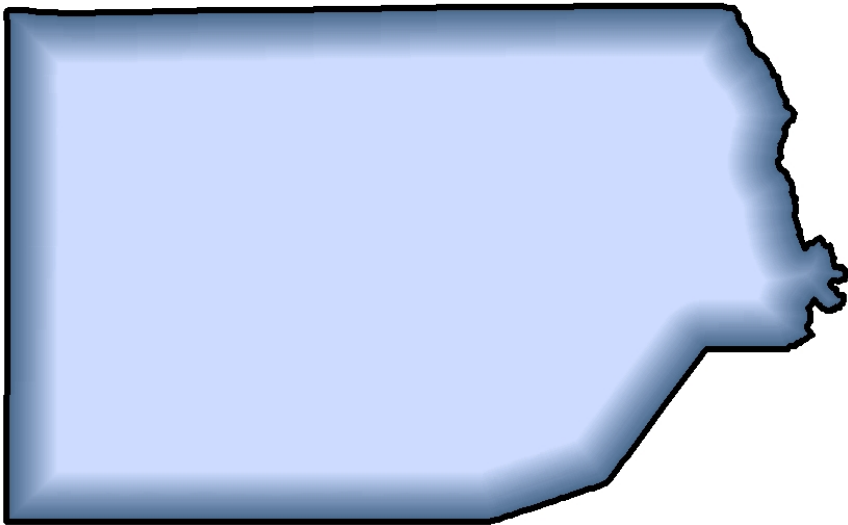


SECTION 6:
BOX ELDER COUNTY - COMMUNITY RISK
ASSESSMENTS



GENERAL BACKGROUND INFORMATION

Box Elder County is located in the northwest corner of Utah extending from the western edge of the Wasatch Mountains to the Idaho border and then west to the Nevada border. Box Elder County is surrounded by Cache, Weber, Tooele, and Davis Counties, and is the fourth largest of Utah's counties. Created in 1856, it was named for its abundance of Box Elder trees throughout the County.

Early inhabitants of the County were prehistoric hunters and gatherers that roamed the area as early as 12,000 years ago. In the 1820's and 1830's, fur trappers, including Peter Skene Ogden and Joseph Walker, explored the eastern and northern parts of the county. Permanent white settlement began in 1851 when a group of Mormon pioneers settled in present day Willard. The area was already inhabited by Shoshone Indians when the Mormon settlers entered the area. This resulted in livestock raids and violent confrontations between the Indians and the settlers. On July 30, 1863, Territorial Governor James Duane Doty negotiated the Treaty of Box Elder ending the conflict between the Shoshone Indians and the settlers. In 1856 the territorial legislature created Box Elder County from part of Weber County.

Box Elder is historically known for the Golden Spike National Historical Site where, in May of 1869, the driving of the Golden Spike, in Promontory, joined the Union Pacific Railroad from Omaha, Nebraska, and the Central Pacific Railroad from the Pacific Coast. A dramatization of that ceremony is reenacted every year, allowing visitors to witness the event.

The County contains rich farmlands consisting of about 33% of the County's land. The standard crops are hay, grain, alfalfa, and the county is also known for its peaches and other fruit crops. Besides agriculture, Box Elder County accommodates several large manufacturing facilities including ATK Launch Systems, the single largest employer in the County which operates two rocket motor and missile plants and produces fuel for space vehicles. Autoliv, the automobile airbag manufacturer, is also a major employer which is expanding rapidly. Others include the Wal-Mart Distribution Center, Nucor Steel, and Vulcraft .

Box Elder County's economy and fortunes have been closely tied to individual industries throughout its history. Starting with early reliance on the opportunities made available by the trans-continental railroad, the sugar beet industry, and most recently, the ATK Corporation and the military industrial complex. Proctor and Gamble is currently in the process of constructing a new manufacturing facility west of Corinne and Bear River City, which will also provide employment with the possibility of expansion.

The county has recently increased efforts to diversify its economy to avoid reliance on single markets, and shows signs of succeeding in this effort. The growth trend in Box Elder County is less rapid than Cache County, but as the Wasatch Front builds out there will be increased pressure on Box Elder County to absorb future growth.

Although Box Elder County had its economic beginnings in agriculture and livestock production, manufacturers in the defense and space industry have given the county higher employment rates and per capita incomes than the rest of the state. Agriculture still plays a large part in the

regional economy, but is increasingly seen as a source of supplemental income. The manufacturing sector has diversified and grown at a steady rate in Box Elder County reducing the importance of agriculture to local economies. Simultaneously, employment opportunities have steadily moved from the agricultural sector to the manufacturing sector.

| Table 6-1: Box Elder County Participating PDM Jurisdictions | | | |
|--|-----------------|----------------|----------------|
| Box Elder County | Bear River City | Brigham City | Corinne City |
| Deweyville Town | Elwood Town | Fielding Town | Garland City |
| Honeyville City | Howell Town | Mantua Town | Perry City |
| Plymouth Town | Portage Town | Snowville Town | Tremonton City |
| Willard City | | | |



BOX ELDER COUNTY FLOODING

Background

Areas in Box Elder County have experienced significant impacts related to flooding in recent recorded history. Box Elder County has several large rivers and smaller tributaries that are susceptible to flooding. The Bear River is the largest river in the county. Cutler Reservoir lies mostly in Cache County, while just across the county line in Box Elder County, there is a hydroelectric dam called Cutler Dam. The existence of this dam does provide some meaningful flood control for downstream portions of the Bear River in Box Elder County. Other major rivers are the Malad River and Box Elder Creek. A number of small intermittent streams are located in some of the canyons of the Wellsville and Wasatch Mountains. Each of these streams can pose a threat in terms of flooding. In addition a number of canals are located in the county that under certain conditions may fail or overflow and result in flooding. Also, flooding can also take place concurrently with some landslide events, particularly sediment/mud/debris flows. Flood water is rarely clean and clear, and much of the damage from flooding can be in the form of debris (Scott Stoddard, personal communication, 8/13/09).

Most flooding in Box Elder County is attributed to snowmelt rates in surrounding watersheds that are in excess of the capacity of the drainage systems or unusually heavy storm events that temporarily overwhelmed drainage capacity (or a combination of the both). Some limited flooding is the result of rising groundwater levels. **See the “FEMA Flood Zone” map on page 105.**

History of Flooding in Box Elder County

In terms of property damage and disruption of community life, Brigham City, along with the Willard/Perry area, has been among the communities in the county most impacted by flooding. The floods of August 1923 in Willard were some of the most destructive in the state’s recorded history. A significant portion of Willard was inundated by flood water and associated mud and debris flows. Four dwellings were destroyed and two women died when their homes were demolished (see cover photos).

In the mid-1980’s large portions of Box Elder County were negatively impacted by the rise in the level of the Great Salt Lake. A significant amount of high value wetlands and agricultural land surrounding the lake were flooded by the rise of the briny water, including the Bear River Bird Refuge. Although their immediate value was reduced by a natural dry cycle that resulted in the lake level dropping, the State of Utah installed large pumps on the lake to moderate the rise of the lake by moving the water to the west desert. These pumps can return to operation if needed.

Following is a summary of significant flooding events in Box Elder County from 1847 to present:

| Table 6-2: Box Elder County Flood History 1847-2009 | | |
|--|-------------|--|
| Location | Date | Description |
| Brigham City | 1851 | Box Elder Creek flooding through early settlement. |

| Table 6-2: Box Elder County Flood History 1847-2009 | | |
|---|------------------|--|
| Location | Date | Description |
| | 1881, 1907 | No information available |
| | Feb 1911 | Snowmelt and heavy rain resulted serious damage to homes, roads and bridges. |
| | Aug 1947 | Crop & road damage, flooded homes |
| | May 1957 | Low area flooding |
| | Aug 1959 | Extensive road damage |
| | June 1960 | Crop damage |
| | June 1963 | Crop damage and flooded homes |
| | June 1969 | Main Street flooding and one home |
| | Spring 1983 | Homes flooded, waste treatment plant threatened by Box Elder Creek. |
| Fielding | July 1957 | Flooded highway, crop damage |
| | 1958, 1979, 1980 | No information available |
| Garland | 1899, 1918, 1980 | No information available |
| | Spring 1983 | Dike along Bear River failed and damaged community water supply pump house. |
| Honeyville | Spring 1983 | Homes flooded from high groundwater |
| Howell | 1968, 1969, 1980 | No information available |
| Perry | May 1949 | Road, orchard and crop damage |
| Plymouth | 1891, 1941 | No information available |
| Promontory | Sept 1959 | Crop damage |
| Snowville | June 1953 | Crop damage, road closure |
| | 1954, 1980 | No information available |
| Thatcher | 1934, 1980 | No information available |
| Willard | 1906, 1912 | No information available |
| | Aug 1923 | Widespread flooding and debris flow. Significant property damage and loss of life. |
| | Aug 1952 | \$100,00 in damage to orchard |
| | Sept 1982 | Flooding from Holmes Canyon east of Willard. Road damage as flood waters crossed U.S. 89 at about 680 South. |
| | Spring 1983 | Several homes flooded, Facer Canyon Flooding |
| Land around the Great Salt Lake | 1982-1984 | Flooding of land around the Great Salt Lake (wetlands and agricultural land). |
| Entire County | Spring 1984 | Debris flows on private land, debris basins in Willard filled to capacity. Widespread road damage. |
| Entire County | Aug 2005 | FEMA disaster declaration – flood and landslide |
| FEMA Flood insurance study for Brigham City, 2-17-81, Local Surveys (see appendix A) (Butler & Marsell, 1972), (Division of Comprehensive Emergency Management, 1981), FEMA, 2005 | | |

Table 6-3: Box Elder County Flood Hazard Assessment: Hazard Profile

| | |
|--|--|
| Frequency | Some flooding occurs nearly every year in Box Elder County |
| Severity | Moderate |
| Location | Generally along rivers, streams, ravines, and canals. |
| Seasonal Pattern | Spring flooding as a result of snowmelt. Mid-late summer cloudburst events. |
| Duration | A few hours or up to three weeks for snowmelt flooding |
| Speed of Onset | 1-6 hours |
| Probability of Future Occurrences | High-for delineated flood plains there is a 1% chance of flooding in any given year. |

Taken as a whole, Box Elder County has relatively minor flood threats. This, in part, is reflected in the low number of communities participating in the National Flood Insurance Program (NFIP). Nonetheless, significant flooding has occurred in the past and with certainty will occur in the future. The question is when, where and to what extent?

