



## **NEVADA EARTHQUAKE SAFETY COUNCIL**

*c/o Nevada Bureau of Mines and Geology  
University of Nevada, Reno  
Mail Stop 178  
Reno, Nevada 89557-0088*

*(775) 784-6691 Ext 126  
(775) 784-1709 Fax  
e-mail: [jprice@unr.edu](mailto:jprice@unr.edu)  
Web site: [www.nbmg.unr.edu/nesc](http://www.nbmg.unr.edu/nesc)*

*Jon Price, Secretary  
Terri Garside, NBMG Executive Secretary*

---

May 9, 2012

TO: Mr. Ron Lynn, Chairman, Nevada Earthquake Safety Council  
Board of Directors, Nevada Earthquake Safety Council

FROM: B. Jim Reagan, Chairman, Strategic Planning Committee

RE: Annual Report of Activities for Plan Year 2011

I am pleased to provide a summary of activities and efforts achieved by the Standing Committees and members of the Nevada Earthquake Safety Council for the calendar year 2011. As with previous years, the committee members and members of the council have made great progress toward the mission and goals of the council and earthquake safety in Nevada. This year's accomplishments include:

### **EDUCATION COMMITTEE**

Diane dePolo reported that some inroads have been made for the 2011 Great Nevada ShakeOut. School districts have been given announcements about FEMA-sponsored webinars regarding earthquake safety.

Jenelle Hopkins noted that National Lab Day is scheduled in May to promote science-technology-engineering-mathematics (STEM) education. Las Vegas will be holding a Science Festival for one week in May to demonstrate how STEM affects everyone's lives. Ron Lynn and Mike Blakely noted that Engineering Week (E-week) is at the end of February, this year February 20-26. Ron suggested that the Awareness and Education Committee coordinate some earthquake activities with that event. Ron also noted that May is National Building Safety Month, another opportunity to highlight earthquake awareness.

The 2011 Great Nevada ShakeOut website ([www.shakeout.org/Nevada](http://www.shakeout.org/Nevada)) is operational, and she urged everyone to register and have co-workers register. Governor Sandoval is willing to participate; a request for a declaration from the Governor will be made formally within 60 days of the event. Diane will make extra efforts to reach the Indian tribes in Nevada and the Hispanic community.

The Great Nevada ShakeOut will coincide with the ShakeOut in California. UNR will practice evacuation of a collapsed building, with help from the Medical School on triage. UNR's media relations group is trying to get the local media to participate. The goal is to get 500,000 people to participate in Nevada this year.

Diane dePolo reported on progress to promote the Great Nevada ShakeOut. Five of the 17 school districts have signed up for ShakeOut. She has contacted many of the private schools as well. The Diocese of Reno signed up. A draft of the Governor's proclamation was handed out for review and comments. Graham Kent will be meeting with officials of the Clark County School District in late September to promote their participation. Please see <http://www.shakeout.org/nevada/> to register to participate.

### **RESEARCH & INFORMATION COMMITTEE**

Craig dePolo noted that the 43rd Symposium on Engineering Geology and Geotechnical Engineering will be held in the UNLV Student Union on 23-25 March 2011. Barbara Luke and Jim Werle are Co-Chairs for the Symposium. It will feature two sessions on earthquakes.

The 1915 earthquake centennial is approaching. This was the largest historical earthquake in Nevada. The current best estimate of the moment magnitude is 7.4, although estimates of the magnitude range from 7.1 to 7.6. Terri Garside, Alan Wallace, and Craig are investigating the historical (newspaper) records. There may have been foreshocks for as much as two years before this earthquake. Plans for the centennial may include a scientific meeting and a public meeting in Winnemucca. This will also be a good opportunity to focus on dealing with unreinforced masonry buildings (URMs) in Nevada, because Winnemucca appears to have a large percentage of URMs among its buildings. FEMA has produced a new document (FEMA 774, dated October 2009) on dealing with unreinforced masonry buildings (URMs).

Craig displayed two new NBMG geologic maps – one covering three 7.5-minute quadrangles in the Reno area and the Ute Quadrangle in southern Nevada. The latter includes the California Wash fault, one of the faults that pose threats to Las Vegas.

