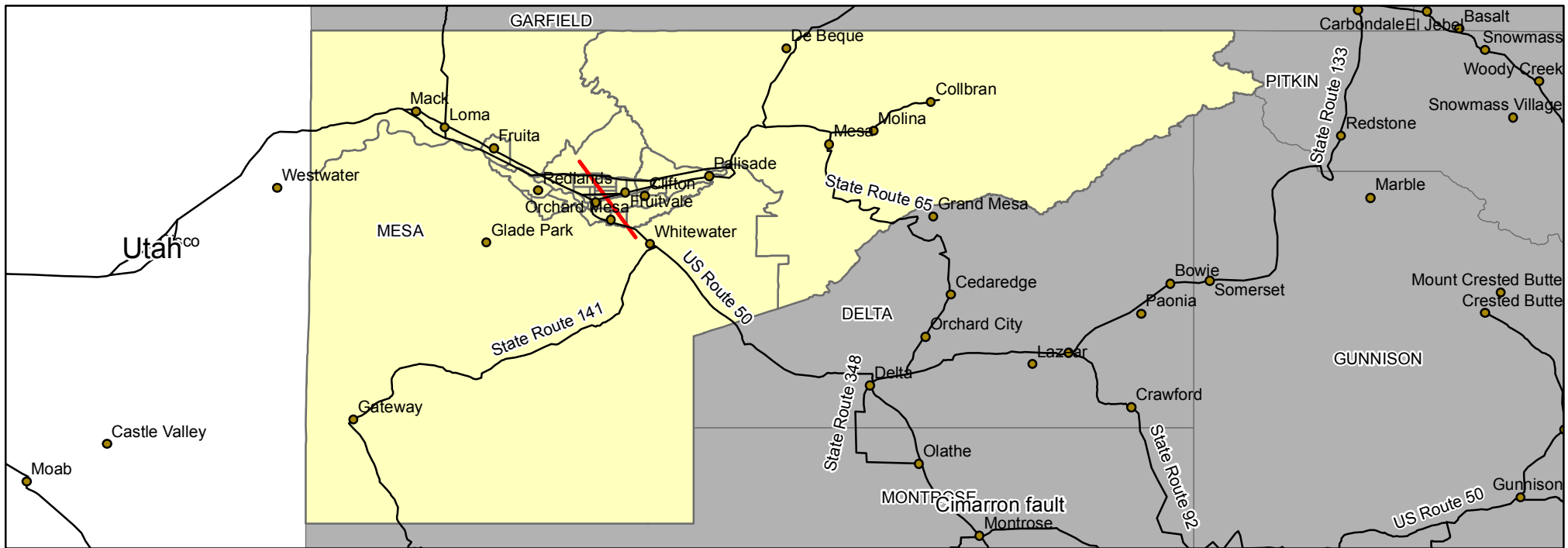


Study Region: Mesa County

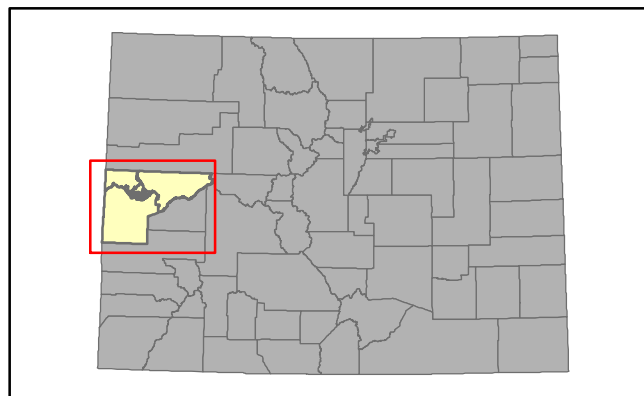
Hazard Scenario: Random Fault 6.5

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: Mesa 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 15 30 60 Miles



HAZUS
EARTHQUAKE • WIND • FLOOD

Hazus-MH: Earthquake Event Report

Region Name: Mesa County Random fault 2010Census

Earthquake Scenario: Random Mesa 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.

Table of Contents

Section	Page #
General Description of the Region	3
Building and Lifeline Inventory	4
Building Inventory	
Critical Facility Inventory	
Transportation and Utility Lifeline Inventory	
Earthquake Scenario Parameters	6
Direct Earthquake Damage	7
Buildings Damage	
Critical Facilities Damage	
Transportation and Utility Lifeline Damage	
Induced Earthquake Damage	11
Fire Following Earthquake	
Debris Generation	
Social Impact	12
Shelter Requirements	
Casualties	
Economic Loss	13
Building Losses	
Transportation and Utility Lifeline Losses	
Long-term Indirect Economic Impacts	
Appendix A: County Listing for the Region	
Appendix B: Regional Population and Building Value Data	