Given existing and potential future development, areas around the Bear and Malad Rivers are most likely to see impacts related to flooding. At present most of the risk for flood damage is centered on potential agricultural losses. Certainly as more development occurs, if it is not properly managed, threats to structures and human safety will certainly increase.

During the 2004 Pre-Disaster Mitigation planning process, BRAG staff acquired and digitized all existing FEMA Flood Insurance Rate Maps (FIRM's) into a GIS file format. These FIRM's included floodplains designated by FEMA as Zone A and Zone B. Zone A floodplains are those that are considered to be 100 year flood plains, with a 1% chance of flooding in any given year. Zone B floodplains are those areas between the limits of the 100 year floodplain and the 500 year flood plain (the 500 year flood plain are those areas with a 0.2% chance of flooding in any given year). Because both of these floodplain zones could pose a potential risk to residents and their property, both zones were included for the 2008 analysis.

While FEMA floodplains are a great planning tool for hazard mitigation, there is much of Box Elder County that has never been mapped by FEMA. An August 2003 report entitled Flood Hazard Identification Study: Bear River Association of Governments by the U.S. Army Corps of Engineers was completed to help communities without floodplain data. This study generally identified areas of concern for flooding for municipalities lacking data (See Appendix B for the full report). However, this report was only intended to give communities very general estimates of where flood risk may exist. Also, many flooding events happen outside of the FEMA 100-year floodplain delineations (around 40%). There are other ways that flooding occurs as well, such as canals, reservoirs/ponds, wildfire, incorrect grading, and plugged sewer and storm water systems (Scott Stoddard, personal communication, 11/13/08). FEMA is currently in the process of updating Box Elder Counties floodplain maps, which will help communities better identify flood hazards. Below is a discussion of flooding risks for communities in Box Elder County. Only those communities thought to be at risk for flooding have been included.

Numerous isolated pockets of flood-prone development are located in the **unincorporated portions of Box Elder County**. Some of these developments are located largely adjacent to the

Malad River and the Bear River, and various intermittent streams and drainages. There are also susceptible structures in the floodplain north of the Bear River Bay of the Great Salt Lake, where the Bear River deposits into the lake.

According to the U.S. Army Corps of Engineers (2003), **Bear River City** could be at high risk for flooding events. The city does not participate in NFIP. Without floodplain data, it is difficult to know how many existing structures are at risk. The Malad River and a tributary of the river run to the west, posing a threat to future development if not planned for accordingly.

Areas at risk from flooding in **Brigham City** include mostly homes along Box Elder Creek, from John Adams Park west to about 1400 West. Also at risk are several structures south of 1500 North and west of 500 West.

The Ogden-Brigham (Pineview) Canal flows into Brigham City from the south. It enters the southern part of the county and flows through or above Willard, Perry and Brigham City. The Perry Canal begins in an equalization pond below Mantua Reservoir and flows partially through Brigham as it flows to Perry City to the south. These two canals parallel each other for a time flowing in opposite directions. Historically, not much flooding has occurred from these canals. About seven years ago the Perry Canal overflowed with spring runoff around 600 South and 800 East in Brigham City due to a blocked culvert and one home was flooded. Brigham City could be impacted by upstream conditions on the Pineview Canal.

Corinne City participates in the NFIP and the digitized floodplain shows significant risk to citizens in the southern portion of the city. There are potentially 35 of 45 at risk structures in this portion of the city with an estimated 1.8 million dollars in estimated property damages. Mill Run to the north is also a potential flood hazard threat. The floodplain nearly surrounds the city on every side save the west side, illustrating the need to incorporate flood mitigation planning for any proposed future development. Potential loss estimates for Corinne are shown in Table 6-4.

Deweyville Town does not participate in the NFIP and does not have detailed floodplain data. The town borders the Bear River, but all of the current development is located a considerable distance from the river and does not seem to be at risk from flooding. However, some eastern tributaries flowing off the Wellsville Mountains present a threat to portions of the town from site specific flooding, and future development could easily be placed in harm's way (U.S. Army Corps of Engineers, 2003).

Elwood Town does not participate in NFIP. It is surrounded along jurisdictional boundaries by the Bear River on the east and the Malad River on the west. This creates an obvious flood threat. While the older development seems to be far enough away from the two rivers, new development seems to be creeping closer to flood-prone areas (U.S. Army Corps of Engineers, 2003).

A similar situation occurs for **Honeyville Town**, which also has east canyon drainages and the same canal which could cause problems during severe weather events or structural damage. Salt Creek, which runs west of the main town, eastern drainages, and the Bear River could affect about 20 structures during a 100 year event.

Although the potential loss chart for Box Elder County shows only two structures at risk for flooding in **Mantua Town**, aerial imagery shows that there could actually be up to 5 or 6 more structures at risk along the east side of Highway 89-91. One drainage of concern in Mantua is the Big Creek drainage which comes out of Mantua Reservoir, joining Box Elder Creek, and down to Brigham City. Mantua participates in the NFIP, and has adequate floodplain data.

Perry City and Willard City share common flood threat types, as is discussed in more detail in the Willard City section. Eastern drainages and western wetlands border municipal boundaries. Perry City participates in the NFIP, with floodplain data digitized by BRAG in the 2004 Pre-Disaster Mitigation Plan. Risks for Perry come mostly from Black Slough and Three Mile Creek, which currently threaten several structures along their drainages, and could become problematic during a severe flooding event.

According to the U.S. Army Corps of Engineers (2003), much of **Plymouth Town** appears to be vulnerable to flooding. The north eastern portion seems especially vulnerable. Because the town does not participate in the NFIP, no flood plain map has been produced. Some approximation is required in carrying the flood boundary that has been mapped for the adjacent unincorporated county through the town of Plymouth. Plymouth has several piped drains (field drains) running through town that provide drainage during high rainfall events and/or spring runoff. These drains run west of 5100 West and East of 5000 West and are in need of repair in order to prevent the flooding of nearby residences. Some flooding of residences occurred in town in the early 1980's. Another consideration for Plymouth Town is the potential for water and other utility lines being severed during an earthquake, causing flooding and other issues. These lines generally run underneath the streets of the town.

Snowville Town has several Deep Creek tributary drainages that are located in or near the town, with Deep Creek running west of the main town. Snowville does not participate in NFIP and so no official flood plain map has been produced for the town. Flooding from the intermittent tributaries would seem to pose a significant flood threat for a large portion of the community (U.S. Army Corps of Engineers, 2003).

Tremonton City does not participate in the NFIP and flood plains have not been delineated for the community. For the most part structures in the city have been built away from drainages. However the eastern part of the city has been built along the Malad River suggesting that some flooding is possible in developed portions. If the rough extent of the Malad River floodplain boundary mapped for the unincorporated county was carried through the Tremonton Boundary, several residences could be threatened by flooding. Future development could easily encroach on the floodplain as well (U.S. Army Corps of Engineers, 2003).

Willard City participates in the NFIP and has experienced some of the worst flooding in the state's history. As a result of flooding that occurred in the early 1900's, Willard has made several improvements to mitigate any future flood related impacts. Nonetheless, some flooding vulnerability still exists for Willard. The Zone A floodplain bisects the valley east to west from the canyon mouth between 300 and 750 North, all the way to Willard Reservoir.

Much of the steep mountainous area east of Perry City, Willard, and the South Willard area extending to the Weber County line on the south, are drained by a number of steep mountain canyons. These include Facer, Willard, Cook, Holmes and Pearsons Canyons. A long history of flood related problems have occurred in some of these canyons (especially above Willard City). Further exacerbating the situation is the presence of the Ogden-Brigham Canal (Pineview) that runs perpendicular to these canyon drainages at the base of the foothills.

Responding to flooding, significant flood control work has been completed in these drainages (much of it done by Civilian Conservation Corps (CCC) crews). Detention basins have been constructed at Facer Creek, Willard Creek and Pearson Canyon. Land terracing has been completed on the upper portion of the Willard Creek drainage. Gabions have been installed to direct flood waters in Pearson and Holmes Canyons. In addition a number of debris basins have been constructed.

Community officials have also attempted to respond to flood water from east-west canyons entering the northern flowing Ogden-Brigham Canal. Chutes have been built over the canal and most of the sections of the canal subject to flooding have been piped to prevent flood waters and debris from entering the canal. Also storm water pipes have been installed to help handle storm water discharges for Perry and Willard cities (RB & G Engineering, Inc, 1999).

Assessing Vulnerability: Addressing Repetitive Loss Properties

There are no repetitive loss properties in Box Elder County (FEMA, 2008).

Assessing Vulnerability: Identifying Assets & Estimating Losses

| Table 6-4: Box Elder County Residential and Commercial Development at Risk from Floods | | | | | | |
|---|--|----------------------------------|-------------------|---------------------------------|-------------------|-------------------------------------|
| Jurisdiction | ~Residents at Risk* | Residential Units at Risk | | Commercial Units at Risk | | |
| | | # Units | \$ Value** | # Units | \$ Value** | \$ Potential Revenue Loss*** |
| Brigham City | 164 | 51 | 4,049,696 | 3 | 1,609,380 | 2,636,841 |
| Corinne | 145 | 45 | 2,237,880 | 0 | 0 | 0 |
| Honeyville | 64 | 20 | 1,143,866 | 0 | 0 | 0 |
| Mantua | 6 | 2 | 54,000 | 0 | 0 | 0 |
| Perry | 19 | 6 | 1,011,260 | 2 | 3,641,400 | 1,757,894 |
| Willard | 48 | 15 | 1,484,160 | 0 | 0 | 0 |
| Unincorporated | 515 | 160 | 11,950,212 | 4 | 862,000 | 3,515,788 |
| Bear River | Not participating in NFIP - No Floodplain Data (See Appendix ?) | | | | | |
| Deweyville | Not participating in NFIP - No Floodplain Data (See Appendix ?) | | | | | |
| Elwood | Not participating in NFIP - No Floodplain Data (See Appendix ?) | | | | | |
| Fielding | Not participating in NFIP - No Floodplain Data (See Appendix ?) | | | | | |
| Garland | Not participating in NFIP - No Floodplain Data (See Appendix ?) | | | | | |
| Howell | Not participating in NFIP - No Floodplain Data (See Appendix ?) | | | | | |
| Plymouth | Not participating in NFIP - No Floodplain Data (See Appendix ?) | | | | | |

