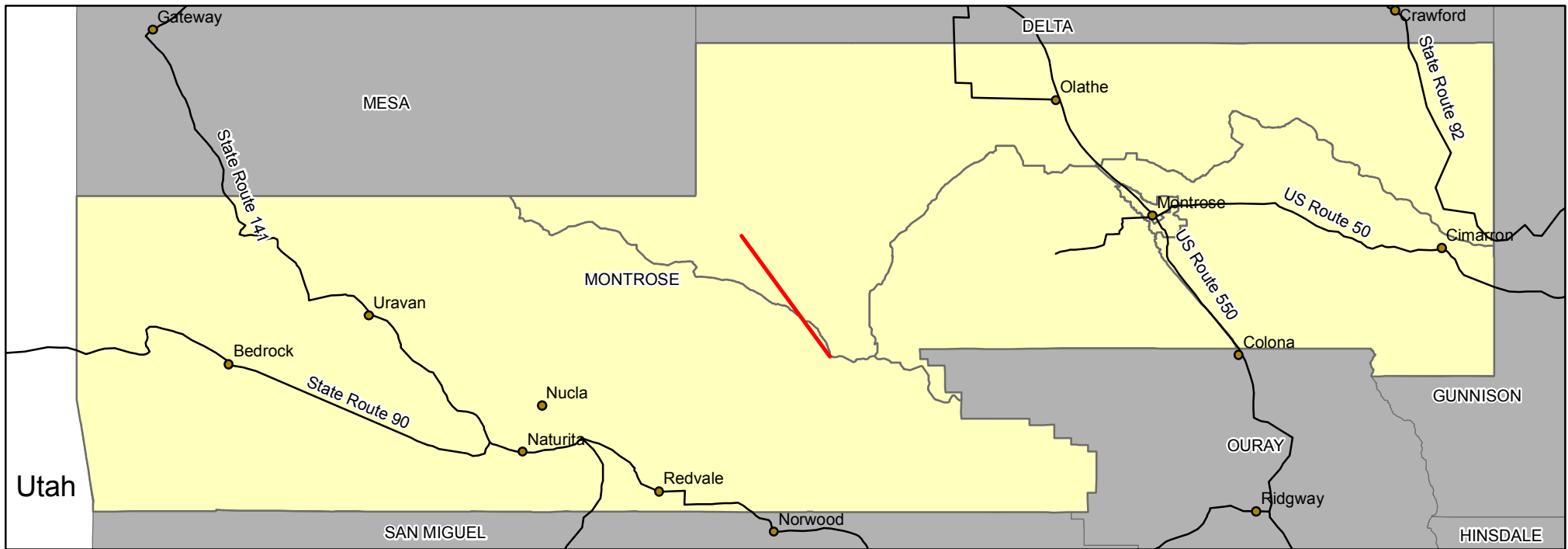


Study Region: Montrose County

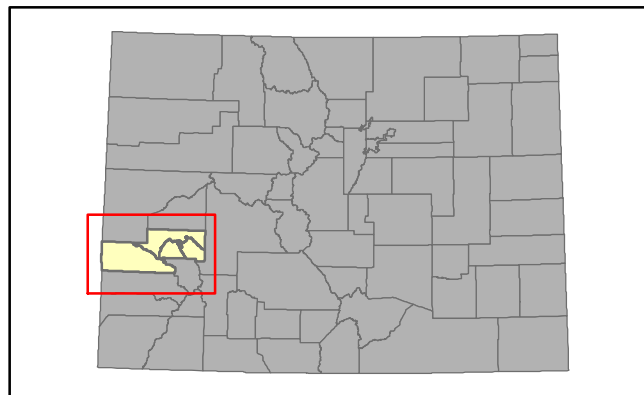
Hazard Scenario: Random Fault 6.5

Overview Map



Legend

- Cities
- Roads
- Fault
- Study Region Tract



Created by: Colorado Geological Survey

Team: Matt Morgan and Scot Fitzgerald

Date Created: April 2013

Location: Montrose County Colorado

Fault Parameters: arbitrary, magnitude 6.5, depth 10km

Data: Changed to CGS Landslides and CGS/FEMA Soils data

Projection: GCS North American 1983

0 10 20 40 Miles



HAZUS
EARTHQUAKE • WIND • FLOOD

Hazus-MH: Earthquake Event Report

Region Name: Montrose County Random fault 2010Census

Earthquake Scenario: Random Montrose County

Print Date: April 08, 2013

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 1 county(ies) from the following state(s):

Colorado

Note:

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

The geographical size of the region is 2,240.41 square miles and contains 6 census tracts. There are over 16 thousand households in the region which has a total population of 41,276 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 19 thousand buildings in the region with a total building replacement value (excluding contents) of 3,180 (millions of dollars). Approximately 90.00 % of the buildings (and 74.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 1,704 and 328 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 19 thousand buildings in the region which have an aggregate total replacement value of 3,180 (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 59% 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 facilities (HPL). 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 1 hospitals in the region with a total bed capacity of 0 beds. There are 20 schools, 10 fire stations, 9 police stations and 1 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 28 dams identified within the region. Of these, 6 of the dams are classified as 'high hazard'. The inventory also includes 4 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 2,032.00 (millions of dollars). This inventory includes over 296 kilometers of highways, 114 bridges, 10,799 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	114	34.50
	Segments	21	1,469.90
	Tunnels	0	0.00
	Subtotal		1,504.50
Railways	Bridges	0	0.00
	Facilities	0	0.00
	Segments	14	26.50
	Tunnels	0	0.00
	Subtotal		26.50
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	0	0.00
	Subtotal		0.00
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	2	21.30
	Runways	4	151.90
	Subtotal		173.20
		Total	1,704.10

