



FEMA

Dam Break Analysis of Emmett, Idaho

For

Federal Emergency Management Planning

Prepared for: FEMA, Office of Response Planning (Professor Guth)

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(Mark Mallett, 2010)

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Introduction

This report is in response to a request for geospatial analytical services, dated 24 Feb 2010, from the Federal Emergency Management Agency (FEMA), Office of Response Planning. It provides emergency response planners with a geospatial analysis of Emmett, Idaho and Black Canyon Dam. It is intended to support emergency response planning in the event the Black Canyon Dam breaks as a result of seismic activity in the region.

A brief overview identifies the geographic and physical characteristics of Black Canyon Dam, the City of Emmett, and the surrounding area. Included in this overview is the nearby Squaw Creek fault system and its historical earthquakes. There is also a landslide potential analysis, which can have a significant impact on the dam's structure as well as planned relief operations.

As part of the analysis, possible site locations for a potential early warning system are explored using a line-of-sight method. Mandatory and secondary evacuation zones along the Payette River are included to support first responders with relocating people in the events leading up to a possible dam break. Logistically, a supply depot at Boise Air Terminal, a staging area at Emmett Municipal Airport, and supply routes are examined. Finally, a short summary of the analysis methods used details the steps taken to create the results.

Geographic Overview

There are four southwest Idaho counties making up the geographic region of interest for this study; Payette, Canyon, Ada, and Gem. Gem County is the main focus area and is home to the City of Emmett and the Black Canyon Dam.

Gem County was established in 1915 and named after the state's nickname, "Gem State." According to the U.S. Census Bureau, Gem County is 566 square miles, of which only 3 square miles is water (Wikipedia, 2010). It is located about 16 miles north of Boise on State Highway 16. Emmett is the count seat and is approximately 2,373 feet above sea level.

The Black Canyon Dam on the Payette River was originally built in the early 1920's to supply irrigation water. The 183-foot dam was named for the black basalt rocks prevalent in the region (Gem County, 2009).

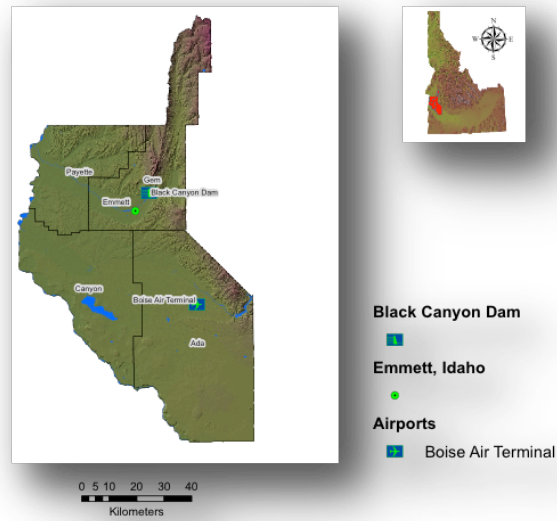


Figure 1: Geographic Overview

Black Canyon Dam

Black Canyon Dam is a concrete gravity dam, which sits on the Payette River about 5 miles northeast of Emmett, Idaho. It has a structural height of 183 feet with a full capacity of 44,650 acre-feet. A two-unit power plant is limited to about 10,000 kilowatts, which supplies power to the Southern Idaho Federal Power System for the Bureau of Reclamation and for non-Bureau purposes (U.S. Department of the Interior, 2009).



Figure 2: Black Canyon Dam(U.S. Department of the Interior, 2009)

Table 1: Dam Specifications(U.S. Department of the Interior, 2009)

County	Gem	Structural Height	183 ft
Dam Type	Concrete gravity	Total Water Storage at Elevation	44650 acre-ft at 2497.5
Reservoir	Black Canyon	Watercourse	Payette River
Original Construction	1922-1924	Modified Construction	1951-1952, 1955
Location	5 mi NE of Emmett	National ID Number	ID00282

Emmett, Idaho

Emmett is located along the Payette River about 5 miles southwest of Black Canyon Dam. It is a small town covering about 1.8 square miles (Wikipedia, 2010).