Craig also noted that the third Basin and Range Province Seismic Hazard Summit may be held in the spring of 2012 in Reno. Graham Kent advocated separating the Walker Lane from the rest of the Basin and Range in discussions of seismic hazards.

Ken Smith announced the publication of the Wells earthquake report (Nevada Bureau of Mines and Geology Special Publication 36). Upcoming issues for the Research Committee include unreinforced masonry buildings (URMs) and ground-shaking hazards. The Las Vegas Valley parcel maps are being released today.

Ken Smith discussed the need for Light Detection and Ranging (LiDAR) in urban northwestern Nevada and an effort to build an initiative to acquire these data. Craig dePolo noted that while recently responding to a questionnaire from the USGS, he urged that the USGS work toward acquiring LiDAR data for the entire state. Gary Johnson noted that the Nevada Geographic Information Society ([www.ngis.org](http://www.ngis.org)) is developing a clearinghouse of information on where LiDAR data are currently available in Nevada and how to contact agencies and individuals to get access.

Ken opened a discussion of low-probability catastrophic events that are not completely accounted for in hazard assessments. He stated that big events will surprise a lot of people in Nevada. He raised the question: Are there large events that we're not accounting for? Woody Savage and Ron Lynn stressed the need for long-term protection through building codes and standards. Woody suggested focusing on the large earthquakes that occurred during the late Quaternary Epoch (the last 130,000 years). Craig noted that the earthquake and tsunami that destroyed the nuclear power plant in Japan was unexpected by local communities and the power company. He suggested that action regarding low-probability catastrophic events should focus on critical facilities – hospitals, emergency operations centers, power plants, etc.

Ken discussed addressing earthquake awareness issues for the tourism industry and suggested working more with the security officials. Jim Ruhr stated that the Northern Nevada Security Directors Association focuses mostly on crime but is open to hearing more about earthquake hazards and risk reduction. He noted that Dean Hill from the Peppermill, who chairs the association, would be willing to entertain more discussion. Jeff Hahn and Jim Ruhr noted that the functions of safety, security, surveillance, and emergency management are merging at some casinos.

## **POLICY COMMITTEE**

Wayne Carlson provided an update on the Unreinforced Masonry Inventory Project. The project is identifying some possible residential and commercial URMs, based on likely URM construction types for buildings build prior to 1974. Gary Johnson (NBMG) has collected data from all the county assessor offices, completed the address matches and entered the data into GIS, and is currently putting the information into HAZUS, FEMA's loss-estimation model. NBMG will be producing a report on this project.

Wayne noted that the draft Western States Seismic Policy Council (WSSPC) policy statement 11-4 doesn't provide a potential source for URM data; our experience in Nevada is that county assessors hold a tremendous amount of useful data for identifying possible URMs. The WSSPC policy recommendation also talks about 1964 as a date beyond which building codes called for some reinforcement of URMs, but it wasn't until 1970 that the Uniform Building Code prohibited URM construction, and the codes weren't adopted in Nevada until a few years later.

Update on the Unreinforced Masonry Inventory Project: The project is identifying some possible residential and commercial URMs, based on likely URM construction types (with masonry walls) for buildings build prior to 1974. Gary Johnson (NBMG) has collected data from all the county assessor offices, completed the address matches and entered the data into a geographic information system (GIS), and is currently putting the information into HAZUS, FEMA's loss-estimation model. NBMG will be producing a report on this project. Web application that Gary has developed and posted at [http://gisweb.unr.edu/URM\\_project](http://gisweb.unr.edu/URM_project). All the county assessors' information is already available publically. The data will be useful for emergency-response planning and for mitigation. Communities can follow up with confirming that the possible URMs are actual URMs, assessments of occupancy of specific buildings, etc.

The following motion was unanimously approved by the Council: The Nevada Earthquake Safety Council supports WSSPC policy recommendation 11-5 ("The Western States Seismic Policy Council (WSSPC)

recommends that an Earthquake Emergency Handbook for first responders and incident commanders be developed, preferably by an interagency task force.”) and urges FEMA to take the necessary action.