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	131.90
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		131.90
Waste Water	Distribution Lines	NA	79.10
	Facilities	4	258.40
	Pipelines	0	0.00
	Subtotal		337.50
Natural Gas	Distribution Lines	NA	52.70
	Facilities	0	0.00
	Pipelines	22	69.50
	Subtotal		122.20
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		0.00
Electrical Power	Facilities	17	0.00
	Subtotal		0.00
Communication	Facilities	6	0.60
	Subtotal		0.60
		Total	592.20

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	Random Montrose County
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-108.28
Latitude of Epicenter	38.39
Earthquake Magnitude	6.50
Depth (Km)	10.00
Rupture Length (Km)	17.18
Rupture Orientation (degrees)	150.00
Attenuation Function	Central & East US (CEUS 2008)

Building Damage

Building Damage

Hazus estimates that about 7,459 buildings will be at least moderately damaged. This is over 38.00 % of the buildings in the region. There are an estimated 1,322 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 summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes 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	51	0.62	25	0.61	29	0.83	28	1.03	17	1.29
Commercial	195	2.39	151	3.67	305	8.85	301	11.17	195	14.77
Education	5	0.06	3	0.07	4	0.12	5	0.17	3	0.26
Government	12	0.15	7	0.17	12	0.35	13	0.49	9	0.71
Industrial	71	0.87	56	1.37	115	3.34	114	4.25	75	5.64
Other Residential	1,142	13.99	921	22.48	1,152	33.44	960	35.69	589	44.55
Religion	19	0.23	11	0.26	16	0.47	18	0.66	12	0.89
Single Family	6,666	81.69	2,925	71.36	1,813	52.60	1,252	46.53	422	31.89
Total	8,160		4,098		3,447		2,690		1,323	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	6,424	78.73	3040	74.17	1,404	40.73	601	22.35	130	9.84
Steel	43	0.52	32	0.78	98	2.86	141	5.25	129	9.79
Concrete	48	0.59	43	1.04	104	3.02	122	4.52	83	6.28
Precast	55	0.67	31	0.76	80	2.33	106	3.94	81	6.13
RM	926	11.35	345	8.41	740	21.46	804	29.89	357	26.96
URM	145	1.77	113	2.76	146	4.22	108	4.02	58	4.35
MH	520	6.37	495	12.07	875	25.38	808	30.02	485	36.66
Total	8,160		4,098		3,447		2,690		1,323	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 0 hospital beds available for use. On the day of the earthquake, the model estimates that only 0 hospital beds (4.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 18.00% of the beds will be back in service. By 30 days, 61.00% 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	1	1	0	0
Schools	20	14	0	5
EOCs	1	0	0	0
PoliceStations	9	0	0	5
FireStations	10	0	0	4

Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

Table 6: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	21	0	0	21	21
	Bridges	114	3	0	111	111
	Tunnels	0	0	0	0	0
Railways	Segments	14	0	0	14	14
	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	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	2	0	0	2	2
	Runways	4	0	0	4	4

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	4	2	0	2	4
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	17	4	0	13	17
Communication	6	1	0	6	6

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	6,593	905	226
Waste Water	3,956	455	114
Natural Gas	251	10	2
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	16,484	1,344	689	24	0	0
Electric Power		7,302	3,316	855	104	16

Induced Earthquake Damage

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 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (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 0.39 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 15,480 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 723 households to be displaced due to the earthquake. Of these, 456 people (out of a total population of 41,276) 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
2 AM	Commercial	3	1	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	6	2	0	1
	Industrial	5	1	0	0
	Other-Residential	87	21	2	4
	Single Family	107	29	4	9
	Total	208	54	7	14
2 PM	Commercial	193	60	10	20
	Commuting	0	0	0	0
	Educational	192	57	10	19
	Hotels	1	0	0	0
	Industrial	34	10	2	3
	Other-Residential	20	5	0	1
	Single Family	26	7	1	2
	Total	466	139	23	45
5 PM	Commercial	138	42	7	14
	Commuting	2	2	4	1
	Educational	16	5	1	2
	Hotels	2	1	0	0
	Industrial	21	6	1	2
	Other-Residential	32	8	1	1
	Single Family	42	11	2	3
	Total	252	75	16	23

Economic Loss

The total economic loss estimated for the earthquake is 804.98 (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 765.23 (millions of dollars); 23 % 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 45 % 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	2.80	36.26	1.17	4.93	45.15
	Capital-Related	0.00	1.20	26.30	0.68	1.06	29.24
	Rental	6.68	5.68	15.45	0.30	1.44	29.55
	Relocation	23.62	7.84	25.30	1.58	13.60	71.94
	Subtotal	30.30	17.52	103.31	3.74	21.03	175.89
Capital Stock Losses							
	Structural	45.65	14.13	32.06	5.73	16.91	114.49
	Non_Structural	136.68	50.97	95.23	18.81	48.10	349.79
	Content	37.26	10.17	42.07	11.08	20.47	121.05
	Inventory	0.00	0.00	1.06	2.63	0.31	4.01
	Subtotal	219.58	75.28	170.42	38.26	85.80	589.33
	Total	249.88	92.79	273.73	42.00	106.82	765.23

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	1,469.93	\$0.00	0.00
	Bridges	34.53	\$1.43	4.14
	Tunnels	0.00	\$0.00	0.00
	Subtotal	1504.50	1.40	
Railways	Segments	26.51	\$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
	Subtotal	26.50	0.00	
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
	Subtotal	0.00	0.00	
Bus	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Ferry	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Port	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Airport	Facilities	21.30	\$4.30	20.17
	Runways	151.86	\$0.00	0.00
	Subtotal	173.20	4.30	
	Total	1704.10	5.70	