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 3,337.44 square miles and contains 28 census tracts. There are over 58 thousand households in the region which has a total population of 146,723 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 65 thousand buildings in the region with a total building replacement value (excluding contents) of 11,320 (millions of dollars). Approximately 93.00 % of the buildings (and 75.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,845 and 439 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 65 thousand buildings in the region which have an aggregate total replacement value of 11,320 (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 65% 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 6 hospitals in the region with a total bed capacity of 0 beds. There are 60 schools, 19 fire stations, 11 police stations and 1 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 118 dams identified within the region. Of these, 15 of the dams are classified as 'high hazard'. The inventory also includes 16 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 3,284.00 (millions of dollars). This inventory includes over 448 kilometers of highways, 286 bridges, 11,048 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	286	277.60
	Segments	96	2,296.20
	Tunnels	2	4.20
	Subtotal		2,577.90
Railways	Bridges	2	0.20
	Facilities	1	2.70
	Segments	92	178.40
	Tunnels	0	0.00
	Subtotal		181.30
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	1	10.70
	Runways	2	75.90
	Subtotal		86.60
		Total	2,845.80

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	130.30
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		130.30
Waste Water	Distribution Lines	NA	78.20
	Facilities	4	258.40
	Pipelines	0	0.00
	Subtotal		336.60
Natural Gas	Distribution Lines	NA	52.10
	Facilities	8	0.00
	Pipelines	117	172.70
	Subtotal		224.80
Oil Systems	Facilities	1	0.00
	Pipelines	2	6.20
	Subtotal		6.20
Electrical Power	Facilities	23	0.00
	Subtotal		0.00
Communication	Facilities	22	2.10
	Subtotal		2.10
		Total	700.20

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 Mesa County
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-108.53
Latitude of Epicenter	39.07
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 43,840 buildings will be at least moderately damaged. This is over 66.00 % of the buildings in the region. There are an estimated 14,488 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	53	0.56	39	0.31	54	0.31	49	0.42	82	0.56
Commercial	152	1.61	109	0.86	368	2.08	683	5.85	1,781	12.29
Education	7	0.08	6	0.04	9	0.05	12	0.10	28	0.20
Government	16	0.16	7	0.06	12	0.07	18	0.15	47	0.33
Industrial	75	0.80	49	0.39	139	0.79	240	2.05	596	4.11
Other Residential	1,209	12.77	2,195	17.37	3,492	19.76	2,943	25.20	4,986	34.41
Religion	20	0.21	19	0.15	34	0.19	43	0.37	105	0.73
Single Family	7,935	83.81	10,216	80.83	13,566	76.76	7,691	65.86	6,863	47.37
Total	9,468		12,640		17,674		11,678		14,489	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	7,887	83.31	11,815	93.47	15,025	85.02	6,455	55.27	1,795	12.39
Steel	53	0.56	29	0.23	88	0.50	244	2.09	959	6.62
Concrete	55	0.58	40	0.32	142	0.80	307	2.63	869	5.99
Precast	49	0.52	24	0.19	84	0.48	169	1.44	639	4.41
RM	969	10.23	373	2.95	1,389	7.86	2,693	23.06	5,713	39.43
URM	117	1.24	92	0.73	220	1.25	370	3.17	1,179	8.14
MH	337	3.56	267	2.12	725	4.10	1,442	12.35	3,333	23.01
Total	9,468		12,640		17,674		11,678		14,489	

*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 (0.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 2.00% of the beds will be back in service. By 30 days, 18.00% 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	6	6	4	0
Schools	60	56	48	0
EOCs	1	1	0	0
PoliceStations	11	4	0	1
FireStations	19	7	0	7

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	96	0	0	96	96
	Bridges	286	84	18	210	232
	Tunnels	2	0	0	2	2
Railways	Segments	92	0	0	92	92
	Bridges	2	0	0	2	2
	Tunnels	0	0	0	0	0
	Facilities	1	1	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	1	1	0	0	0
	Runways	2	0	0	2	2

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	4	0	0	1
Natural Gas	8	3	0	5	7
Oil Systems	1	1	0	0	1
Electrical Power	23	18	0	9	17
Communication	22	18	0	9	16

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	6,517	1927	482
Waste Water	3,910	968	242
Natural Gas	599	52	13
Oil	22	2	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	58,095	19,639	16,832	10,912	0	0
Electric Power		37,123	22,868	11,183	2,868	58

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 2.72 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 30.00% 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 108,720 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 10,567 households to be displaced due to the earthquake. Of these, 6,334 people (out of a total population of 146,723) 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	38	13	2	4
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	38	12	2	4
	Industrial	39	13	2	4
	Other-Residential	683	193	23	44
	Single Family	1,476	455	76	150
	Total	2,273	686	106	206
2 PM	Commercial	2,271	758	133	262
	Commuting	2	3	4	1
	Educational	2,419	810	145	283
	Hotels	7	2	0	1
	Industrial	288	95	16	32
	Other-Residential	142	40	5	9
	Single Family	327	100	17	32
	Total	5,457	1,807	320	619
5 PM	Commercial	1,598	530	93	181
	Commuting	37	56	86	17
	Educational	393	133	24	47
	Hotels	11	4	1	1
	Industrial	180	59	10	20
	Other-Residential	254	72	9	16
	Single Family	577	175	30	56
	Total	3,051	1,027	252	338