| | |
|--|--|
| Portage | Not participating in NFIP - No Floodplain Data (See Appendix ?) |
| Snowville | Not participating in NFIP - No Floodplain Data (See Appendix ?) |
| Tremonton | Not participating in NFIP - No Floodplain Data (See Appendix ?) |
| <p>Notes: All residential and commercial units and values were derived from Box Elder County parcel data.</p> <p>*Based on average persons per household for Box Elder County from 2000 Census data, which is 3.22. Numbers were adjusted for multi-family residential units accordingly.</p> <p>**Current Market Value</p> <p>***Derived from 2002 Survey of Business Owners for Box Elder County, US Census Bureau. Average firm receipts totaled \$878,947.</p> <p>Communities not listed do not have any residential or commercial potential losses according to this assessment.</p> | |

| Table 6-5: Box Elder County - Other Facilities at Risk from Flood | | | | | | |
|--|--|-------|-------|------------|------------|------------|
| Jurisdiction | Critical Facilities | Roads | | | Rail Lines | |
| | | Type | Miles | \$ Value* | Miles | \$ Value** |
| Brigham City | Brigham City Waste Treatment Facility (\$55 Million) | IH | 0.9 | 7,907,751 | 0.6 | 894,898 |
| | | SH | 0.2 | 921,744 | 0 | 0 |
| Corinne | None | SH | 0.8 | 4,684,254 | 0.02 | 30,221 |
| Honeyville | None | IH | 1.2 | 11,169,324 | 0.9 | 1,467,280 |
| Mantua | None | SH | 0.1 | 487,536 | 0 | 0 |
| Perry | None | SH | 0.1 | 573,834 | 0.1 | 109,606 |
| Willard | None | IH | 0.05 | 447,831 | 0.1 | 219,292 |
| | | SH | 0.1 | 600,912 | 0 | 0 |
| Unincorporated | None | IH | 2.6 | 22,962,843 | 5.0 | 7,914,412 |
| | | PLR | 0.7 | 3,988,698 | 0 | 0 |
| | | SH | 6.5 | 19,626,258 | 0 | 0 |
| Bear River | Not participating in NFIP - No Floodplain Data (See Appendix ?) | | | | | |
| Deweyville | Not participating in NFIP - No Floodplain Data (See Appendix ?) | | | | | |
| Elwood | Not participating in NFIP - No Floodplain Data (See Appendix ?) | | | | | |
| Fielding | Not participating in NFIP - No Floodplain Data (See Appendix ?) | | | | | |
| Garland | Not participating in NFIP - No Floodplain Data (See Appendix ?) | | | | | |
| Howell | Not participating in NFIP - No Floodplain Data (See Appendix ?) | | | | | |
| Plymouth | Not participating in NFIP - No Floodplain Data (See Appendix ?) | | | | | |
| Portage | Not participating in NFIP - No Floodplain Data (See Appendix ?) | | | | | |
| Snowville | Not participating in NFIP - No Floodplain Data (See Appendix ?) | | | | | |
| Tremonton | Not participating in NFIP - No Floodplain Data (See Appendix ?) | | | | | |
| <p>IH = Interstate Highway (6 lanes), SH = State Highway (4 lanes), PLR = Paved Local Roads (2 lanes)</p> <p>*Average building cost for roads = \$1.5 million per lane-mile (Utah's Unified Transportation Plan, 2007-2030, UDOT & Utah MPO's)</p> | | | | | | |

**Average building cost for rail lines = \$300.00 per foot, minimum, or \$1,584,000 per mile, minimum (Jim Marshall, Manager Special Projects Industry & Public, Union Pacific Railroad, Utah, personal communication)

Communities not listed do not have any potential losses according to this assessment.

Assessing Vulnerability: Analyzing Development Trends

As far as numerical growth is concerned, Brigham City and Tremonton will most likely add the most population to the county. Currently, Brigham City's main flood threat to new development is on the north and northwest section of town. South of 1500 N and west of 500 W is an area that has experienced recent growth and includes FEMA floodplain. Commercial/Industrial potential development areas which could be at risk from flooding include south of W. Forest Street along I-15 and surrounding freeway onramps. The Malad River runs through the east side of Tremonton, and new development seems to be encroaching closer to the floodplain. While older development seems to be sited a reasonable distance from the river, new development may continue to be constructed in areas prone to flooding.

Perry had the highest growth rate in the county in the past several years, and is expected to continue to grow at high rates. Some of this development, as well as in Willard, will probably be along the eastern benches. If this is the case, flooding risk could be an issue along the eastern drainages. In Perry, the Threemile Creek drainage could prove destructive to any structures that could eventually be built in that area. This property is along the east bench, which is consistently being developed along the Wasatch Front. The other area of future concern is east of Perry St. (1200 W.) in a flood prone area which crosses Davis St. This area is adjacent to recent development, and will most likely be built out in the future. Willard, as has been proven in the past, is susceptible to flooding and other hazards coming from the drainages to the east. These foothills could eventually be developed like much of the Wasatch Front as well. There are also wetland areas northwest of town which is near to recent development. Flooding could be an issue in these areas as well.

Elwood is currently in the process of funding a sewer system. When the system is complete, development will most likely come to the town at higher rates than in the past. Recently, homes have been built closer to the Bear River than in past years, creating more flood risk. Particularly on the east end of 9600 N., development is creeping towards the floodplain. In general, the Malad River and Bear River floodplains could pose the most risk to future development.

One unincorporated area that will most likely see high growth will be the south Willard area. Future residents may need to be cautious building along the eastern benches below Pearson's Canyon and other drainages, where there is already a new subdivision.

Another important aspect to consider with flood risk in Box Elder County is wildfire damage. When steep slopes along the east bench of the county are cleared of vegetation by wildfire, flooding and mud slides/earth flows can threaten the life and property of residents, not to mention the infrastructure and emergency access issues that could arise.



BOX ELDER COUNTY WILDFIRES

Background

The vast geographic majority of Box Elder County has minimal threat to life and property from wildfire. However, the most populated areas are at the most risk from wildfire. Much of the development in the county is at the base of the Willard and Wellsville Mountain Ranges. These steep slopes are dry and vulnerable to wildfire, which poses great risk to residents along the benches. Most of western Box Elder County consists of dry land vegetation types which are vulnerable to wildfire. While threats to life and property are not as high in these areas, grazing vegetation loss and wildlife habitat can suffer tremendously. See the “Wildfire Hazard” map on page 106.

History of Wildfires in Box Elder County

Major fires in Box Elder County include the “Wildcat”, “Fort Ranch”, “Thiokol”, “Pilot Peak”, “Dry Canyon”, “Morris Ranch”, and “West Hills” fires. In 1992 a large fire burned uncontained for over a week in the mountains above Perry City. There have also been several fires along the east slopes above Brigham City as well. In 2002 there was also a large wildfire in the Promontory area. In August, 2006, there was a wild fire near the Brigham City/Perry border that burned approximately 100 acres. The following graphic illustrates the number, general size, and general location of wildfires in Box Elder County from 1973 to 2008.

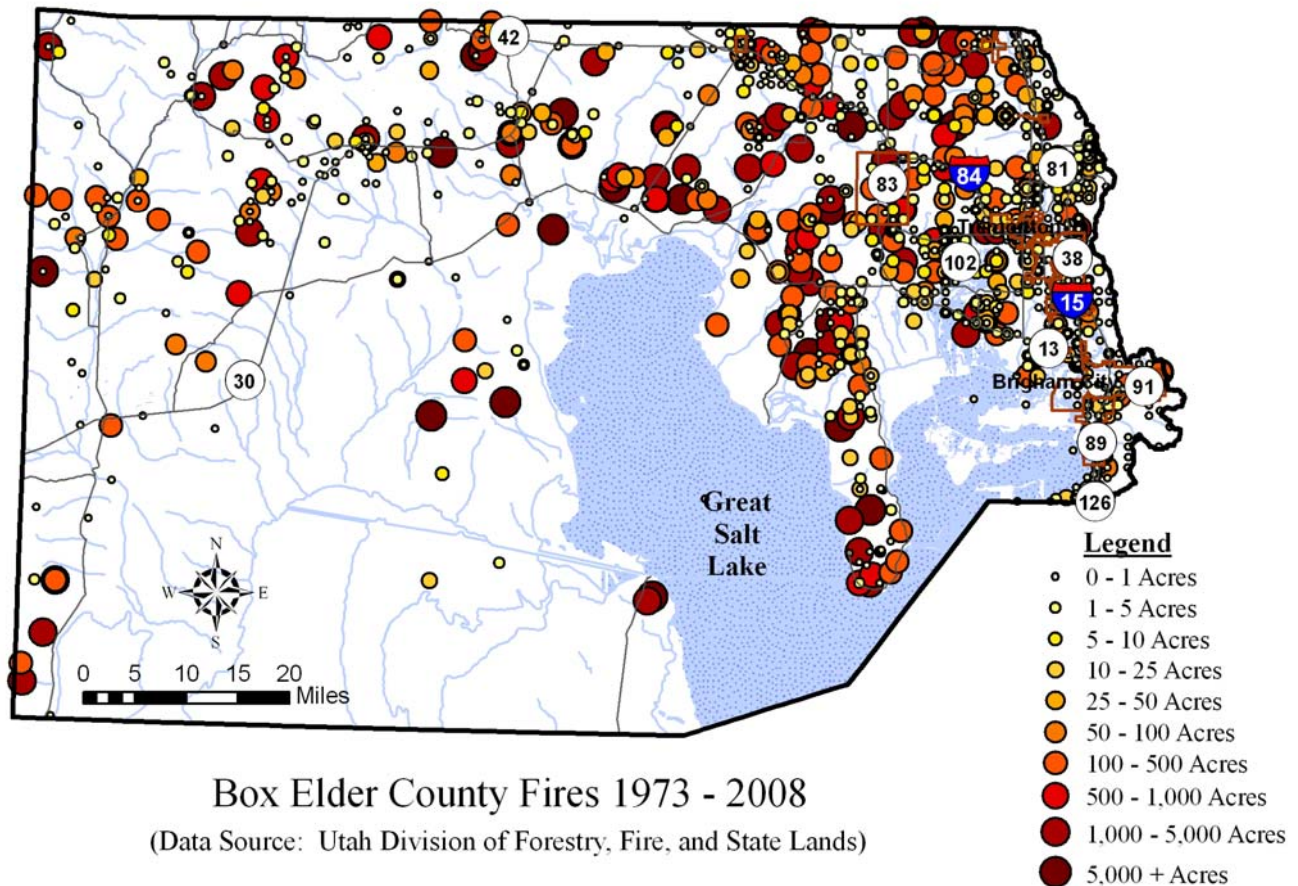


Table 6-6: Box Elder County Wildfire Hazard Assessment: Hazard Profile

| | |
|--|---|
| Frequency | Annually to some extent |
| Severity | Severe |
| Location | Dispersed throughout the whole county |
| Seasonal Pattern | Generally the worst from early July to mid September (depends on drought conditions) |
| Duration | A few hours to two weeks |
| Speed of Onset | 1-6 hours |
| Probability of Future Occurrences | Very High (Since 1973, there has been an average of more than two wildfires per year that burned 1,000 acres or more) |

In general, **Willard, Perry, Brigham City, Honeyville, Deweyville,** and **unincorporated areas** with housing along the eastern foothills of the Wellsville and Willard mountain ranges are at high risk from wildfire. Areas of specific concern in unincorporated areas along the bench include south Willard, between Brigham City and Honeyville, north of Deweyville, and west of Fielding from Cutler Dam to Sleepy Hollow. Other unincorporated areas include structures scattered throughout the Park Valley and Grouse Creek areas, and generally throughout fire risk areas in the rest of the county. Many of these are spread across remote areas.

