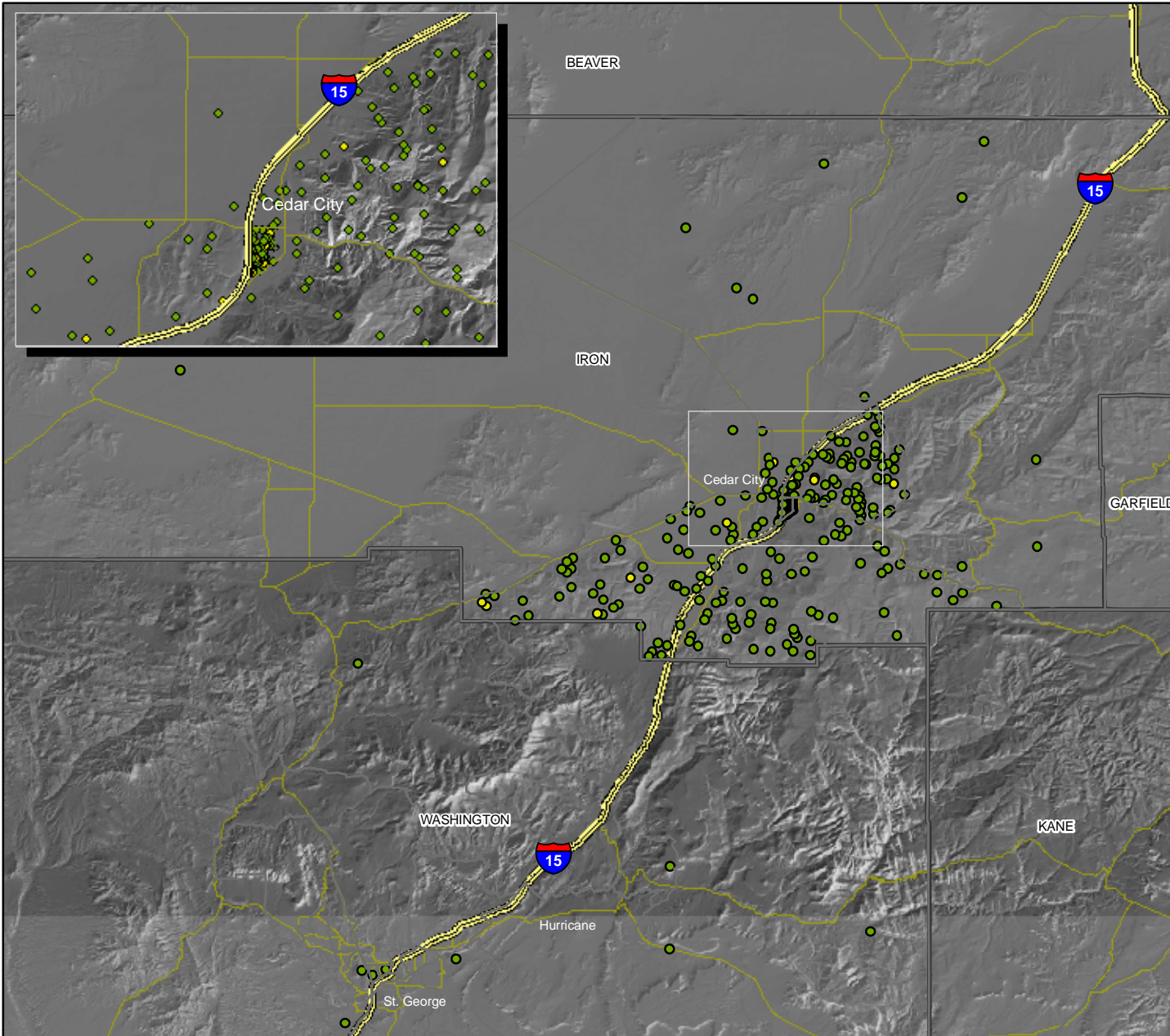
*\* There are NO Natural Gas Facilities in our database for the study region.*