### **AD-HOC COMMITTEE ON VISITORS**

Jeffrey Hahn reported that the ShakeOut website has been quite useful. The short timeframe for 2010 meant little formal participation by casinos, but 2011 should have a lot more participation. Jeff stated that getting the 9,000 employees of his company to “drop, cover, and hold” should be doable. He suggested that NBMG reduce size of the PDF file of *Living with Earthquakes in Nevada* from 100+ Mb to 5 Mb for easy e-mail distribution to employees. It is currently available on the NBMG website.

Jeff Hahn reported that he has been handing out ShakeOut fliers. He noted that the website for the ShakeOut ([www.ShakeOut.org](http://www.ShakeOut.org)) is loaded with useful information and downloadable material. He can't guarantee that his company will sign up on the website to participate as a company, but many individual employees will. The emphasis will be “drop, cover, and hold on.” They will follow up with having employees consider a couple of leading questions: What is going to fall on your head during an earthquake? What didn't you secure in your work space/cube? Jeff further noted that there is an interesting 90-minute video with clips showing how people responded to the magnitude 9 earthquake off the eastern shore of Japan; few people followed the advice to “drop, cover, and hold on.”

Craig dePolo noted that hotels in Crescent City, California, are well prepared to deal with tsunamis. Inundation zones and evacuation routes are nicely displayed on their city maps.

Jeff asked for more information on best practices for staying informed about earthquake activity. He noted that the USGS Earthquake Notification System (ENS) is the go-to site for earthquake information, but there is uncertainty regarding the magnitude thresholds for earthquake magnitude that should be requested for different parts of the U.S. and world. In part, the thresholds should be high enough to keep people interested and reminded that earthquake hazards exist in Nevada, but they shouldn't be so low that a person is inundated with useless e-mails.

### **SCIENTIFIC AND INFORMATIONAL PRESENTATIONS**

#### **NEVADA WORKING GROUP ON QUATERNARY FAULT SURFACE RUPTURE HAZARDS**

Eric Hubbard noted that the charge to the working group is to assess the status of fault hazard work in Nevada, evaluate what other states are doing, and make recommendations. This may include recommendations regarding the guidelines for fault investigations. Eric reported that the working group held a conference call recently. They came to the general consensus that faults for which the last movement was as old as 130,000 years ago should be considered for setbacks to avoid building homes, businesses, or critical facilities on top of areas likely to see large surface displacements during earthquakes. The working group is also investigating the possibility of archiving reports from consultants regarding fault investigations. They are also looking into setback guidelines (what should be an appropriate distance for Nevada's normal faults versus strike-slip faults, and for single family homes versus critical facilities).

Eric noted that the working group may take advantage of holding workshops connected with the Basin and Range Seismic Hazard Summit in the spring of 2012 and/or the Association of Environmental and Engineering Geology (AEG) annual meeting in Salt Lake City in the fall of 2012.

Craig dePolo noted that it is helpful to understand what other states and experts are doing and proposing with regard to defining active faults for regulatory purposes. He said that the California Division of Safety of Dams (Bill Fraser) is using a 35,000-year date, rather than 130,000. The Alquist-Priolo Act in California uses a Holocene (11,700-year) date for requirements of setbacks from faults for buildings that are occupied by people. Several years ago Clarence Allen proposed using the term “conditionally active” for a Quaternary fault or a fault that is in a tectonically likely area. At the Burt Slemmons Symposium, Jim McAlpin proposed paying close attention to faults near the end of their seismic cycle. For example, a fault that characteristically moves once every 50,000 years but hasn't moved for 49,000 years would be near the end of its seismic cycle. Bill Lund (Utah Geological Survey) proposed using any fault with a scarp, recognizing that erosion typically destroys scarps within 200,000 years.

Craig dePolo reported that the working group is writing a white paper on the issue of defining an active fault. The group is zeroing in on defining “faults of interest” as any Quaternary faults (ones that have moved at least once in the last 2.6 million years), “active faults” as ones that have moved in the last 130,000 years (late Quaternary), and “conditionally active faults” as ones with some evidence for late Quaternary movement but not enough to demonstrate an age of less than 130,000 years.

