Seismic Risk of Unreinforced Masonry Buildings in Nevada

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- **Unreinforced Masonry Building earthquake risk**
  - **What is a URMB?**
  - **What is their seismic vulnerability?**
- **URMBs in Nevada**
- **What has been done to reduce the seismic risk of URMBs in Nevada?**
- **What needs to be done?**
- **Resilience Committee's recommendation**

Unreinforced Masonry Building (URMB)

- Buildings made of brick or stone that lack steel rebar or other reinforcement. They commonly have structural deficiencies beyond construction style.

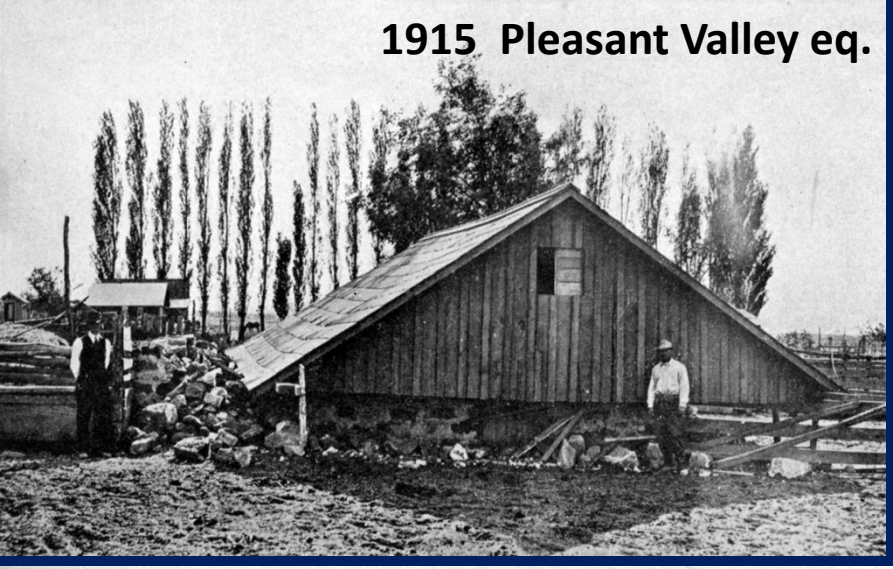
- Seismic Problem:
  - little lateral resistance with smooth-faced bricks,
  - old lime-based mortar disintegrates and loses bonding,
  - lack structural tying together,
  - dangerous crowning concrete beams,
  - rubble wall infill and foundation,
  - made quickly, cheaply, and sometimes without skill.

- 30-40% of URM Buildings can have partial to total collapse during strong shaking.

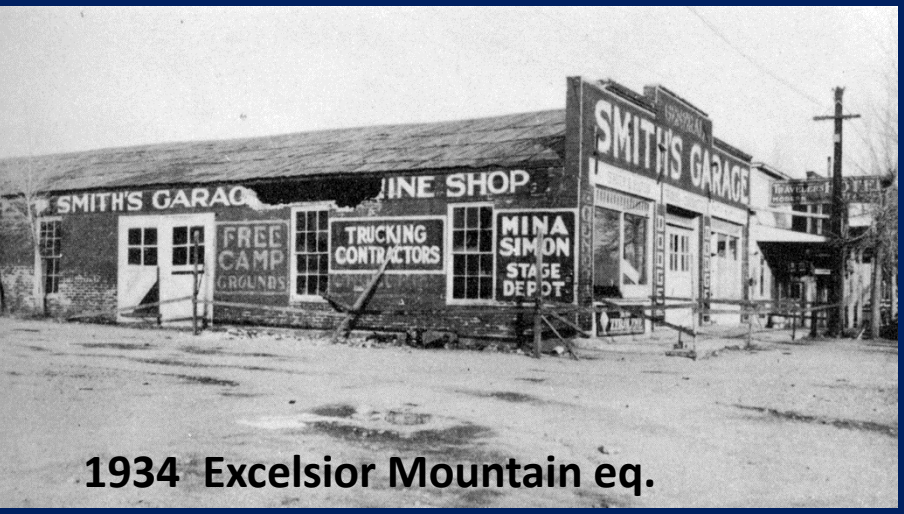
Rock rubble foundation; every 8th brick course in on end to tie wall together