<p><b>PGA (% g's)</b></p> <ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #ccccff; border: 1px solid black; margin-right: 5px;"></span> &lt; 0.02</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #9999ff; border: 1px solid black; margin-right: 5px;"></span> 0.02 - 0.04</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #99ff99; border: 1px solid black; margin-right: 5px;"></span> 0.04 - 0.09</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #ffff99; border: 1px solid black; margin-right: 5px;"></span> 0.09 - 0.18</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #ff9933; border: 1px solid black; margin-right: 5px;"></span> &gt; 0.18</li> </ul>	<ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 10px; border: 1px dashed black; margin-right: 5px;"></span> Hurricane Fault: Cedar City Segment</li> <li><span style="display: inline-block; width: 15px; height: 10px; border: 1px solid black; margin-right: 5px;"></span> Counties</li> <li><span style="display: inline-block; width: 15px; height: 10px; border-bottom: 2px solid black; margin-right: 5px;"></span> Interstate</li> <li><span style="display: inline-block; width: 15px; height: 10px; border-bottom: 1px solid black; margin-right: 5px;"></span> Major Roads</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #cccccc; border: 1px solid black; margin-right: 5px;"></span> City Boundaries</li> </ul>
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# Estimated Building Inspection Needs - Earthquake Scenario: Cedar City Segment, UT



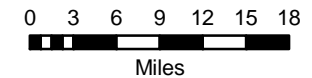
## M 6.6 Cedar City Segment Earthquake

	Estimated # of Structures	Estimated # of Inspectors Needed
Red (Complete)	9	1
Yellow (Extensive)	176	3
Light Green (Slight/Moderate)	2,843	19
Total	3,028	23

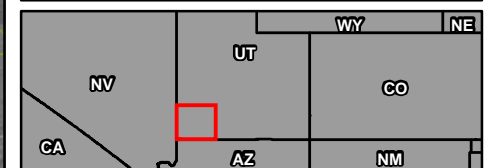
\*Estimated number of inspectors needed to complete inspections in 30 days.

- Red Tag (Complete Damage)
- Yellow Tag (Extensive Damage)
- Green Tag (Slight/Moderate Damage)

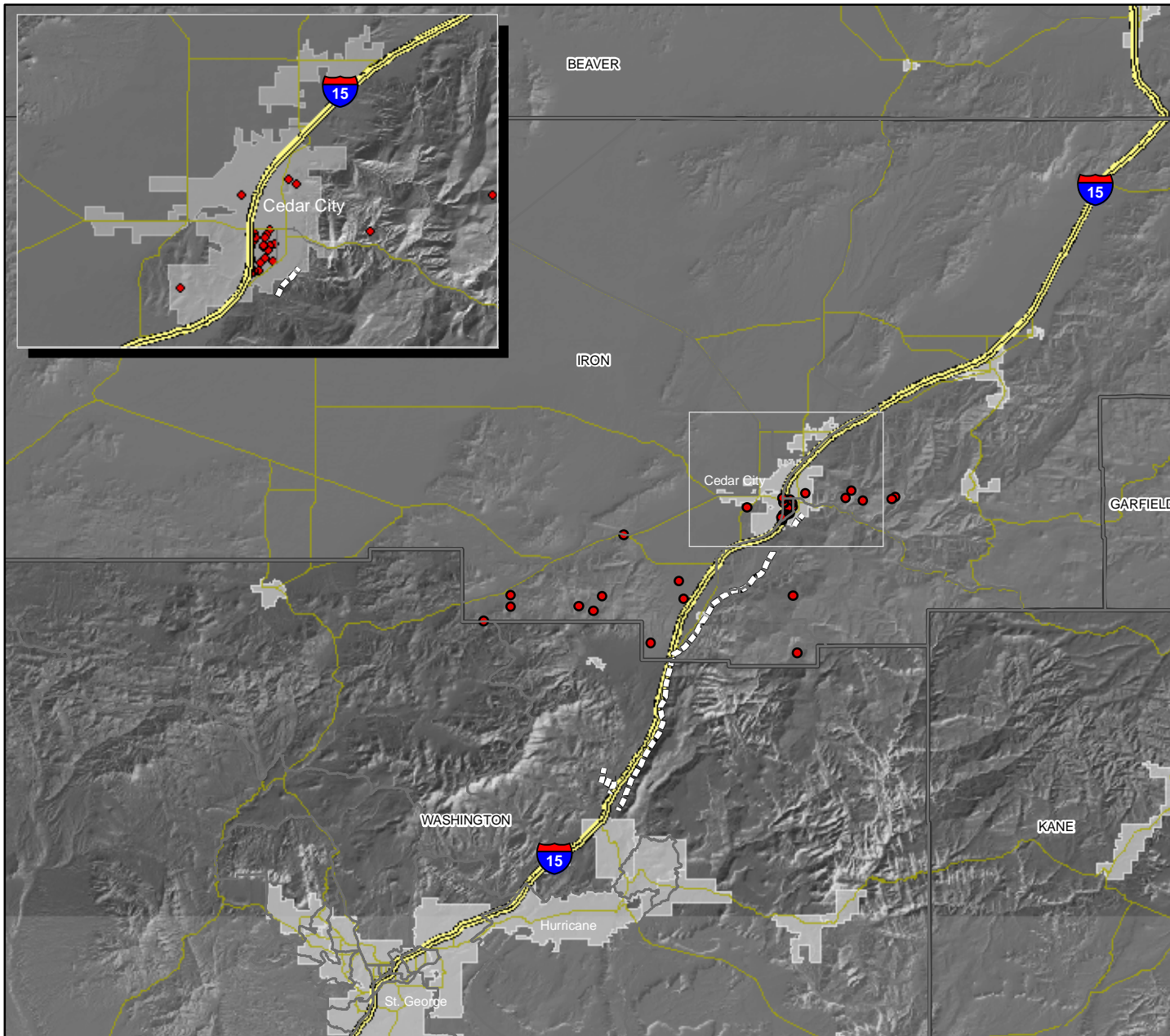
\*1 Dot = 10 (by census tract)