Economic Loss

The total economic loss estimated for the earthquake is 7,273.08 (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 7,067.82 (millions of dollars); 18 % 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 50 % 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	18.25	244.47	7.07	30.46	300.26
	Capital-Related	0.00	7.75	174.37	4.22	10.36	196.71
	Rental	65.37	50.19	83.49	1.78	12.73	213.56
	Relocation	227.23	43.61	164.04	7.87	123.41	566.17
	Subtotal	292.60	119.81	666.37	20.95	176.96	1,276.70
Capital Stock Losses							
	Structural	436.55	98.07	238.03	36.16	100.85	909.65
	Non_Structural	1,574.25	471.13	868.32	156.77	450.95	3,521.40
	Content	437.97	110.95	446.51	97.06	230.65	1,323.14
	Inventory	0.00	0.00	11.92	23.82	1.18	36.92
	Subtotal	2,448.77	680.14	1,564.78	313.81	783.63	5,791.12
	Total	2,741.37	799.95	2,231.15	334.76	960.59	7,067.82

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	2,296.24	\$1.56	0.07
	Bridges	277.56	\$42.36	15.26
	Tunnels	4.15	\$0.04	0.94
	Subtotal	2577.90	44.00	
Railways	Segments	178.43	\$0.00	0.00
	Bridges	0.23	\$0.01	4.61
	Tunnels	0.00	\$0.00	0.00
	Facilities	2.66	\$1.92	72.15
	Subtotal	181.30	1.90	
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	10.65	\$8.01	75.18
	Runways	75.93	\$0.00	0.00
	Subtotal	86.60	8.00	
	Total	2845.80	53.90	

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	130.30	\$8.67	6.65
	Subtotal	130.34	\$8.67	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	258.40	\$135.88	52.58
	Distribution Lines	78.20	\$4.36	5.57
	Subtotal	336.61	\$140.23	
Natural Gas	Pipelines	172.70	\$0.11	0.06
	Facilities	0.00	\$0.00	0.00
	Distribution Lines	52.10	\$1.49	2.86
	Subtotal	224.83	\$1.60	
Oil Systems	Pipelines	6.20	\$0.00	0.07
	Facilities	0.00	\$0.00	0.00
	Subtotal	6.24	\$0.00	
Electrical Power	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	\$0.00	
Communication	Facilities	2.10	\$0.85	39.79
	Subtotal	2.13	\$0.85	
	Total	700.15	\$151.36	

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

Mesa,CO

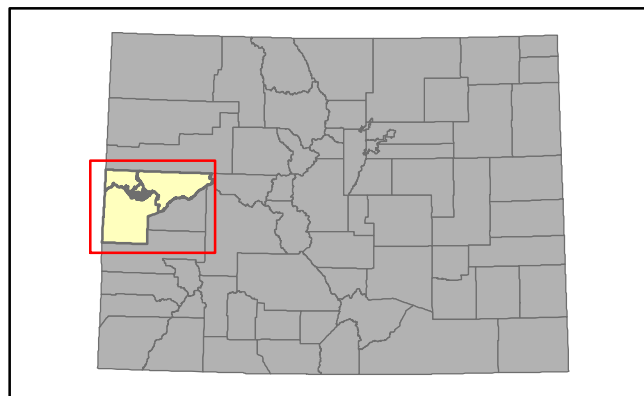
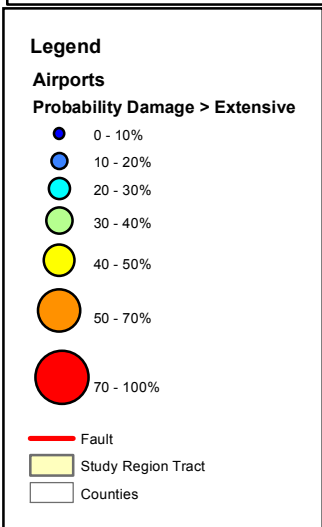
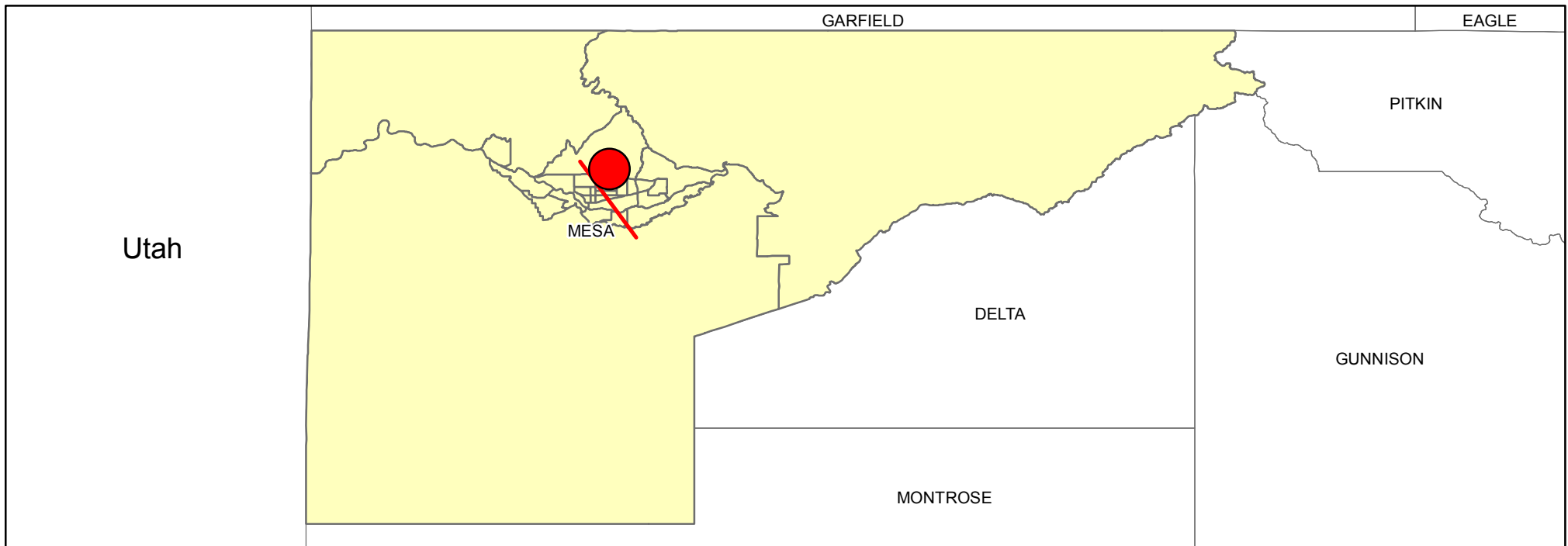
Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Mesa	146,723	8,464	2,855	11,320
Total State		146,723	8,464	2,855	11,320
Total Region		146,723	8,464	2,855	11,320