Figure 3: Panorama of Emmett (Wikipedia, 2010)

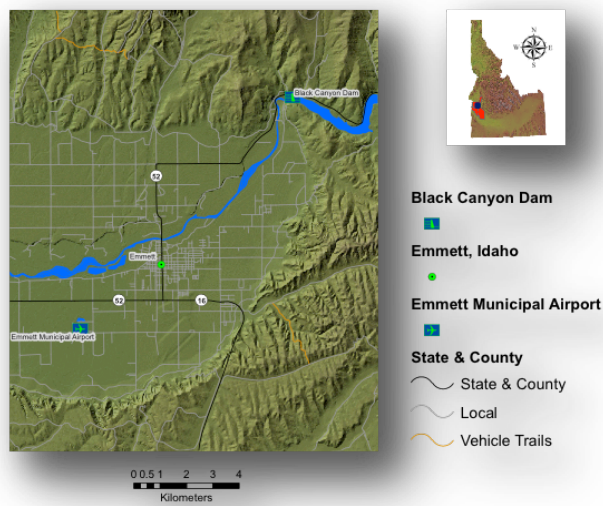


Figure 4: Geographic overview of Emmett, Idaho

As of July 2008, the number of people in Emmett was 6,357, of which 3,022 were males (about 47.5 percent of the city population). The estimated female population in Emmett was 3,335, which represents 52.5 percent of the total population (City-Data.com, 2010).

The median age of people living in Emmett is 34.6 years where the number of people under the age of 5 was 455. There are 3,932 people above the age of 18, which represents 71.6 percent of the entire population. 17.8 percent of the population (976) in the community is 65 years and over (American Towns, 2010).

There are approximately 2,264 total housing units in Emmett, of which 2,095 are occupied (92.5 percent). 1,450 are owner-occupied (69.2 percent), and 645 are renter-occupied. There are also 169 vacant homes in Emmett at the time of the last complete survey. (American Towns, 2010)

Seismicity

From 1973 to Present, the geographic and historical distribution of earthquakes shows concentrations mostly in the central and southeast mountain ranges of Idaho. There were approximately 1,221 earthquakes ranging in magnitude from 0 to 7 (US Geological Survey, 2010).

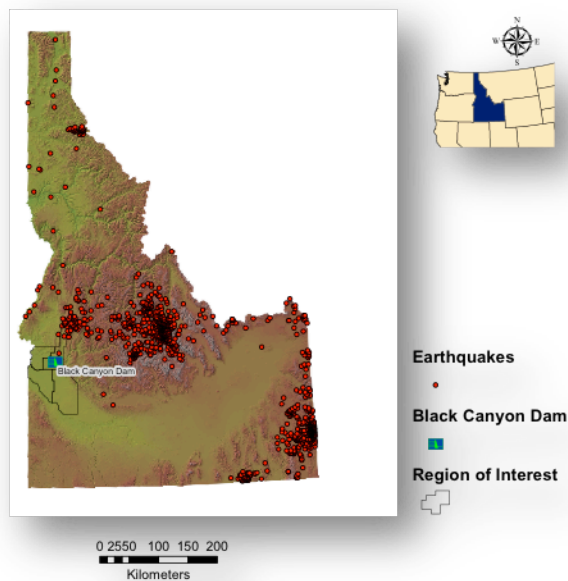


Figure 5: Seismicity of Idaho

Historical earthquake activity for the region near Emmett is significantly below the state average and 20% smaller than the overall U.S. average (City-Data.com, 2010).

- 2/17/1992, a magnitude 4.3 earthquake, at a depth of 3.1 miles, occurred 95.9 miles away
- 11/10/1993, a magnitude 4.6 earthquake, at a depth of 6.2 miles, occurred 90.5 miles away
- 10/27/1994, a magnitude 4.0 earthquake, at a depth of 6.2 miles, occurred 69.7 miles away
- 1/28/1995, a magnitude 4.7 earthquake, at a depth of 3.1 miles, occurred 95.3 miles away.
- 4/11/1995, a magnitude 4.2 earthquake, at a depth of 3.1 miles, occurred 82.1 miles away
- 11/30/2002, a magnitude 4.1 earthquake, at a depth of 6.2 miles, occurred 78.7 miles away

Most of the earthquakes near Black Canyon Dam are concentrated along the Squaw Creek fault line system to the north. The closest earthquake to Black Canyon Dam was a magnitude 3.2, at a depth of 5 miles, which occurred 9 miles away in 1978. Two of the most recent earthquakes occurred in 2007. The first happened approximately 39 miles away with a magnitude of 3.5, at a depth of 5 miles on 24 April. Later that same day another earthquake occurred about 35 miles away with a magnitude of 2.9, at a depth of 5 miles (US Geological Survey, 2010).