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# Estimated Concrete, Steel Debris & Highway Damage - Earthquake Scenario: Cedar City Segment, UT



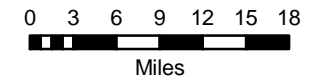
## M 6.6 Cedar City Segment Earthquake

● 1 Dot = 1 thousand tons of Concrete and Steel Debris (by census tract)

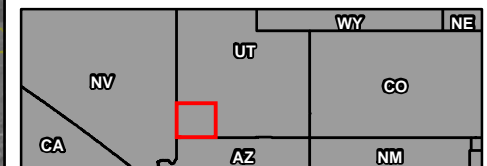
County	Brick and Wood (tons)	Concrete and Steel (tons)	*Estimated Truck Loads
Beaver	0	0	0
Garfield	0	0	0
Iron	15,000	44,000	2,360
Kane	0	0	0
Piute	0	0	0
Sevier	0	0	0
Washington	0	0	0
Wayne	0	0	0
<b>Total</b>	<b>15,000</b>	<b>44,000</b>	<b>2,360</b>

\* Truck loads estimated at 25 tons per truck

- ▭ Hurricane Fault: Cedar City Segment
- ▭ Counties
- ▬ Interstate
- ▬ Major Roads
- ▭ City Boundaries

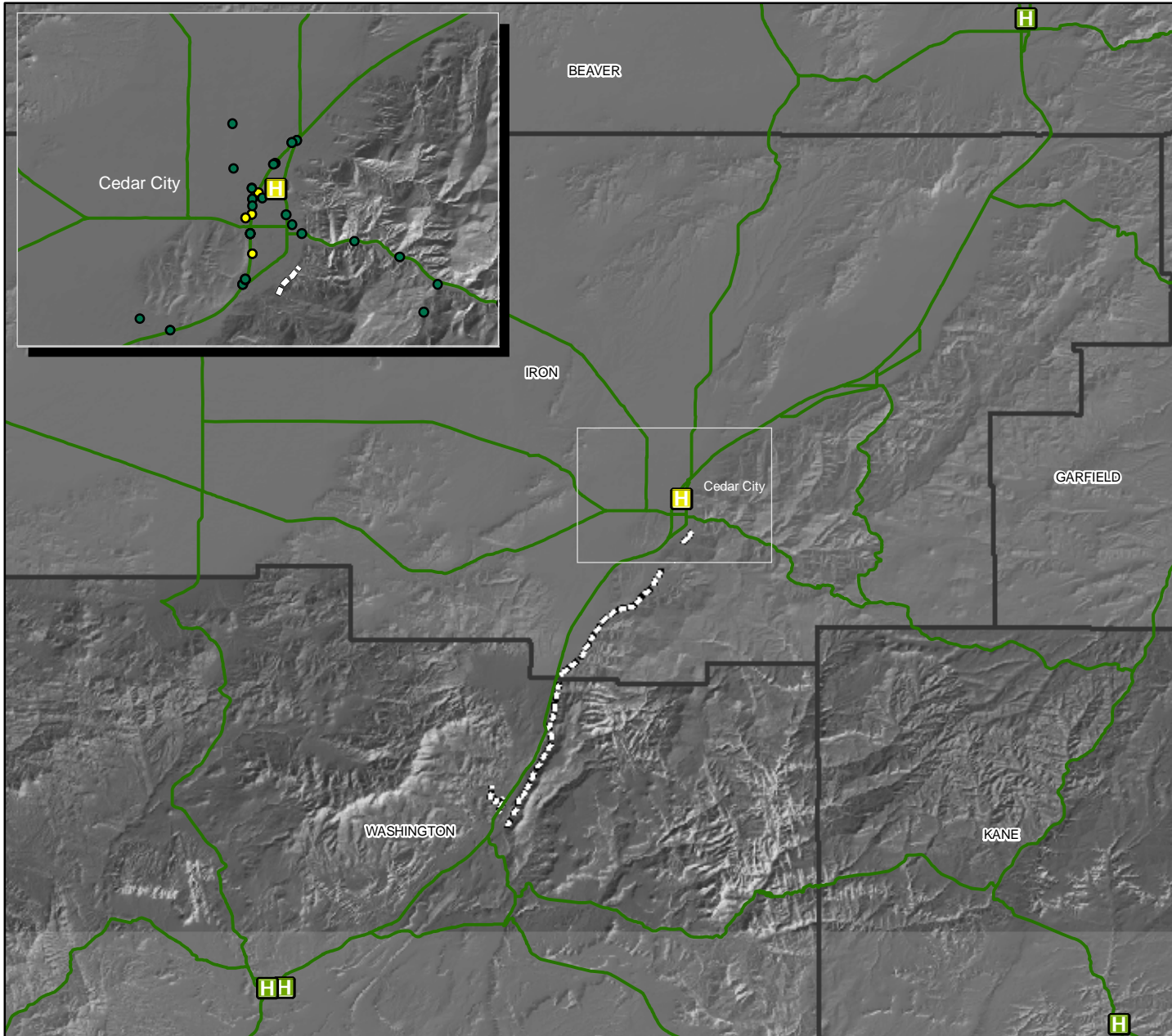


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# Demographic Distribution & Highway Damage - Earthquake Scenario: Cedar City Segment, UT



## M 6.6 Cedar City Segment Earthquake

### Highway Damage

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

Highway Segment Impact	Major Roadway Bridge Impact
Low	Low
Moderate	Moderate
High	High

### Impaired Hospitals (Day 1)

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

Low
Moderate
High

### Demographics

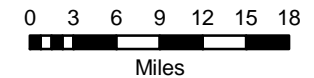
- English Speaking
- Potentially Non-English Speaking

\*1 Dot = 500 People (by census tract)

