

# **Nevada**

# **Earthquake**

# **Risk**

# **Mitigation**

# **Plan**

Prepared by:

**Nevada Earthquake Safety Council**

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## Nevada Earthquake Risk Mitigation Plan

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Engagement of the Plan - Earthquake risk assessment and mitigation activities are the continuing responsibility of the Nevada Earthquake Safety Council (NESC). Those wanting current information about the ongoing activities will find them in the minutes of the NESC and at [www.unr.edu/nesc](http://www.unr.edu/nesc)

Significant portions of this plan have been modeled and paraphrased from the *California Earthquake Loss Reduction Plan*, written by the California Seismic Safety Commission, principally because the California plan was recommended by Federal Emergency Management Agency representatives as a good model plan to follow, and improvements on many parts of the California plan would be difficult. We acknowledge the excellent work the California Seismic Safety Commission has done and thank them for the use of their plan as a model.

We also acknowledge Dr. Craig de Polo of the University of Nevada Reno for his extensive work in preparation of the initial draft of this plan and his contribution to numerous risk mitigation projects on behalf of the Nevada Earthquake Safety Council.

# Executive Summary

Nevada is earthquake country, ranking third in the Nation in the number of major earthquakes. Since the 1850s, 62 earthquakes have occurred in Nevada that have had potentially destructive magnitudes of 5.5 or greater. Nevada leads the Nation in population growth, and the risk of harm and loss from earthquakes increases proportionally with population and development. We can expect earthquakes to continue to occur in Nevada and some of these will strike our growing urban centers and communities. Nevada needs to prepare for these earthquakes.

Experience from California and throughout the world clearly indicates that earthquake risks can be mitigated and that we can live with earthquakes, without them being major disasters. The benefits of pursuing a seismically resistant Nevada cannot be ignored. Minimizing the loss of life, the number of injuries, the loss of property, the loss of businesses, and the loss of tourism is possible with the support and engagement of all Nevadans in reducing earthquake risks. The motivation to be prepared for earthquakes and reduce losses usually arises following a deadly and disastrous earthquake. We need to cultivate that motivation now and apply it toward avoiding the occurrence of deadly and disastrous earthquakes in Nevada.

The *Nevada Earthquake Risk Mitigation Plan* sets forth the statewide policy and direction in pursuit of the vision of a safer Nevada. The plan is a partnership between the Nevada Earthquake Safety Council, the Federal Emergency Management Agency, and many other agencies and groups; it lays out some of the initial strategies to be taken towards making Nevada a seismically resistant state. The plan addresses seven initial elements that focus on reducing the earthquake threat: Geosciences, Awareness and Education, Land Use, Existing Buildings, New Construction, Utilities & Transportation, Preparedness, Emergency Response, and Recovery. The objectives and strategies are laid out in abbreviated form in the Plan Matrix that follows. Strategies prioritized as critically important should be addressed immediately.

The ultimate goal is to make Nevada a seismically resistant state within the next 30 years, and to make significant strides in this direction within the next five years. Being prepared for earthquakes means identifying and becoming familiar with the actions that can save lives during a strong earthquake. It is clear that earthquake risk mitigation works. Loss reduction from earthquakes is possible and practical.

# The Vision

Since the 1850s, 62 potentially destructive earthquakes with magnitudes of 5.5 or greater have occurred in Nevada. In the last half of the 19<sup>th</sup> century several major earthquakes occurred in the region of the Reno-Carson City urban corridor prior to most of the development that characterizes the area today. These events would have caused substantial damage if they had occurred 100 years later. The 20<sup>th</sup> century included three major earthquake sequences with earthquakes of magnitude 7.1 or greater in Nevada, in 1915, 1932, and 1954. These events progressively caused more damage as Nevada was developed over time. Since the seismic network was installed in western Nevada in the 1970s over 38,000 small earthquakes have been recorded. Seismic, geologic, and geodetic data indicate that earthquake activity will continue to occur throughout Nevada, including events close to or within communities and urban centers.

Nevada's urban population and infrastructure continues to grow at a rapid pace, but growth continues in all areas of the state, steadily increasing the statewide risk of disastrous earthquakes. In fact, Nevada has had the highest population growth rate in the United States for the last 14 years. This high rate of growth represents an opportunity as well. If this growth can be guided to be seismically resistant, it would reduce the earthquake risk of a major portion of our population in a short time period.

Earthquakes will occur in the future in Nevada and, to prevent them from becoming disasters, Nevada's communities need to become seismically resistant. Buildings need to perform to acceptable levels, without loss of life or undue loss of property. The insides of buildings, the nonstructural components, need to be secure as well. All of Nevada's citizenry need to prepare for earthquakes before the next event. This includes developing an earthquake plan, reducing nonstructural hazards, identifying safety spots in every room you occupy, knowing how to duck, cover and hold, and successfully surviving the aftermath of an earthquake with emergency radios, lights, water and food. The recovery of the earthquake-affected area needs to begin immediately following the emergency response, to minimize business down time and to help protect local standards of living.

In order to build toward a seismically resistant Nevada, a continuous effort and profile must be maintained by a concerned and responsible public, officials, and professionals. The actions we take today towards being seismically resistant will increase safety and reduce losses from earthquakes that will occur tomorrow. It takes time to enhance building codes, to establish policies that promote seismic resistance, and for people to be motivated to prepare. What we can initiate now is better understanding of the earthquake hazards of the state and how to evade them. We can take aggressive action on policy, code, and behavioral changes that need to occur to truly make Nevada seismically resistant.

No one can prevent nor accurately predict earthquakes, but through the *Nevada Earthquake Risk Mitigation Plan*, the loss of life and property from an earthquake can be significantly reduced. This plan is the foundation to make Nevada seismically resistant at all levels, citizenry, business, and government, wisely living with the earthquake hazard that naturally exists in this state.

The ultimate goal is to make Nevada a seismically resistant state within the next 30 years, and to make significant strides in this direction within the next five years. Preliminary projections indicate that the average annual loss from earthquakes to Nevada is about \$60 million. Most of this will likely be incurred from multibillion-dollar earthquakes that occasionally will affect major urban areas of Nevada. If we are fortunate enough not to experience any disastrous earthquakes in Nevada over the next 30 years and we

become seismically resistant, we will lower the annual loss amount to Nevada, and Nevadans and our visitors distinctly will be safer from earthquakes.

# The Perspective

The *Nevada Earthquake Risk Mitigation Plan* continues an effort to make Nevada safe from earthquakes. This effort began with the more serious work on defining faults and earthquake hazards of Nevada in the 1960s and 1970s. The Nevada Seismological Laboratory was established in the 1970s and began locating earthquakes in the most seismically active parts of Nevada, providing significantly better earthquake locations and completeness of the earthquake catalog for western Nevada. The seismic network gradually expanded to the south to central Nevada and has incorporated the seismic network around the Nevada Test Site.

In the late 1980s, the pamphlet *Earthquakes in Nevada, and How to Survive Them* was first distributed jointly by the Nevada Bureau of Mines and Geology, Nevada Seismological Laboratory, and Nevada Division of Emergency Management, beginning a serious effort to get the word out to all Nevadans that there is an earthquake hazard in Nevada, erasing the misconception that earthquakes are principally a California problem. This pamphlet was printed in English and Spanish and is available on the Internet (see [www.seismo.unr.edu](http://www.seismo.unr.edu)).

