2015

# Unreinforced Masonry (URM) Seismic Retrofit Project:

## Retrofit Standards Committee Report


Bureau of Development Services
FROM CONCEPT TO CONSTRUCTION

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PBEM

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4/24/2015

## Executive Summary

There are approximately 1800 unreinforced masonry buildings (URM) in Portland. These structures experience a higher rate of collapse and sustain higher levels of damage than other building types in a seismic event. In their 2011 report, *The Oregon Resilience Plan,* the Oregon Seismic Safety Policy Advisory Commission (OSSPAC) recommended that URM buildings "should not be allowed to remain in service indefinitely unless they are fully upgraded."

Currently, the City of Portland requires seismic upgrades to buildings based on Title 24.85. These provisions require seismic upgrades when there is a change of use to a more hazardous classification, an increase in occupancy, or an alteration to the building that exceeds specific cost thresholds. Because Title 24.85 provisions only require seismic retrofits when an owner voluntarily undertakes an alteration or upgrade to their property, they are called "passive triggers." The Bureau of Development Services estimates that less than 20% of Portland's URM inventory has been upgraded since Title 24.85 went into effect in 1995. This rate would need to quadruple to meet the Oregon Resilience Plan goal of retrofitting these most vulnerable buildings within 50 years.

The Portland City Council has directed the Portland Bureau of Emergency Management (PBEM), Portland Development Commission (PDC), and Portland Bureau of Development Services (BDS) to investigate best practices regarding how other jurisdictions have addressed this problem and submit a policy recommendation report by summer 2016. The URM Seismic Retrofit Project recommendations will be developed by three committees. This report represents the Retrofit Standards Committee recommendations, which were developed by experts in the fields of structural engineering, architecture, and geology working with BDS staff to review relevant research and best practices from other west coast jurisdictions. Members of the public attended the meetings and had opportunity to comment throughout the policy recommendation development process.

The key recommendation of the Retrofit Standards Committee is that Portland adopt a mandatory seismic strengthening program that would require some level of upgrade for all URM structures with the exception of one and two family dwellings.

The committee's goal in developing recommendations for a mandatory seismic retrofit program was to assign an appropriate upgrade standard to URM buildings based the building use and the risk to human safety posed by the structure. To accomplish this, the Committee divided the City's URM inventory into 5 "URM Classifications." Class 1 buildings represent essential facilities such as hospitals and fire stations. These buildings must undertake comprehensive seismic upgrades so that they may be occupied and are operational immediately after an earthquake. Class 2 buildings include schools and other high occupancy structures. These structures must be upgraded to provide a performance standard between Life Safety and Immediate Occupancy. The remaining URM classifications range from Class 3 buildings that exceed 4 stories or have 300 or more occupants, to one or two story Class 5 buildings with ten or less occupants. The required performance levels for these classifications range from Life Safety Performance in a Design Level Earthquake for Class 3 buildings, to roof parapet bracing and exterior wall to floor attachments to

mitigate falling and collapse hazards for Class 5 buildings. The URM classification and performance standards are specified in Table 1 on pages 13-14 and described on pages 10-12.

When considering required timelines for mandatory upgrades, the Retrofit Standards Committee sought to balance the need for seismic safety improvements in the near term, with the need expressed by building owners to plan for the cost and disruption associated with retrofit projects. This balance was achieved by allowing longer time frames for the entire retrofit, while establishing intermediate benchmarks so that significant life/safety benefits are realized in a shorter time horizon. For example, Class 3 buildings must complete all retrofits within 25 years, but parapet and wall to roof attachments must be completed in 10 years, and all exterior/bearing wall to floor attachments must be complete within 20 years. All buildings must have a seismic evaluation within 3 years of notification by the City so that owners are able to plan for the required upgrades. Complete timeline recommendations are specified in Table 2 on page 16 and described on pages 16-18.