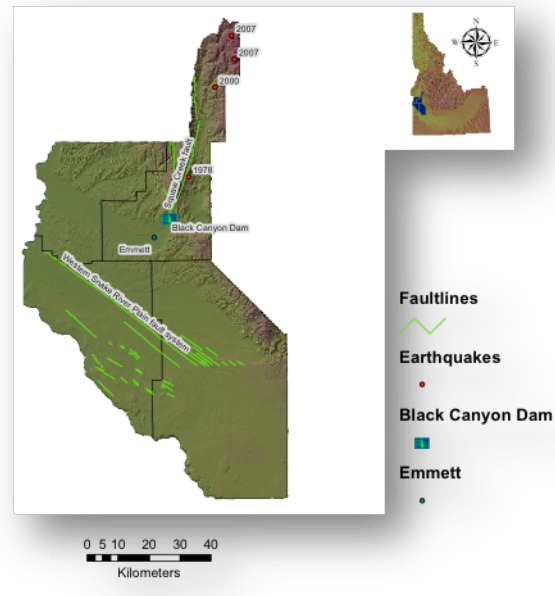


Figure 6: Seismicity of Region of Interest

Landslide Potential

Landslides are a significant concern in any mountainous region. Depending on environmental conditions; e.g., rainfall amounts, soil type, etc., landslides can cause severe damage. There are two potential landslide areas located in Gem County requiring further study. First is the mountain pass on state highway 16 just south of Emmett. This is a major thoroughfare providing a direct route for evacuation and supplies.

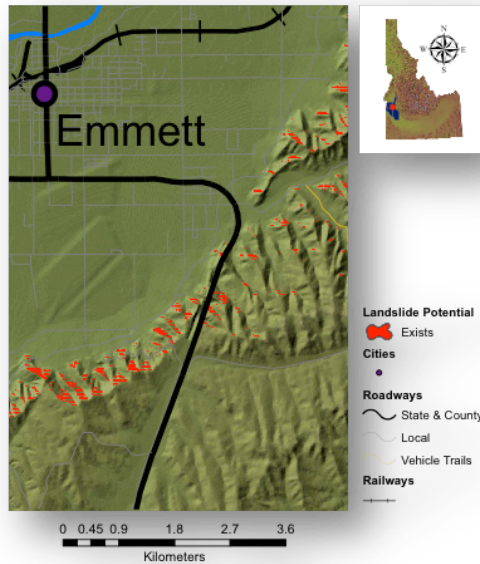


Figure 7: Landslide potential near State Highway 16

Second, are the hills just to the south and southeast of the Black Canyon Dam are of concern. Potential exists for rock slides near the dam, which does not appear to be significant. Additional field study of this area is recommended. Further southeast of the dam is a large area of potential landslides. If an area of this size were to slide into the reservoir, there could possibly be enough wave action to impact the dam during an earthquake. Additional physical and computational modeling is recommended to further study this threat.

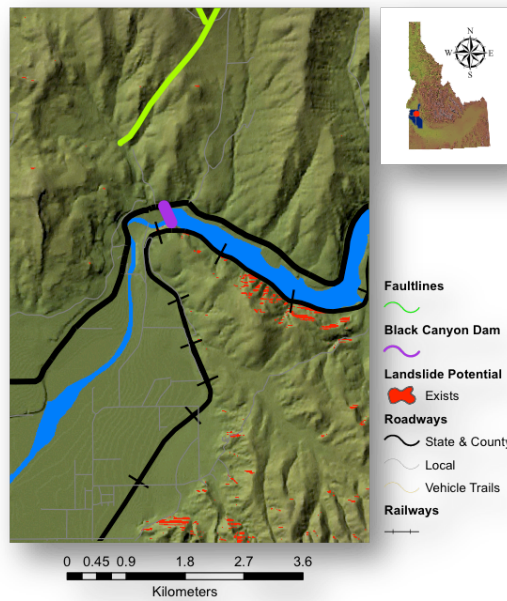


Figure 8: Landslide potential near Black Canyon Dam

Emergency Response Analysis

Early Warning System

This next section explores the concept of an early warning system using a line-of-sight UHF radio transmitter located at an elevated position near Black Canyon Dam. Gem County Sheriff's Office will host the receiver.

An earthquake may only weaken a dam's structure to the edge of failure, causing it not to break until days or weeks after an event. In this circumstance, the force of the water would continue to weaken the dam's structural integrity to the point of failure with little or no warning. An early warning system would monitor a dam's physical structure using vibration sensors mounted at various points across the face of the dam. If the sensors indicate a possible dam break, a UHF transmitter would send a warning message to the Gem County Sheriff's Office. In theory, this should provide enough lead-time to evacuate people and close off bridges.