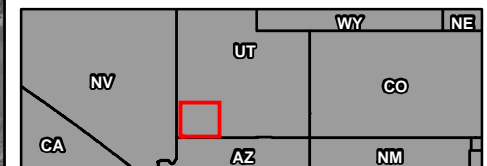
Hurricane Fault: Cedar City Segment

Counties

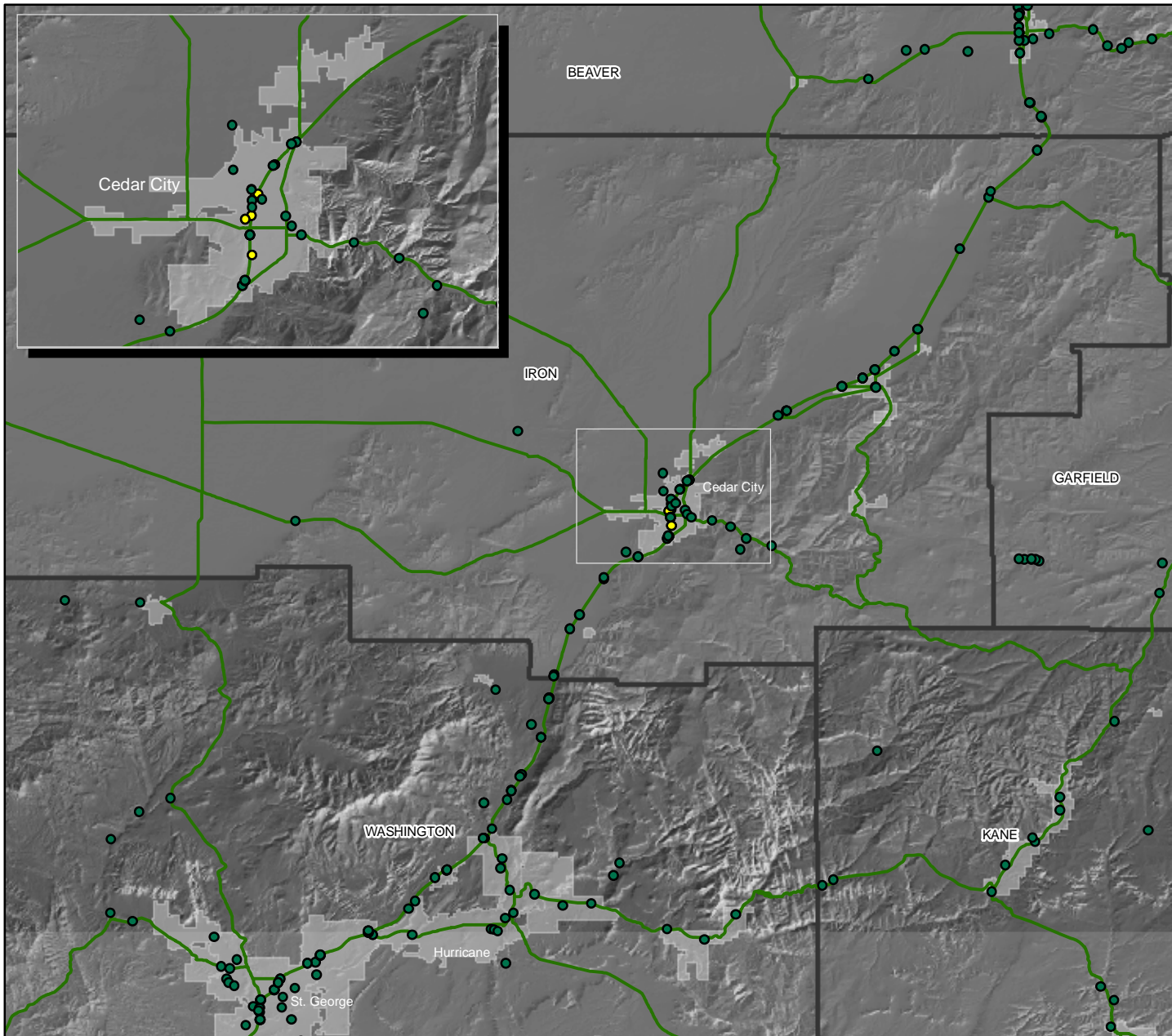
City Boundaries



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# Estimated Highway Infrastructure Damage - Earthquake Scenario: Cedar City Segment, UT



## M 6.6 Cedar City Segment Earthquake

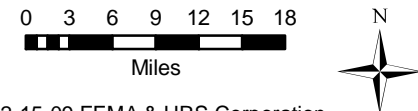
### Highway Damage

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

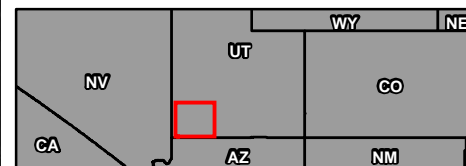
Highway Segment Impact	Major Roadway Bridge Impact
<span style="color: green;">—</span> Low	<span style="color: green;">●</span> Low
<span style="color: orange;">—</span> Moderate	<span style="color: yellow;">●</span> Moderate
<span style="color: red;">—</span> High	<span style="color: red;">●</span> High

County	Total # of Bridges	# Bridges Needing Priority Inspection	*# of Bridge Engineers Needed
Beaver	54	0	0
Garfield	57	0	0
Iron	89	11	1
Kane	22	0	0
Piute	17	0	0
Sevier	157	0	0
Washington	109	0	0
Wayne	15	0	0
<b>Total</b>	<b>520</b>	<b>11</b>	<b>1</b>

\*Based on assuming that 2 engineers can inspect 5 bridges a day for 3 days.

