Assessment of Risks and Vulnerability to Flood Hazards in Nevada

NEVADA BUREAU OF MINES AND GEOLOGY OPEN-FILE REPORT 07-2

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INTRODUCTION

From Section 3 of the State of Nevada Hazard Mitigation Plan (NHMP), posted at:
http://dem.state.nv.us/documents/NHMP/NHMP_Section_3_18Oct07.pdf

3.3.8 Floods *(High Risk Hazard)*

3.3.8.1 *Nature*

Flooding is the accumulation of water where there is usually none or the overflow of excess water from a stream, river, lake, reservoir, or coastal body of water onto adjacent floodplains. Floodplains are lowlands adjacent to water bodies that are subject to recurring floods.
Floods also occur along streams and arroyos (stream channels that are normally dry) that do not have classic floodplains. These include flash floods in mountains (sometimes with rapidly rising water several tens of feet deep) and on alluvial fans, which are typically fan-shaped, gently sloping areas between the steep parts of mountain ranges and the nearly flat valley floors. Because much of Nevada is part of the Great Basin (an area of internal drainage, in which streams are not connected to rivers that flow to the oceans), flood waters will commonly drain into interior lakes (e.g., Walker Lake at the terminus of the Walker River, Pyramid Lake at the terminus of the Truckee River), wetland areas (e.g., Carson Sink at the terminus of both the Carson and Humboldt Rivers), or playas (normally dry lake beds, such as Roach Lake, south of Las Vegas, where a new airport is planned).

Floods are natural events that are considered hazards only when people and property are affected. Nationwide, on an annual basis, floods have resulted in more property damage than any other natural hazard. Physical damage from floods includes the following:

- Inundation of structures, causing water damage to structural elements and contents.
- Erosion or scouring of stream banks, roadway embankments, foundations, footings for bridge piers, and other features.
- Impact damage to structures, roads, bridges, culverts, and other features from high-velocity flow and from debris carried by floodwaters. Such debris may also accumulate on bridge piers and in culverts, increasing loads on these features or causing overtopping or backwater effects.
- Destruction of crops, erosion of topsoil, and deposition of debris and sediment on croplands.
- Release of sewage and hazardous or toxic materials as wastewater treatment plants are inundated, storage tanks are damaged, and pipelines severed.

Floods also cause economic losses through closure of businesses and government facilities; disrupt communication; disrupt utilities such as water and sewer service; result in excessive expenditures for emergency response; and generally disrupt the normal function of a community.

Floods are described in terms of their extent (including the horizontal area affected and the vertical depth of floodwaters) and the related probability of occurrence. Flood studies often use historical records, such as stream flow gages, to determine the probability of occurrence for floods of different magnitudes. The probability of occurrence is expressed as a percentage for the chance of a flood of a specific extent occurring in any given year.

Factors contributing to the frequency and severity of flooding include the following:

- Rainfall intensity and duration
- Antecedent moisture conditions
- Watershed conditions, including steepness of terrain, soil types, amount and type of vegetation, and density of development
- Changes in landscape resulting from wild fires (loss of moisture-trapping vegetation and increased sediment available for runoff)
- The existence of attenuating features in the watershed, including natural features such as swamps and lakes, and human-built features such as dams
- The existence of flood control features, such as levees and flood control channels
- Velocity of flow
- Availability of sediment for transport, and the erodibility of the bed and banks of the watercourse

These factors are evaluated using (1) a hydrologic analysis to determine the probability that a discharge of a certain size will occur, and (2) a hydraulic analysis to determine the characteristics and depth of the flood that results from that discharge.

The magnitude of flood used as the standard for floodplain management in the United States is a flood having a 1 percent probability of occurrence in any given year. This flood is also known as the 100-year flood or base flood. The most readily available source of information regarding the 100-year flood is the system of Flood Insurance Rate Maps (FIRMs) prepared by FEMA. These maps are used to support the National Flood Insurance Program (NFIP). The FIRMs show 100-year floodplain boundaries for identified flood hazards. These areas are also referred to as Special Flood Hazard Areas (SFHAs) and are the basis for flood insurance and floodplain management requirements.

3.3.8.4. *Vulnerability Assessment and Analysis of Potential Losses*

Flood hazards are considered high risk in most of Nevada. Floods affect many areas developed for businesses and homes, and they occur with more frequency than most other natural disasters. Large rainstorms can affect multiple jurisdictions, as was the case in January of 1997, when Carson City, Douglas, Lyon, Storey, and Washoe Counties were impacted by floods on the Carson, Walker, and Truckee Rivers. Based on the frequency of flooding in the past, the probability of future, damaging floods is high.

To assess risks and vulnerability, the Nevada Bureau of Mines and Geology has … run FEMA's loss-estimation model, HAZUS-MH (Version 2, HAZUS MR2), for reaches of the Carson, Humboldt, Muddy, Truckee, Virgin, and Walker Rivers. The preliminary results using HAZUS-MR2 are summarized in Tables 3-11 and 3-12. In all cases, the HAZUS runs used floods with average 100-year return periods.

Failures of dams can cause flash floods. No specific HAZUS runs were made to simulate dam failures. Nonetheless, the 100-year return period can be used to approximate the damage that could occur from some dam failures, particularly along the Truckee River (with the Stampede, Boca, and Prosser Reservoirs along tributaries in California, upstream from Reno), Carson River (with Lahontan Reservoir upstream from Fallon), and Humboldt River (with Rye Patch Reservoir upstream from Lovelock).