A special session at the annual meeting of the Association of Environmental and Engineering Geologist in September of 2012 in Salt Lake City will be dedicated to this issue.

### **FACTORS THAT CONTRIBUTED TO DAMAGE FROM THE 2008 WELLS EARTHQUAKE**

Craig dePolo discussed why the Wells earthquake (magnitude 6.0 on 21 February 2008) caused damage. Factors contributing to damage can be divided into two groups: ground-motion factors and building factors. Among the ground-motion factors are:

- Proximity of the earthquake to Wells
- Possible high stress-drop source effects (stress drops are typically 16 to 93 bars for normal faults in the Basin and Range Province, according to studies for the proposed Yucca Mountain repository, but Ken Smith estimated a stress drop of 89 bars for the Wells earthquake)
- Possible rupture directivity
- Basin effects
- Basin-edge effects
- Long duration of shaking (modeling for this size of earthquake would predict 2 seconds, but people reported 40 seconds, and surveillance cameras document up to 45 seconds of shaking)
- Locally low near-surface shear-wave velocity.

Building factors include:

- URM's
- Lack of seismic detailing
- Poor construction practices
- Poor building materials
- Poor building condition and maintenance
- Second-story effects
- Proximity to a damaged building.

It appears that the most important effects are URM's, poor construction practices, basin effects, and locally low near-surface shear-wave velocity. Craig noted that the 2009 earthquake probability maps produced by the USGS demonstrate that the Las Vegas area has about the same probability for magnitude 6.0 earthquakes as Wells and that the Reno-Carson City urban area has about a probability approximately six times higher than Wells.

### **POST-DISASTER VOLUNTEER ENGINEERS FOR WASHOE COUNTY**

Aaron Kenneston, Washoe County Emergency Manager, discussed “ReadyWashoe.com,” a website for, among other uses, reporting damage after a hazard event. People can send digital photos from iPhones and digital cameras. This should help speed up the County’s rapid damage assessment. The building and safety professionals are sent to the field to verify the damage reported by citizens. The state then activates a Preliminary Damage Assessment Team. A regional debris management plan has been prepared and is currently under review with FEMA. The Sheriff has deputized the Association of General Contractors to help with debris removal. Washoe County has amateur radio operators on their Preliminary Damage Assessment Team. The Nevada Emergency Management Assistance Compact (NEMAC) allows local governments to help one another. Don Jeppson, Washoe County Building and Safety Director, discussed the possible failure points in responding to an emergency and the need for fuel and vehicles. They have 15 field kits (boxes of supplies for building inspectors with placards for up to 6,000 structures). Half of the boxes are in inspectors’ vehicles and the rest at the County Facility on Wells Avenue in Reno. They have about ten engineers on call. The County’s Building and Safety Department is set up to handle assessments for a few days, and the Public Works and Water Resources Departments have additional engineers who can help if necessary.

The Building and Safety Department sent about 1/3 of their staff to Wells and Fernley for the most recent disasters (in 2008). They refined their kits afterward to include cells phones, GPS units, and retractable ink pens.

### **POST-DISASTER VOLUNTEER ENGINEERS FOR RENO**

Alan Bennett distributed a handout and discussed Reno’s efforts for post-disaster building inspections. The city is concerned about the need for special inspection of the two hospitals and other high-rise buildings. He noted

that “Disaster Mitigation-A Guide for Building Departments” (published by the International Code Council in 2009) is an excellent publication.

Glade Myler noted that volunteers can be covered under Workers Compensation, but the State’s risk management department will not do so without a complete list of potential volunteers.

Mike Blakely stated that the building officials of the cities and counties have lists of engineers who agree to come to help as needed. There should be formal agreements in place (for either volunteer work or paid work), so that the cities and counties can be assured that the engineers they have engaged will show up and won’t be committed to help other clients. He also noted that several individual businesses have agreements with local engineers in place.