There are a few units at risk from wildfire in and near to the northwest section of **Tremonton** on the hillsides.

Mantua has several structures at risk on the west side of Highway 89-91, and on the south end of municipal boundaries as well.

On the south side of **Snowville**, several structures are in high risk wildfire areas.

Assessing Vulnerability: Identifying Assets & Estimating Losses

Table 6-7: Box Elder County Residential and Commercial Development at Risk from Wildfire

| Jurisdiction | ~Residents at Risk* | Residential Units at Risk | | Commercial Units at Risk | | |
|----------------|---------------------|---------------------------|------------|--------------------------|------------|------------------------------|
| | | # Units | \$ Value** | # Units | \$ Value** | \$ Potential Revenue Loss*** |
| Brigham City | 370 | 115 | 9,503,434 | 3 | 859,680 | 2,636,841 |
| Deweyville | 48 | 15 | 780,350 | 0 | 0 | 0 |
| Honeyville | 74 | 23 | 1,528,322 | 0 | 0 | 0 |
| Mantua | 13 | 4 | 656,640 | 0 | 0 | 0 |
| Perry | 167 | 52 | 7,506,630 | 0 | 0 | 0 |
| Snowville | 3 | 1 | 39,081 | 1 | 610,400 | 878,947 |
| Tremonton | 16 | 5 | 200,196 | 0 | 0 | 0 |
| Willard | 126 | 39 | 3,650,182 | 0 | 0 | 0 |
| Unincorporated | 918 | 285 | 26,157,322 | 3 | 781,800 | 2,636,841 |

Notes: All residential and commercial units and values were derived from Box Elder County parcel data.

*Based on average persons per household for Box Elder County from 2000 Census data, which is 3.22. Numbers were adjusted for multi-family residential units accordingly.

**Current Market Value. Mean (average) current market values were used for structures where values were absent. Values were based on means for each respective building type, i.e. duplex, single family residential, townhouse, etc.

***Derived from 2002 Survey of Business Owners for Box Elder County, US Census Bureau. Average firm receipts totaled \$878,947.

Communities not listed do not have any potential residential or commercial losses according to this assessment.

Table 6-8: Box Elder County - Other Facilities at Risk from Wildfire

| Jurisdiction | Critical Facilities | Roads | | | Rail Lines | |
|----------------|---|-------|-------|-------------|------------|------------|
| | | Type | Miles | \$ Value* | Miles | \$ Value** |
| Brigham City | None | IH | 1.9 | 17,123,508 | 1.0 | 1,573,330 |
| | | SH | 2.5 | 14,963,976 | | |
| Deweyville | None | SH | 0.1 | 572,976 | 0 | 0 |
| Honeyville | None | SH | 0.5 | 2,876,688 | 0 | 0 |
| Howell | None | IH | 1.5 | 13,123,953 | 0 | 0 |
| | | SH | 0.2 | 1,074,288 | | |
| Mantua | None | SH | 0.5 | 3,262,320 | 0 | 0 |
| Snowville | None | IH | 1.0 | 9,004,383 | 0 | 0 |
| | | PLR | 0.1 | 233,901 | | |
| Tremonton | None | IH | 0.3 | 2,653,560 | 0 | 0 |
| Willard | Willard Police Department and Willard Fire Department | SH | 0.1 | 585,006 | 0 | 0 |
| Unincorporated | Grouse Creek Fire Station | IH | 24.5 | 220,244,868 | 52.8 | 83,638,914 |
| | | PLR | 16.1 | 48,197,820 | | |
| | | SH | 78.0 | 468,003,858 | | |

IH = Interstate Highway (6 lanes), SH = State Highway (4 lanes), PLR = Paved Local Roads (2 lanes)
 *Average building cost for roads = \$1.5 million per lane-mile (Utah's Unified Transportation Plan, 2007-2030, UDOT & Utah MPO's)
 **Average building cost for rail lines = \$300.00 per foot, minimum, or \$1,584,000 per mile, minimum (Jim Marshall, Manager Special Projects Industry & Public, Union Pacific Railroad, Utah, personal communication)

Communities not listed do not have any potential losses according to this assessment.

Assessing Vulnerability: Analyzing Development Trends

Areas that have the greatest risk from wildfire are often the most desirable places to live. These places afford residents good views, access to public lands, open space and a connection with nature. Most jurisdictions have found it difficult to restrict, limit or modify development proposals for these areas.

In terms of future development trends, Brigham City, Perry, Willard, south Willard, Mantua, and possibly Honeyville and Deweyville will likely see the most growth pressure in these wildfire

prone areas. As these areas continue to grow, development pressure will likely increase on the margins of town and the trend will likely be to develop higher on the foothills. Some of this risk is moderated by the presence of U.S. Forest Service land that will set some bounds on this trend in certain areas



BOX ELDER COUNTY LANDSLIDES

Background

Most of the landslide risk in Box Elder County is in Willard, Honeyville, and Perry. Unincorporated areas on the east foothills north of Brigham City and in south Willard are also in high landslide susceptibility areas. Willard and Honeyville could be substantially at risk if landslide events occurred. Most of the developed areas in these two municipalities are in what the Utah Geological Survey has designated as high landslide susceptibility areas in a 2007 dataset. Floods and high water content in soils can also potentially increase damages caused by landslides, and communities should be aware of future potential risks. **See the “Landslide Potential” map on page 107.**

History of Landslides in Box Elder County

| Table 6-9: Historical Box Elder County Landslides 1850-1978 (incomplete) | | | |
|---|---|--------------|---|
| Year | Location | Type | Description |
| Recent | Honeyville | Rock Fall | |
| Recent | North of Mantua | Rock Fall | On Highway 89-91 |
| 1983 | Near Facer Creek | Landslide | North of Willard |
| 1983-84 | Three Mile Canyon near Perry | Mud Slide | Over \$1 Million detention basin and overflow facilities were constructed as a result |
| 1958 | Sleepy Hollow near Fielding | Debris Flow | Debris converged at Beaver Dam and flowed into residential zones |
| 1949 | Perry | Debris Flow | Rocks and silt up to three ft. deep deposited on the roads |
| 1937 | Brigham Canyon | Debris Flow | One inch of rain fell in 30 minutes |
| 1936 | Willard Canyon | Debris Flow? | Seven homes were partially buried |
| 1931 | Collinston | Debris Flow | Occurred near irrigation canal |
| 1923 | Willard and Perry Canyons | Debris Flow | Cloudbursts? |
| 1919 | Garland | Debris Flow | Several inches of mud covered crops |
| 1899 | Willard | Debris Flow | Rocks, debris, and slime covered fields |
| 1897 | Bear River Canyon | Rock Fall | Rock fall struck train trestle and split it in two |
| 1890 | Bothwell Canyon in or near Brigham City | Landslide | Saturated ground and blasting in the area could have caused the landslide |
| 1890 | Bear River Canal near Collinston | Landslide | Occurred on the canal two and a half miles north of Collinston |
| Sources: Elliott and Kirschbaum, 2007, and the Box Elder County Working Group Risk Assessment Meeting, 7/15/08. | | | |

Landslide events in Box Elder County have been known to damage homes, roads, and even take lives.

Debris flows associated with the 1923 flooding of Willard City were very destructive and destroyed a number of homes and buildings. Main Street Willard was covered in a thick layer of mud, rocks and debris. The force was strong enough to move large boulders.

In 1949 a five mile stretch of U.S 89 between South Willard and Utah Hot Springs was covered with mud, rocks and boulders.

In late May 1983 a large landslide occurred on the face of the mountain north of Willard near Facer Creek. Also in 1983-84 Three Mile Canyon near Perry City experienced a mud slide. As a result over \$1 Million was spent constructing a detention basin and overflow facilities.

Recent rock falls have also occurred north of Mantua along Highway 89-91, and near Honeyville.

The Perry to south Willard area along the base of the Willard Mountains has had ongoing problems with debris flows, landslides and flash flooding. A number of debris basins have been constructed as well as other debris flow management structures. Portions of the Ogden-Brigham Canal susceptible to debris flow blockage have been placed in culverts to avoid flooding.

Table 6-10: Box Elder County Landslide Hazard Assessment: Hazard Profile

| | |
|--|--|
| Frequency | Annually to some extent |
| Severity | Sever |
| Location | Dispersed throughout the whole county, but mostly in the mountains on the east and northwest ends of the county. |
| Seasonal Pattern | Generally the worst from early July to mid September (depends on drought conditions) |
| Duration | A few hours to two weeks |
| Speed of Onset | 1-6 hours |
| Probability of Future Occurrences | Very High |

Brigham City is at minimal threat for landslides on residential or commercial land. There is one structure at risk east of Highway 89-91 at the base of Dunns Canyon. There is also landslide potential in Kotter Canyon on the north end of Brigham City.

Honeyville has high risk to landslides over most of the existing development in the center of town. Included in this is Honeyville School and extensive amounts of infrastructure. This landslide area extends all the way up to the bench on the east.