Three transmitter sites were chosen for this analysis based on their close proximity to Black Canyon Dam and their elevation. Figure 9 shows the line-of-sight from the Gem County Sheriff's Office to all three transmitters. Transmitter and receiver heights were set to 10 meters. Blue dots along the line identify the visible obstruction to the transmitters. According to this analysis, the third site is the better choice.

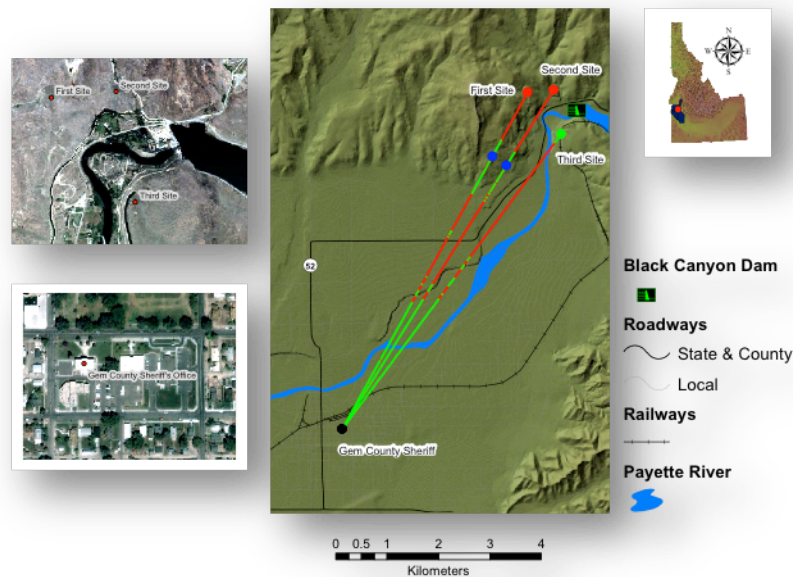


Figure 9: Line of sight analysis of three potential early warning systems

Figure 10 identifies the obstruction to the first site located approximately 6 km from the Sheriff's Office at an elevation of 850 m.

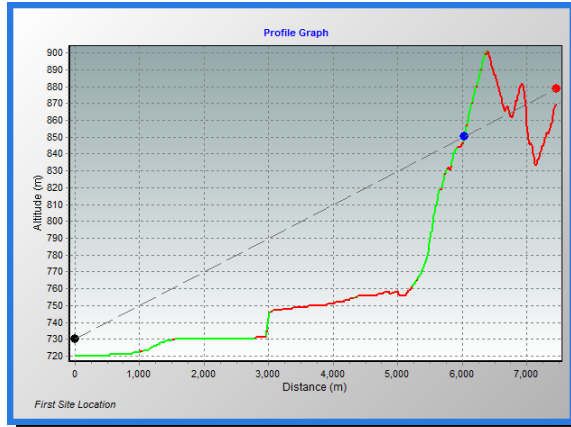


Figure 10: Line of sight profile for first site location

Figure 11 identifies the visible obstruction to the second site located approximately 6 km from the Sheriff's Office at an elevation of approximately 795 m.

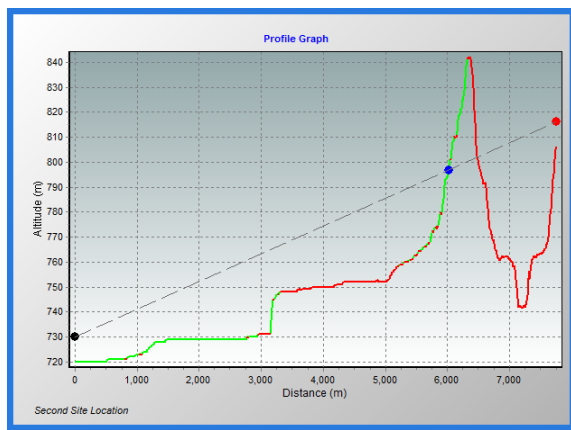


Figure 11: Line of sight profile for second site location

Figure 12 clearly shows no visible obstruction to the third transmitter site.