#### **NEXT-LEVEL SHAKEZONING FOR EARTHQUAKE HAZARD DEFINITION IN NEVADA**

John Louie described what he considers to be the next level of hazard mapping. The basic problem that he sees is that the USGS ShakeMap is based on statistical averages, with most data coming from California, Japan, and Taiwan. Over the last three years, UNR has made 10,721 measurements of near-surface shear-wave velocity in Las Vegas Valley (missing North Las Vegas) resulting in a parcel classification map (showing either National Earthquake Hazard Reduction Program [NEHRP] soil classification D, C, and what Clark Co. calls C+, meaning higher velocities than C but not qualifying as soft rock under the IBC). Higher velocities tend to be on the west side of the valley. The next-level approach is to put the basin geometry interpreted from gravity and reflection seismic data into a three-dimensional model, add the near-surface shear-wave velocities, then calculate likely ground motions (velocities, accelerations, and amplifications) for various earthquakes that could occur. This model is more sophisticated than the typical ShakeMap produced by the USGS, because it takes into account local soil classification from the shear-wave measurements, basin effects, and effects of directivity of scenario earthquakes. The distribution of energy is dependent on the assumed rupture model (direction of motion on either side of a fault plane). John is computing dozens of scenarios for Las Vegas Valley, including earthquakes on the Death Valley – Furnace Creek fault system.

John will be testing the need to incorporate deeper shear-wave velocity measurements in Las Vegas Valley, which are available from studies by Cathy Snelson, Wanda Taylor, Barbara Luke, and others. So far, geodetic data and background earthquakes (ones on unknown faults) are not included in the models.

John hopes to demonstrate that his approach to ShakeZoning can be used to improve the probabilistic seismic hazard analysis currently done by the USGS as part of the NEHRP provisions for the International Building Code. The USGS approach to probabilistic seismic hazard analysis combines historical earthquake information, published information on the geologic history of movements on known faults, and geodetic data; makes assumptions about attenuation functions that describe the general decrease in shaking farther from the earthquake hypocenter; and assigns a significant probability to background earthquakes.

#### **REPORT ON SEISMIC ACTIVITY SINCE JANUARY 1, 2011**

Graham Kent, Director of the Nevada Seismological Laboratory (NSL) talked about working with Senator Reid’s office and the U.S. Geological Survey to increase funding for seismic monitoring in Nevada, given that the Nevada network had been funded partly by the Yucca Mountain Project but is no longer.

Ken Smith reported that we have had about 90 earthquakes of magnitude 3 or greater since the beginning of the year. Swarms of earthquakes have occurred along U.S. Highway 93 in southern Lincoln County, west of Las Vegas, on the Nevada Test Site, near Scotty’s Castle (near Death Valley), Scotty’s Junction, Mina, north of Reno, near Lake Davis (in California), near Mount Rose (near Reno), northwest Pyramid Lake (caught because of deployment of extra instruments for a geothermal project), near Hawthorne, including (1) east of Hawthorne, (2) southwest of Hawthorne (near Aurora and the Borealis gold mine), (3) near Schurz, and (4) southeast of Hawthorne.

The biggest earthquakes have been southwest of Hawthorne, near a 250,000 year-old lava flow. The earthquakes are shallow and do not have the characteristics of earthquakes associated with magma movement or volcanic activity. The earthquakes started to the southwest and have generally progressed toward the northeast at approximately 200 meters per day, based on relocations of currently processed activity. Speculating on this NE progression of activity would suggest seismicity would approach the Wassuk Range front fault by sometime in June. This swarm has included 25 earthquakes with magnitude 3.5 and above. One of the more recent earthquakes had a moment magnitude ( $M_w$ ) of 4.0, depth of 4.5 km, and occurred on a northeast-striking normal fault. The largest event, on April 27th, showed normal faulting with an  $M_w$  of 4.6, at a depth of 2 kilometers (likely between 2 and 5 km). There have been a large number of small events, but the sequence appears to be

quieting down. A USGS NetQuakes instrument was installed on April 20th at the Court House in Hawthorne. It sends data via the wireless network in the building to a data server in Menlo Park, where NSL retrieves the data. These are triggered instruments. Ken described the process of creating moment tensor solutions for the earthquakes, which provide information on the orientation of the likely fault plane and the type of motion (right-lateral or left-lateral strike-slip, normal, or reverse). Moment tensor solutions provide the best estimates of earthquake size and therefore are the most appropriate input for HAZUS following significant events. Moment tensor solutions also provide the best estimate of fault plane orientation, particularly for areas where the seismic network coverage is poor. We have systematically compared NSL Moment Tensor estimates with those of UC Berkeley and the USGS; all groups are producing consistent solutions.