Study Region: Mesa 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: Mesa 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 15 30 60 Miles

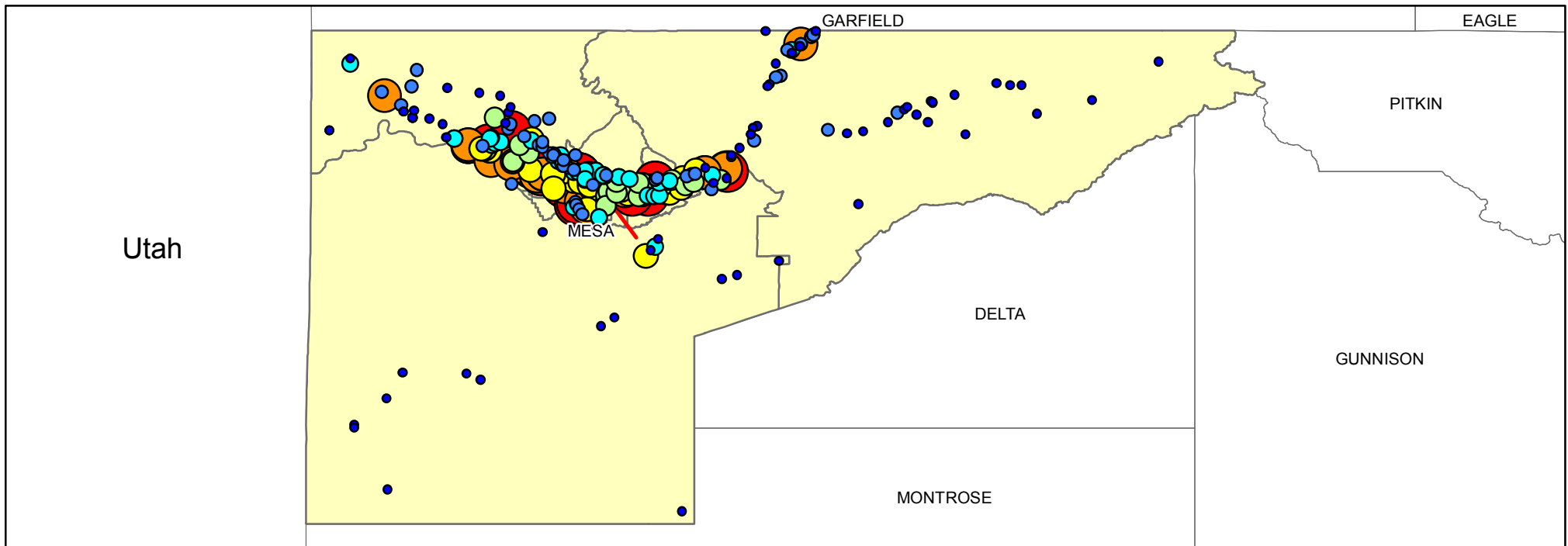


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Study Region: Mesa County

Hazard Scenario: Random Fault 6.5

Bridges Map

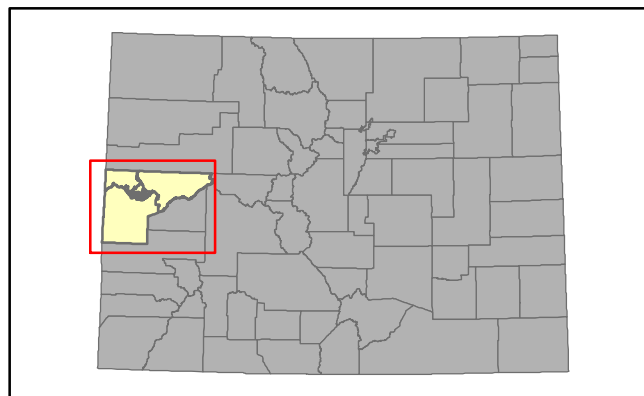


Legend

Bridges
Probability Damage > Extensive



— Fault
— Study Region Tract
— Counties



Created by: Colorado Geological Survey

Team: Matt Morgan and Scot Fitzgerald

Date Created: April 2013

Location: Mesa 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 15 30 60 Miles