In addition to mandatory seismic upgrades, the Retrofit Standards Committee also recommended several amendments to Title 24.85 and made additional recommendations to support the proposed mandatory seismic upgrade program. The proposed Title 24.85 amendments focus on making the passive triggers in 24.85 more effective by tightening requirements for parapet bracing, as well as modifying the cost, use, and occupancy thresholds that trigger seismic upgrades when an owner applies for an alteration or addition permit for the building. The committee also recommended that an enforcement policy be coupled with the mandatory upgrade provisions to ensure compliance and advocated several strategies to inform the public and building occupants about a building's seismic resilience. These include tenant notification, building placards, and real estate transaction disclosures. The committee also noted that consideration should be given to an upgrade policy for other dangerous building types such as non-ductile concrete structures, and the importance of further policy development to strengthen historic URM buildings against seismic events. All the Committee's proposed recommendations are summarized in Section V found on pages 20-23.

The Oregon Resilience Plan found that the State currently has a low seismic resilience, leaving Oregon residents vulnerable to significant loss of infrastructure, basic services, and slow economic recovery following a major Cascadia subduction zone earthquake. URM buildings are some of the most vulnerable structures in a seismic event, and even minor earthquakes can pose public hazards when parapet walls and other loosely attached structures fall. The Seismic Retrofit Standards Committee urges the adoption of the mandatory upgrade program and associated recommendations as an important step in improving the safety of Portland's residents and it's infrastructure during and after an earthquake.

# I. Introduction

## Issue

Unreinforced masonry buildings (URMs) include some of the City of Portland's most historically significant structures. These buildings help define the character and culture of our neighborhoods and business districts. Unfortunately, URM buildings also pose considerable risk to the safety of building occupants and the general public during an earthquake. This is due to the higher incidence of collapse and serious damage sustained by URM structures as compared to other building types during seismic events. Debris from these structures may block nearby sidewalks and streets and cause damage to neighboring property. The buildings themselves will require extensive repairs or complete replacement. The business and infrastructure disruption associated with URM buildings following an earthquake poses a challenge to the City's economic and social recovery following such an event.

Based on a survey of buildings completed by the City of Portland Bureau of Buildings in 1995, there are approximately 1,800 unreinforced masonry structures in commercial use within the City. The City's existing URM retrofit requirements (codified in Title 24.85, established in 1995, and amended in 2004) have been inadequate in addressing the problem. The Portland Bureau of Development Services estimates that less than 20% of the existing inventory of URM buildings has been seismically upgraded or demolished since the inception of Title 24.85. In 2013, the Oregon Seismic Safety Policy Advisory Commission issued a comprehensive set of recommendations to improve the State's earthquake preparedness. *The Oregon Resilience Plan* recommended that vulnerable buildings, especially URM structures, be upgraded within 50 years. The current pace of URM retrofits in Portland would need to quadruple in order to meet this goal.

## URM Seismic Retrofit Project Description

The Portland City Council seeks to reduce the risk posed by unreinforced masonry buildings. To this end, City Council has directed staff from Portland Bureau of Emergency Management, Portland Development Commission, and Portland Bureau of Development Services to conduct best practices research to investigate how other cities have addressed this problem. Staff will return to Council in the summer of 2016 with policy recommendations, including proposed code changes and an incentive program(s) to support implementation of retrofit efforts. To assist in this effort, the City has assembled three advisory committees to provide expert input and guidance in the development of the staff recommendations. These include a Retrofit Standards Committee to provide input on code change recommendations, an Incentive Committee to provide input on a suite of programs to incentivize owners to retrofit their URM structures, and a Policy Committee that will facilitate public input on the final recommendations.

## URM Retrofit Standards Committee Charter

The URM Retrofit Standards Committee served as an advisory body to the City's URM Seismic Retrofit Project team in the evaluation and development of seismic code change recommendations to support the objectives outlined in the URM Project Description document. The charter of the URM Retrofit Standards Committee was to:

- Examine the existing URM seismic upgrade requirements established in Title 24.85.
- Consider if mandatory upgrades are feasible.
- Determine the standard and performance levels to which the URM buildings should be upgraded [use American Society of Civil Engineers (ASCE) 41-13 as a basis] and at what point upgrades should be triggered.
- Determine how code change recommendations will impact URM buildings where no changes of occupancy, tenant, or seismic improvements (existing triggering events) are proposed.
- Develop a building evaluation system that will require some level of mandatory ASCE 41 Tier 1 and Tier 2 seismic evaluation to be performed for each URM building.
- Create a ranking or prioritization system that will result in high vulnerability occupancies being retrofitted earlier rather than later, and consider whether all URM buildings should eventually be retrofitted.
- Propose a reasonable implementation time frame for the committee recommendations.
- Contribute recommendations reflecting technical expertise, current industry and academic ideas, and professional opinions.
- Consider the interests and concerns of the professions and organizations represented by the Committee, the community at large, and other stakeholders, as part of the development of the code change recommendations that will best serve the City.
- Serve as a communication conduit between the organizations they represent, other stakeholders and city staff.