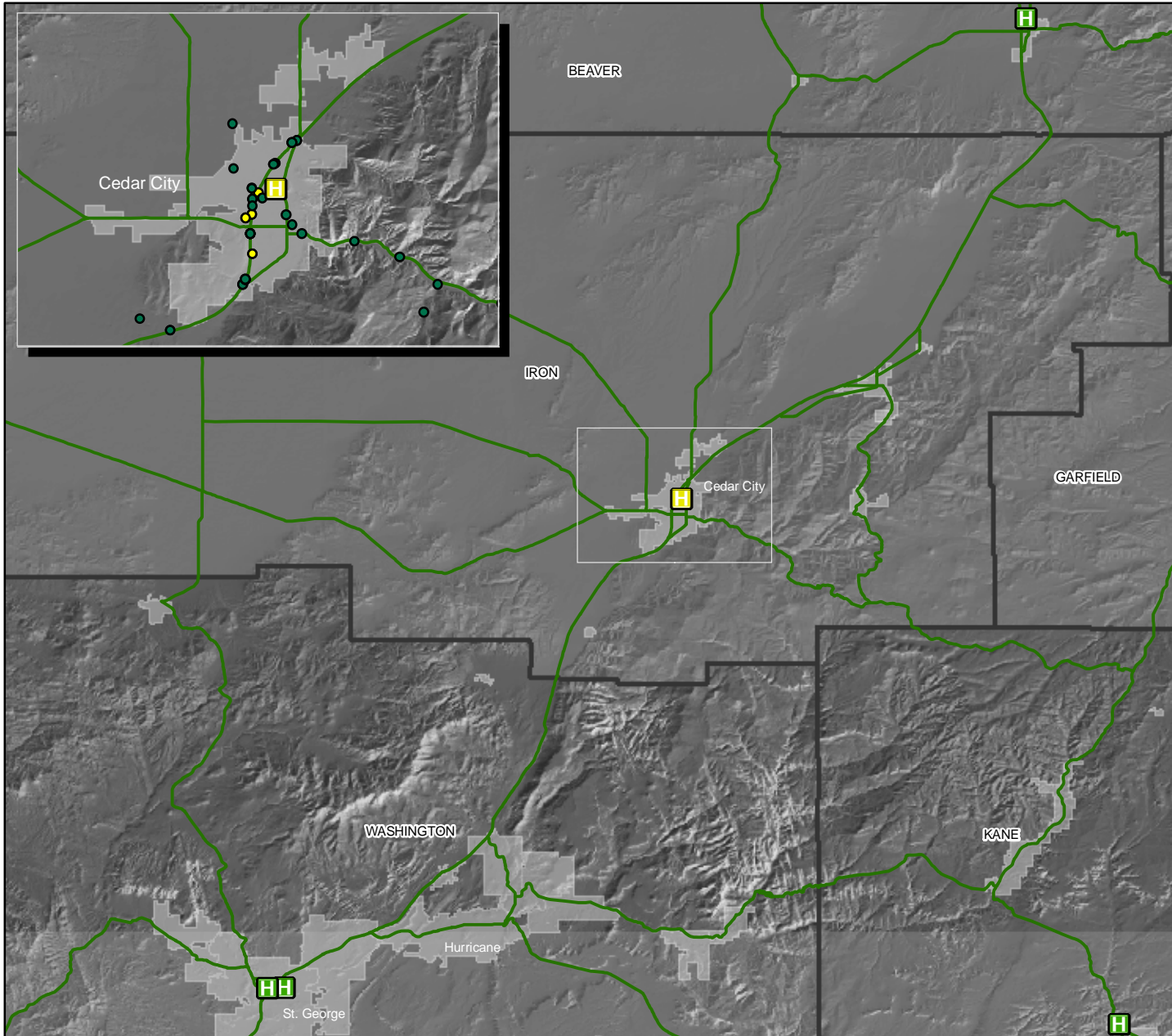


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# Impaired Hospitals (Day 1), Hospital Bed Availability & Highway Functionality - Earthquake Scenario: Cedar City Segment, UT



## M 6.6 Cedar City Segment Earthquake

### Highway Damage

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

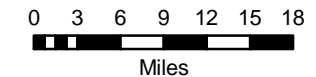
Highway Segment Impact	Major Roadway Bridge Impact
<span style="color: green;">—</span> Low	● Low
<span style="color: orange;">—</span> Moderate	● Moderate
<span style="color: red;">—</span> High	● High

### Impaired Hospitals (Day 1)

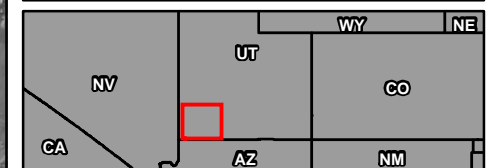
Damage is expressed as the probability that a given hospital will realize at least moderate damage.

<span style="color: green;">H</span> Low
<span style="color: yellow;">H</span> Moderate
<span style="color: red;">H</span> High