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	131.90	\$4.07	3.09
	Subtotal	131.86	\$4.07	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	258.40	\$27.12	10.49
	Distribution Lines	79.10	\$2.05	2.59
	Subtotal	337.52	\$29.17	
Natural Gas	Pipelines	69.50	\$0.02	0.04
	Facilities	0.00	\$0.00	0.00
	Distribution Lines	52.70	\$0.70	1.33
	Subtotal	122.20	\$0.73	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	\$0.00	
Electrical Power	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	\$0.00	
Communication	Facilities	0.60	\$0.06	10.43
	Subtotal	0.58	\$0.06	
	Total	592.17	\$34.03	

Table 14. Indirect Economic Impact with outside aid

(Employment as # of people and Income in millions of \$)

LOSS	Total	%

Appendix A: County Listing for the Region

Montrose,CO

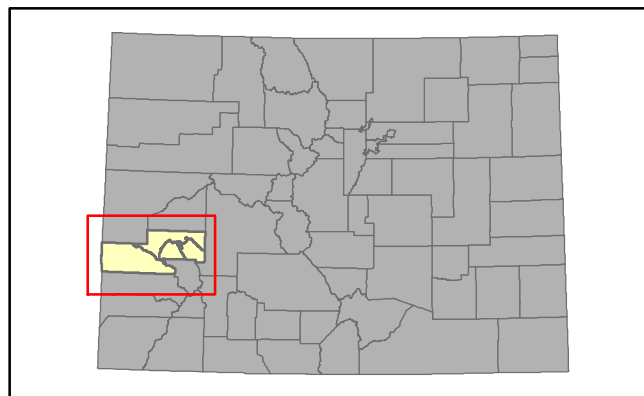
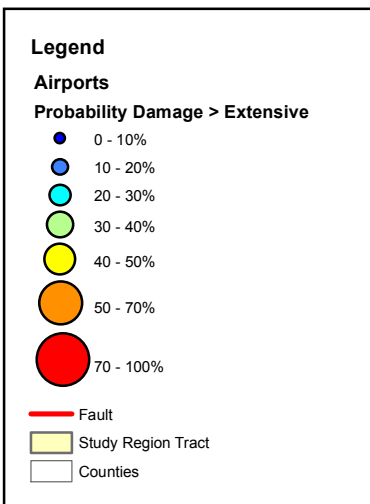
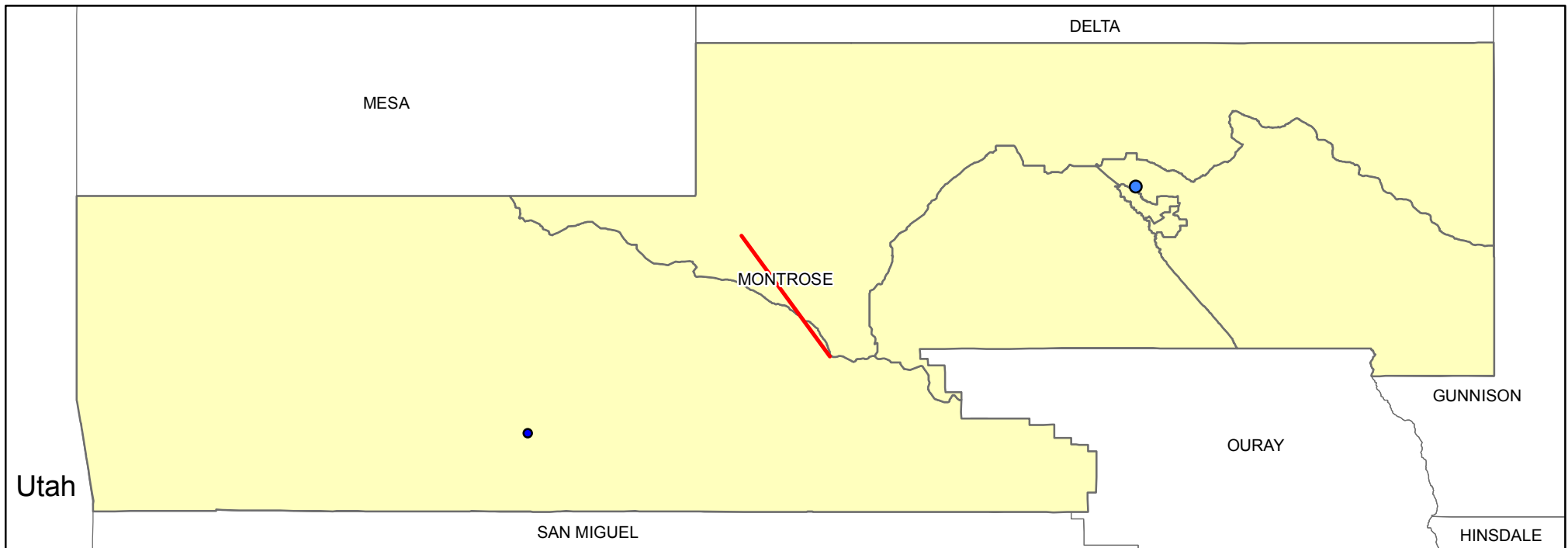
Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Montrose	41,276	2,357	823	3,180
Total State		41,276	2,357	823	3,180
Total Region		41,276	2,357	823	3,180

Study Region: Montrose County

Hazard Scenario: Random Fault 6.5

Airports Map



Created by: Colorado Geological Survey
Team: Matt Morgan and Scot Fitzgerald
Date Created: April 2013
Location: Montrose County Colorado
Fault Parameters: arbitrary, magnitude 6.5, depth 10km
Data: Changed to CGS Landslides and CGS/FEMA Soils data
Projection: GCS North American 1983