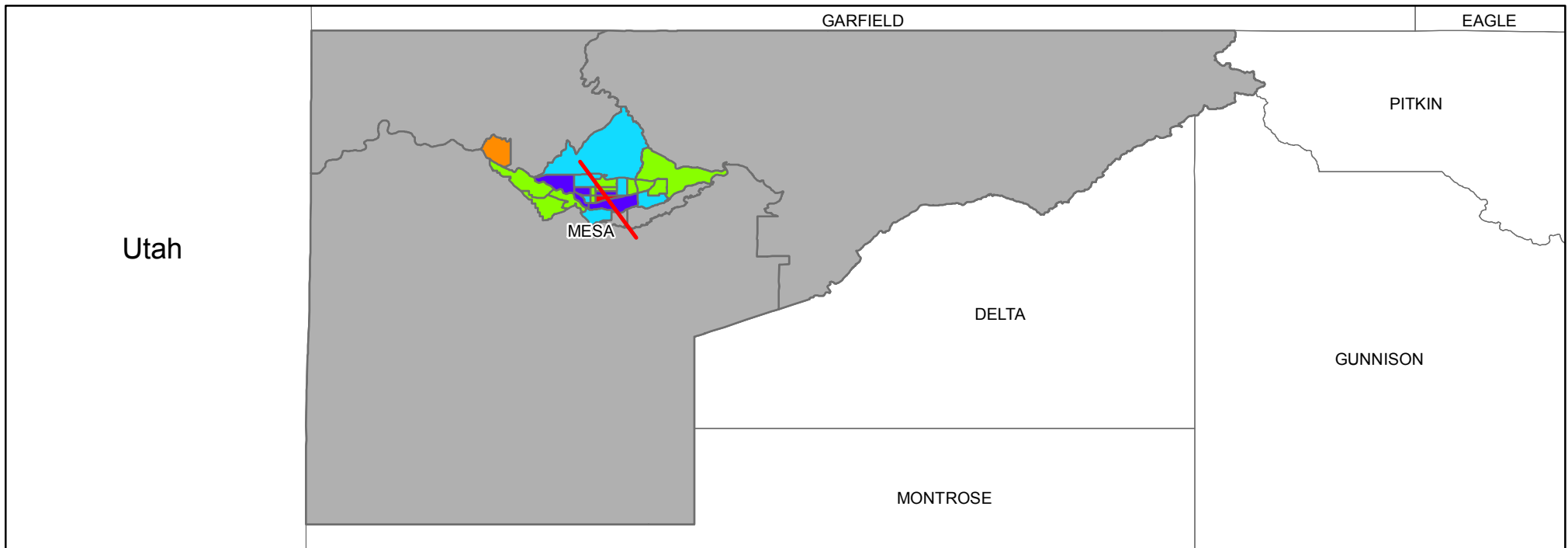


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Study Region: Mesa County

Hazard Scenario: Random Fault 6.5

Building Economic Loss Map

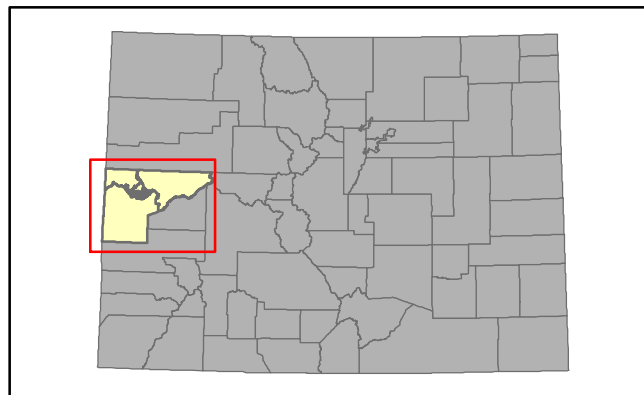


Legend

— Fault

Building Economic Loss in Thousands of Dollars

- 8168 - 126015
- 126015 - 243862
- 243862 - 361709
- 361709 - 479556
- 479556 - 597403
- 597403 - 715252
- Study Region Tract
- Counties