Created in 1993, the Nevada Earthquake Safety Council has met quarterly every year since. This council represents all Nevadans and presented a uniform momentum to reduce earthquake risks in the state. It furthered communication of the hazard by producing earthquake maps and sponsoring local seismic hazard conferences, and produced an earthquake scenario for western Nevada emergency managers. The council established an Annual Earthquake Awareness Week and an earthquake program for Nevada schools. The schools program includes earthquake risk reduction poster contests, an earthquake hazard and risk calendar, and a earthquake drill held at all schools across the state at the same time during earthquake awareness week. With this program the Council fosters earthquake-knowledgeable next generations of Nevadans, and reinforces the knowledge of teachers. The council knows that Nevada must work aggressively today for a seismically safe tomorrow.

The first organization of a plan for earthquake risk reduction was *A Strategic Plan for Earthquake Safety in Nevada*, written by the Nevada Earthquake Safety Council. This plan serves as a framework for the activities of the Nevada Earthquake Safety Council. The vision laid out in this plan is “To enhance the personal safety and economic security of our citizens and visitors, and to reduce social and economic disruption when earthquakes occur in Nevada.”

Earthquakes are part of the ongoing geologic process that created Nevada’s beautiful mountainous landscape, pathways for many of Nevada’s fantastic hot springs, and contributed to forming some of the rich mining ores in Nevada. Earthquakes create a number of different hazards, including:

- Strong Ground Shaking
- Surface Faulting and Cracking
- Landslides, Slope Failures and Rock Falls
- Liquefaction and Related Ground Failure
- Regional and Local Subsidence or Uplift
- Flooding from Various Types of Failures
- Tsunamis from Lakes

Strong ground shaking can damage weak buildings and throw unsecured contents around creating safety hazards and property losses. Strong shaking can occur from local earthquakes, and in some situations where a location is within a sediment-filled valley, strong shaking can be generated by regional events.

As with any community, we will receive national and international attention when a damaging earthquake strikes Nevada. How well prepared we are, how much damage occurs, how we handle the response, and how we take care of our visitors will be the first and most important public relations opportunity to counter the negative image of an earthquake. We would like to show the world that we acknowledge that we live in earthquake country and that we have made great strides in dealing with this natural threat. We must make Nevada earthquake safe.

Recent California earthquakes taught us that earthquake risk mitigation and earthquake preparedness works. Lives were saved, injuries were minimized, property losses were reduced, and business disruption was limited by being prepared for earthquakes. These are the same goals we have for Nevada. To this end, we are aided by the knowledge and experience gained from California's efforts to become seismically resistant. Additionally, the Federal Emergency Management Agency has been supporting the development of techniques for the seismic rehabilitation of buildings and nonstructural hazard mitigation, many which are now published. We are in a unique position with many earthquake-risk mitigation strategies available to us, many of which have been tested by strong-ground motion from earthquakes in California and elsewhere. We need to evaluate and promote the most cost-effective of these mitigation strategies in making Nevada earthquake prepared and safe.

The ultimate goal for Nevada with respect to earthquake hazards is to have seismically resistant communities within a seismically resistant state. This means that when earthquakes occur, there is little or no loss of life, injuries are kept to a minimum and property and infrastructure losses are minimized and not critical. It also requires rapid emergency response that is well-organized, effective, and with adequate resources. Recovery must be rapid with minimal loss of business, and a complete return to the prior, or better, standard of living. Engagement in the activities noted by the *Nevada Earthquake Risk Mitigation Plan* is a way to achieve these goals.

## **The Plan**

The *Nevada Earthquake Risk Mitigation Plan* provides guidance to achieving a seismically safer Nevada. It consists of prioritized actions that will reduce losses from future earthquakes, including loss of life, loss of property, and loss of income/revenues. Given the historical earthquake and geologic record of Nevada, preparedness and mitigation actions are the only responsible course.

The plan addresses four major areas of earthquake risk reduction:

- Defining the earthquake hazard
- Learning about earthquake hazards, preparedness, and risk mitigation
- Planning and building for earthquakes
- Living with earthquakes

Defining earthquake hazards is addressed in the Geoscience section. This includes mapping faults, characterizing the size and occurrence of earthquakes along faults, and expanding the seismic station network.

Earthquake awareness and education is the major focus of communicating earthquake hazards, preparedness for earthquakes, and earthquake risk mitigation to Nevada's citizens, professionals, and decision makers. Part of the strategy of this task is the Nevada Schools Earthquake Program, a concentrated effort toward making the next generations of Nevadans well informed about earthquakes.

In making a more seismically resistant built environment, the plan addresses issues of land use and improvements for existing buildings and new construction, including the mitigation of nonstructural hazards, and utilities and transportation. For living with earthquakes, the plan includes the enhancement of earthquake preparedness, emergency response, and recovery from an earthquake disaster.

The different major elements of this plan (e.g., Awareness and Education) are described using "objectives" and "strategies." Objectives are short statements of an overall goal to be achieved under each major element. Strategies are specific activities or categories of activities that will help in reaching the objective.

In the Plan Matrix some additional terms are used:

- ❖ "Concern" is a short highlight of the problem addressed by the objective;
- ❖ "Benefits" are some of the main, end-line enhancements resulting from achieving the objective;
- ❖ "Responsibilities" are the main state and local agencies or groups that would be engaged in the strategies listed.

Priorities are given to the different strategies that primarily indicate temporal and relative urgency. Only strategies with the first two priorities ("critically important" for first priority, "very important" for second priority) are included in this initial draft plan. All strategies that make the plan are "important," meaning they should be engaged as soon as possible and completed by the target date.

Strategies that should be implemented immediately and finished as soon as possible are labeled “critically important.” These are the first-priority strategies that fill an immediate gap in earthquake risk reduction or are foundations for other strategies. The strategies labeled “very important” need to be implemented soon. Even though priorities are given, all strategies should be undertaken, at least at a conceptual or planning level.

The plan is a living document, meant to grow and dynamically evolve in ways that focus on the most effective strategies for earthquake risk reduction. As such, the plan needs a specific identification number. This plan can be referred to as **NERMP-2001/2002**.

This plan provides the framework for a 30-year effort to make Nevada a seismically resistant state. The plan will be refined annually after reviews by the Nevada Earthquake Safety Council and the Federal Emergency Management Agency. The plan details many of the strategies laid out in the *Strategic Plan for Earthquake Safety in Nevada* (prepared in 1996 by the Nevada Earthquake Safety Council) and challenges all Nevadans to address our earthquake hazard.

The Nevada Earthquake Safety Council will review this plan annually, with responsibility for updating assigned to its Risk Mitigation Committee. Implementation, monitoring and evaluation of the plan will be a shared function of each of the standing committees coordinated through the Risk Mitigation Committee. Overall responsibility for the plan rests with the NESC as advisors to the State of Nevada Office of Emergency Management.

# Awareness and Education

Policy makers, professionals, and private citizens need to be adequately prepared for making knowledgeable decisions that reduce seismic risk. Engagement and encouragement of many facets of society will help with this preparation through education.

## Objective #1: Increase Knowledge to make Effective Decisions

Develop a comprehensive education strategy that will affect all segments of society and will specifically target policy makers, professionals, members of the public, and the students of Nevada, enabling all to make effective decisions about reducing losses from earthquakes. This requires promoting a change in attitude about earthquake safety and awareness of prevention and mitigation benefits in reducing earthquake losses.

### Benefits:

Nevada citizens, students, public officials, and visitors would become more earthquake safe. Public officials will become better educated and informed, design professionals more capable, and public support stronger.

### Strategies:

#### 1.1.1 Increase public awareness in Nevada

Develop information, maps, fact sheets, newspaper inserts, and other means to get the message out about earthquake hazards, preparedness, and the mitigation of earthquake risks. Engage the public through Nevada Earthquake Awareness and Preparedness Week, meetings and presentations, the media and Internet.