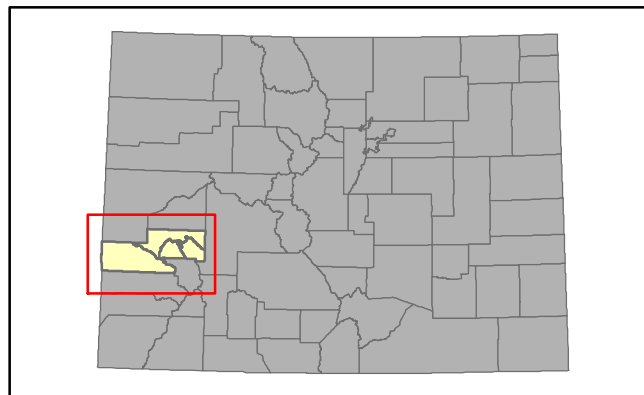
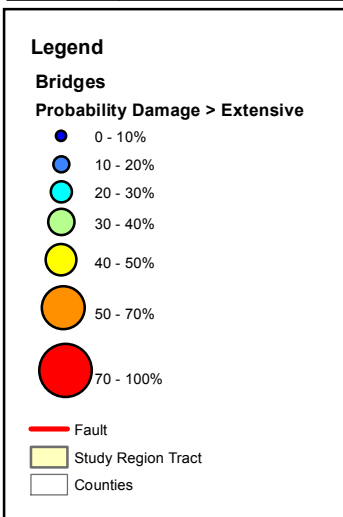
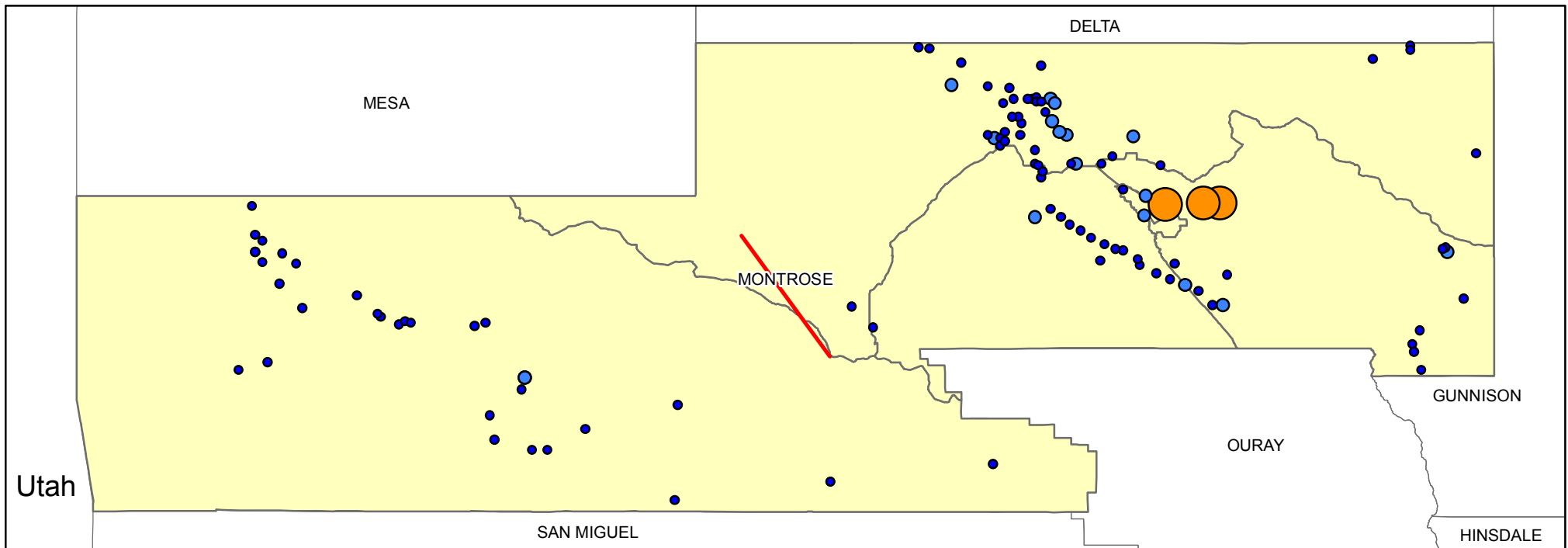
0 10 20 40 Miles