Cathy Snelson noted that National Security Technologies (NSTech, a National Nuclear Security Administration funding organization) is supporting eight real-time UNR-NSL seismic stations at the Nevada National Security Site (previously known as the Nevada Test Site) for transparency activities related to the Comprehensive Test Ban Treaty. NSTech is conducting a series of source-physics experiments (conventional explosions; non-nuclear) for nuclear non-proliferation research. They are supporting UNLV with some experiments as well.

Jonathan Carter, UNLV Geoscience graduate student, discussed his M.S. thesis project. The Stateline fault system is a northwest-striking fault system along the California-Nevada border near Pahrump; it poses a significant hazard for Las Vegas Valley. There have been at least three recent events on the fault: between 1956 AD and 890 years before present (CAL years BP), between 1270 and 1390 CAL years BP, and after 8,595 +/- 45 CAL years BP.

### **REPORT ON SEISMIC ACTIVITY SINCE MAY 2011**

Ken Smith updated the Council on earthquake activity in the last 90 days. There were magnitude 4 earthquakes near Hawthorne; a magnitude 3 near Caliente; continuing activity, which began in 2010, near Scotty's Junction; two magnitude 3s on the Nevada National Security Site (previously known as the Nevada Test Site); and renewed activity with small earthquakes at Mogul, near Reno. The earthquakes southwest of Hawthorne are no longer progressing in a northeastern direction toward the Wasuck Range frontal fault close to the town of Hawthorne. Two faults have been identified in this swarm of earthquakes. One dips to the northwest; the other dips to west-northwest. Both appear to have dominantly normal displacement, but there is some strike-slip displacement within the sequence.

Ken reported that 11 new broadband seismic instruments have been installed in the eastern California – Nevada region network through American Recovery and Reinvestment Act (ARRA) funding. These help with moment tensor solutions and allow for rapid, automated calculation of moment magnitude (M<sub>w</sub>) instead of local magnitude (M<sub>l</sub>). The M<sub>w</sub> input is a more reliable measure of earthquake size and theoretically produces a more reliable ShakeMap output, which can help guide emergency responders and provide better input for HAZUS calculations. These new broadband stations constitute a significant upgrade to the Nevada regional network.

### **3-D SHEAR-WAVE VELOCITY MODEL OF LAS VEGAS BASIN SEDIMENTS AND STATUS OF PROBABILISTIC ANALYSIS TO EVALUATE EARTHQUAKE HAZARDS FOR LAS VEGAS VALLEY**

Suchan Lamichhane and Helena Murvosh, UNLV graduate students at the Applied Geophysics Center and Department of Civil and Environmental Engineering, discussed their work. Suchan's analysis of probabilistic hazards indicates higher ground shaking than predicted by the USGS analysis, primarily because he used additional faults in and around Las Vegas Valley that were not in the USGS analysis.

Helena described the 3-D shear-wave velocity model, which provides additional information beyond the USGS's probabilistic analysis by taking into account the effects of low-velocity sediments in Las Vegas Valley. They collected data to a maximum depth of 370 meters, using 212 profiles. They used approximately 1,400 well logs within the valley to construct a 3-D model for the shallow sediments. These data are complementary and similar to data collected by John Louie (NSL) for the upper 30 meters. They now have a model for the entire basin, which includes specific values of shear-wave velocity for bedrock, deep-basin sediments, and intermediate-depth sediments, plus variable values for near-surface sediments. She concluded that long-period accelerations may be significantly higher in some locations of the valley than previously predicted.

### **PROGRESS ON THE NEVADA UNREINFORCED MASONRY BUILDING SURVEY**

Gary Johnson discussed the Nevada HAZUS Users Group's recent meeting during the Nevada Geographic Information Society's annual meeting in Reno. They discussed a practice event for running HAZUS; it

demonstrated the need for modifying procedures. There are approximately 20 active members of the Nevada HAZUS Users Group.