The public needs to understand the earthquake threat in Nevada, how to behave during earthquakes to minimize personal risk, and how to secure home and work environments to minimize injuries, deaths, and economic losses from earthquakes. Some methods for information include:

- Seismo-Watch – public earthquake activity and preparation information published in newspapers, via fax, and a Web site [www.seismo-watch.com](http://www.seismo-watch.com)
- Web site information: Nevada Bureau of Mines and Geology [www.nbmg.unr.edu](http://www.nbmg.unr.edu) and the Seismological Laboratory [www.seismo.unr.edu](http://www.seismo.unr.edu)
- Emergency Management and Preparedness Courses taught by emergency management professionals around Nevada.
- Public-private partnerships including local milk company milk carton informational campaigns.
- Wide distribution of “Living with Earthquakes in Nevada,” a publication of the NBMG, particularly to schools, but also available to the public.
- Publish regular updates to Nevada Bureau of Mines and Geology epicenter maps (publication updated in 1999).

Priority: Critically important  
Target date: Annual activity

### **1.1.2 Nevada Schools Earthquake Program**

Develop a Nevada Schools Earthquake Program that engages students, faculty, and administrators in understanding earthquakes and ways to reduce earthquake risks. The program should include promoting an annual statewide earthquake drill, promoting earthquake-awareness activities, such as an earthquake safety poster contest, and disseminating earthquake-awareness information to schools, such as an earthquake safety school calendar and distribution of the Preparedness Guide for Schools (Caughlin Ranch Model 1998/99). These activities are geared at educating the next generations about earthquakes and earthquake safety, and sustaining a well-informed, earthquake-safe public.

Priority: Critically important  
Target date: Annual activity

### **1.1.3 Inform public officials**

Conduct workshops and make presentations at meetings for city, county, and state officials on local earthquake hazards, earthquake risks, and loss reduction measures. Engage with officials supporting inquiries and seismic safety initiatives. The goal is to have better informed decision and policy makers who can lead Nevada into becoming earthquake safe.

Priority: Very important  
Target Date: Annual activity

# Media and Public Information

Media distribute information rapidly and widely in a short time. Accurate and responsible release of information, particularly during a disaster, is critical to assist response and recovery decision makers and private citizens with understanding the disaster and avoiding worsening the disaster due to panic. In addition, the media plays a valuable role in helping the public understand and prepare for earthquakes.

## Objective #1: Increase Knowledge to make Effective Decisions

Develop a comprehensive media and public information strategy that will affect all segments of society and will specifically target policy makers, professionals, and members of the public, enabling all to make effective decisions about preparing for and reacting to losses from earthquakes. This requires promoting a change in attitude about earthquake safety and awareness of prevention and mitigation benefits in reducing earthquake losses.

### Benefits:

Nevada citizens, public officials, and visitors would become more earthquake prepared. Public information and emergency alerts will enhance better understanding during disasters and reduce potential for panic.

### Strategies:

#### 2.1.1 Increase public awareness in Nevada

Distribute information, maps, fact sheets, newspaper inserts, and other means to get the message out about earthquake hazards, preparedness, and the mitigation of earthquake risks. Engage the public through Nevada Earthquake Awareness and Preparedness Week. The public needs to understand the earthquake threat in Nevada, how to behave during earthquakes to minimize personal risk, and how to secure home and work environments to minimize injuries, deaths, and economic losses from earthquakes. Some methods for information include:

- Publish earthquake activity and preparation information in newspapers, via fax, and a Web site [www.seismo-watch.com](http://www.seismo-watch.com)
- Web site information: Nevada Bureau of Mines and Geology [www.nbmg.unr.edu](http://www.nbmg.unr.edu) and the Seismological Laboratory [www.seismo.unr.edu](http://www.seismo.unr.edu)
- Public informational campaigns about the earthquake hazards and preparedness
- Distribution of “Living with Earthquakes in Nevada,” a publication of the NBMG, as a newspaper supplement for the benefit of the public.

Priority: Very important

Target Date: 2001

### **2.1.2 Establish earthquake event media official information sources**

Media sources should work with the Nevada Earthquake Safety Council and state and local emergency response officials to establish accurate information sources for use during an earthquake event. Such sources should include the earthquake scientist's databases and a list of knowledgeable emergency operations center officials who can provide appropriate and relevant guidance. Information and instructions to be released to the public should be factual and useful to assist emergency officials and the public in having sufficient and appropriate information during a disaster.

Priority: Very important

Target Date: 2001

### **2.1.3 Establish earthquake event media protocols**

Media sources should work with the Nevada Earthquake Safety Council and state and local emergency response officials to establish protocols for release of information. Such protocols should include:

- ✓ Post-earthquake announcements timing and media scripts for first 10 minutes following an event
- ✓ Post-earthquake announcements timing and media scripts for after ten minutes to two hours following the event
- ✓ Post-earthquake announcements timing and media scripts for two to six hours following the event

The types of information and timing of release are critical to assist the public following an earthquake event. The information can be life saving, but should be clear and avoid inducing panic as a result of misinformation. Verification of facts before release of information is essential.

Priority: Very important

Target Date: 2001

### **2.1.4 Establish post earthquake event recovery role for media**

Media should become informed and utilize official sources for information about the recovery process. The media should play a role in providing adequate information to the public to inform them about the recovery efforts, sources for relief assistance and how to cope during the recovery time.

Priority: Very important

Target Date: 2001

# Preparedness

Individuals, business owners, and corporate decision makers do not fully understand the potential loss of life, injury, personal dislocation, social disruption, and economic losses that can result from earthquakes. Yet, this is an area where some of the largest impacts on seismic safety can be made. If Nevadans are better prepared for earthquakes, earthquake losses will be reduced.

## **Objective #1: Increase Earthquake Consequence Understanding**

Increase understanding of the consequences from earthquakes (personal devastation, social disruption, and economic loss), options from mitigation of earthquake risks, and the need to take action.

### **Benefits:**

Increased preparedness for earthquakes will yield significant reduction in the losses from earthquakes, a significantly smoother emergency response period for citizenry and consequently fewer injuries and losses.

### **Strategies:**

#### **3.1.1 Prepare earthquake planning scenarios**

Develop earthquake planning scenarios for all major communities in Nevada. These will help community leaders and planners to conceptualize the potential hazard and risks and to develop emergency response plans accordingly. These scenarios can motivate mitigation and a reduction of risks because they are community specific and easy to relate to public concerns. With HAZUS, the Geosciences Committee can prepare scenarios to assist with this process.

Priority: Very important

Target date: 2005

#### **3.1.2 Distribution of earthquake preparedness and risk mitigation information**

Create and distribute earthquake preparedness and risk mitigation information in different formats with the goal of reaching most Nevadans including operators of hotels and casinos.

Publicly recognize mitigation efforts by public and private agencies through an Award in Excellence for Earthquake Risk Mitigation program. Announce awards during Earthquake Awareness and Preparedness Week.

Promote nonstructural mitigation focusing on schools and high occupancy facilities.

Priority: Very important

Target date: 2002

## **Emergency Response**

Emergency response needs to be enhanced through improved communication systems, training and familiarization of the members of the emergency response community, and improved techniques, such as in search and rescue.

### **Objective #1: Improve Emergency Management, Response and Recovery Systems**

Integrate the existing emergency management system at all levels of the government and the private sector, and conduct training and exercises to accomplish an effective level of readiness for the protection of life, health, property, and the environment during and after an earthquake.

#### **Benefits:**

Improved and effective emergency responses will lead to preservation of lives, health, and property.

#### **Strategies:**

##### **4.1.1 Enhance the integrated emergency management system statewide**

Review multilevel emergency management linkages and reacquaint personnel from different levels with each other. Integrate further emergency plans and mutually work on problems to smooth out difficult or missing linkages. Encourage development of coordinated communication systems for integrated response and recovery systems statewide.