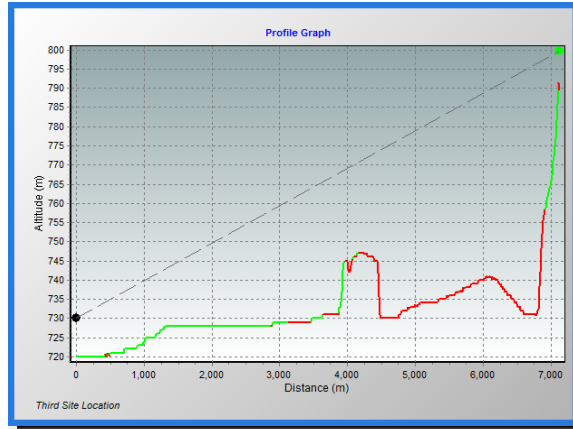


Figure 12: Line of sight profile for third site location

Evacuation Zones

In anticipation of a catastrophic failure at Black Canyon Dam, two evacuation zones have been established along the Payette River. Assuming the early warning system provides enough lead time, Gem County Sheriff's Deputies, with the support of the Emmett City Police and Fire Departments, will evacuate people and close bridges in the mandatory zone first (Figure 13). If time permits, additional evacuations in the secondary zone should be conducted as a precautionary measure.

These zones are based off the geographic centerline of the Payette River. The mandatory zone is 250m on either side of the centerline and the secondary zone is an additional 250m. Figure 13 identifies all critical emergency response facilities located outside of the evacuation zones.

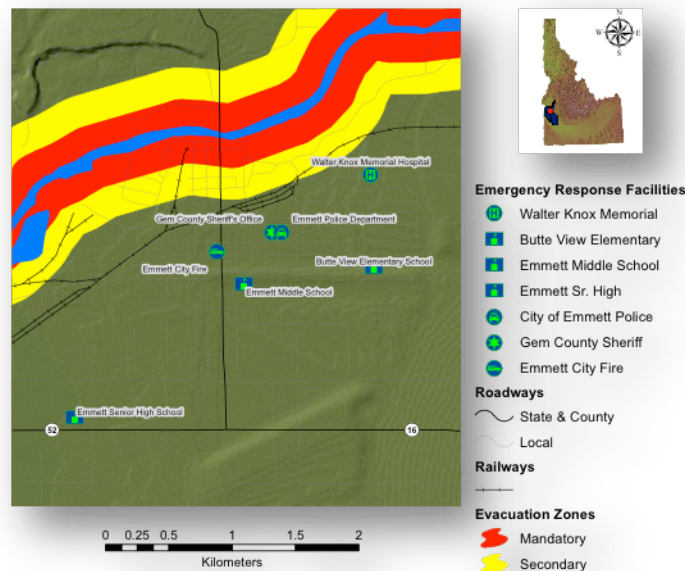


Figure 13: Evacuation zones for Emmett, Idaho

Logistics

Supply Depot

A critical component of any emergency response is the movement of supplies and resources into the affected area. Depending on the severity of the disaster, the Idaho state governor may request a federal emergency response. The nearest location to the Emmett able to support the influx of cargo is the Boise Air Terminal. The 124th Boise Air National Guard Wing, co-located at Gowen Field, will be able to support federal responders by providing ramp space for aircraft and cargo (Figure 14). In addition, C-130 cargo planes from the 189th Airlift Squadron can provide airlift support to Emmett Municipal Airport.

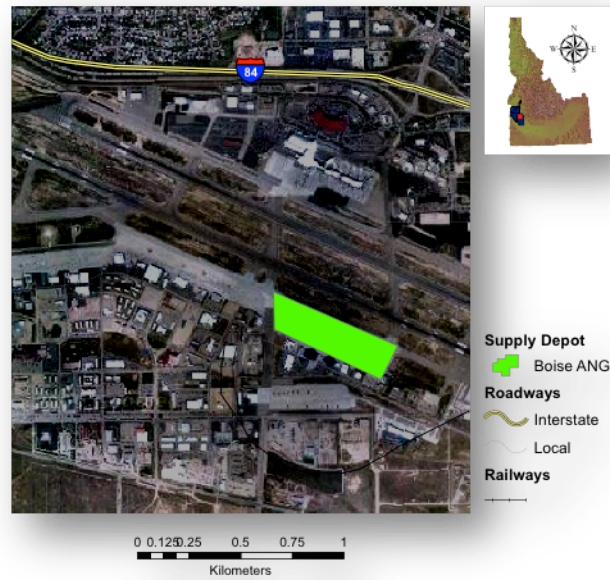


Figure 14: Supply depot at Boise Air National Guard (ANG)

Staging Area

Based on anticipated road conditions and possible airlift operations, Emmett Municipal Airport was chosen as a possible staging area for operations and logistics. Details for supporting airlift operations are listed in Appendix A – Background Information on Emmett, Idaho. The aircraft parking ramp can provide enough space to off-load supplies (Figure 15). Civilian aircraft can be relocated to the adjacent golf course without damage. Supplies can also be relocated to the golf course if more storage space is needed. Due to the airport's small footprint, no more than two C-130's can be on the ground at any given time in order to maintain safety of flight and ground operations.