Several structures on the south end of **Perry** are in high landslide susceptibility areas. Several homes along Highway 89-91 could be affected by a landslide event.

Willard City has high landslide susceptibility for large sections of the developed town as well. Most of the town south of 100 South is at risk. This includes Willard School, a significant stretch of Highway 89-91, and city infrastructure. There are also structures on the north end of municipal boundaries on the east side of Highway 89-91 in high risk areas.

There are also 15 structures in the **unincorporated areas** of the county that are at risk from landslides. These are south of Willard, north of Brigham City, east of Plymouth, and west of Park Valley.

Assessing Vulnerability: Identifying Assets & Estimating Losses

| Table 6-11: Box Elder County Residential and Commercial Development at Risk from Landslides | | | | | | |
|--|---------------------|---------------------------|------------|--------------------------|------------|------------------------------|
| Jurisdiction | ~Residents at Risk* | Residential Units at Risk | | Commercial Units at Risk | | |
| | | # Units | \$ Value** | # Units | \$ Value** | \$ Potential Revenue Loss*** |
| Brigham City | 3 | 1 | 27,500 | 0 | 0 | 0 |
| Honeyville | 506 | 157 | 12,830,170 | 0 | 0 | 0 |
| Perry | 35 | 11 | 1,403,850 | 0 | 0 | 0 |
| Willard | 821 | 255 | 21,471,100 | 2 | 64,500 | 1,757,894 |
| Unincorporated | 48 | 15 | 1,551,840 | 0 | 0 | 0 |

Notes: All residential and commercial units and values were derived from Box Elder County parcel data.
 *Based on average persons per household for Box Elder County from 2000 Census data, which is 3.22.
 **Current Market Value. Mean (average) current market values were used for structures where values were absent. Values were based on means for each respective building type, i.e. duplex, single family residential, townhouse, etc.
 ***Derived from 2002 Survey of Business Owners for Box Elder County, US Census Bureau. Average firm receipts totaled \$878,947.

Communities not listed do not have any potential residential or commercial losses according to this assessment.

| Table 6-12: Box Elder County - Other Facilities at Risk from Landslides | | | | | | |
|--|---------------------|-------|-------|-----------|------------|------------|
| Jurisdiction | Critical Facilities | Roads | | | Rail Lines | |
| | | Type | Miles | \$ Value* | Miles | \$ Value** |
| Honeyville | Honeyville School | SH | 0.7 | 4,089,930 | 0.2 | 270,902 |
| Mantua | None | SH | 0.2 | 1,480,338 | 0 | 0 |
| Perry | None | SH | 0.3 | 1,569,312 | 0 | 0 |
| Willard | Willard School | SH | 0.7 | 3,961,416 | 0 | 0 |
| Unincorporated | None | SH | 0.8 | 4,997,256 | 0 | 0 |

IH = Interstate Highway (6 lanes), SH = State Highway (4 lanes), PLR = Paved Local Roads (2 lanes)
 *Average building cost for roads = \$1.5 million per lane-mile (Utah's Unified Transportation Plan, 2007-2030, UDOT & Utah MPO's)
 **Average building cost for rail lines = \$300.00 per foot, minimum, or \$1,584,000 per mile, minimum (Jim Marshall, Manager Special Projects Industry & Public, Union Pacific Railroad, Utah, personal communication)

Communities not listed do not have any potential losses according to this assessment.

Assessing Vulnerability: Analyzing Development Trends

Willard could see more development in the future to the east of the main town. These homes could be at risk of landslide. Also, east of Highway 89-91 in northern Willard and southern Perry there are large landslide risk areas covering the foothills which could also potentially be developed in the future.

On the east end of Honeyville, the large landslide risk area discussed previously includes the foothills. Development could easily continue north of the gravel pit where there are already roads and some structures.



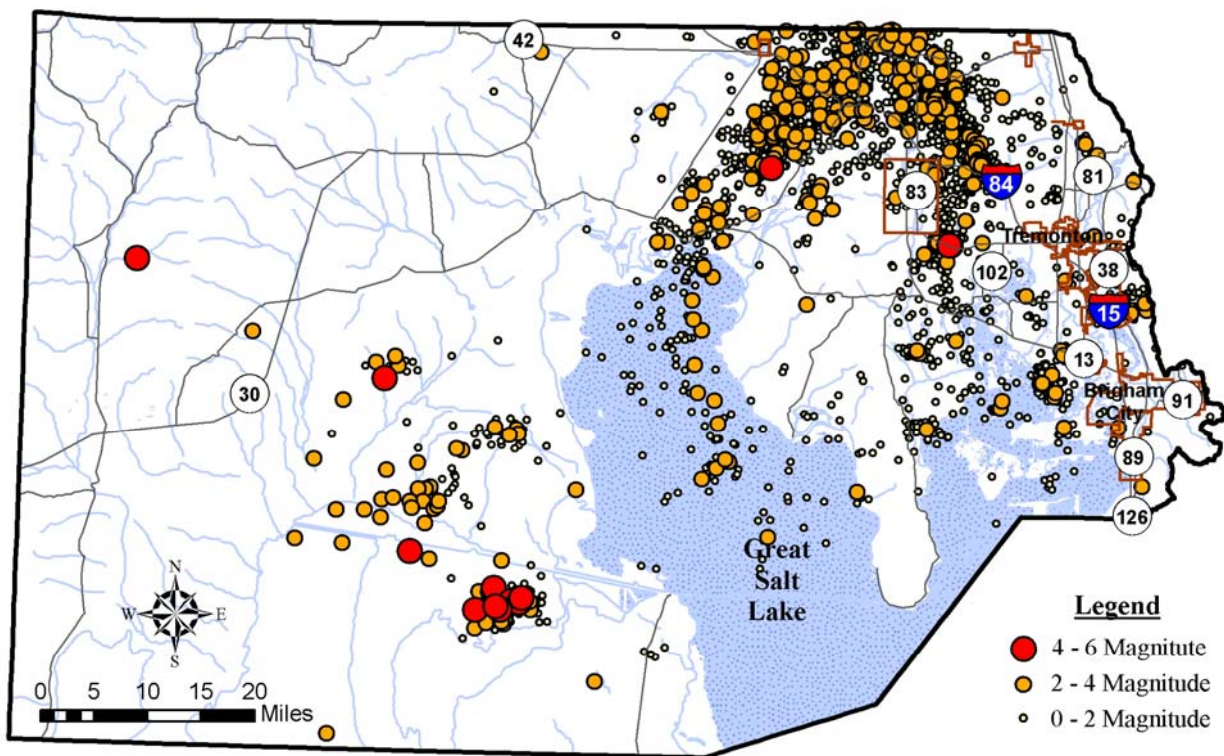
BOX ELDER COUNTY EARTHQUAKES

Background

The most populated portions of Box Elder County are located on the Intermountain Seismic Belt and the northern most segment of the Wasatch Fault. Earthquakes are common in Box Elder County, although no major earthquake resulting in significant property damage has occurred since early European settlement. Geologic evidence establishes the possibility of a major earthquake in Box Elder County. See the “Geological Faults” and “Liquefaction Potential” maps on pages 108 and 109.

History of Earthquakes in Box Elder County

The 1934 Hansel Valley Earthquake (6.54 magnitude) is widely regarded as the state’s largest earthquake in modern recorded history. Four aftershock earthquakes occurred ranging from 4.8 to 6.1 magnitudes. The epicenter was in a largely unpopulated portion of the county and little or no property damage occurred. This earthquake resulted in surface fault rupture. In 1909 a 6.0 magnitude earthquake also occurred in the Hansel Valley. More recently, an earthquake of 3.9 magnitude occurred near Tremonton on September 1, 2007. This earthquake damaged a historic structure in Tremonton which had to be demolished.



Box Elder County Earthquakes 1962 - 2001

(Data Source: AGRC)

Table 6-13: Box Elder County Earthquake Hazard Assessment: Hazard Profile

| | |
|--|--|
| Frequency | Low magnitude events occur frequently. Larger magnitude events are rare (although not necessarily on geologic time). |
| Severity | Potentially Catastrophic |
| Location | Entire County with highest frequency north of the Great Salt Lake. Surface fault ruptures are likely to occur in fault zones and liquefaction would impact most of the populated county. |
| Seasonal Pattern | None |
| Duration | A few minutes with potential aftershocks |
| Speed of Onset | No warning |
| Probability of Future Occurrences | Based on 1962-2001 data, there is a 35.9% chance every year of an earthquake of 4.0 magnitude or greater. |

Much of the populated corridor in Box Elder County is located near the Wasatch Fault. According to Hecker (1992), the Wasatch Fault Zone is the longest and most active normal fault in Utah. The Wasatch Fault extends from south of Malad, Idaho to western Sanpete County in Utah, much along the populated Wasatch Front. Ten distinct segments have been identified along the fault.

Based on geologic evidence of the last 6000 years, of all the studied segments of the Wasatch Fault, the Brigham City segment is the most overdue for seismic release. This segment exists along much of the populated areas of the eastern side of the county. Evidence suggests that it has been at least 3,000 years since a significant release has occurred on the Brigham City fault segment. All the other studied segments of the fault indicate faulting in the last 3000 years which suggests these segments have had release of seismic energy (Hecker, 1992).

While a geological fault may not be very wide physically, damage around the fault can be detrimental. This is often referred to as the “damage zone (Susanne Janecke, personal communication, 9/25/08).” This damage zone is now thought to be much larger than recognized previously. While geologists used to recommend a general fault buffer of fifty feet on either side of the fault, they now recognize a much larger damage zone. According to the Utah Geological Survey, up thrown sides of well defined quaternary faults require planning for a 250 foot damage zone; while down thrown sides of well defined faults require planning for a 500 foot damage zone. For those faults not well defined, a general 1,000 foot damage zone should be considered (Richard Giraud, personal communication, 10/6/08; Christopher Duross, personal communication, 10/30/08; Christensen et al., 2003). Because of data and time limitations in this plan, a standard 500 foot damage zone was analyzed for well defined quaternary faults, and a standard 1,000 foot damage zone was analyzed for those faults that are not well defined.

One very important aspect of earthquake damage which is often overlooked is liquefaction. Liquefaction generally occurs when certain soil types when saturated with water can liquefy during an earthquake, moving, tilting, and destroying buildings. Whole foundations can be lifted and moved by the saturated soils. Eastern Box Elder County is largely covered by moderate-high to high liquefaction potential; especially in the lower elevation areas.