Created by: Colorado Geological Survey

Team: Matt Morgan and Scot Fitzgerald

Date Created: April 2013

Location: Mesa County Colorado

Fault Parameters: arbitrary, magnitude 6.5, depth 10km

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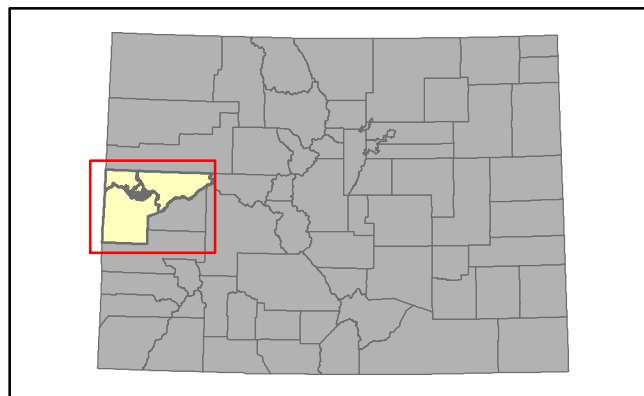
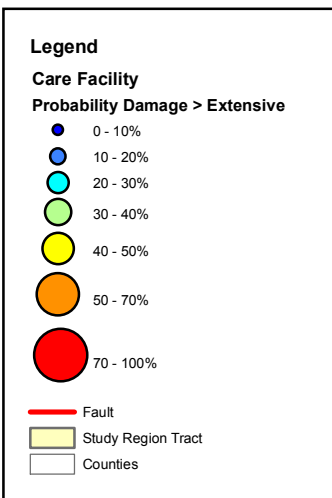
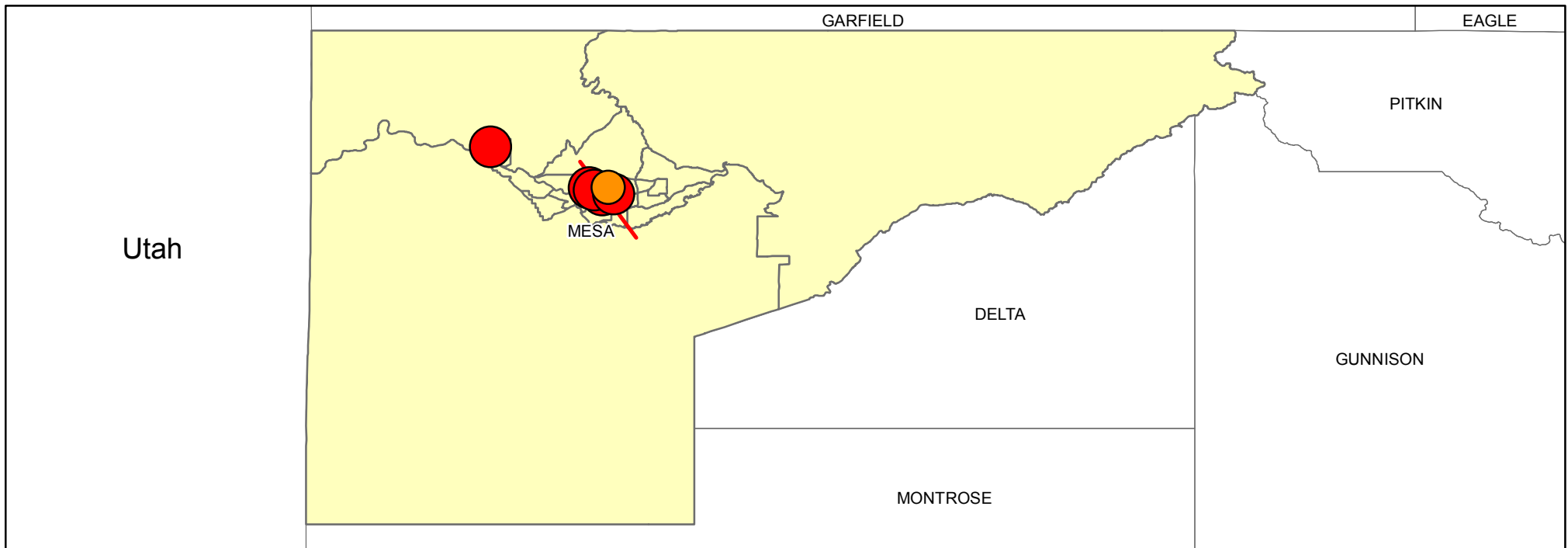


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Study Region: Mesa County

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: Mesa 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 15 30 60 Miles