Three story URMB with some earthquake cracks; occupancy is variable

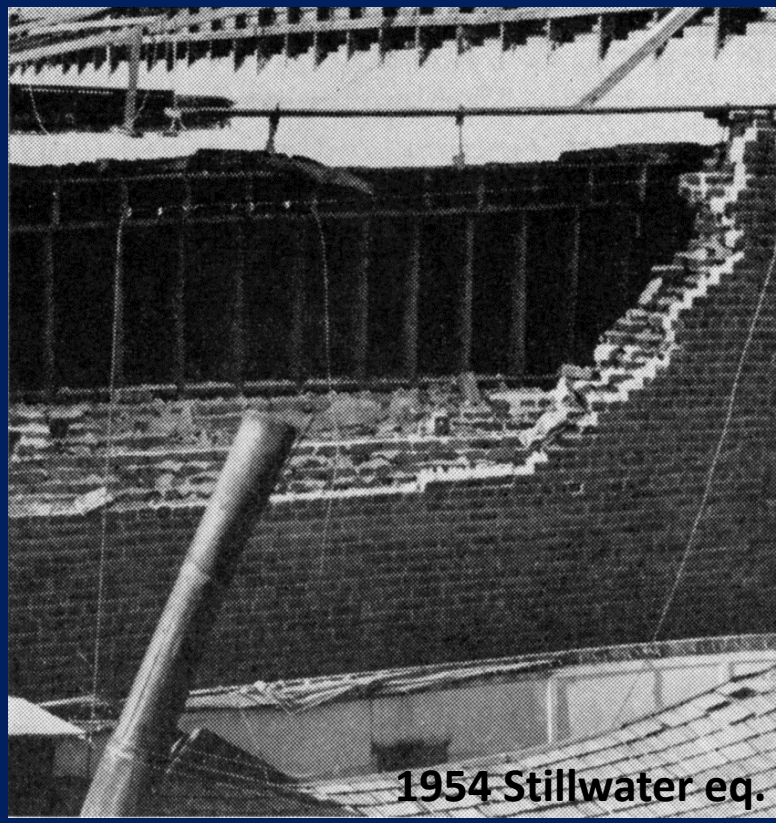
Commercial 5-story apartment building; continuous high occupancy


1915 Pleasant Valley eq.


1932 Cedar Mountain eq.



1934 Excelsior Mountain eq.


1954 Stillwater eq.

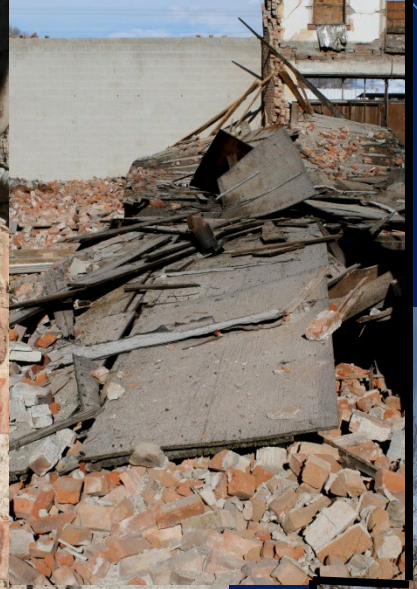
URM Building Damage has Occurred during Most Major Nevada Earthquakes

2008 Wells Eq.

2008 Wells, Nevada Earthquake

Ceiling joist pulling out of wall socket; note diagonal fire cut on end of beam

2008 Wells eq.



rubble Infill makes walls weak

Below – Lincoln Hall has an air gap between the interior wall that holds up the floors and the outside wall that holds up the roof

beyond interior brick wall is open space

Crowning bond beam failure

2008 Wells, Nevada Eq.

2008 Wells Earthquake
Commercial Unreinforced Masonry Buildings

- **10 of 15** moderately to severely damaged (67%) – **potentially life threatening**.
- 3 of 15 partial to total collapse (20%).
- 1 of 15 potentially deadly staying inside (7%).
- 15 of 33 exits had potentially deadly debris (45%)

Unreinforced masonry can *fall into* Buildings during earthquakes

Photo courtesy of
Ariel D. Benson,
Richmond, UT

Christchurch, New Zealand

Sept 4, 2010 Magnitude 7.1 earthquake 25 mi (40 km away)

Feb 22nd, 2011 Magnitude 6.3 earthquake 6 mi (10 km) away

June 13, 2011 Magnitude 5.5 and 6.0 earthquakes

Thought Question:

Does time matter in this *progressive damage to URMBs with multiple earthquakes*?

i.e.,

If these earthquakes occurred over a day, or if they were separated by decades, would the effects on the URMB be the same?

Thought Question:

Does time matter in this progressive damage with multiple earthquakes?

If these earthquakes occurred over a day or two, or if they were separated by decades, would the effects be the same?

I do think that the fragility of URMB's goes up once damage has occurred. In other words, once the bond between brick and mortar has been broken, the assumed strength of the assembly has been compromised.

Barry Welliver, 8/14/19
Utah engineer with a lot
Of URMB experience

CMU – concrete masonry unit – *unreinforced* cinder block buildings

Insert movie here

Brown URMB (upper right quarter) immediately before the earthquake

Near the beginning of the eq., people reacting, upper part of right-facing wall is starting to fall outwards from top. Some cracks are forming in this wall shown by dust.

Upper part of right-facing wall has fallen out (above top ceiling joist) and is falling down the side of the building.