Moderate-high to high liquefaction potential presents risk for every commercial and residential structure in **Bear River City**.

Brigham City is probably the most at risk from geological fault zone damage than any other municipality, due to its large population found along the Wasatch Fault. On 500 West, from about the Brigham City Community Hospital to 500 North on both sides of the road, there are many structures in the potential damage zone. On the east of Brigham City, there are also structures east of N. Highland Blvd, from Bywater Way north to 900 North which are in the damage zone as well. Interestingly, Brigham City growth patterns tend to shy away from liquefaction potential areas. These areas are on the western and northern edges of the developed parts of the city. However, there are still about 400 structures in these liquefaction potential areas on the western and northern edges of town.

Corinne is also completely covered by moderate-high to high liquefaction potential.

While **Deweyville** does have several parcels with structures that intersect fault damage zones, the faults are mostly in the foothills east of town. It does not appear that there are any structures at serious risk. However, most of the development in town is susceptible to moderate-high to high liquefaction, with the exception of several structures on the eastern edge.

Moderate-high to high liquefaction potential could threaten every resident and structure in the town of **Elwood**.

In **Honeyville**, there are about 20 structures in the fault damage zones. These are primarily along Highway 38 on both sides of the road from just north of 8800 North to 7820 North.

Most of **Fielding** is at risk for liquefaction, threatening most structures and their occupants.

Most of **Garland** is at risk for liquefaction, with the exception of the very eastern edge.

Most of the structures along Highway 38 in **Honeyville** are susceptible to liquefaction. However, with the exception of the western edge of the main town, most of the main town is not at risk. There is also some development on the north end of the municipal boundaries that is not at risk.

Perry could suffer some serious losses in the event of an earthquake as well. From Perry Street and about 2500 South to about 1850 South on the west side of Highway 89, including some recent development, could be at risk during an earthquake. Several dozen structures along 3275 St. and west of 1200 West are also at risk. Also, there are a few homes on the east bench in Perry that could be at risk. The western edge of the developed areas in Perry are beginning to encroach more into liquefaction potential areas. The city currently has about 230 structures currently at risk from liquefaction.

Plymouth has several piped drains (field drains) running through town that provide drainage during high rainfall events and/or spring runoff. These drains run west of 5100 West and East of 5000 West and are in need of repair in order to prevent the flooding of nearby residences. Some

flooding of residences occurred in town in the early 1980's. These drains, as well as culinary water pipes and utility lines, are at risk for being severed during an earthquake, causing flooding and other issues. These lines generally run underneath the streets of the town.

Nearly all of **Tremonton City** lies within moderate-high to high liquefaction zones. The exception to this is on the northwestern side across the freeway (north of the canal near 12000 North). Downtown and commercial/industrial areas could be damaged and people at risk from liquefaction during a large magnitude earthquake.

While **Willard** does have fault zones on the east and the northwest, most development seems to be fairly safe from fault damage zones. Several structures could be at risk, but most of the property in the damage zones seems to be agricultural. There is risk to structures from liquefaction in Willard. However, most of the older structures in town and along the highway north of town are out of high risk areas. South of town along the highway there are structures at risk, and also west of the highway and town center. Willard has about 140 structures in moderate-high to high liquefaction areas.

In **unincorporated areas** of the county, there are also fault damage zones which may include structures as well. Between Brigham City and Honeyville, on the east side of Highway 38, there are about a dozen structures which could be damaged. The Collingston area also has several structures in the fault damage zone east of 3100 West. There are also two structures that could sustain damage west of Howell. South of south Willard, near the mobile home park, where Highways 126 and 89-91 merge, there are also several homes in fault zone risk areas. Since moderate-high to high liquefaction zones cover most of the eastern populated area in Box Elder County, potential losses could be highest in unincorporated areas. About 1,388 structures are at risk in these areas. Most of south Willard is at risk, and scattered development between Brigham City, Corinne, Honeyville, Bear River City, Elwood, Tremonton, Garland, Deweyville, and Fielding are all at risk for liquefaction. Data for liquefaction was only collected to about mid-way through the Great Salt Lake running north to the Idaho border. Anything west of that line, such as Howell, Snowville, and the Park Valley and Grouse Creek areas do not have any liquefaction data.

Assessing Vulnerability: Identifying Assets & Estimating Losses

Table 6-14: Box Elder County Residential and Commercial Development at Risk in Geological Fault Damage Zones

| Jurisdiction | ~Residents at Risk* | Residential Units at Risk | | Commercial Units at Risk | | |
|----------------|---------------------|---------------------------|------------|--------------------------|------------|------------------------------|
| | | # Units | \$ Value** | # Units | \$ Value** | \$ Potential Revenue Loss*** |
| Brigham City | 1,945 | 604 | 44,635,719 | 5 | 517,600 | 4,394,735 |
| Deweyville | 6 | 2 | 115,610 | 0 | 0 | 0 |
| Honeyville | 64 | 20 | 1,470,228 | 0 | 0 | 0 |
| Perry | 544 | 169 | 20,720,430 | 1 | 1,630,700 | 878,947 |
| Willard | 26 | 8 | 694,026 | 0 | 0 | 0 |
| Unincorporated | 225 | 70 | 6,173,848 | 2 | 196,000 | 1,757,894 |

Notes: All residential and commercial units and values were derived from Box Elder County parcel data.

*Based on average persons per household for Box Elder County from 2000 Census data, which is 3.22. Numbers were adjusted for multi-family residential units accordingly.

**Current Market Value. Mean (average) current market values were used for structures where values were absent. Values were based on means for each respective building type, i.e. duplex, single family residential, townhouse, etc.

***Derived from 2002 Survey of Business Owners for Box Elder County, US Census Bureau. Average firm receipts totaled \$878,947.

Communities not listed do not have any potential residential or commercial losses according to this assessment.

Table 6-15: Box Elder County - Other Facilities at Risk in Geological Fault Damage Zones

| Jurisdiction | Critical Facilities | Roads | | | Rail Lines | |
|----------------|--|-------|-------|------------|------------|------------|
| | | Type | Miles | \$ Value* | Miles | \$ Value** |
| Brigham City | Brigham City Community Hospital, Box Elder High School, Brigham City Emergency Services facility (\$5 Million) | SH | 0.8 | 4,620,906 | 0.1 | 85,195 |
| Honeyville | None | SH | 1.0 | 6,021,204 | 0 | 0 |
| Perry | None | IH | 0.1 | 633,789 | 1.8 | 2,815,026 |
| Willard | None | IH | 0.3 | 2,747,367 | 0.6 | 972,714 |
| Unincorporated | None | IH | 3.3 | 30,023,874 | 4.7 | 7,369,284 |
| | | SH | 1.7 | 10,383,342 | | |

IH = Interstate Highway (6 lanes), SH = State Highway (4 lanes), PLR = Paved Local Roads (2 lanes)

*Average building cost for roads = \$1.5 million per lane-mile (Utah's Unified Transportation Plan, 2007-2030, UDOT & Utah MPO's)

**Average building cost for rail lines = \$300.00 per foot, minimum, or \$1,584,000 per mile, minimum (Jim Marshall, Manager Special Projects Industry & Public, Union Pacific Railroad, Utah, personal communication)

Communities not listed do not have any potential losses according to this assessment.

Table 6-16: Box Elder County Residential and Commercial Development at Risk from Liquefaction

| Jurisdiction | ~Residents at Risk* | Residential Units at Risk | | Commercial Units at Risk | | |
|--------------|---------------------|---------------------------|------------|--------------------------|------------|------------------------------|
| | | # Units | \$ Value** | # Units | \$ Value** | \$ Potential Revenue Loss*** |
| Bear River | 847 | 263 | 17,428,420 | 0 | 0 | 0 |
| Brigham City | 1,114 | 346 | 26,797,509 | 62 | 21,170,168 | 54,494,714 |
| Corinne | 644 | 200 | 11,090,086 | 12 | 5,404,580 | 10,547,364 |
| Deweyville | 351 | 109 | 6,504,928 | 0 | 0 | 0 |
| Elwood | 895 | 278 | 23,942,074 | 3 | 934,000 | 2,636,841 |
| Fielding | 374 | 116 | 7,231,952 | 1 | 78,200 | 878,947 |
| Garland | 592 | 184 | 8,880,352 | 37 | 5,822,159 | 32,521,039 |
| Honeyville | 564 | 175 | 13,887,956 | 0 | 0 | 0 |

| | | | | | | |
|----------------|-------|-------|------------|-----|-------------|-------------|
| Perry | 725 | 225 | 24,775,758 | 5 | 8,750,400 | 4,394,735 |
| Tremonton | 2,183 | 678 | 39,461,078 | 173 | 122,799,531 | 152,057,831 |
| Willard | 441 | 137 | 14,159,512 | 3 | 498,400 | 2,636,841 |
| Unincorporated | 4,405 | 1,368 | 98,890,728 | 20 | 2,209,788 | 17,578,940 |

Notes: All residential and commercial units and values were derived from Box Elder County parcel data.

*Based on average persons per household for Box Elder County from 2000 Census data, which is 3.22. Numbers were adjusted for multi-family residential units accordingly.

**Current Market Value. Mean (average) current market values were used for structures where values were absent. Values were based on means for each respective building type, i.e. duplex, single family residential, townhouse, etc.

***Derived from 2002 Survey of Business Owners for Box Elder County, US Census Bureau. Average firm receipts totaled \$878,947.