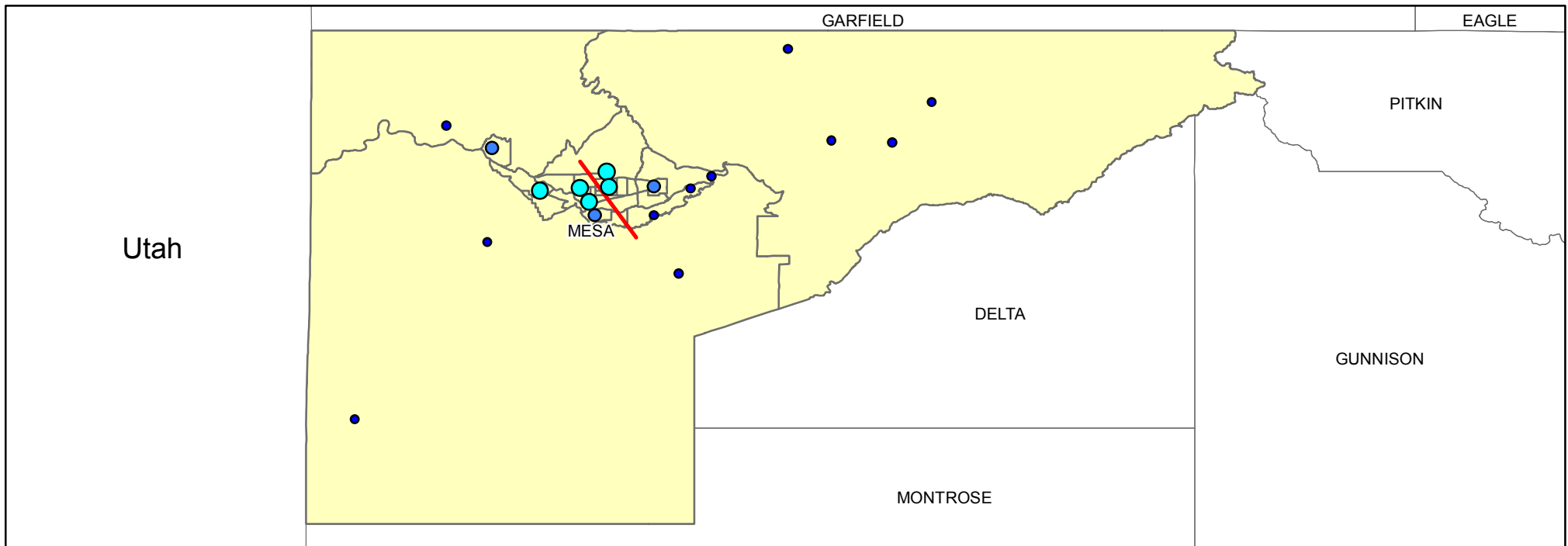


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Study Region: Mesa County

Hazard Scenario: Random Fault 6.5

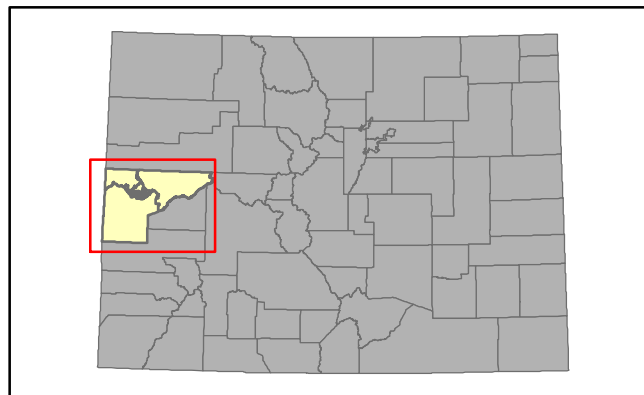
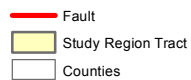
Fire Stations Map