Priority: Critically important

Target date: 2002

##### **4.1.2 Enhance communication capabilities for responders**

Promote upgrading regional and local emergency communications and establish regional standards for emergency communication, including response and recovery broadcast channels for the public. Encourage use of Incident Command System for local governments, public safety agencies, business and industry, hospital facilities and nonprofit agencies.

Priority: Very important

Target date: 2003

#### **4.1.3 Establish specialized community emergency response teams (CERTs) and damage assessment teams statewide**

Develop annual training programs for CERTs and establish CERTs throughout Nevada. A roster of these teams needs to be kept and supplies, such as vests for emergencies, distributed to the teams.

Priority: Very important

Target date: Annual activity (start in 2001)

#### **4.1.4 Develop effective exercises and training, based on earthquake scenarios, for all levels of the emergency management system statewide, including hospitals**

Create and promote exercises and training using local earthquake scenarios to familiarize personnel with earthquake disasters, evaluate the effectiveness of existing response plans, and enhance response strategies, plans, and interagency communication using lessons learned from the exercise and training activities.

Priority: Very important

Target date: Annual activity

#### **4.1.5 Establish mutual-aid agreements among communities within the state and with other states**

Review existing mutual-aid agreements, evaluate what other mutual-aid agreements would be beneficial, and promote the establishment of those additional agreements.

Priority: Critically important

Target date: 2002

#### **4.1.6 Enhance planning to deal with hazardous materials releases related to earthquakes**

Develop plans to handle simultaneous, multiple-incident, multiple-location, multiple-component hazardous material spills and the posed risks, including procedures for mass warnings and evacuations. Use information developed by Local Emergency Preparedness Committees. Promote the use of inter-agency hazardous materials response teams.

For high-risk, high-public interest areas such as Yucca Mountain, plans should encompass physical hazards and the public perception of risk of nuclear releases after an earthquake. To the extent earthquake events can release hazardous materials that cause damage to public waterways and waterworks facilities ability to provide clean water, the plans should address alternative sources for public water supplies.

Priority: Very important

Target date: 2004

# Recovery

The earthquake recovery process is generally less planned for than the more immediate and visible aspects of a disaster, such as emergency response, yet earthquake recovery has a major impact on the long-term financial and social health of an area following a major earthquake disaster. Recent earthquakes in California and floods in Nevada reveal clear problems that can develop following an earthquake disaster, many of which can be ameliorated or eliminated with a pre-disaster plan. Effective management of the recovery process can aid a community in a rapid and complete recovery in normalizing its financial base, standard of living, and social environment following an earthquake disaster.

## **Objective #1: Develop State, County, and Community Level Plans for Recovery after a Major Earthquake.**

Develop state, county, and community level plans to gain a scope of potential problems, and familiarize decision makers, business people, and the public with the recovery process following a disastrous earthquake. The strategy for dealing with recovery will facilitate a rapid and complete recovery.

### **Benefits:**

Facilitate the rapid and complete recovery of a Nevada community from a disastrous earthquake, minimizing negative impacts on the financial community and local standards of living.

### **Strategies:**

#### **5.1.1 Develop a multilevel plan for the rapid recovery of a community struck by a disastrous earthquake**

A recovery plan should involve all levels of government and private businesses and industry. It should focus on the main problems associated with the recovery of an area following a disastrous earthquake and what strategies have successfully been employed to deal with these problems. Use of Local Emergency Preparedness Committee information for environmental hazards should be incorporated into the plan. It should define the disaster recovery operations period, initial recovery decision processes, financing/funding resources and federal, state and local roles. It should include elements from the State Emergency Response Commission's plans.

Priority: Very important

Target date: 2003

#### **5.1.2 Hold conferences, workshops, and exercises on the recovery plan**

Upon completion of the Nevada Earthquake Recovery Plan, hold a statewide conference to present, promote, and improve the plan. Additionally hold exercises and workshops based upon the Western

Nevada Earthquake Planning Scenario to promote the idea of earthquake recovery, further develop or enhance the recovery plan, evaluate the effectiveness of the recovery plan, and to promote policies that support rapid and complete recovery from earthquakes. Inform business and industry and the public about the plans and exercises and invite participation.

Priority: Very important

Target date: 2003

## **Objective #2: Rapid and Effective Post-Earthquake Assessment of Structures**

Rapid inspection teams need to be set up throughout the state. The teams should be trained, certified, and credentialed to respond following a damaging earthquake, to organize and assess the levels of damage to building stock and infrastructure, and to post results for rescue operations, occupancy following an earthquake, damage assessment, and recovery planning.

### **Benefits:**

Trained groups of Nevada professionals throughout the state could respond quickly to any earthquake disaster in the state, would have credibility as trained Nevada professionals to increase the likelihood of compliance, and would have the linkages to Nevada emergency and disaster managers to make the information available to use as quickly as possible. The safety of rescue teams and the safety of citizens and visitors post-earthquake would be maximized. The recovery process can proceed more rapidly.

### **Strategies:**

#### **5.2.1 Develop post-earthquake assessment teams throughout Nevada**

Hold beginning and enhancing training sessions and workshops to train and keep trained Nevada professionals willing to perform post-earthquake assessments. Active rosters, a command structure, credentialing, and resources, such as red, yellow, and green placards should be maintained with each team.

Priority: Very important

Target date: Annual activity

#### **5.2.2 Develop guidelines for streamlined post disaster permitting and rebuilding processes.**

Guidelines should be developed defining essential services as including hospitals, fire, ambulance and police services and shelters (schools and auditoriums). The guidelines should include:

1. Assignment of priority codes for performance of new buildings
2. Mitigation of existing buildings to bring to current codes
3. Mitigation of nonstructural hazards
4. Assessment of risks and promotion of mitigation plans
5. Maintaining functional capacity of structures using performance based design standards

Priority: Very important  
Target date: 2002

### **5.2.3 Utilize HAZUS to estimate the degree of risk of injury and damage**

HAZUS software applied to GIS databases should be used to simulate scenarios in identified high probability earthquake hazard areas where concentrations of structures or people may indicate potential for significant losses. The scenarios should assist with understanding the risk characteristics of the scenario so that mitigation and disaster management efforts can better be targeted.

HAZUS also should be used for scenarios where properties of historical significance are located. This would enable the State Historic Preservation Office and local officials to understand the damageability potential and to take measures to prevent or mitigate damage to these structures.

Scenarios also should be used to measure the damage to critical infrastructure and facilities such as healthcare and emergency response services. This would enable officials to plan for alternative measures to ensure their ability to provide needed public services during a disaster.

Scenarios will show direct and induced earthquake damage and include the social and economic losses. Social losses include casualties and shelter requirements. Economic losses include building damage, transportation and utility lifeline losses and long-term indirect economic impacts.

Priority: Important  
Target date: 2005

# Geosciences

Effective land-use planning and design must recognize the geologic environment and identify earthquake hazards. Every major earthquake yields new geologic data. However, this new knowledge is not being fully incorporated in planning, design, and construction. Most advances have been motivated by reaction to disasters rather than good risk reduction strategies based on current and proven geologic knowledge. Rapid urbanization in Nevada is causing the loss of critical sites for studying and defining earthquake hazards. Unless the remaining critical sites are studied soon, we will be left with characterizing earthquake hazards with uncertain assumptions and indirect data.

## **Objective #1:      Develop Geoscience Information**

Continue to improve the structural performance of buildings, utility, and transportation systems through effective use of new and existing geoscience data.

### **Benefits:**

New, more available, and consequently better use of geoscientific knowledge will enable professionals to improve planning and design to achieve higher levels of performance and ensure reduced losses. Evaluating faults in rapidly urbanizing areas will salvage critical information that will soon be destroyed or buried by construction.