Study Region: Montrose County

Hazard Scenario: Random Fault 6.5

Bridges Map



Created by: Colorado Geological Survey

Team: Matt Morgan and Scot Fitzgerald

Date Created: April 2013

Location: Montrose County Colorado

Fault Parameters: arbitrary, magnitude 6.5, depth 10km

Data: Changed to CGS Landslides and CGS/FEMA Soils data

Projection: GCS North American 1983

0 10 20 40 Miles

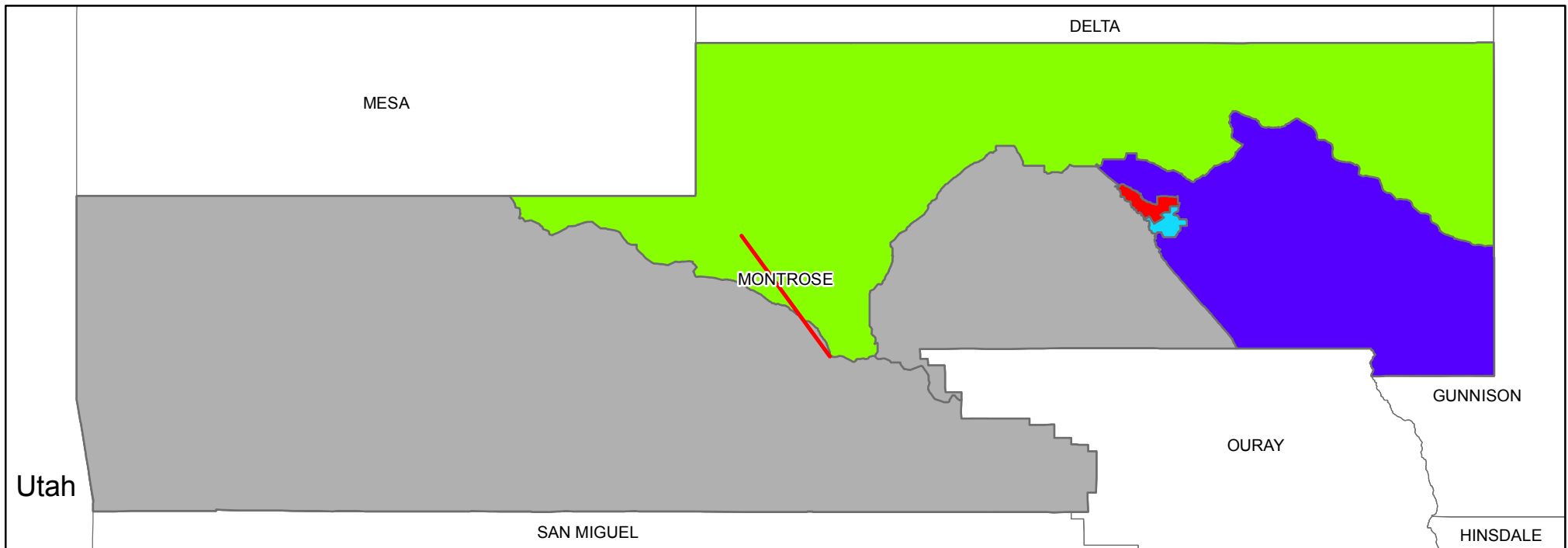


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Study Region: Montrose County