A major portion of the right-facing wall is peeling off and falling next to the building. One man has hands on head in awe.

Large portion of the right-facing wall is falling on ground and dismembering. Dust rising from central part of the building indicates failure there.

Upper part of left-facing wall is starting for fail and fall.

Large part of upper part of wall on the left-facing wall is falling off as more of the upper part of that wall fails.

More of the upper part of the left-facing wall is failing in chunks.

Continued failure of the upper part of the left-facing wall – chunks of Bricks continue to fall.

Damaged URMB – major failure of right facing wall exposing rooms and Failure of the upper part of the left facing wall. Debris surrounds building.

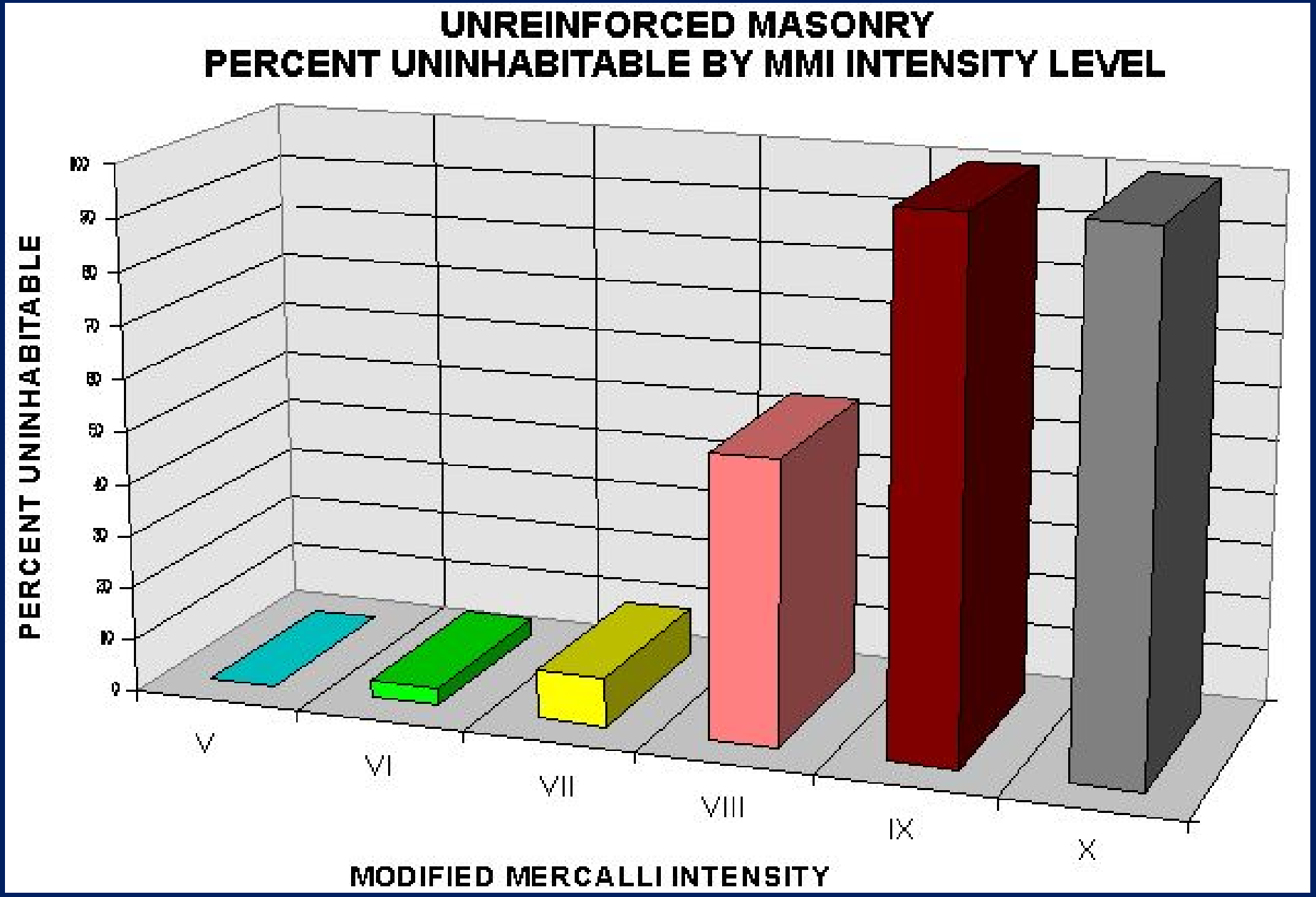
Insert movie here

Christchurch from Port Hills Feb 22, 2012

From Ian Buckle, UNR Eq. Engineering

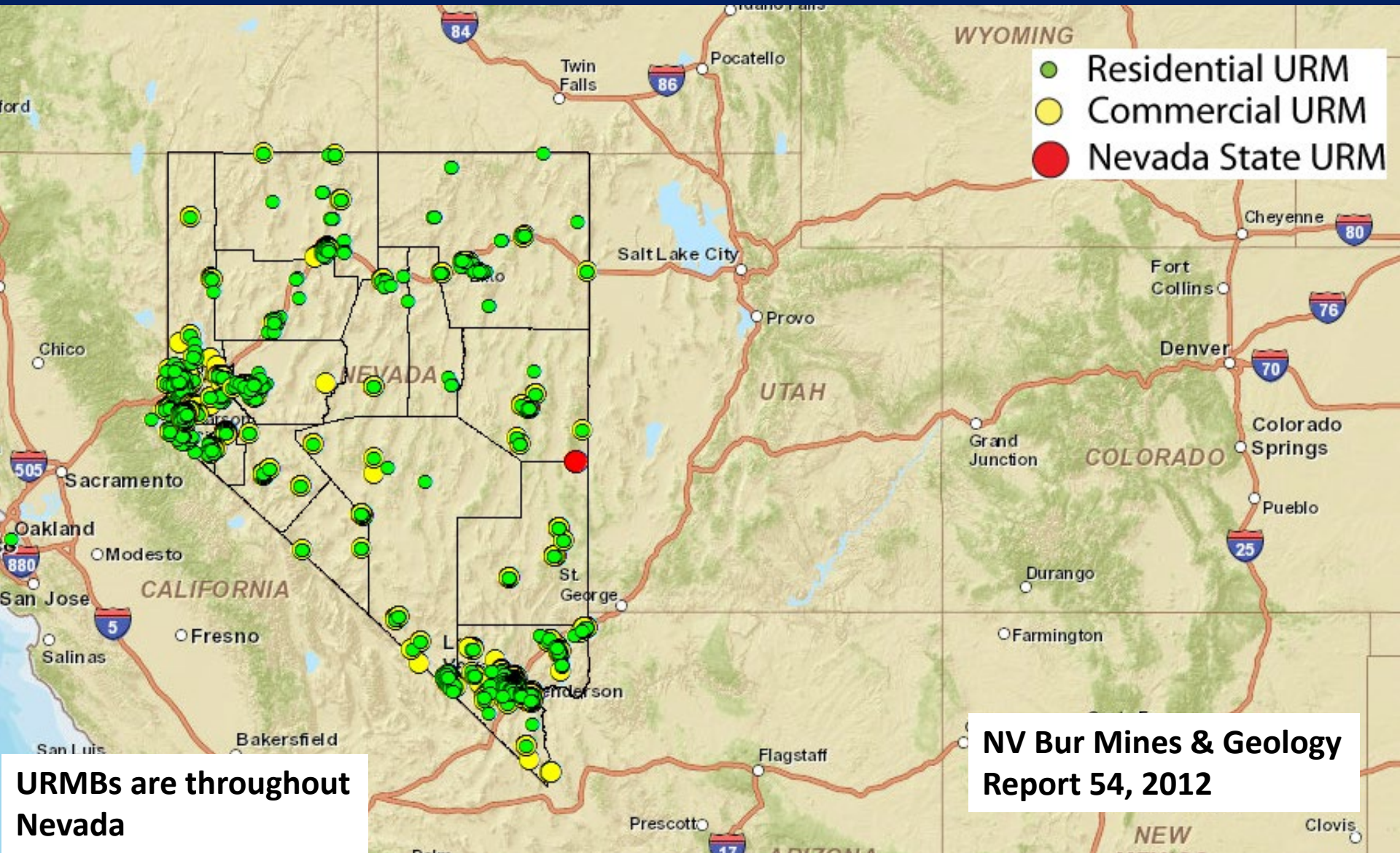
Unreinforced Masonry Buildings (URMBs) are the most seismically vulnerable buildings in Nevada.

On the order of about a third of URMBs are expected to have failures in areas of strong shaking.