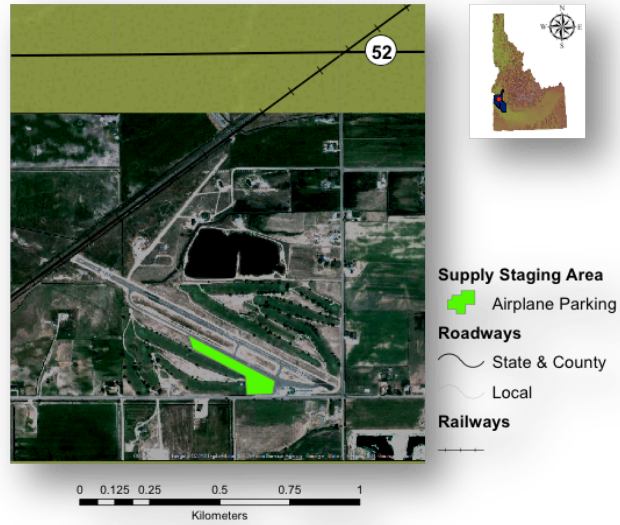


Figure 15: Supply staging area at Emmett Municipal Airport

Supply Routes

In order to support ground transportation of supplies, a least cost route analysis was performed to determine the fastest route from Boise Air Terminal to Emmett Municipal Airport (Figure 16). This route uses Interstate 84 westbound until the Kiov exit. The route travels a short distance through the mountains and reaches State Highway 52 eastbound, which passes just to the north of Emmett Municipal Airport. The total distance for this route is 57 miles (91 km). Coincidentally, this route avoids the landslide potential area along State Highway 16 just to the south of Emmett (Figure 7).

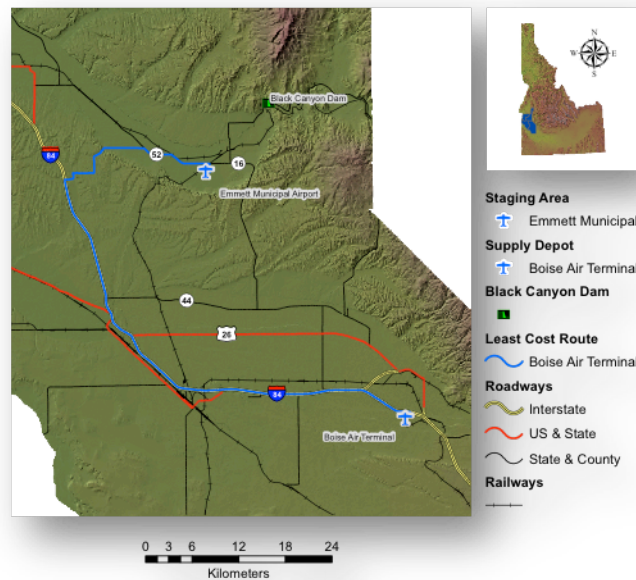


Figure 16: Least cost route from Boise Air Terminal

Analysis Methods

Seismicity

1. Added point locations of earthquakes from 1973 to present on a 10m shaded relief map
2. Used measurement tool to identify proximity of nearby earthquakes to Black Canyon Dam
3. Identified magnitude and depth from associated attribute table

Landslide Potential

1. Created aspect and slope maps from the 1/3 second DEM.
2. Used map algebra to determine the landslide potential:

$$\text{landslide potential} = \{[\text{slope} \geq 30] \& (\text{aspect} \leq 30 \mid \text{aspect} \geq 330)\}$$

3. Categorized the output:
 - 0 = no potential
 - 1 = potential exists
4. Overlaid results on a 10m shaded relief map

Early Warning System

1. Created line-of-sight analyses from Gem County Sheriff's Office to each of the three proposed site locations near Black Canyon Dam
2. Created graphic profiles of each line-of-sight to determine distance and altitude of visible obstruction
3. Overlaid results on a 10m shaded relief map

Evacuation Zones

1. Created 250m mandatory evacuation buffer of the geographic centerline of the Payette River
2. Created an additional 250m secondary evacuation buffer
3. Overlaid the results on a 10m shaded relief map
4. Added emergency response facilities, roadways, and railways to identify areas on Emmett that lie within each zone