Salvaging of information from faults that soon will be lost due to urbanization.

### **Strategies:**

#### **6.1.1 Map earthquake hazards in planned and developed urban areas in Nevada**

Promote efficient, accurate, and reliable mapping of earthquake hazards in all planned and developed urban areas in Nevada, as soon as practical. These maps should include a process of independent review to add to their credibility. End users should be included in the review process.

Priority: Critically important

Target date: 2010

#### **6.1.2 Characterize earthquake hazards in Nevada**

Promote statewide mapping, trenching, paleoseismic research, and characterization of the seismic hazards of Quaternary faults. Establish a working group on seismic hazards for Nevada to gain consensus on input values for seismic hazards in Nevada, documentation of these consensus, and the posting of the results through publication and on the World Wide Web.

Much of the seismic hazard information for individual faults is uncertain. As the information becomes clearer, the NESC working group on seismic hazards will need to develop a probability ranking of hazard related events and the NESC then should develop priorities for addressing the high potential hazards.

Conduct conference on seismic hazards in the Las Vegas area.

Priority: Critically important

Target date: 2003

### **6.1.3 Urban strong-ground motion network**

Promote the development of dense strong-ground motion networks in the Las Vegas area, the Reno-Carson City urban corridor, and other major communities in Nevada to characterize basin response influences on ground motion, influences of local site effects on ground motion, and ground motion prediction techniques.

Funding for expansion of the strong motion network added five instruments in the Reno/Sparks/Carson City area and three in Las Vegas in 1999. Additional instruments should be added to enhance data collection.

Priority: Critically important

Target date: 2010

### **6.1.4 Completion of seismic network in Nevada**

Because Western Nevada has a history of major earthquakes, the existing seismic network is focused on West-Central Nevada. And with the Yucca Mountain area in Southern Nevada being considered as a national high-level nuclear waste disposal site, the network was extended to that area. Hazardous events generally are considered to be of magnitude 5.5 or greater. Although the network can detect such events anywhere in the state, scientists are limited in gaining a precise location of a particular event in most parts of the state without deploying temporary seismic stations.

Support for the expansion and completion of the seismic station array of the Nevada Seismological Laboratory to include all of Nevada, and particularly the enhancement of coverage in the Las Vegas region. Accurate recording of all earthquakes occurring in Nevada helps in defining of the seismic hazards of Nevada and in understanding the location and potential damage from an earthquake for emergency response activities.

Priority: Critically important

Target date: 2010

### **6.1.5 Characterize site response in urban areas**

Promote measurement and characterization of site response to strong ground motion in urban areas, particularly where new development is going to occur. Past earthquakes have shown that damage is concentrated in areas with unfavorable site responses; if these effects are characterized, special considerations for ground motion in these areas is required for designing seismically resistant structures.

Priority: Critically important  
Target date: 2010

### **6.1.6 Characterize land subsidence and liquefaction hazards in Nevada**

Continue to develop and implement guidelines for evaluating land subsidence and liquefaction hazards in Nevada. Promote use of existing guidelines (posted on the NESC and NBMG Web sites).

Priority: Very important  
Target date: 2010

## **Objective #2: Full Application of Geosciences**

Ensure consistent and effective application of geoscience knowledge and continuously improve risk reduction strategies based on application of the most current knowledge available.

### **Benefits:**

Better use of geoscientific knowledge will enable professionals to improve planning and design to achieve higher levels of performance and ensure reduced losses.

### **Strategies:**

#### **6.2.1. Upgrade/produce earthquake hazard maps**

Existing earthquake-hazard maps should be updated, and new forms of presentation should be developed to facilitate the use of these data as rapidly as possible. These maps should include direct fault rupture hazard, surficial shear-wave velocities and other data relevant to potential ground motion, and collateral hazards, such as rock fall, landslide, and liquefaction potentials.

Nevada Bureau of Mines and Geology produced several new and updated maps in 1999. These will serve as a basis for future expanded map efforts. Publish regular updates NBMG epicenter maps (updated in 1999). A map of the existing hazards has been incorporated into the "Living with Earthquakes in Nevada" pamphlet published in 2000 by the Nevada Bureau of Mines and Geology (Special Publication 27). The pamphlet can be ordered from NBMG or downloaded from their Web Site [www.nbmge.unr.edu](http://www.nbmge.unr.edu).

Priority: Very important  
Target date: 2010

#### **6.2.2 Hold learning workshops**

Workshops that present new maps and tools and improve the use of current geoscience knowledge should be held in different parts of the state following development of Strategies 6.1.1 and 6.2.1 to infuse and invigorate the most effective use of geoscience information in the planning of urban development and the best approaches to getting the desired performance levels out of buildings in Nevada.

Priority: Very important  
Target date: 2004

### **6.2.3 Put seismic hazard and earthquake risk mitigation information on the Internet**

A specific element to Strategy 6.2.1 should include the development of a posting on the World Wide Web of seismic hazard information for Nevada and the promotion of several links to that site. This information should be detailed and easy to search, documenting all major decisions in characterizing seismic hazards in Nevada.

Priority: Very important  
Target date: 2004

### **6.2.4 Outreach activities**

Conduct specific outreach activities, such as giving talks, leading tours and field trips, writing short hazard-description papers, creating earthquake-planning scenarios activities, and explaining local hazards and scenarios to communities.

Conduct structural and non-structural mitigation workshops for the public in cooperation with local vendors. The goal is to inform the public about cost effective mitigation measures for existing structures and non-structural hazards and to provide them the skills with which to perform their own mitigation measures.

Priority: Very important  
Target date: Annual activity

## **Objective #3: Improve Seismic Safety Practices**

Ensure consistent and effective application of geoscience knowledge and continuously improve risk reduction strategies based on application of the most current knowledge available.

### **Benefits:**

Better use of geoscience knowledge and information will enable professionals to improve planning and design to achieve higher levels of performance and reduce losses.

### **Strategies:**

#### **6.3.1 Promote seismic mitigation strategies**

Develop guidelines for earthquake hazards that are a consensus of professionals working in the state and that represent professional practice. Specific guidelines to be developed should include special study zones along faults and liquefaction hazards.

Presently risks are measured using the Mercali Scale, but no mapping showing overlays of population, property values and risk variables demonstrates in a measurable way the degree of risk. With HAZUS technology, we now have the ability to begin such mapping.

The Geosciences Committee should select the earthquake risk areas to target for expanded mapping and select the variables, priorities and weightings for identified hazard areas. HAZUS scenarios initially should be prepared for Clark County, Churchill County, Douglas County, and Washoe County at specific fault sites identified by seismologists.

Master plans adopted by planning commissions and governing bodies must, per Nevada Revised Statutes 278.160.1(n), incorporate a Seismic Safety Plan that consists of an identification and appraisal of seismic hazards such as susceptibility to surface ruptures from faulting to ground shaking or to ground failures.

Incorporate geoscientific knowledge of seismic hazards into the development and/or modification of land use planning policies through local government ordinances. Recommend the inclusion of hazard mitigation features for new and existing structures subject to such plans.

Priority: Very important  
Target date: 2000

### **6.3.2 Promote seismic safety considerations**

Promote the incorporation of geoscientific knowledge in planning, design, and construction processes at the initial phase of public consideration, and ensure that site-specific data are incorporated into the strategy for seismic safety.

Priority: Critically important  
Target date: 2003

# Land Use

Efficient use of land is one of the most critical issues in effective loss reduction and recovery from the disastrous effects of earthquakes.

## **Objective #1: Develop in and Use Areas that Are Relatively Safe or can be Made Safe from Seismic Hazards.**

Improve land-use planning so that balance is achieved between the needs of the state's increasing population and economic growth, and the constraints imposed by seismic hazards.