Source: Association of Bay Area Governments

2011-2012 Nevada
URM Building Inventory; Co. Accessor's Data



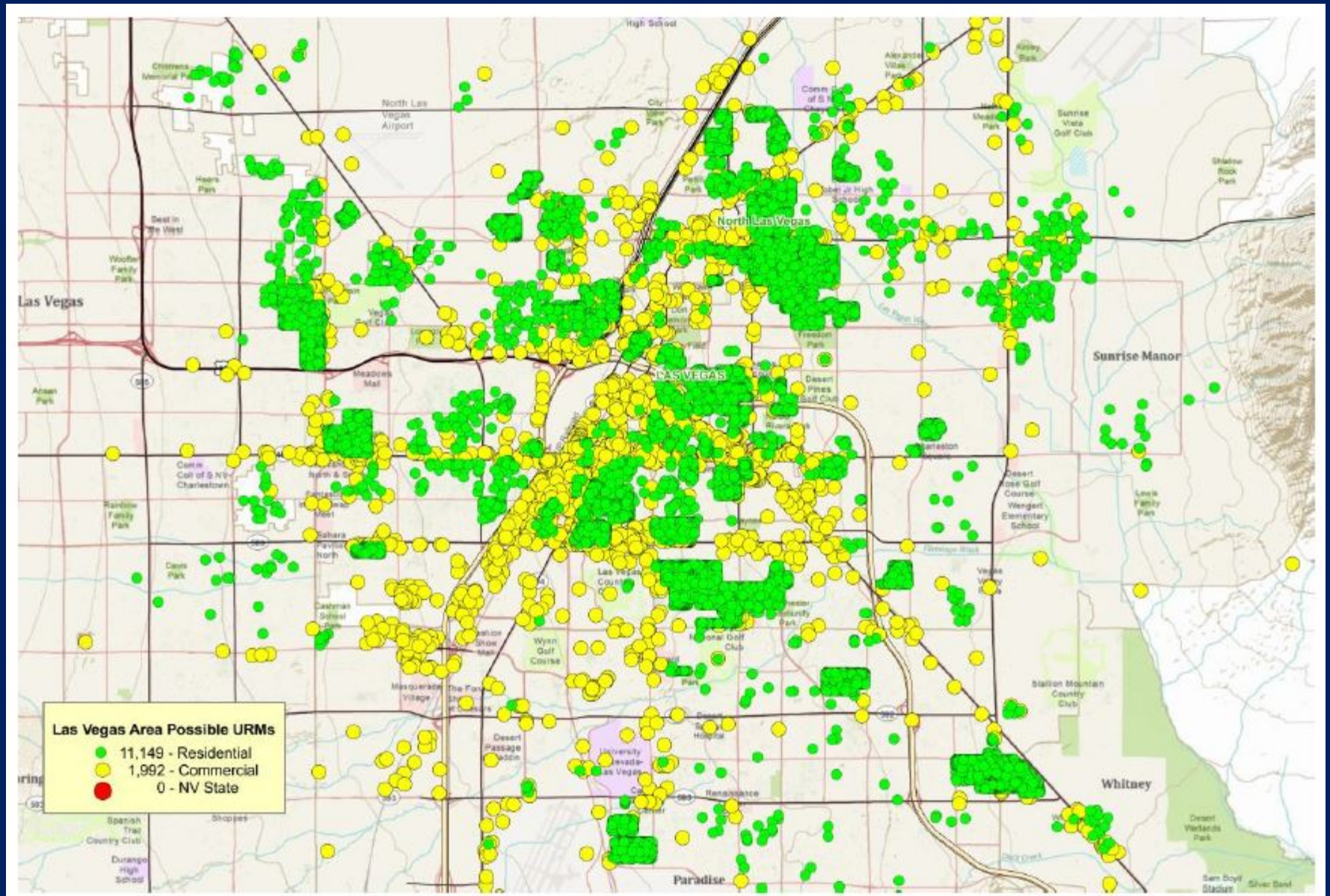
URMBs are throughout Nevada

NV Bur Mines & Geology Report 54, 2012

Table 2. Number of potential URMs in Nevada by county.

County	Commercial & Public	State	Residential	Total[#]
Carson City	487	72	175	734
Churchill	177		192	369
Douglas	114		294	408
Elko	39		23	62
Eureka	0		35	35
Humboldt	192	1	184	377
Lander	57		67	124
Lyon	234	1	175	410
Mineral	60		57	117
Pershing	37		31	68
Storey	3		21	24
Washoe	2,445	21	3,322	5,788
White Pine	138	1	93	232
Subtotal, N. Nevada	**3,983**	**96**	**4,669**	**8,748**
Clark	11,963		2,396	14,359
Esmeralda	2		14	16
Lincoln	53	2	47	102
Nye	144		228	372
Subtotal, S. Nevada	**12,162**	**2**	**2,685**	**14,849**
All of Nevada	**16,145**	**98**	**7,354**	**23,597**