## URM Retrofit Standards Committee Membership

The Retrofit Standards Committee was composed of professional experts in the fields of structural engineering, geotechnical engineering, and architecture. Additionally, the committee included two staff members from the Bureau of Development Services (BDS).

**Seismic Retrofit Standards Committee Membership**

| Name | Organization | Representing |
|---|---|---|
| David Bugni, P.E., S.E. | David Bugni and Associates | Structural Engineers |
| Brian Emerick | Emerick Architects P.C. and Portland Historic Landmarks Commission | Architects and Historic Preservation |
| Mike Hagerty, P.E., S.E. | Retired, City of Portland | Structural Engineers |
| Ian Madin | Oregon Department of Geology and Mineral Industries (DOGAMI) | Geotechnical Engineers |
| Mark Tobin, P.E., S.E. | KPFF Consulting Engineers | Structural Engineers |
| Reid Zimmerman, P.E. | KPFF Consulting Engineers | Structural Engineers |
| Amit Kumar. P.E., S.E. | Senior Engineer, Portland Bureau of Development Services | City Staff |
| Andrew Peterson | Manager, Permitting Services Division, Portland Bureau of Development Services | City Staff |

The committee met six times between December 2014 and May 2015. All meetings were open to the public, and the public had an opportunity to comment at each meeting. The recommendations in this report will be forwarded to the Incentive Committee to provide a basis for its recommendations. The recommendations of both committees will be forwarded to the Policy Committee to facilitate public input on the recommendations. The Policy Committee will create a final recommendation report to submit to City Council.

# II. Background:

## Why are URM Buildings Hazardous?

An unreinforced masonry (URM) building is one with at least one bearing wall constructed of masonry with little or no reinforcement. Masonry units such as clay brick, hollow clay tile, concrete block, or stone are very strong under compression, but they tend to shear and crack as a result of lateral and uplift forces exerted on buildings during an earthquake. Because they lack steel reinforcement to bond the masonry units together and resist seismic shaking, these buildings are prone to significant damage or collapse in an earthquake. Additionally, the mortar that holds older masonry bricks together is weaker than modern mortar and tends to weaken further with age.

Another risk posed by URM buildings is that there is generally little or no structural attachment between the exterior brick walls and the roof and floors of the building. In an earthquake, ground shaking can cause the walls to separate from other building components, leading to a partial or total building collapse. Even in less serious seismic events, non-structural building components such as roof parapet walls and building ornamentation are prone to falling. These aesthetic elements are usually found on street facing facades and over primary building entry points, creating a significant hazard to the building occupants and general public on the street below.

In an earthquake, URM buildings have historically been the most vulnerable building type, having a high risk of collapse and structural failure. Life threatening partial or complete collapses of URM buildings have occurred in virtually every major earthquake around the world and in the United States. The Klamath Falls and Scotts Mills earthquake of 1993 have demonstrated that URMs pose a threat in Oregon as well.

## What Efforts Have Been Undertaken to Mitigate the Hazards Posed by URM Buildings?

Along the west coast, several jurisdictions in high seismic risk areas, including Portland, have adopted several measures to mitigate hazards posed by URM buildings.

In 1986, the State of California mandated that local jurisdictions identify all potentially dangerous buildings and adopt policies and procedures aimed at reducing or eliminating the seismic hazards posed by these structures. Several jurisdictions adopted a range of policies including notification of building owners, requiring placards identifying buildings as a seismic risk, voluntary strengthening, and mandatory upgrade requirements for URM buildings. Mandatory upgrade requirements were particularly effective, resulting in 87% of buildings being retrofitted or demolished, significantly decreasing the seismic risk from these structures in the jurisdictions where they were employed.