Communities not listed do not have any potential residential or commercial losses according to this assessment.

| Table 6-17: Box Elder County - Other Facilities at Risk from Liquefaction | | | | | | |
|--|---|--------------|--------------|------------------|-------------------|-------------------|
| Jurisdiction | Critical Facilities | Roads | | | Rail Lines | |
| | | Type | Miles | \$ Value* | Miles | \$ Value** |
| Bear River | Century Elementary School | SH | 2.2 | 13,363,866 | 0 | 0 |
| Brigham City | Box Elder County Sheriff, Discovery Elementary School, Brigham City Public Works/Fleet Management Yard, Waste Treatment Facility (\$80 Million) | IH | 4.0 | 36,434,349 | 8.9 | 14,083,140 |
| | | SH | 2.7 | 16,423,668 | | |
| Corinne | Corinne Fire Station, Corinne Elementary School | SH | 3.1 | 18,802,278 | 3.6 | 5,770,401 |
| Deweyville | None | SH | 2.9 | 17,336,724 | 4.2 | 6,666,681 |
| Elwood | None | IH | 2.9 | 26,231,553 | 3.5 | 5,495,313 |
| | | SH | 3.8 | 22,984,296 | | |
| Fielding | Fielding Fire Station, Fielding Elementary School | PLR | 0.2 | 743,391 | 0 | 0 |
| | | SH | 0.9 | 5,125,224 | | |
| Garland | Garland Police Department, Garland Fire Department, Bear River Middle School, Bear River High School, North Community High School | IH | 0.5 | 4,821,678 | 3.6 | 5,654,067 |
| | | SH | 0.1 | 328,644 | | |
| Honeyville | Honeyville Fire Station | IH | 3.7 | 33,693,831 | 7.3 | 11,621,900 |
| | | SH | 1.7 | 9,993,228 | | |
| Perry | None | IH | 3.0 | 26,660,592 | 5.5 | 8,632,928 |
| | | SH | 0.4 | 2,130,222 | | |
| Tremonton | Bear River Valley Hospital, Tremonton Police | IH | 3.1 | 28,047,123 | 5.1 | 8,024,706 |

| | | | | | | |
|--|---|-----|------|-------------|------|------------|
| | Department, Tremonton Fire Department, Harris Intermediate School, North Park Elementary School, McKinley Elementary School | PLR | 0.5 | 1,363,566 | | |
| | | SH | 4.0 | 23,942,784 | | |
| Willard | Willard Police Department, Willard Fire Department | IH | 3.5 | 31,773,654 | 6.6 | 10,521,223 |
| | | SH | 0.8 | 4,596,696 | | |
| Unincorporated | None | IH | 12.3 | 110,390,193 | 45.6 | 72,216,076 |
| | | PLR | 9.0 | 26,902,128 | | |
| | | SH | 43.4 | 260,157,276 | | |
| <p>IH = Interstate Highway (6 lanes), SH = State Highway (4 lanes), PLR = Paved Local Roads (2 lanes)</p> <p>*Average building cost for roads = \$1.5 million per lane-mile (Utah's Unified Transportation Plan, 2007-2030, UDOT & Utah MPO's)</p> <p>**Average building cost for rail lines = \$300.00 per foot, minimum, or \$1,584,000 per mile, minimum (Jim Marshall, Manager Special Projects Industry & Public, Union Pacific Railroad, Utah, personal communication)</p> <p>Communities not listed do not have any potential losses according to this assessment.</p> | | | | | | |

Box Elder County HAZUS MH Analysis

HAZUS MH 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 MH is to provide a methodology and software application to develop earthquake and flood losses at a regional scale. These loss estimates can be used 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 model that was used simulates a 2,500 year event with an earthquake magnitude of 7.0. Below are some of the results from the model for Box Elder County:

Table 6-18: HAZUS MH Casualties

Casualties Summary Report

October 24, 2008

| | Injury Severity Level | | | | |
|-------------------------------|-----------------------|------------|------------|------------|------------|
| | Severity 1 | Severity 2 | Severity 3 | Severity 4 | Total |
| Box Elder | | | | | |
| Casualties - 2am | | | | | |
| <i>Commuting</i> | 0 | 0 | 0 | 0 | 0 |
| <i>Commercial</i> | 2 | 1 | 0 | 0 | 3 |
| <i>Educational</i> | 0 | 0 | 0 | 0 | 0 |
| <i>Hotels</i> | 1 | 0 | 0 | 0 | 2 |
| <i>Industrial</i> | 5 | 2 | 0 | 0 | 7 |
| <i>Other-Residential</i> | 77 | 19 | 2 | 4 | 102 |
| <i>Single Family</i> | 282 | 74 | 10 | 20 | 387 |
| Total Casualties - 2am | 367 | 96 | 13 | 25 | 502 |
| Casualties - 2pm | | | | | |
| <i>Commuting</i> | 1 | 1 | 1 | 0 | 3 |
| <i>Commercial</i> | 175 | 54 | 9 | 18 | 255 |
| <i>Educational</i> | 106 | 32 | 6 | 11 | 154 |
| <i>Hotels</i> | 0 | 0 | 0 | 0 | 0 |
| <i>Industrial</i> | 38 | 11 | 2 | 4 | 54 |
| <i>Other-Residential</i> | 15 | 4 | 0 | 1 | 20 |
| <i>Single Family</i> | 58 | 15 | 2 | 4 | 79 |
| Total Casualties - 2pm | 392 | 117 | 20 | 37 | 567 |
| Casualties - 5pm | | | | | |
| <i>Commuting</i> | 11 | 15 | 25 | 5 | 56 |
| <i>Commercial</i> | 166 | 51 | 9 | 17 | 242 |
| <i>Educational</i> | 7 | 2 | 0 | 1 | 11 |
| <i>Hotels</i> | 0 | 0 | 0 | 0 | 1 |
| <i>Industrial</i> | 24 | 7 | 1 | 2 | 34 |
| <i>Other-Residential</i> | 29 | 7 | 1 | 2 | 38 |
| <i>Single Family</i> | 111 | 29 | 4 | 8 | 152 |
| Total Casualties - 5pm | 348 | 112 | 40 | 34 | 534 |

**Table 6-19:
HAZUS
MH**

Injury Classification Scale

| Injury Severity | Injury Description |
|-----------------|--|
| Severity 1 | Injuries requiring basic medical aid without requiring hospitalization |
| Severity 2 | Injuries requiring a greater degree of medical care and hospitalization, but not expected to progress to a life threatening status |
| Severity 3 | Injuries that pose an immediate life threatening condition if not treated adequately and expeditiously. The majority of these injuries are a result of structural collapse and subsequent collapse or impairment of the occupants. |
| Severity 4 | Instantaneously killed or mortally injured |

Injury Classification Scale. Source: FEMA HAZUS-MH MR3 User's Manual.

Table 6-20: HAZUS MH Building Damage

Building Damage by Count by General Occupancy

October 24, 2008

| | # of Buildings | | | | | Total |
|--------------------------|----------------|--------|----------|-----------|----------|--------|
| | None | Slight | Moderate | Extensive | Complete | |
| Box Elder | | | | | | |
| <i>Religion</i> | 1 | 3 | 6 | 5 | 4 | 19 |
| <i>Agriculture</i> | 2 | 4 | 6 | 4 | 3 | 18 |
| <i>Government</i> | 2 | 3 | 5 | 5 | 3 | 17 |
| <i>Industrial</i> | 6 | 9 | 22 | 20 | 15 | 72 |
| <i>Other Residential</i> | 67 | 189 | 384 | 343 | 225 | 1,209 |
| <i>Commercial</i> | 10 | 21 | 54 | 51 | 41 | 176 |
| <i>Single Family</i> | 1,806 | 3,617 | 4,246 | 1,380 | 730 | 11,780 |
| <i>Education</i> | 1 | 2 | 4 | 3 | 3 | 12 |

**Table 6-21: HAZUS MH Shelter Summary Report
Shelter Summary Report**

October 24, 2008

| | # of Displaced Households | # of People Needing Short Term Shelter |
|---------------------|------------------------------|---|
| Box Elder | 1,083 | 240 |
| Cache | 1,997 | 514 |
| Rich | 16 | 3 |
| Total | 3,096 | 757 |
| Region Total | 3,096 | 757 |

Table 6-22: HAZUS MH Transportation System Losses

Transportation System Dollar Exposure

October 24, 2008

All values are in thousands of dollars

| | Highway | Railway | Light Rail | Bus Facility | Ports | Ferries | Airport | Runway | Total |
|------------------|------------------|----------------|------------|--------------|----------|----------|---------------|---------------|------------------|
| Box Elder | | | | | | | | | |
| Segments | 1,731,039 | 278,471 | 0 | | | | | | 2,009,510 |
| Bridges | 194,913 | 85 | 0 | | | | | | 194,999 |
| Tunnels | 0 | 0 | 0 | | | | | | 0 |
| Facilities | | 0 | 0 | 1,068 | 0 | 0 | 16,023 | 91,375 | 17,091 |
| Total | 1,925,952 | 278,556 | 0 | 1,068 | 0 | 0 | 16,023 | 91,375 | 2,312,975 |

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Study Region : Bear River Region

Scenario : Bear River Region Mag. 7 EQ

Table 6-23: HAZUS MH Utility System Losses

Utility System Dollar Exposure

October 24, 2008

All values are in thousands of dollars

| | Potable Water | Waste Water | Oil Systems | Natural Gas | Electric Power | Communication | Total |
|------------------|----------------|----------------|-------------|---------------|----------------|---------------|----------------|
| Box Elder | | | | | | | |
| Facilities | 0 | 261,072 | 0 | 0 | 0 | 490 | 261,562 |
| Pipelines | 152,175 | 91,305 | 0 | 60,870 | | | 304,350 |
| Total | 152,175 | 352,377 | 0 | 60,870 | 0 | 490 | 565,912 |

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Study Region : Bear River Region

Page : 1 of 1

Scenario : Bear River Region Mag. 7 EQ

Assessing Vulnerability: Analyzing Development Trends

The development trend for many cities in eastern Box Elder County has been to build further up in the foothills of the Wellsville and Willard Mountains. As cities “build-out,” this trend will likely continue. This new development will be exposed to the risk associated with potentially unstable slopes or surface fault rupture in the event of an earthquake. In Perry, if new development continues to follow current growth patterns, many more residents could be at risk in geological fault zones. Neighborhoods on the southwest and west of town are continuing to grow in the middle of these fault zones. In Brigham City, as infill occurs on the west side of town, more structures could likely be placed in harm’s way. On the northeast of town, north of the gravel pit, as development continues to creep up the hillsides, people could be put at risk as well. On the north side of Honeyville, as development fills in along Highway 38 near existing development, potential losses could increase.

Liquefaction will continue to be one of the major risks for eastern Box Elder County residents. While several towns are completely built on moderate-high to high liquefaction zones, some jurisdictions could still manage growth in ways that reduce risks. Brigham City, Perry, Willard, Deweyville, Honeyville, and Box Elder County are some of those that can still plan for growth in ways that save lives, property, and revenue. Brigham City, Perry, and Willard are similar with their growth patterns, in that the major development has taken place east of the high liquefaction zones. However, if these cities continue to build to the west, as they have recently, more people

could be at risk. Deweyville and Honeyville have homes scattered throughout the high risk areas west of their main town centers as well, but structures seem to be scattered among farms and large lots. As farmers sell their property, subdivisions would add higher density in liquefaction risk areas. South Willard and between Brigham City and Honeyville could have similar development patterns, where as land is subdivided higher densities could mean more people at risk.