Las Vegas Valley 2011 study results – superseded by Clark County study



Clark County Inventory Study; Clark County Building Department

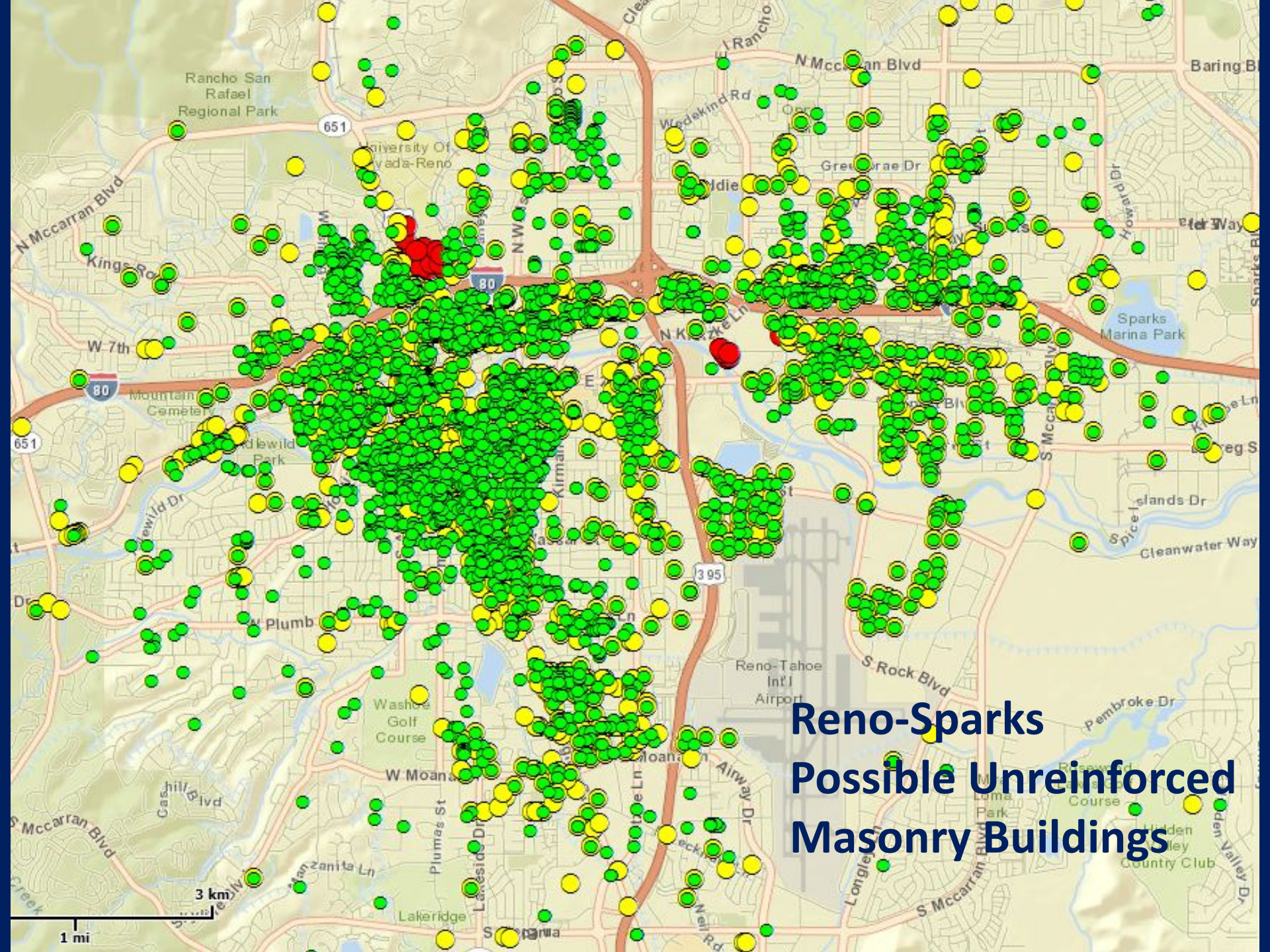
2012 NBMG study 14,359 potential URMBs

Contemporary Clark County projections: 300 to 500 commercial URMBs; 600-1000 residential URMBs