### **Benefits:**

Land-use planning that incorporates earthquake hazard risk mitigation strategies and minimizes the impact on property when an earthquake occurs.

### **Strategies:**

#### **7.1.1 Incorporate seismic hazards into general plans**

Promote the incorporation of earthquake risk reduction practices into general plans, such as the adoption of contemporary editions of the International Building Code. Include subsidence and liquefaction risks into general plans.

Incorporate geoscientific knowledge of seismic and liquifaction hazards into the development and/or modification of land use planning policies through local government ordinances. Recommend the inclusion of hazard mitigation features for new and existing structures subject to such plans.

Priority: Very important  
Target date: 2005

#### **7.1.2 Develop mitigation strategies**

Facilitate the adoption of earthquake risk reduction practices. These practices need to be described and/or developed, and their practicality, effectiveness, and positive benefit-to-cost ratios demonstrated. This can be arrived at through research and through the promotion of existing mitigation projects. Promote local planning codes to include earthquake risk mitigation strategies.

Priority: Very important  
Target date: 2005

# Lifeline Utilities

Lifeline utilities systems can experience severe disruptions when there are insufficiently earthquake resistant major supply lines or ones that lack adequate redundancy (alternate systems). Numerous local distribution lines and alternate systems likewise can be seismically vulnerable and be overwhelmed by widely distributed earthquake damage.

Primary concerns arise about most public and private water supply systems, including dams, and older natural gas distribution systems. Power systems disruptions can affect innumerable electricity based devices in critical facilities essential to disaster management. Disruption of these systems could cause extensive long-term economic losses, social disruption and personal danger.

## **Objective #1: Ensure only short term interruptions**

To ensure that all public and private lifeline utilities systems can withstand earthquakes to the degree that they will be able to provide protection of life, limit property damage and provide for the prompt resumption of system functions. Only short-term interruptions, minimal losses and minor economic disruption to an affected region should be the goal.

### **Benefits:**

Timely restoration of utilities links will ensure a significant reduction in societal costs and minimize economic devastation.

### **Strategies:**

#### **8.1.1 Establish seismic performance standards**

Establish seismic performance standards for all lifeline utilities systems, including interdependent systems, such as water and gas, to ensure adequate risk reduction strategies.

Priority: Very important

Target date: 2003

#### **8.1.2 Minimize secondary effects**

Establish a comprehensive program to minimize the secondary effects such as gas fires, hazardous materials spills, sanitation overflows, etc. that result from damage and disruption to a utility system.

Priority: Very important

Target date: by 2003

#### **8.1.3 Evaluate system vulnerability**

Evaluate each system to identify its vulnerabilities for life safety and service disruption. Establish priorities for risk reduction strategies, including redundancy, to mitigate the vulnerabilities.

Priority: Very important

Target date: by 2002

#### **8.1.4 Retrofit critical systems**

Evaluate, fund and authorize retrofit of all major lifelines.

Priority: Very important

Target date: by 2005

# Transportation and Bridges

Transportation, essential highway bridge systems and major railroad systems can experience severe disruptions when there are insufficiently earthquake resistant major routes and bridges and high volume routes or ones that lack adequate redundancy (alternate systems). Numerous local traffic routes and secondary routes likewise can be seismically vulnerable and be overwhelmed by widely distributed earthquake damage.

Disruption of these systems could cause extensive long-term economic losses, social disruption and personal danger. Bridges can collapse and cause severe disruptions to transportation routes.

## **Objective #1: Ensure only short term interruptions**

To ensure that all public and private transportation systems can withstand earthquakes to the degree that they will be able to provide for the prompt resumption of system functions. Only short-term interruptions, minimal losses and minor economic disruption to an affected region should be the goal.

### **Benefits:**

Timely restoration of bridges and transportation links will ensure a significant reduction in societal costs and minimize economic devastation.

### **Strategies:**

#### **9.1.1 Establish seismic performance standards**

Establish seismic performance standards for all bridges and transportation systems, including interdependent systems to ensure adequate risk reduction strategies.

Priority: Very important

Target date: 2003

#### **9.1.2 Minimize secondary effects**

Establish a comprehensive program to minimize the secondary effects of route disruptions such as fires, hazardous materials spills, etc. that result from damage and disruption to a bridge or transportation system.

Priority: Very important

Target date: by 2003

### **9.1.3 Evaluate system vulnerability**

Evaluate each system to identify its vulnerabilities for life safety and transportation disruption. Establish priorities for risk reduction strategies, including redundancy, to mitigate the vulnerabilities.

Priority: Very important

Target date: by 2002

## **Objective #2: Replace or Retrofit Critical Bridges**

Initiate retrofit or replacement program to ensure that all public and private transportation systems can withstand earthquakes to the degree that they will be able to avoid disruption of emergency response efforts.

### **Benefits:**

Avoidance of disruption to transportation links will ensure effective emergency response and permit rapid recovery from an earthquake, thus enabling a significant reduction in societal costs and minimizing economic devastation.

### **Strategies:**

#### **9.2.1 Establish seismic performance standards**

Establish seismic performance standards for all bridges to ensure adequate risk reduction strategies.

Priority: Very important

Target date: 2005

#### **9.2.2 Minimize secondary effects**

Establish a comprehensive program to minimize the secondary effects such as interruption of emergency response and recovery efforts. Develop alternative access route recommendations for emergency vehicles.

Priority: Very important

Target date: by 2003

#### **9.2.3 Evaluate system vulnerability**

Evaluate each bridge and related transportation system to identify its vulnerabilities to disruption of emergency response and recovery. Develop a priority ranking system that identifies the highest hazard bridges from an emergency response and transportation lifeline preservation perspective.

Priority: Very important  
Target date: by 2003

#### **9.2.4 Retrofit critical systems**

Evaluate, fund and authorize rebuilding or retrofit of all bridges critical to emergency response following and earthquake.

Priority: Very important  
Target date: by 2005

## Existing Buildings

Many of Nevada's buildings, including homes, are vulnerable to damage from earthquakes. Vulnerable buildings can be upgraded to prevent the loss of life or to the anticipated levels of performance.

### **Objective #1: Upgrade Vulnerable Buildings to Acceptable Levels of Performance**

Initiate aggressive efforts toward reducing vulnerability to loss of life and property in existing buildings.

#### **Benefits:**

Significant reductions in life loss, property damage, and business interruptions will result from applying retrofitting strategies to vulnerable buildings.

#### **Strategies:**

##### **10.1.1 Develop educational program on retrofit methodologies**

Develop an education program that provides information and promotes the seismic rehabilitation of buildings, including the compiling of potential methodologies and some examples of the types of methods that have been used in Nevada. The results could be compiled into a pamphlet and on a World Wide Web site.

Promote use of local codes to include earthquake retrofit features during major renovations, expansions or reconstruction of existing buildings. Develop effective methodologies for seismic retrofit including minimum standards and enhanced performance-based standards for structural and nonstructural elements of all buildings, particularly those used for essential services.

Priority: Very important

Target date: 2003

### **Objective #2: Mitigate Nonstructural Risks**

Aggressively promote the securing, removing, replacing, or relocating of nonstructural hazards in places of human occupancy or of high property loss potential, and educate Nevadans and visitors to Nevada about taking cover and avoiding nonstructural hazards during earthquakes. Any object in a building that is not a part of the structural framework is considered a nonstructural

component. Bookshelves, windows, televisions, computers, water heaters, lights, office equipment, file cabinets and ventilation ducts are examples of nonstructural components subject to becoming falling objects during an earthquake.

**Benefits:**

Significant reduction in the number of deaths, injuries, loss of property, and business interruption from earthquakes. Increase in psychological adaptation to earthquakes due to sense of empowerment gained from mitigation activities.