Legend

Fire Stations

Probability Damage > Extensive



Created by: Colorado Geological Survey

Team: Matt Morgan and Scot Fitzgerald

Date Created: April 2013

Location: Mesa 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

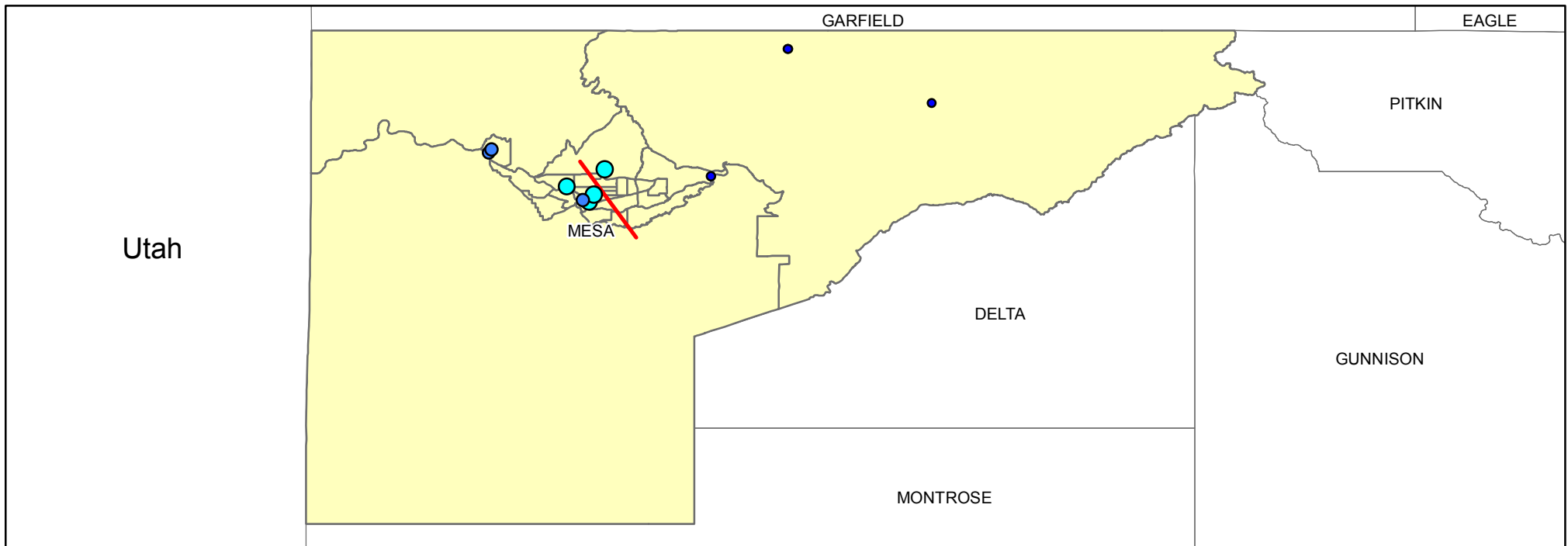
0 15 30 60 Miles



Study Region: Mesa County

Hazard Scenario: Random Fault 6.5

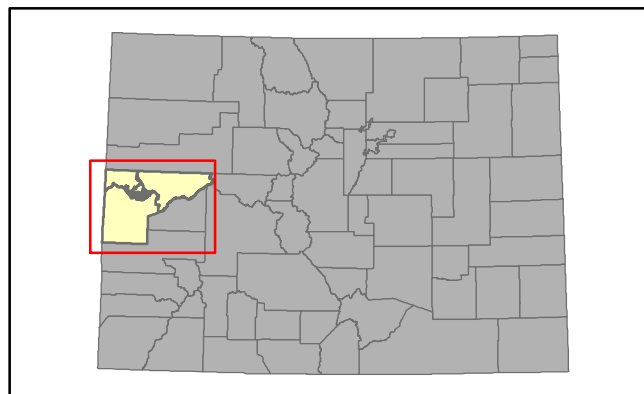
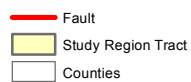
Police Stations Map



Legend

Police Stations

Probability Damage > Extensive



Created by: Colorado Geological Survey

Team: Matt Morgan and Scot Fitzgerald

Date Created: April 2013

Location: Mesa 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 15 30 60 Miles

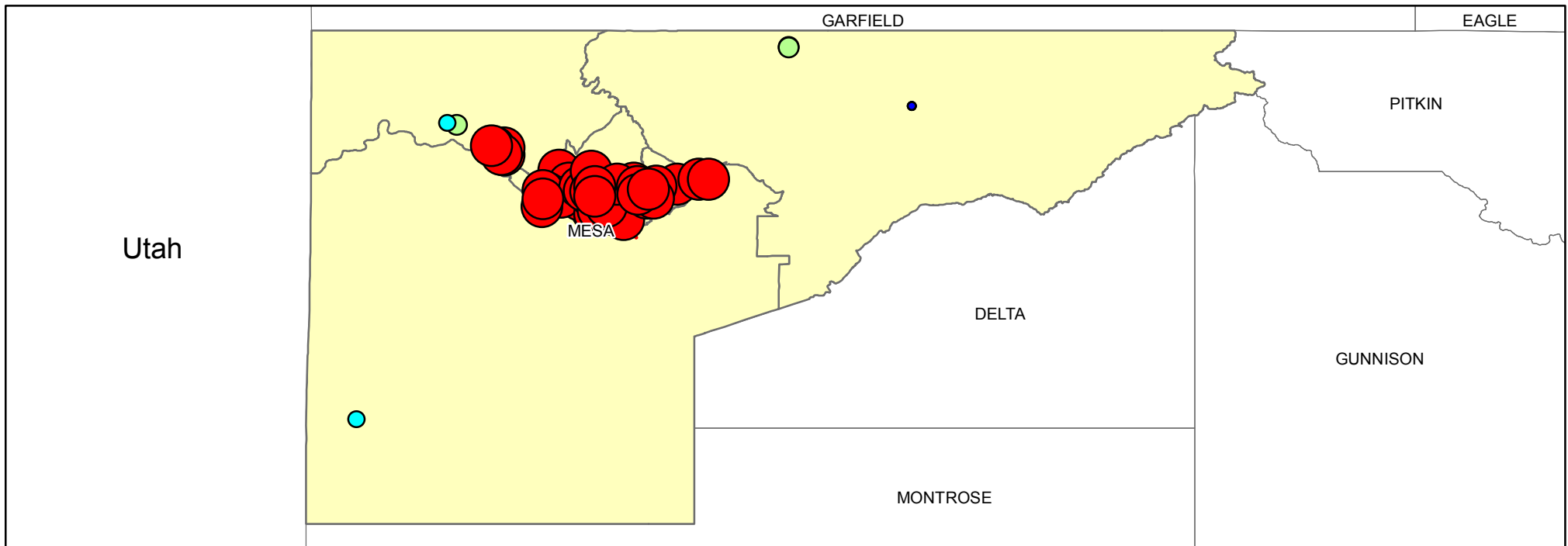


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Study Region: Mesa County

Hazard Scenario: Random Fault 6.5

Schools Map

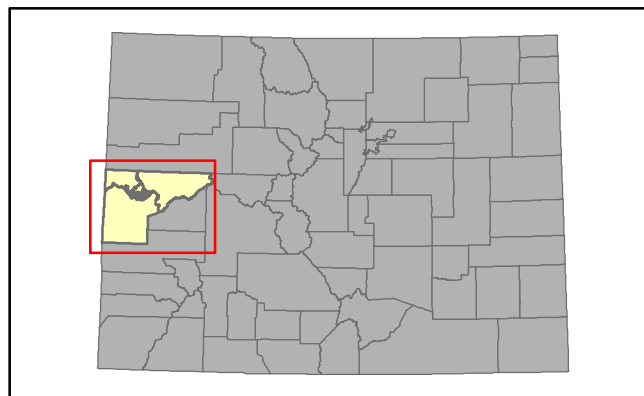


Legend

Schools
Probability Damage > Extensive



— Fault
— Study Region Tract
— Counties



Created by: Colorado Geological Survey

Team: Matt Morgan and Scot Fitzgerald

Date Created: April 2013

Location: Mesa 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 15 30 60 Miles



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