Hazard Scenario: Random Fault 6.5

Building Economic Loss Map



Legend

— Fault

Building Economic Loss in Thousands of Dollars

15958 - 63592

63592 - 111226

111226 - 158860

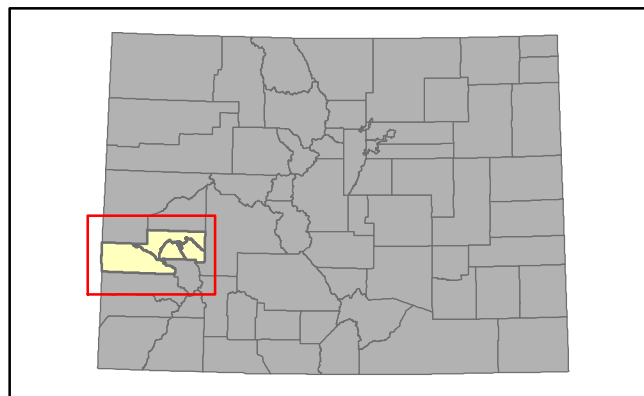
158860 - 206494

206494 - 254128

254128 - 301762

Study Region Tract

Counties



Created by: Colorado Geological Survey

Team: Matt Morgan and Scot Fitzgerald

Date Created: April 2013

Location: Montrose County Colorado

Fault Parameters: arbitrary, magnitude 6.5, depth 10km

Data: Changed to CGS Landslides and CGS/FEMA Soils data

Projection: GCS North American 1983

0 10 20 40 Miles

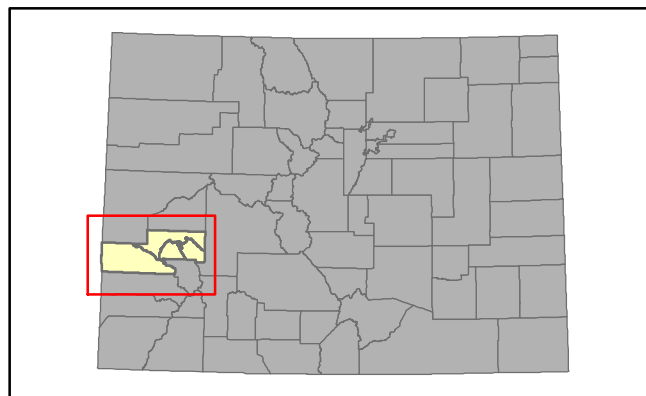
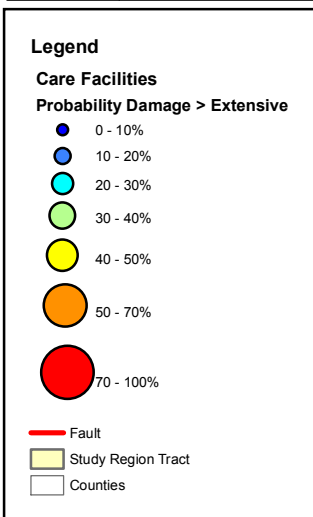
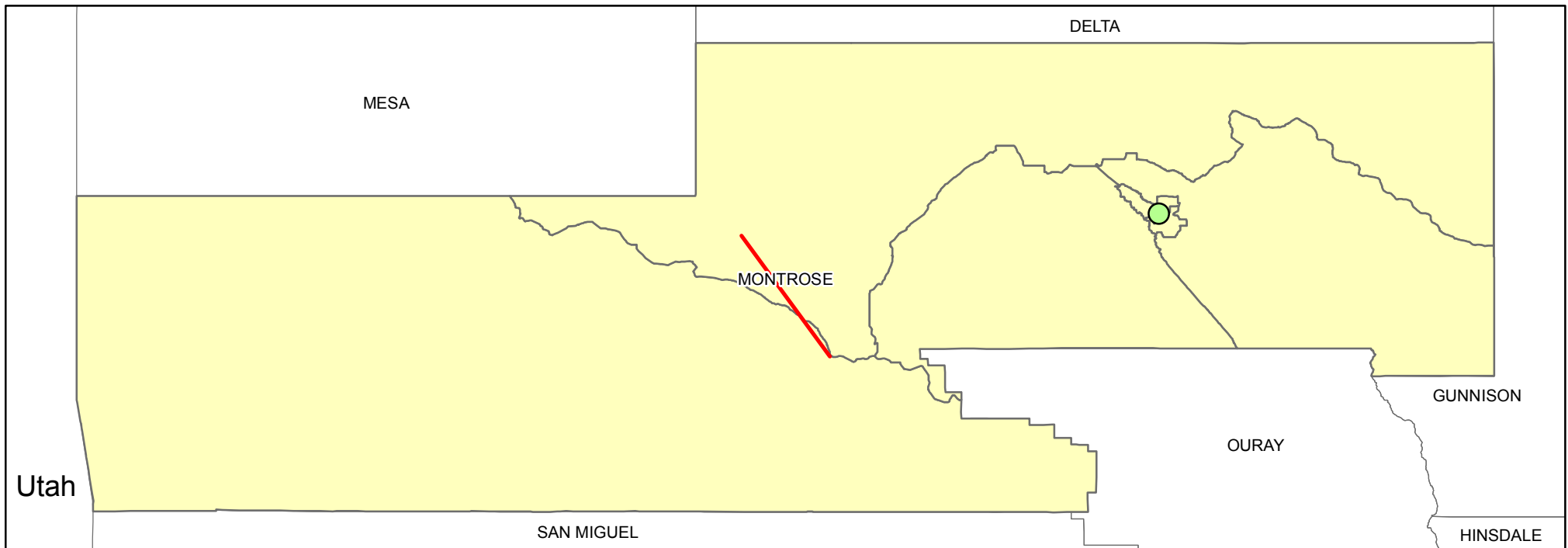


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Study Region: Montrose County

Hazard Scenario: Random Fault 6.5

Care Facilities Map



Created by: Colorado Geological Survey

Team: Matt Morgan and Scot Fitzgerald

Date Created: April 2013

Location: Montrose County Colorado

Fault Parameters: arbitrary, magnitude 6.5, depth 10km

Data: Changed to CGS Landslides and CGS/FEMA Soils data

Projection: GCS North American 1983

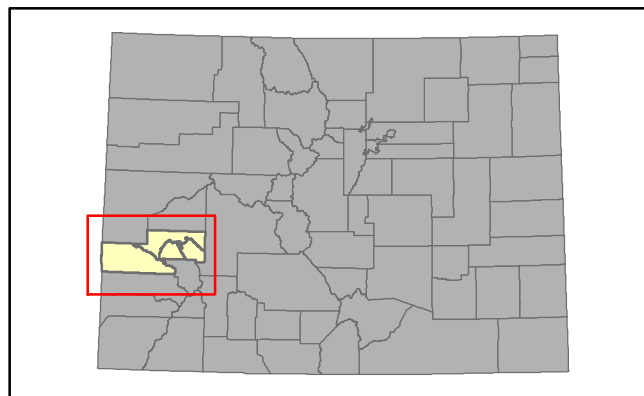
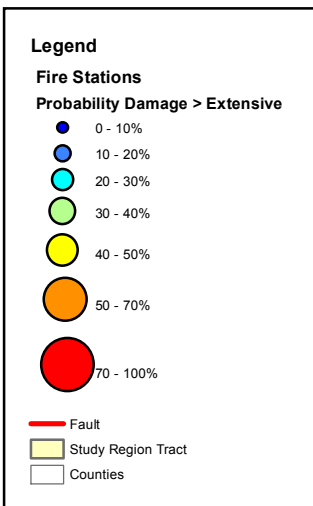
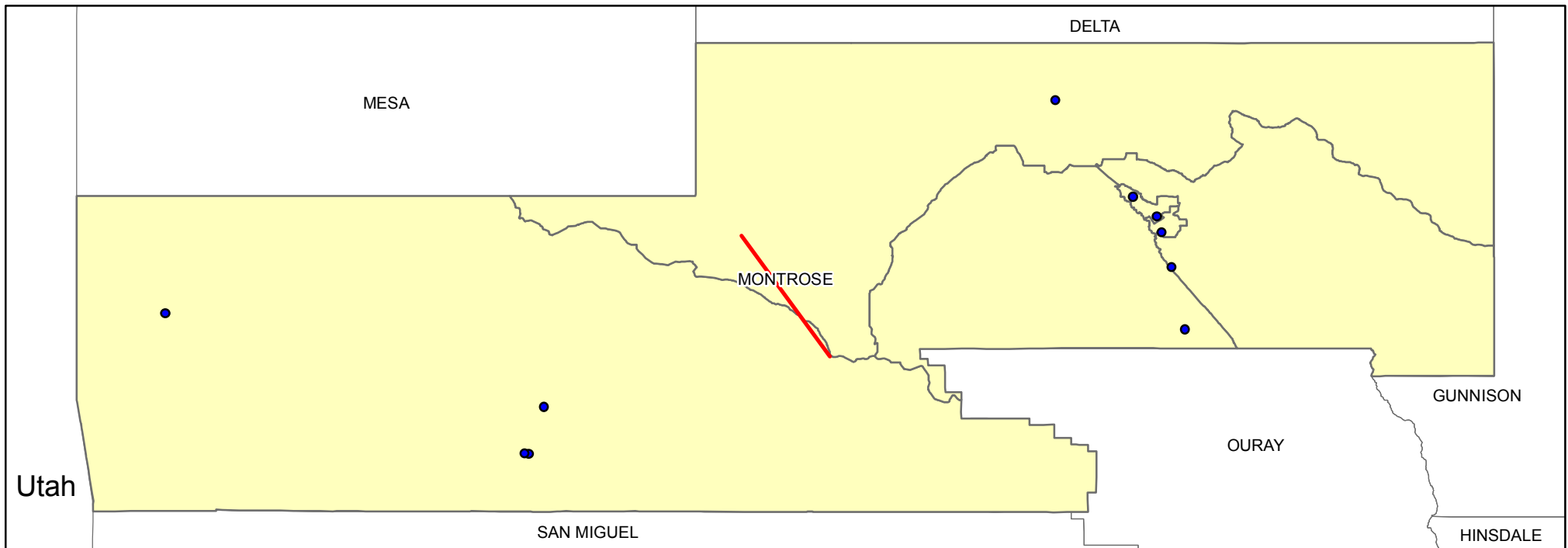
0 10 20 40 Miles