**Strategies:**

**10.2.1 Develop education program on nonstructural hazard mitigation**

Promote the mitigation of nonstructural hazards through information and guidelines, active introduction of the concept and mitigation techniques to Nevadans, demonstration projects, and potential workshops or forums on nonstructural mitigation.

Priority: Critically important

Target date: Annual activity

**10.2.2 Promote research on nonstructural hazard mitigation**

Promote and support research on strategies and techniques to easily and cost-effectively mitigate nonstructural hazards. Priority will be given to testing existing techniques recommended for mitigation and to new techniques that are practical for Nevadans to use.

Priority: Very important

Target date: Annual activity

**Objective #3: Inventory Potentially Seismically Dangerous Buildings in Nevada**

Conduct an inventory of potentially seismically dangerous buildings in Nevada, including unreinforced masonry construction, soft-story construction, and non-ductile concrete construction; compile information on general potential rehabilitation techniques and associated costs.

**Benefits:**

An inventory of buildings that are potentially seismically dangerous would allow the Nevada public and officials to understand the scope of our seismic vulnerabilities and the potential earthquake risk. These data would allow more accurate loss estimations from earthquakes to be made for the overall state and for local earthquake scenarios.

**Strategies:**

### **10.3.1 Develop the types of potentially seismically dangerous buildings to be inventoried and the approach to inventorying**

Create a subcommittee of NESC to review the kinds of buildings to be included in the inventory and what possible approaches can be used to conduct the inventory. Focus on historic, schools and public occupancy structures in which life safety and cultural preservation are priority elements.

Priority: Very important

Target date: 2001

### **10.3.2 Conduct the inventory of potentially seismically dangerous buildings**

Inventory buildings that are seismically dangerous by city/community, county, and state, including existing and planned buildings, and projections of future buildings to be built. Include a FEMA HAZUS format in the final compilation to be used for creating earthquake scenario loss estimations.

Priority: Very important

Target date: 2003

### **10.3.3 Evaluate losses from inventory, benefits and losses of mitigation, strategies of financing**

Evaluate and summarize the losses implied by the inventory of potentially seismically dangerous buildings. Summarize possible mitigation strategies and develop some sample cost-benefit analyses. Also summarize possible strategies for financing mitigation projects.

Priority: Very important

Target date: 2005

# New Construction

Earthquake protection of new construction using new technology for life safety and collapse resistant structures proved successful in California earthquakes. Nevada should learn from the poor results in California earthquakes for new construction that did not utilize the new technology. Incomplete information and knowledge about the performance of materials and systems, lack of an integrated approach to seismic design, and inadequate quality control in design and construction have compromised both life safety and property preservation. Achieving continuous improvement in understanding structural performance and cost-effective construction methods should lead to a safer Nevada whether replacing old structures with new or building entirely new structures.

## **Objective #1: Upgrade Understanding of Building Design to Achieve Acceptable Levels of Performance**

Initiate aggressive efforts toward reducing vulnerability to loss of life and property in planning and designing new buildings. Develop techniques that achieve higher levels of earthquake performance that will reduce damageability, minimize environmental damage and mitigate the effects of earthquake damage on the economic viability of the state.

### **Benefits:**

Significant reductions in life loss, property damage, and business interruptions will result from applying aggressive seismic safety strategies to new construction.

### **Strategies:**

#### **11.1.1 Develop integrated approach to seismic design**

Enforce applicable seismic safety codes for all new construction, including publicly owned facilities, industrial facilities and others that presently have exemption from building regulation.

Utilize an integrated approach to design of new facilities that considers all elements of the construction (structural and nonstructural elements, support systems, site improvements, etc.) that contribute to seismic performance. Responsibility should be vested in the identified design professional for the facility.

Priority: Very important

Target date: 2003

#### **11.1.2 Adopt amendments to the model building code that affect seismic safety**

Create the ability at all jurisdictional levels in Nevada to develop, adopt and enforce those state amendments to the model building code that affect seismic safety and are necessary to meet the specific needs of Nevada.

Priority: Very important

Target date: 2005

### **11.1.3 Conduct performance focused research**

Sponsor and encourage problem-focused research and development to improve the reliability and economic effectiveness of performance based seismic design and construction methods.

Priority: Very important

Target date: 2005

#### **Objective #2: Mitigate Nonstructural Risks**

Aggressively promote in the design and construction of new buildings, means of securing, placement, or location of nonstructural hazards in places of human occupancy or of high property loss potential, and educate Nevadans and visitors to Nevada about taking cover and avoiding nonstructural hazards during earthquakes.

#### **Benefits:**

Designing in seismic safety features will result in significant reduction in the number of deaths, injuries, loss of property, and business interruption from earthquakes through preventative measures.

#### **Strategies:**

### **11.2.1 Encourage design professionals to include nonstructural hazard mitigation**

Promote the mitigation of nonstructural hazards through information and guidelines, active introduction of the concept and mitigation techniques to Nevadans, demonstration projects, and potential workshops or forums on nonstructural mitigation.

Priority: Critically important

Target date: Annual activity

### **11.2.2 Promote research on nonstructural hazard mitigation**

Promote and support research on strategies and techniques to easily and cost-effectively mitigate nonstructural hazards. Priority will be given to testing existing techniques recommended for mitigation and to new techniques that are practical for Nevadans to use.

Priority: Very important

Target date: Annual activity

# Dams

Dam breaks create primary concerns about the effect on public and private water supply systems. Disruption of these systems could cause extensive long-term economic losses, social disruption and personal danger.

## **Objective #1: Replace or Retrofit Critical Dams**

Initiate retrofit or replacement program to ensure that all public and private dams can withstand earthquakes to the degree that they will be able to avoid downstream effects of a release of water, both injury to persons and property damage. Develop damage potential cost estimates compared with cost of mitigation of hazards.

### **Benefits:**

Avoidance of dam breaks will ensure a significant reduction in societal costs and minimizing additional economic devastation.

### **Strategies:**

#### **12.1.1 Establish seismic performance standards**

Establish seismic performance standards for all dams to ensure adequate risk reduction strategies.

Priority: Very important  
Target date: 2005

#### **12.1.2 Minimize secondary effects**

Establish a comprehensive program to minimize the secondary effects such as flooding downstream property, causing injury to persons, and interruption of emergency response. Install seismic network instruments to capture performance data and install breakage-warning alarms to warn those downstream.

Priority: Very important  
Target date: by 2003

#### **12.1.3 Evaluate dam vulnerability**

Evaluate each dam to identify its vulnerabilities to collapse or release of water in an earthquake. Consider effects of roots and burrowing in weakening dam structure integrity. Develop a priority ranking system that identifies the highest hazard dams.

Priority: Very important  
Target date: by 2003

#### **12.1.4 Retrofit critical dams**

Evaluate, fund and authorize rebuilding or retrofit of all high hazard dams critical to community recovery. Produce cost benefit report for submission to dam owners to generate a mitigation plan.

Priority: Very important

Target: by 2010

#### **12.1.5 Establish emergency action plans**

Each dam structure should have an emergency action plan that addresses potential dam failure warning systems, defines the role of local authorities in responding to warnings and provides guidance to response and recovery.

Priority: Important

Target: by 2003

# Plan Updating

## Objective #1: Annual Review

The Nevada Earthquake Safety Council's Risk Mitigation Committee will schedule an annual review of the Nevada Earthquake Risk Mitigation Plan, solicit input from other NESC Committees regarding elements of the plan and propose revisions to the NESC for adoption each year.

### Benefits:

Ensures that the plan remains contemporaneous for current users and incorporates the most recent advances in earthquake science and mitigation techniques so that it assists the public in understanding earthquake risks, planning for mitigation, preparing for disasters and in recovering from earthquake events.