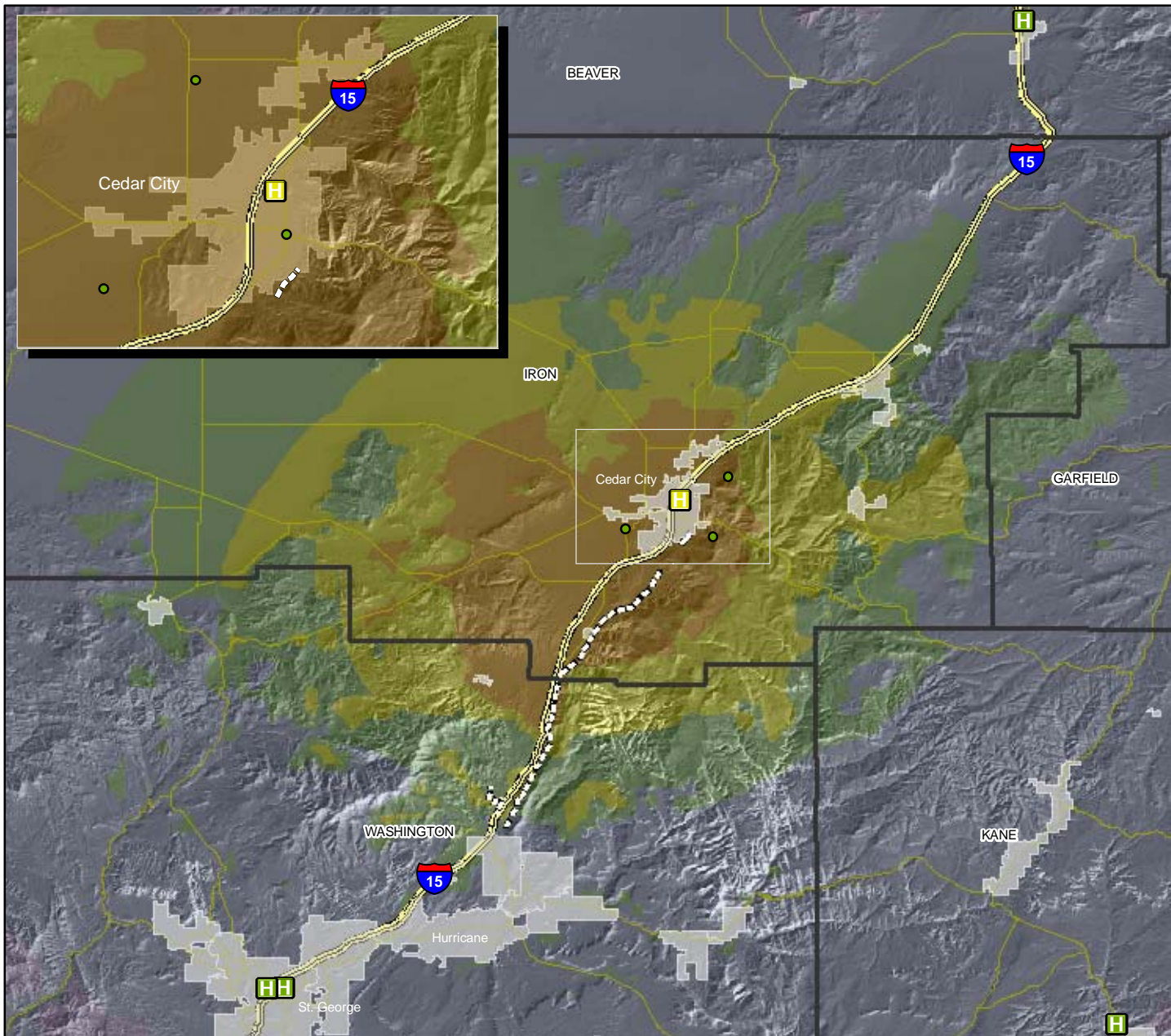
County	Total # Hospital Beds	Hospital Beds Available	Injuries Requiring Hospital Treatment 2pm
Beaver	70	70	0
Garfield	44	44	0
Iron	48	1	3
Kane	37	37	0
Sevier	42	42	0
Washington	296	295	0
<b>Total</b>	<b>537</b>	<b>489</b>	<b>3</b>



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# Potential Search and Rescue Needs - Earthquake Scenario: Cedar City Segment, UT



## M 6.6 Cedar City Segment Earthquake

### Impaired Hospitals (Day 1)

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

- H Low
- H Moderate
- H High

### PGA (% g's)

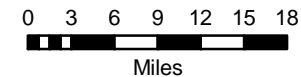
- < 0.02
- 0.02 - 0.04
- 0.04 - 0.09
- 0.09 - 0.18
- > 0.18

- 1 Dot = 1 Life Threatening Injury (Severity Level 3)
- \*Severity Level 3 is defined as injuries that require hospitalization and can become life threatening if not promptly treated.*

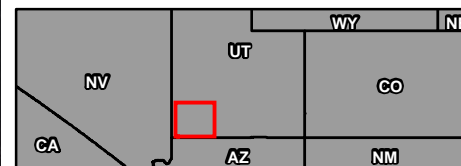
Hurricane Fault:  
Cedar City Segment

Structure Type	Red (Complete)	Collapse Rates for Complete Damage	Total Collapse
Wood	0	3%	0
Steel	1	6%	0
Concrete	0	10%	0
Precast	0	13%	0
Reinforced Masonry	3	10%	0
Unreinforced Masonry	1	15%	0
Manufactured Housing	3	3%	0
<b>Total</b>	<b>8</b>		<b>1</b>