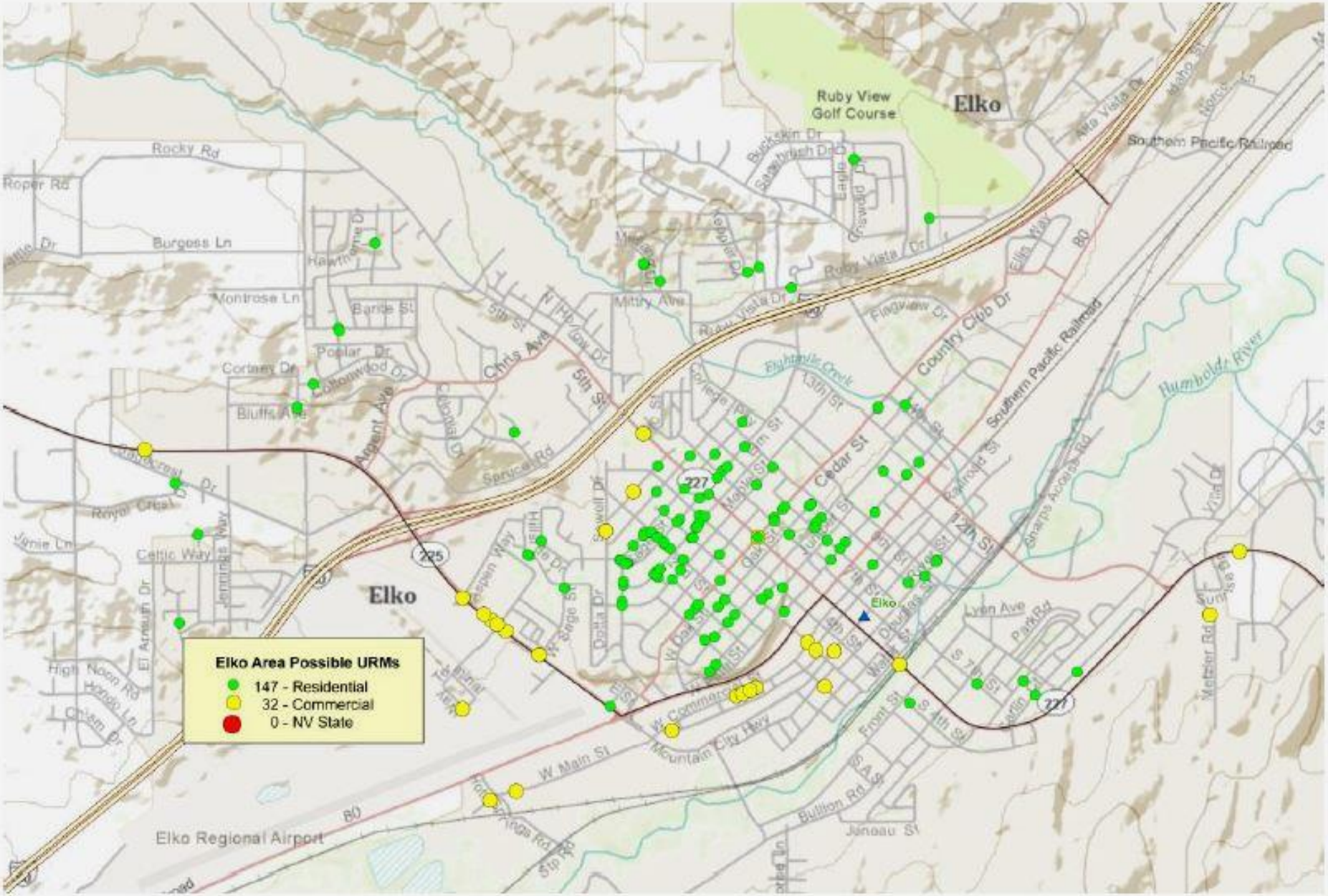
Major benefits of Las Vegas liking to blow up or tear down and replace old buildings.

1961 **UBC being the change point [reinforcement required] and use *1974* (similar to NBMG Report 54) as an effective date for implementation and enforcement.**

Werner Hellmer, Clark County Building Department


Reno-Sparks
Possible Unreinforced
Masonry Buildings

2012 study 734 poss URMBs; Carson City survey identified about 100 prob. URMBs



Elko – 170 possible URMBs

What has been done in Nevada to reduce this risk?

- Buildings code seismic provisions have been adopted by all Nevada Counties – outlaws URMBs
- Many state URMBs have been retrofit
- About 0 to 6 buildings rehabilitated/year
- Thousands of URMBs have been torn down
- URMB Committee developed risk reduction roadmap

Unreinforced Masonry Buildings are the ***most difficult contemporary challenge*** in creating an earthquake-resistant society.

- **Social challenges** with owners, tenants, neighbors, community.

- **Money** is needed that is **rarely available**. [retrofit costs, business disruption, moving costs, increases in rent to cover the cost]

- **Risk is not always compelling**. [high consequence but low probability – risk is chance of earthquake times chance of damage at specific location; low belief in local hazard]

Rehabilitation of Unreinforced Masonry Construction is Achievable

Interior cross bracing helps prevent building collapse

Bracing of URM parapets keeps them from toppling to the sidewalk below

Utah State Capitol – seismic strengthening and base isolation (above)


Fiberglass mesh epoxied
to bricks & tied to beam

Floors tied to walls

Lincoln Hall Seismic Rehabilitation

Cost of seismic retrofit:

$100,000s to $Millions

Large ticket item **– especially to individual owners, who might doubt an earthquake will ever occur and damage their building – come on really**

Problem – strong earthquakes occur in Nevada

Shared cost – grants, bonds, contributions from those that would benefit from the risk reduction, other.
A strategy would be best.