Gary then described progress on the project to identify potential unreinforced masonry buildings (URMs) throughout Nevada. Thanks to help from Wayne Carlson with the Nevada Public Agency Insurance Pool, and from the county assessor's offices, Gary has pulled together a geographic information system (GIS) database on potential URMs. Mike Blakely helped Wayne define potential URMs as buildings built prior to 1974 that are described in the assessors' databases as masonry, generally brick, cement block, or stone. Mike explained that these buildings have not been inspected on the ground, nor have the plans for their construction been reviewed to verify whether they are truly URMs. Some could simply be reinforced construction with masonry veneer. Mike explained that most pre-1940 masonry buildings are probably unreinforced, and that most masonry buildings built between 1960 and 1974 are probably reinforced, but considerable variation existed in local adoptions of building codes throughout those years.

The Nevada Bureau of Mines and Geology (NBMG) plans to release an open-file report on the potential URMs, after review by the county assessors and others. A draft of the web application that Gary described is available for preliminary review at [http://gisweb.unr.edu/URM\\_Project](http://gisweb.unr.edu/URM_Project). Wayne Carlson noted that one of the objectives of the project is to inform emergency planners where URMs are located, so that they can plan the allocation of resources to areas in which many of the URMs are occupied by lots of people.

Mike Blakely stated that this database also can be used by local building officials to help decide whether to allow certain occupancy of buildings when the owners plan remodeling or additions. Mike noted that the National Cathedral in Washington, D.C. is a URM made of cut limestone blocks with steel pins to hold the blocks in place. It was damaged during the 23 August 2011 magnitude 5.8 earthquake in Virginia, approximately 150 miles from the epicenter of the earthquake.

Gary provided the following table that summarizes the database.

#### **Potential Unreinforced Masonry Buildings in Nevada**

County Number of Potential URMs - Commercial\* / Residential

Carson City 487* / 175	Eureka 0* / 35	Nye 144* / 228
Churchill 177* / 192	Humboldt 192* / 184	Pershing 37* / 31
Clark 11,963* / 2,396	Lander 57* / 67	Storey 3* / 21
Douglas 114* / 294	Lincoln 53* / 47	Washoe 2,445* / 3,322
Elko 39* / 23	Lyon 234* / 175	White Pine 138* / 93
Esmeralda 2* / 14	Mineral 60* / 57	<b>TOTALS 16,145 Com* / 7,354 Res.</b>

\*Commercial includes public, non-residential building, but currently does not include State (or State University) buildings.

#### **THE GREAT CALIFORNIA SHAKEOUT, AND BEYOND**

Mark Benthien discussed the Great California ShakeOut and its expansion to now include the Great Nevada ShakeOut. There is a tremendous amount of information for earthquake preparedness and emergency response on the ShakeOut's website, <http://www.shakeout.org>, and related websites, including [www.dropcoverholdon.org](http://www.dropcoverholdon.org). The next event will be at 10:20 a.m. on Thursday, October 20, 2011. Nevada and Guam participated with California in 2010. Participants this year will include Nevada, Guam, Idaho, Oregon, and British Columbia, in addition to California. The Central U.S. Earthquake Consortium (CUSEC) states participated earlier this year and will do so again on bicentennial dates of the New Madrid earthquakes. Mark expects that Puerto Rico, Hawaii, Alaska, Utah, and New Zealand may participate in 2012. The exercise that year will be at 10:18 a.m. on 10/18/2012.

The website promotes the simple message of "Drop, cover, and hold on" for what to do during an earthquake. They are working on additional information for people in wheelchairs and with other disabilities. In addition to participation in the exercise, ShakeOut has stimulated broader discussion about earthquake hazards, preparedness, and response.

There was considerable discussion about the validity of the "Triangle of Life." As a structural engineer, Mike Blakely stated that he knows that the safest places are along the walls or stairways, not in doorways, which are generally weaker structural sites. Nonetheless, he feels that "Drop, cover, and hold on" is the best message, largely because there generally isn't enough time for you to get to a structurally safer spot during an earthquake. He advocated getting under and holding onto a table or desk next to a wall, if possible.