BOX ELDER COUNTY DAM FAILURE

Background

There are 297 active dams located in Box Elder County. Most of these dams are small detention ponds or livestock watering facilities and most pose a minimal threat to human safety or property.

Of the 297 active dams, 259 are designated as “low hazard” by the State of Utah Division of Water Rights. As defined by state statute, low hazard dams are those dams which, if they fail, would cause minimal threat to human life, and economic losses would be minor or limited from damage sustained.

A total of 7 dams have been designated as “moderate hazard” by the State of Utah in Box Elder County. Moderate Hazard dams which, if they fail, have a low probability of causing loss of human life, but would cause appreciable property damage including damage to public utilities.

The State of Utah has rated 4 dams in Box Elder County as “high hazard” which means that, if they fail, have a high probability of causing loss of human life or extensive economic loss, including damage to critical public utilities.

Dam failure inundation maps and emergency action plans for each of the high risk dams can be found on the Utah Division of Water Right’s website at: <http://waterrights.utah.gov/cgi-bin/damview.exe?Startup>. See the “Dam Failure” map on page 110.

History of Dam Failure in Box Elder County

No significant dam failures have occurred in Box Elder County. However, A.V. Watkins Dam, on the east side of Willard Bay, did have some leakage occurring in November of 2006. A cement-bentonite wall was placed inside the dam to correct the problem. No damages below the dam were reported, but the repairs cost approximately \$17.4 million (<http://www.usbr.gov/uc/feature/avwatkins/index.html>).

Table 6-24: Box Elder County Dam Failure Hazard Assessment: Hazard Profile

| | |
|--|--|
| Frequency | Rare |
| Severity | Potentially Catastrophic |
| Location | Areas downstream of failed dam. |
| Seasonal Pattern | Anytime. Highest risk in spring during snowmelt. |
| Duration | A few hours |
| Speed of Onset | No warning |
| Probability of Future Occurrences | Low |

Assessing Vulnerability: Identifying Assets & Estimating Losses

Blue Creek Dam

The Blue Creek Dam is located one mile north of the town of Howell and has a hazard rating of high. The inundation area flows southward along blue creek, then just west of the development in Howell before ending at the Great Salt Lake basin.

Mantua Dam

The Mantua reservoir and dam have a high hazard rating. The inundation area covers the entire western side of the dam including significant amounts of the town of Mantua. Within the town, multiple homes and structures are at risk. The inundation continues westward down Box Elder Creek filling the canyon bottom and covering highway 89/91, eventually leading through the center of Brigham City. Once again, significant numbers of people, homes and businesses are within the potential inundation area.

Three Mile Creek (debris and detention basin)

Three Mile Creek detention basin is located about 0.5 miles southwest of the city of Perry. The inundation area flows westward from the dam towards the Great Salt Lake basin. Several structures as well as a section of highway 89/91 lie within the inundation area.

Cutler Dam

Cutler Dam and reservoir lie in extreme western Cache County and about four miles northeast of Fielding in Box Elder County. This facility has a hazard rating of high. The inundation area follows the Bear River flood plain first in southwestern direction and then south past Deweyville, Elwood, Honeyville, Bear River City, and finally Corrine City before ending at the Great Salt Lake. Since the inundation area remains, for the most part, within the flood plain, threats to the population and homes appear to be minimal.

While there are only four dams that are designated as high risk, as noted previously, every dam in the county that had inundation GIS data was analyzed. Potential losses were determined for every community in an inundation area.

Bear River City has roughly 10 structures in the dam inundation area for Cutler Dam. These structures are on the banks above the Bear River on the east of town.

At the base of Box Elder Canyon in **Brigham City**, dam inundation areas for Mantua Reservoir include many structures in the Box Elder Creek area. About 250 structures could be damaged by a dam breach.

Corinne and its residents would be heavily impacted if Cutler Dam breached. The Bear River begins to slow down and fan out in municipal boundaries, where people's safety could be compromised and structures could be damaged. These structures are on the eastern edge of the main town.

Deweyville has several structures at risk from a breach at Cutler Reservoir. These lie in the southern edge of the municipality on the east and west of the Bear River.

Elwood also has several structures at risk from a breach at Cutler Reservoir. They are on the east side of town, and the west side of the Bear River.

Honeyville has 2 structures situated above the east side of the Bear River, susceptible to a breach of Cutler Reservoir.

Howell Town is divided by Blue Creek and its drainage running north to south. There are two structures below Blue Creek Dam on the north side of town which could be affected by a breach.

The dam above **Mantua** surrounds the south, west, and north ends of the reservoir. If there was a breach, it would likely threaten residents and damage 16 structures along the edges of the dam.

Three Mile Creek Dam east of **Perry** is a retention basin which is intended to stop high water or earth flows out of Perry Canyon. If it breached while full of water, it could affect about 170 structures.

Unincorporated areas between Brigham City, Corrine, and Bear River City could be affected by a breach of Cutler Reservoir. The area between Collingston and Riverside could also have some losses during the same. Below Etna Dam, near Grouse Creek, there is also a structure at risk. The unincorporated county has about 114 structures at risk from dam breaches.

| Table 6-25: Box Elder County Residential and Commercial Development at Risk from Dam Failure | | | | | | |
|---|----------------------------|----------------------------------|-------------------|---------------------------------|-------------------|-------------------------------------|
| Jurisdiction | ~Residents at Risk* | Residential Units at Risk | | Commercial Units at Risk | | |
| | | # Units | \$ Value** | # Units | \$ Value** | \$ Potential Revenue Loss*** |
| Bear River | 32 | 10 | 1,092,030 | 0 | 0 | 0 |
| Brigham City | 786 | 244 | 18,830,213 | 8 | 2,853,160 | 7,031,576 |
| Corinne | 322 | 100 | 5,703,258 | 1 | 27,500 | 878,947 |
| Deweyville | 3 | 1 | 53,540 | 0 | 0 | 0 |
| Elwood | 19 | 6 | 640,780 | 0 | 0 | 0 |
| Honeyville | 6 | 2 | 171,500 | 0 | 0 | 0 |
| Howell | 6 | 2 | 12,000 | 0 | 0 | 0 |
| Mantua | 52 | 16 | 2,081,786 | 0 | 0 | 0 |
| Perry | 535 | 166 | 16,107,928 | 2 | 202,100 | 1,757,894 |
| Unincorporated | 361 | 112 | 7,876,924 | 2 | 185,300 | 1,757,894 |

Notes: All residential and commercial units and values were derived from Box Elder County parcel data.
 *Based on average persons per household for Box Elder County from 2000 Census data, which is 3.22. Numbers were adjusted for multi-family residential units accordingly.
 **Current Market Value. Mean (average) current market values were used for structures where values were absent. Values were based on means for each respective building type, i.e. duplex, single family residential, townhouse, etc.
 ***Derived from 2002 Survey of Business Owners for Box Elder County, US Census Bureau. Average firm receipts totaled \$878,947.

Communities not listed do not have any potential residential or commercial losses according to this assessment.

Table 6-26: Box Elder County - Other Facilities at Risk from Dam Failure

| Jurisdiction | Critical Facilities | Roads | | | Rail Lines | |
|----------------|--------------------------|-------|-------|------------|------------|------------|
| | | Type | Miles | \$ Value* | Miles | \$ Value** |
| Bear River | None | SH | 0.1 | 860,616 | 0 | 0 |
| Brigham City | None | SH | 1.2 | 7,457,388 | 0.3 | 538,913 |
| Corinne | Corinne Fire Station | SH | 1.4 | 8,141,064 | 0.8 | 1,295,763 |
| Elwood | None | IH | 0.003 | 26,217 | 0 | 0 |
| Honeyville | None | IH | 0.1 | 658,476 | 0 | 0 |
| Howell | None | PLR | 0.9 | 2,559,756 | 0 | 0 |
| | None | SH | 1.1 | 6,307,182 | 0 | 0 |
| Mantua | Mantua Police Department | SH | 0.3 | 1,762,164 | 0 | 0 |
| Perry | None | SH | 0.4 | 2,548,686 | 0 | 0 |
| Unincorporated | None | IH | 0.7 | 6,617,241 | 1.2 | 1,866,240 |
| | None | PLR | 0.9 | 2,657,103 | 0 | 0 |
| | None | SH | 5.9 | 35,369,928 | 0 | 0 |

IH = Interstate Highway (6 lanes), SH = State Highway (4 lanes), PLR = Paved Local Roads (2 lanes)
 *Average building cost for roads = \$1.5 million per lane-mile (Utah's Unified Transportation Plan, 2007-2030, UDOT & Utah MPO's)
 **Average building cost for rail lines = \$300.00 per foot, minimum, or \$1,584,000 per mile, minimum (Jim Marshall, Manager Special Projects Industry & Public, Union Pacific Railroad, Utah, personal communication)

Communities not listed do not have any potential losses according to this assessment.

Assessing Vulnerability: Analyzing Development Trends

Any new downstream development that is located in the inundation area increases the exposure to risk in terms of human life and property. Given the relatively low probability of catastrophic dam failures, most jurisdictions are unwilling to regulate development in dam failure inundation areas.

If there is infill in the Box Elder Creek drainage through Brigham City, structures could be put at risk. These areas could easily be developed, where an urban framework already exists. Perry City also has new development which could easily expand in the near future in the Three Mile Creek Dam inundation area. Currently the land is about two thirds covered by orchards and other farm ground, and is on both sides of Highway 89-91.

If new housing is built in Mantua within about 1,000 feet of the dam, they would be in the inundation area. However, several developments have been denied approval in Mantua in the past because of a lack of municipal water sources. If Corinne continues to develop on the

outskirts of the north, east, and south of the main town, structures could be in inundation areas for Cutler Dam.

While most of the development in Deweyville, Elwood, Honeyville, and Bear River is outside of the Cutler Dam inundation area, new development has begun and could continue in eastern Elwood and eastern Bear River City.

Along the rest of the unincorporated area near to the Bear River, while there is some existing development, it's difficult to know if, where, and when new development could come. Especially in the Corinne area, the Bear River inundation area spreads wide towards I-15, so any development east of Corinne and Bear River City could be at risk.