Roadmap for Reducing the Seismic Risk of Unreinforced Masonry Buildings in Nevada

1) Complete URMB Survey of Nevada and Prioritize by Seismic Risk

2) Initiate Broad Educational Efforts on the Hazards of URMBs

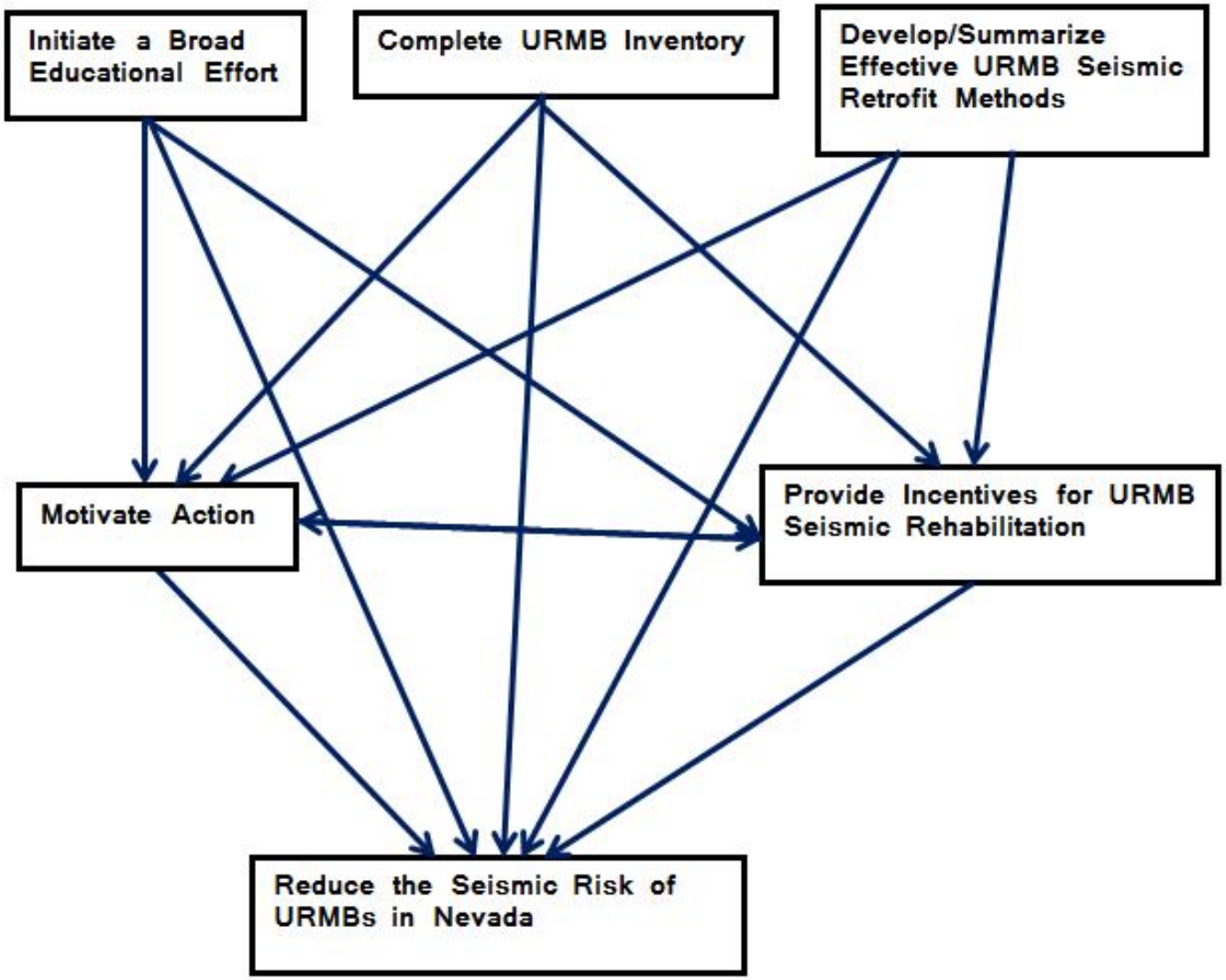
3) Motivate Action that Reduces the Seismic Risk from URMBS

4) Provide Incentives to Retrofit/Reduce the Seismic Risk of URMBs

5) Develop/Summarize Effective Seismic Retrofit Methodologies for URMBs

6) Nevada Decade of Unreinforced Masonry Building Seismic Risk Reduction

7) Rehabilitate or Remove Vulnerable URMBs and Other URM Structures


Initiate a Broad Educational Effort
Complete URMB Inventory
Develop/Summarize Effective URMB Seismic Retrofit Methods
Motivate Action
Provide Incentives for URMB Seismic Rehabilitation
Reduce the Seismic Risk of URMBs in Nevada

Nevada has made modest progress in reducing its overall URMB seismic risk mostly through tearing down a lot of URMBs down and not letting them be built anymore.

Thousands of URMBs exist throughout the state and many have been damaged by past Nevada earthquakes. Many of these buildings are in fragile and dilapidated states.

There does not exist a broad consciousness or effort to reduced the URMB seismic risk in Nevada, as there is in other states with URMB risks (e.g., CA & UT). At this point, Nevada lacks a group to promote this risk reduction.

The next window of opportunity for action will probably be The next damaging Nevada earthquake.

Unreinforced Masonry Buildings (URMBs):

The NRAC recognizes unreinforced masonry buildings as dangerous earthquake risks and encourage actions within Nevada to reduce this risk, with the result of saving lives, reducing injuries, and reducing property loss from earthquakes.