Study Region: Montrose County

Hazard Scenario: Random Fault 6.5

Fire Stations Map



Created by: Colorado Geological Survey
Team: Matt Morgan and Scot Fitzgerald
Date Created: April 2013
Location: Montrose County Colorado
Fault Parameters: arbitrary, magnitude 6.5, depth 10km
Data: Changed to CGS Landslides and CGS/FEMA Soils data
Projection: GCS North American 1983



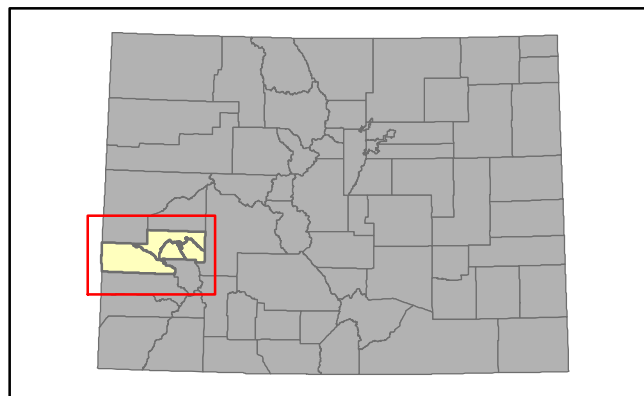
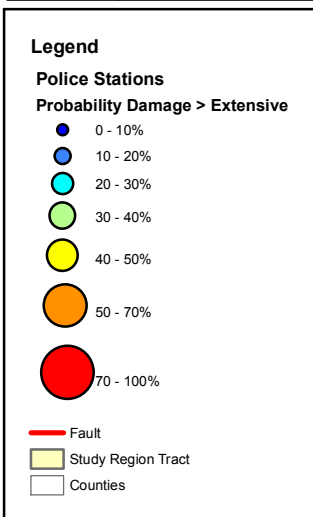
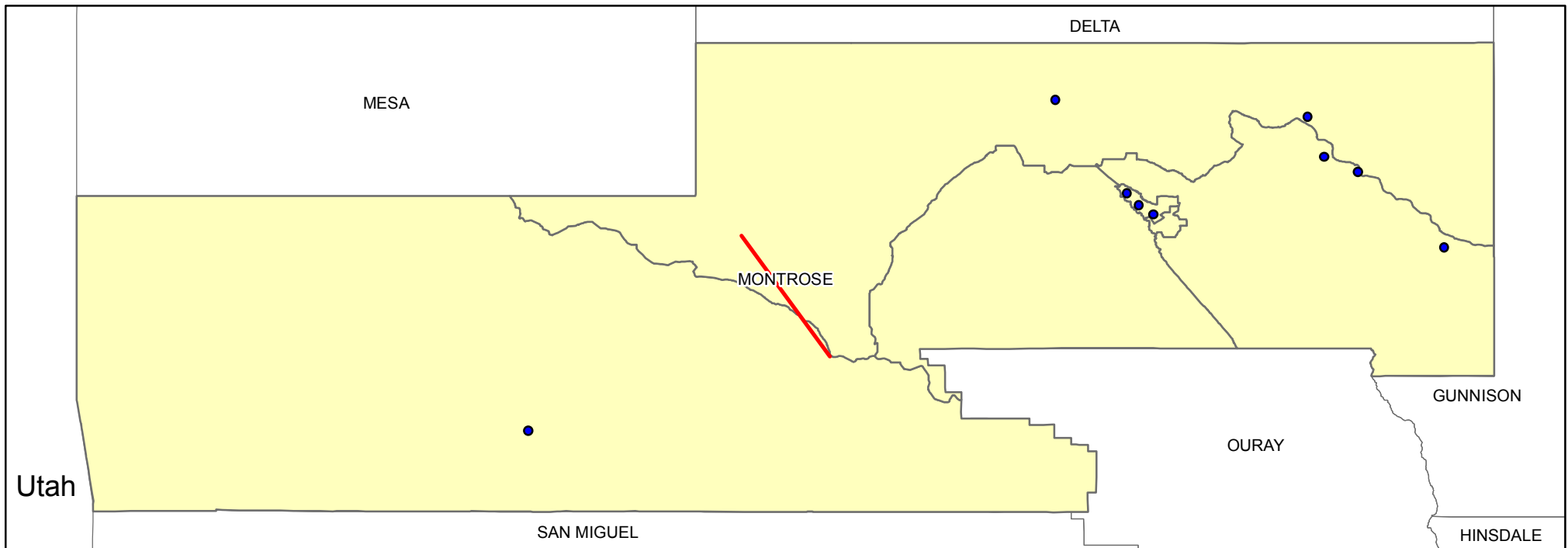
0 10 20 40 Miles