Table 3-11 indicates that damage from floods could range from hundreds of thousands of dollars in sparsely populated rural areas to hundreds of millions of dollars in large urban areas. Hundreds of buildings could suffer complete destruction. Thousands of people may need public shelter. Hundreds of thousands of tons of debris may need to be cleared. One way of assessing vulnerability is in terms of total building-related economic losses, summed for the counties affected by a flood. Using this measure, flood vulnerabilities are ranked as follows:

Highest percentage loss from 100-year flood: Truckee River ($995 million)
2nd highest: Humboldt River ($125 million)
3rd highest: Walker River ($83 million)
4th highest: Carson River ($70 million)
5th highest: Virgin River ($27 million)
6th highest: Muddy River ($21 million)

Clearly, Nevada's northern counties, Washoe County in particular, are more at risk than its southern ones.

Table 3-12 summarizes vulnerability (or risk) from floods using two methods of ranking flood vulnerability: (1) by building-related economic loss and (2) by economic loss as a percentage of building exposure. The county's building exposure, one of the factors within the HAZUS program, is a measure of the economic wealth of the county and a proxy for the ability of the county to recover from a disaster. Hence,

The figures in the Appendix give a graphical indication of the damage expected in Nevada's 6 major river systems for the 100-year flood event, summarized in the figure's title. Colored contour areas represent the peak floodwater depth, an indicator of flooding intensity, scaled from 0 (blank) to 65 m. The flood-depth color scale may be interpreted roughly as follows:

Depth [m]	Color	Meaning
upto 5	none	
6-20	Light pink	
21-35	Dark pink	
36-50	Light red	
51-65	Dark red	
over 65	Black	

FINAL, using MR2

Table 3-10. Summary of HAZUS MR2 loss-estimation output for 100-year floods on selected rivers in Nevada.

River	County	Cities and Towns Affected	Building-Related Economic Loss (1) $ million	Number of People Needing Public Shelter	Debris Generated tons
Carson					
	Douglas	Gardnerville, Minden	56	460	4,800
	Carson City	Carson City	26	2,700	4,400
	Lyon	Dayton, Silver Springs	1.4	0	530
	Churchill	Fallon	N/A*	N/A*	N/A*
	Total		83	3,160	9,730
Humboldt					
	Elko	Elko, Carlin	110	2,000	18,000
	Eureka	Palisade, Beowawe	0.02	0	32
	Lander	Battle Mountain	0.55	1	37
	Humboldt	Winnemucca	13	51	1,900
	Pershing	Lovelock (protected by Rye Patch Res.)	1.4	18	980
	Churchill	no large towns	N/A*	N/A*	N/A*
	Total		125	2,070	20,949
Muddy					
	Lincoln	Ursine, Panaca, Caliente	26	170	3,400
	Clark	Moapa, Glendale, Logandale, Overton	11	360	5,000
	Total		37	530	8,400
Truckee					
	CA counties	Truckee			
	Washoe	Verdi, Reno, Sparks, Wadsworth, Nixon	980	12,000	88,000
	Storey	Lockwood	15	380	9,200
	Total		995	12,380	97,200
Virgin					
	Clark	Mesquite-Bunkerville	70	670	8,400
Walker					
	Lyon	Wellington-Smith, Yerington	18	250	3,000
	Mineral	Schurz, Hawthorne (protected by Walker L.)	3	60	1,500
	Total		21	310	4,500

(1) Includes cost of both building repair/replacement and business interruption

* Not analyzed; negligible damage expected

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FINAL, using MR2

Table 3-11. Vulnerability to HAZUS MR2 100-year floods on selected rivers in Nevada.

River & County		Building Exposure ($ million)	Building-Related Economic Loss ($ million)	Loss as % of exposure (%)	Rank by Economic Loss	Rank by Loss as % Exposure
Carson River					**3**	**4**
Douglas County		3,700	56	1.5		
Carson City County		3,300	26	0.79		
Lyon County		1,700	1.4	0.08		
Churchill County		1,200	N/A*	N/A*		
	Total	9,900	83	0.8		
Humboldt River					**2**	**2**
Elko County		2,200	110	5.0		
Eureka County		120	0.02	0.02		
Lander County		250	0.55	0.22		
Humboldt County		820	13	1.6		
Pershing County		250	1.4	0.56		
Churchill County		1,200	N/A*	N/A*		
	Total	4,840	125	2.6		
Muddy River					**5**	**6**
Lincoln County		234	26	11		
Clark County		85,000	11	0.01		
		85,234	37	0.04		
Truckee River					**1**	**1**
California counties		32,000†	N/A†	N/A†		
Washoe County		25,000	980	3.9		
Storey County		210	15	7.1		
	Total	25,210	995	3.9		
Virgin River					**4**	**5**
Clark County only		85,000	70	0.08		
Walker River					**6**	**3**
Lyon County		1,700	18	1.1		
Mineral		340	3	0.88		
	Total	2,040	21	1.0		

* Not analyzed; negligible damage expected

† Not analyzed; outside State jurisdiction

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APPENDIX

Gallery of figures showing damage expected in Nevada counties for selected flood scenarios.

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