Supply Depot and Staging Area

1. Copied images of Emmett Municipal Airport and Boise Air Terminal from Google Maps™
2. Geo-referenced both images to their respective geographic locations
3. Overlaid roadways and railways to provide visual verification of geo-referencing
4. Digitized areas over each image identifying support to logistics and supply

Supply Routes

1. Created rasters of five road layers based on the CFCC2 field.
2. Reclassified each of the road rasters

Table 2: Route classifications used in cost weight analysis

RASTER	CLASSIFICATION
Expressway	1
U.S. and State Highways	5
State & County Highways	10

Local Highways	20
Off Road Vehicle Trails	40
No Data	9999

3. Combined all 5 rasters into one using Map Algebra

MIN (interstate.img, us_state.img, state_county.img, local.img, trails.img)

4. Created cost direction and cost distance grids to Emmett Municipal Airport using spatial analyst cost weighted tool
5. Created a least cost path grid to Boise and Mt Home airports using spatial analyst shortest path tool

Conclusions

This report provides emergency response planners with geospatial information to adequately plan an emergency response due to a catastrophic failure of the Black Canyon Dam. A line-of-sight analysis supports the exploration of an early warning system in order to provide the residents of Emmett enough lead-time to carry out evacuations. Mandatory and secondary zones identify affected areas within the City of Emmett in the event of a dam break. An overview of the supply depot, staging areas, and least cost route analysis supports logistical planning. The information in this report, with regards to the geographic region, and a geospatial analysis of the logistical footprint, provides the necessary framework to support all aspects of emergency response planning.

Appendix A – Background Information on Emmett, Idaho

Emmett Municipal Airport

Table 3: Standard pilotage information for Emmett Municipal Airport (AirNav, LLC, 2010)

FAA Identifier:	S78
Lat/Long:	43-51-09.5000N / 116-32-21.1000W 43-51.158333N / 116-32.351667W 43.8526389 / -116.5391944 (estimated)
Elevation:	2350 ft. / 716 m (estimated)
Variation:	17E (1985)
From city:	3 miles SW of EMMETT, ID
Time zone:	UTC -6 (UTC -7 during Standard Time)

Table 4: Airport Operations (AirNav, LLC, 2010)

Airport use:	Open to the public	Activation date:	12/1944
Sectional chart:	SALT LAKE CITY	Control tower:	No
ARTCC:	Salt Lake City Center	FSS:	Boise Flight Service Station
NOTAMs facility:	BOI (NOTAM-D service available)	Attendance:	Unattended
Wind indicator:	Lighted	Segmented circle:	Yes
Lights:	Dusk to Dawn	Beacon:	White-green (lighted land airport)

Table 5: Airport Communications (AirNav, LLC, 2010)

CTAF:	122.9
Automated Weather Observation Station #3 Located at Caldwell Industrial Airport (13 nm S):	135.075 (208-454-3953)

Communications provided by Boise FSS on frequency 122.45 (SQUAW BUTTE RCO).

Table 6: Nearby Radio Navigation Aids (AirNav, LLC, 2010)

VOR radial/distance	VOR name	Freq	Var		
BOI r303/23.5	BOISE VORTAC	113.30	17E		
NDB name	Hdg/Dist	Freq	Var	ID	
MERIDIAN	344/15.0	238	16E	MPA	-- .-- .-
ONTARIO	099/22.6	305	17E	ONO	--- -, ---

Table 7: Airport Services (AirNav, LLC, 2010)

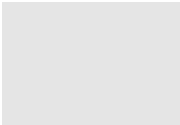
Fuel available:	100LL FUEL AVAILABLE 24 HOURS SELF SERVE CREDIT CARD
Parking:	Tie downs
Airframe service:	NONE
Power plant service:	NONE
Bulk oxygen:	NONE

Table 8: Runway 10/28 (AirNav, LLC, 2010)

Dimensions:	3250 x 50 ft. / 991 x 15 m	Surface:	Asphalt, in fair condition
Weight bearing capacity:	Single wheel: 8.0	Runway edge lights:	Medium intensity

Table 9: Additional Information on Runway 10/28 (AirNav, LLC, 2010)

	<i>RUNWAY 10</i>	<i>RUNWAY 28</i>
Latitude:	43-51.277167N	43-51.038167N
Longitude:	116-32.683167W	116-32.021667W
Gradient:	0.1%	0.1%
Traffic pattern:	Left	Left
Displaced threshold:	385 ft.	260 ft. RWY 28 DISPLACED THLD MARKED WITH WHITE BAR AND WHITE CHEVRONS ONLY.
Markings:	Basic, in fair condition	Basic, in fair condition
Obstructions:	None	3 ft. fence, 200 ft. from