Study Region: Montrose County

Hazard Scenario: Random Fault 6.5

Police Stations Map



Created by: Colorado Geological Survey

Team: Matt Morgan and Scot Fitzgerald

Date Created: April 2013

Location: Montrose County Colorado

Fault Parameters: arbitrary, magnitude 6.5, depth 10km

Data: Changed to CGS Landslides and CGS/FEMA Soils data

Projection: GCS North American 1983

0 10 20 40 Miles

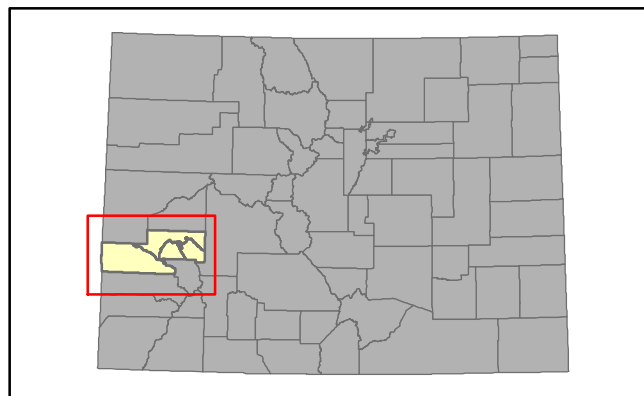
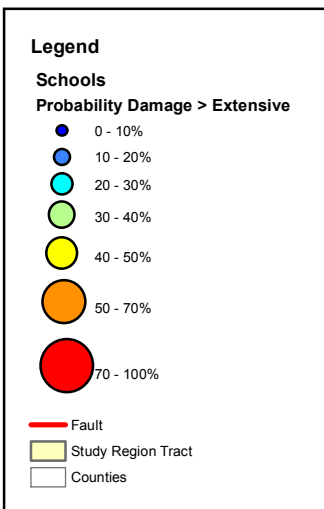
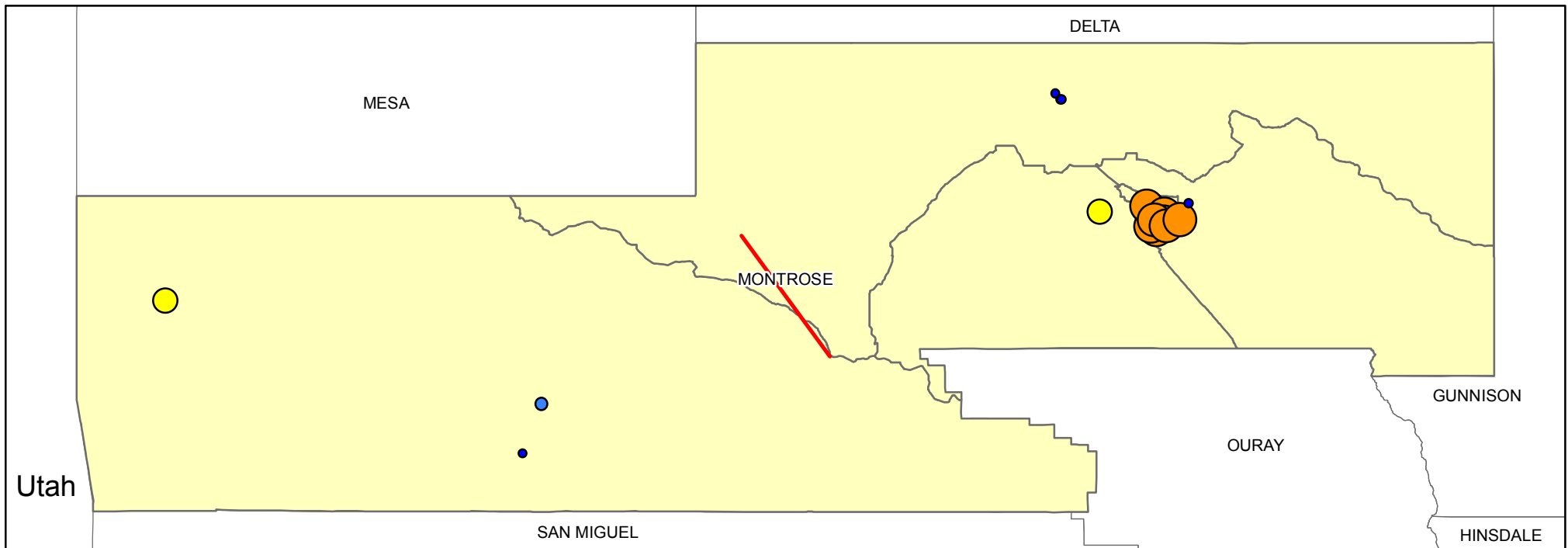


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Study Region: Montrose County

Hazard Scenario: Random Fault 6.5

Schools Map



Created by: Colorado Geological Survey

Team: Matt Morgan and Scot Fitzgerald

Date Created: April 2013

Location: Montrose County Colorado

Fault Parameters: arbitrary, magnitude 6.5, depth 10km

Data: Changed to CGS Landslides and CGS/FEMA Soils data

Projection: GCS North American 1983

0 10 20 40 Miles