Requiring Hospital Treatment	Immediate Life Threatening Injuries
14	3

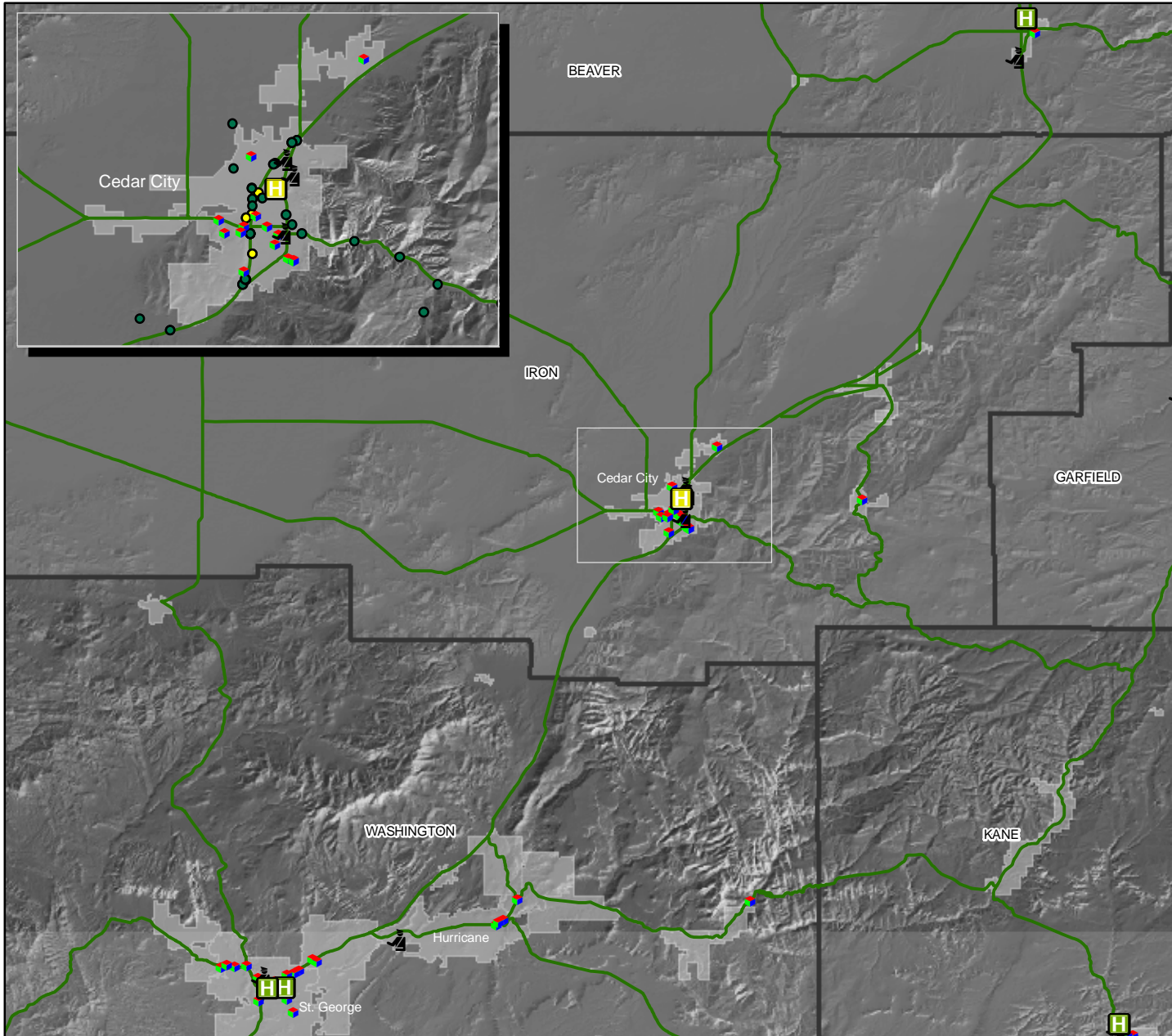


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# Correctional and Daycare Facilities, Impaired Hospitals (Day 1), and Highway Functionality - Earthquake Scenario: Cedar City Segment, UT



## M 6.6 Cedar City Segment Earthquake

### Highway Damage

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

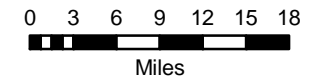
Highway Segment Impact	Major Roadway Bridge Impact
Low	Low
Moderate	Moderate
High	High

### Impaired Hospitals (Day 1)

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

Low
Moderate
High

- Daycare Facilities
- Correctional Facilities



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