APCH SLOPE 50:1 AT
DSPLCD THLD.

runway, 25 ft. left of centerline
RWY 28 10 FT PVT ROAD AT 0',
100'L

Table 10: Airport Ownership and Management(AirNav, LLC, 2010)

Ownership: Publicly-owned

Owner: CITY OF EMMETT	Manager: STEVE BURAK
501 EAST MAIN	1495 E SALESYARD RD
EMMETT, ID 83617	EMMETT, ID 83617
Phone 208-365-6050	Phone 208-861-9055

Additional Remarks (AirNav, LLC, 2010)

- Golf course on both sides of runway.
- 1800' x 20' private gravel agricultural roadway located adjacent to northwest of airport.
- Golf course road crosses near runway 28 threshold. Watch for golfers on runway.(AirNav, LLC, 2010)

Emergency Response Facilities

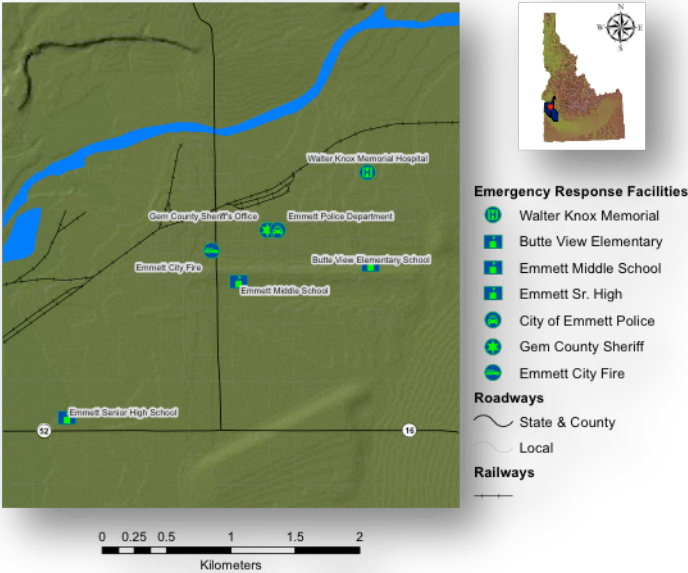


Figure 17: Overview of emergency response facilities at Emmett, Idaho

Emmett Police Department



Figure 18: Emmett City Police Department Personnel (Emmett Police Dept., 2009)

The Emmett Police Department is located in the heart of the Gem County valley with the City of Emmett being the county seat. The Emmett Police Department fields 24-hour patrol officers, a full time investigations team, two narcotics K-9 teams, and a reserve officer program (Emmett Police Dept., 2009).

501 E. Main St.
Emmett, ID 83617
Phone: 208-365-6055
Fax: 208-365-6062
Email: mknittel@emmettpolice.com

Gem County Sheriff's Office

34 member staff(Gem County, 2010)

Dispatch
Lisa Resinkin dispatch@co.gem.id.us
(208) 365-3521
24-7
Enhanced 911

415 E. Main
Emmett, ID 83617
Phone: (208) 365-3521
Fax: (208) 365-7166
Email: sheriff@co.gem.id.us

Emmett Fire Department

The Emmett Fire Department provides Fire and Rescue services to the City of Emmett, about 4 square miles, and 7000 citizens, along with mutual aid to neighboring communities and fire districts. Additional assistance is provided to federal and state agencies in the Wildland-Urban Interface.

As of October 1, 2007, Emmett Fire Department became a combination department with the hiring of a full-time Fire Chief, along with 17 dedicated paid-per-call volunteers. All personnel are highly trained in fire suppression, along with many rescue disciplines, haz-mat operations and decon. Seven members are state certified EMT-B, and five are currently obtaining state medical certification.

Emmett Fire Department operates from one station, located at 231 South Washington, and future plans for a second station on the eastern part of the city. Currently housed at Station 1 are 2-1250 gpm (gallons per minute) engines and 1-1250 gpm reserve engine, 1-Type VI wildland engine, and 1-command vehicle. All apparatus' are equipped for fire suppression, rescue operations, and basic life support medical operations. (Emmett Idaho City Gov., 2010)

Emmett Fire Chief
Shannon Crays
(208) 398-8042
efdchief@qwestoffice.net

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