## **THE LiDAR DATASET AVAILABLE FOR THE LAKE TAHOE BASIN**

Graham Kent described LiDAR applications in the Lake Tahoe area. The dataset has a vertical accuracy of about 1.5 inches (3 cm). He showed numerous pictures of LiDAR data from Fallen Leaf Lake, Angora Lakes, Cascade Lake, and Cathedral Lake. The price for acquiring data has gone down over the years. The Lake Tahoe Basin dataset covers 941 square km, contains 12 billion data points, sent 11 pings (laser bursts) per square meter and got about 2.3 pings per square meter hitting the ground, and cost less than \$300,000. The dataset gives a good representation of trees and has many uses – not just mapping of active faults. The dataset can also be used for mapping vegetation and providing a base level for erosion evaluation. All data are available at [www.opentopography.org](http://www.opentopography.org). The data acquisition was funded by the Tahoe Regional Planning Agency and the U.S. Geological Survey. Graham's research group has also acquired complementary underwater data using sonar. Graham also discussed applications of terrestrial LiDAR (from a tripod-supported instrument) for cm-level measurements. Such instruments have been used to help discern strike-slip as well as normal motion on faults. Graham also showed a model of a landslide-generated tsunami about 50,000 years ago at Lake Tahoe. The model predicted a 400-meter high wave, which, if such an event reoccurred today, would probably kill about 200,000 people.

## **PLANNING FOR THE MAXIMUM OF MAXIMUMS (MOM) DISASTER**

Kenneth Smith talked about the many faults in Nevada that have the potential for magnitude 7 or larger earthquakes. Issues of directivity, site response, and microzonation become much more important when considering worst-case scenarios. In answer to questions about what the maximum expected magnitudes of Nevada earthquakes might be, Craig dePolo suggested that the Mw for the Carson Range Front fault system (which would affect Reno, Carson City, and the Lake Tahoe area) is probably 7.4, and Wanda Taylor suggested that the maximum magnitude for the California Wash fault (which would affect Las Vegas Valley) is probably 7.0. Ken Smith pointed out that basin and site effects can multiply the hazard significantly. Ian Buckle noted that the return period for design ground motions for bridges has recently been increased from 500 to 1,000 years as a step towards recognizing that very large events can happen. In addition, most bridge design codes also include provisions to minimize risk of total collapse in an extreme event, even though the bridge may be heavily damaged. He stated that we can't afford to keep all structures elastic through the maximum events, because doing so would be prohibitively expensive. The engineering community uses acceleration, typically 0.45 g (the acceleration due to gravity) in the Reno area, to design buildings and bridges. The UNR earthquake engineering lab recently took a bridge structure with modern design details on the lab's shake table to 3.5 times 0.45 g, and it did not fail. He stated that for today's structures, we have a lot of safety built in to prevent collapse. In Ian's view, the bigger problems for new structures are fault ruptures, tsunamis, and dam breakages, not ground shaking itself. But, older existing structures can still be very vulnerable to ground shaking.

Jeff Brewer stated that providing resources for responding to such a large event is almost impossible.

Craig dePolo stressed the importance of recognizing MOMs for critical facilities. He used the example of the Fukushima Daiichi nuclear power plant and the recent Japan earthquake. If this power plant had used a MOM tsunami in the design and placement of the back-up generators, much of the disaster that resulted at that plant would likely have been avoided.

## **JOINT MEETING OF NEVADA EARTHQUAKE SAFETY COUNCIL AND UTAH SEISMIC SAFETY COMMISSION**

The complete minutes will be attached for review. Because of this unique opportunity for both commissions, it is important to provide all information from this meeting unedited.

In summary, the Nevada Earthquake Safety Council has provided a successful venue for science, research, and information on Nevada's Earthquake Hazards to be promulgated in legislature, provided to business and industry, and delivered to the citizens of Nevada. Additional information and details of these accomplishments are noted in the minutes of the quarterly meetings. The many contributors to this outstanding effort are recognized in the minutes, and it is important to note that it does indeed take many contributors, individually and in concert with one or more committees, to achieve the goal of Earthquake Safety in Nevada.