### Strategies:

#### 13.1.1 Annual review and update

As potential problems and solutions are identified, the Risk Mitigation Committee will incorporate the needed changes to the plan on a timely, at least annual, basis.

#### 13.1.2 Increase public awareness of plan

The goal of the annual review will be to continually familiarize decision makers, business people, and the public about how the State's plan will help them deal with earthquakes.

#### 13.1.3 Incorporate scientific changes

The update will incorporate the latest scientific information by seeking input from the Geosciences committee.

#### 13.1.4 Add new awareness and education methods

The update will incorporate new awareness and education techniques by utilizing recommendations from the Education and Awareness Committee.

#### 13.1.5 Incorporate building code changes

As building codes for new and existing construction are updated, the plan will incorporate those changes as recommended by the Engineering and Architecture Committee.

#### 13.1.6 Revise response and recovery approaches

Response and Recovery Committee information will be revised as new methods for rapid return of the infrastructure and disaster management efforts evolve.

#### **13.1.7 Revisions to Nevada Earthquake Risk Mitigation Plan**

Revisions will be presented to the NESC for adoption during its winter meeting or as may be required in response to a disaster event, then submitted to the State of Nevada, Department of Emergency Management and FEMA as required.

## Appendix A: The Plan Matrix

Plan Element	Concern	Objectives	Strategies	Benefits	Responsibilities	
Geoscience	Insufficient knowledge	Develop geoscience information	Map geologic hazards in urban and planned urban areas	Reduce earthquake losses	NBMG	
		Characterize seismic hazards in Nevada	Input data for loss reduction activities		NBMG NSL	
		Urban strong ground motion network	Input data for loss reduction activities		NSL	
		Expand weak ground motion network	Input data for loss reduction activities		NSL	
		Complete seismic network in Nevada	Input data for loss reduction activities		NSL	
		Characterize site response in urban areas	Input data for loss reduction activities		NSL	
	Insufficient use of current geologic knowledge	Full application of geosciences		Upgrade / produce maps	Better maps to reduce earthquake loss	NBMG
				Hold learning workshops	Better usage of maps to reduce earthquake loss	NESC NBMG
				Put information on the WWW	Better usage of information to reduce earthquake loss	NBMG NSL
				Use HAZUS /GIS for emergency management	Enhance planning and deployment of resources	NESC NSL

<b>Plan Element</b>	<b>Concern</b>	<b>Objectives</b>	<b>Strategies</b>	<b>Benefits</b>	<b>Responsibilities</b>
<b>Geoscience</b> (Continued)	Insufficient use of current geologic knowledge	Full application of geosciences	Outreach activities	Better usage of information to reduce earthquake loss	NBMG NSL
	Development of professional standards	Improve seismic safety practices	Promote consensus on seismic mitigation strategies  Promote incorporation of geoscience information into planning and construction	Better educate professionals and policy makers  Better educate professionals and policy makers	NESC
<b>Land Use</b>	Seismic hazards are not incorporated in general plans	Developed in areas that are relatively safe from seismic hazards	Incorporate seismic hazards into general plans	Earthquake loss reduction through better planning	NACO USBLM USFS

<b>Plan Element</b>	<b>Concern</b>	<b>Objectives</b>	<b>Strategies</b>	<b>Benefits</b>	<b>Responsibilities</b>
<b>Emergency Response</b>	Insufficient responsive and sustainable systems	Improved emergency management and response systems	Enhance the integrated emergency management system statewide	Reduce losses from earthquakes with more efficient emergency response	NDEM Local EM's
			Enhance communication capabilities for responders	Reduce losses from earthquakes with more efficient emergency response	NDEM Local EM's
			Establish Community Emergency Response Teams	Reduce loss of life and injuries	Local EM's

			Training and exercises based on earthquake scenarios	Increase efficiency and effectiveness of emergency response	NDEM Local EM's
			Establish mutual aid agreements	Increase resources available to respond to an emergency	NDEM Local EM's
			Enhance planning for hazardous materials releases from earthquake <del>scenarios</del>	Increase effectiveness in handling multiple incidents and potential panic	NDEM Local EM's
<b>Recovery</b>	Impairments to effective and speedy recovery	Create a statewide recovery plan	Develop a plan	Reduce lost business and business income by rapid recovery	NDEM

<b>Plan Element</b>	<b>Concern</b>	<b>Objectives</b>	<b>Strategies</b>	<b>Benefits</b>	<b>Responsibilities</b>
			Develop mitigation strategies	Earthquake loss reduction through better planning	NESC
			Promote strong building codes	Life safety and property loss reduction	NACO NESC NDEM
			Encourage planners to consider seismic hazards mitigation requirements	Life safety and property loss reduction	NACO NESC NDEM
<b>Existing Buildings</b>	Property protection deficiencies in buildings	Upgrade vulnerable buildings to acceptable levels of performance	Develop educational programs on methodologies	Earthquake loss reductions through better building performance	NESC NACO Owners
		Retrofit historic (mostly URM) structures with life safety as first priority	Inventory historic value and conditions	Preserve important resource for public use	NACO NESC
		Mitigate non-structural risks	Develop educational program on methodologies	Earthquake loss reduction through better non-structural performance	NESC NACO Owners
			Promote non-structural hazard mitigation research	Earthquake loss reduction through better non-structural performance	NESC UNR UNLV

<b>Plan Element</b>	<b>Concern</b>	<b>Objectives</b>	<b>Strategies</b>	<b>Benefits</b>	<b>Responsibilities</b>
<b>New Construction</b>	Inadequate building codes and enforcement	Increase effectiveness of codes	Promote ISO building code effectiveness grading system	Improves community protection through strong codes	NACO NESC
			Promote uniform minimum building codes	Protects all citizens at basic level	NESC NDEM
			Adopt Nevada design standards	Establishes uniformity in design	NESC
<b>Utilities and Transportation</b>	Increase awareness of effective damage of lifelines	Encourage coordination between GIS system owners	Adopt public-private cooperative arrangements	Enhance knowledge of systems, hazards and importance	NESC
			Encourage retrofit or replacement of aging systems	Promote incentives to retrofit or replace	Enhance response and recovery
<b>Dams and Bridges</b>	Insufficient design	Upgrade vulnerable structures	Provide incentives to retrofit; mitigate downstream hazards	Reduction of loss of life, structures and downstream hazards	NDOT NDWR UNR
<b>Preparedness</b>	Insufficient understanding and lack of preparedness	Increase understanding and ability to act	Prepare earthquake scenarios	Envisioning potential disasters and enhancements of preparedness	NESC NDEM NBMG, NSL
			Distribution of mitigation information	Better public and professional preparedness	NESC, NDEM NBMG, NSL
			Develop preparedness kits and resource lists	Better public preparedness	NESC NDEM

<b>Plan Element</b>	<b>Concern</b>	<b>Objectives</b>	<b>Strategies</b>	<b>Benefits</b>	<b>Responsibilities</b>
			Hold workshop and conference on plan	Minimize economic disaster	NDEM
			Rapid post earthquake assessment of buildings	Rapidly establish safety evaluations, scope, and recovery strategies	NESC Local Gov.
			Develop central resource for financial assistance processing	Increase recovery rate and reduce stress	NESC NDEM
NESC -	Nevada Earthquake Safety Council		NDEM -	Nevada Division of Emergency Management	
NBMG -	Nevada Bureau of Mines and Geology		NSL -	Nevada Seismological Laboratory	
UNR -	University of Nevada Reno		BLM -	U. S. Bureau of Land Management	
UNLV -	University of Nevada Las Vegas		USFS -	U.S. Forest Service	
NACO -	Nevada Association of Counties		NLC -	Nevada League of Cities and Municipalities	