In 2011, the Oregon legislature directed the Oregon Seismic Safety Policy Advisory Commission (OSSPAC) to create a plan to prepare Oregon's infrastructure and economy for the impacts of a large Cascadia subduction zone earthquake. In their report, *The Oregon Resilience Plan,* OSSPAC found that "Unreinforced Masonry (URM) and non-ductile concrete buildings are generally the most dangerous types of buildings in an earthquake, and should not be allowed to remain in service indefinitely unless they are fully upgraded." OSSPAC also recommended that the "the danger of URM and non-ductile concrete buildings should be disclosed at the time of building sale or lease" so that "market pressures and upgrades triggered by other building repairs" would incentivize seismic strengthening of these structures.

In 2013, reflecting the concerns surrounding the slow pace of URM upgrades and the OSSPAC recommendations, BDS prepared a draft *Mandatory Seismic Strengthening Program* for all URM buildings (except one and two family homes) in the City of Portland. The proposed program categorized URM structures into critical, high, and medium risk categories and provided upgrade standards for each. All URM buildings were required, as part of the draft proposal, to be evaluated for seismic risk within 18 months of adoption of the new policy, and to have seismic upgrades completed within 10-15 years, depending on the hazard category of the building. Feedback from the engineering community, URM building owners, and other stakeholders has helped move this project forward and informed the recommendations proposed in this report.

## Current Requirements for Seismic Upgrade of URM Buildings in City of Portland

The City of Portland initially adopted City Code Title 24.85 in 1995 to address the inventory of URM buildings within the City. The Code was modified and updated in 2004, and currently has provisions related to necessary seismic upgrades of URM buildings based on "passive triggers." Passive triggers are actions within the control of the owner that "trigger" a need to do seismic rehabilitation. Currently, Title 24.85 requires owners to upgrade buildings when there is: (1) a change in occupancy or use, resulting in more than 33% of the building area changing to a higher relative seismic hazard classification; (2) a change in occupancy or use resulting in an increased occupant load of more than 149 people; or (3) a major alteration, where the cost of the alteration or rehabilitation exceeds cost thresholds specified in Title 24.85. In addition, when a URM building is being reroofed, and the reroofing involves an area that exceeds 50% of the roof area of the building, parapets are required to be braced and walls are required to be attached to the roof for in-plane and out of plane seismic loads.

Current provisions require the owner to seismically upgrade their buildings, either to ASCE 31 or to the current Building Code standard, depending upon the hazard classification of the building when these passive triggers are reached.

## Why Consider Mandatory Upgrades For URM Buildings?

Based on a survey of buildings conducted by the City of Portland Bureau of Buildings from 1993 to 1995, there were approximately 1,800 unreinforced masonry structures in commercial use at that time. When Title 24.85 was adopted in 1995, it was expected that, because of the older nature of these URM structures, the pace of renovation would cause a significant majority of these buildings to be retrofitted or demolished to make way for new buildings in a relatively short time frame. In either instance the building would pose less of a hazard to the community.

It is estimated that in the twenty years since the adoption of Title 24.85, less than 20% of the existing inventory of URM buildings have either been upgraded or demolished. The Bureau of Development Services is currently in the process of updating the existing URM database to verify the number of URM buildings as well to determine the number that have received seismic retrofits and the level of those upgrades.

At the request of the Retrofit Standards Committee, BDS conducted a pilot study of 38 URM buildings on East Burnside Street, 60 buildings on SE Foster Road, and 49 buildings located in NW Portland's Chinatown listed in the URM database to investigate the extent to which identified URM buildings in these areas had been upgraded. The building permit history of each building was reviewed to verify if the building had undergone any seismic upgrades. Of the 147 total buildings, 13 had been demolished and 13 had received some form of upgrade. This represents less than 20% of the URM buildings in the pilot study sample. It is also important to note that only 4 buildings from this sample had received full seismic upgrades and 5 of the upgrades were limited only to parapet bracing and roof/wall attachments. Based on this preliminary data, it appears that the initial BDS estimate of the number of buildings that have received seismic upgrades under the current regulations is valid. The pilot studies lend further support to the conclusion that the current passive triggers within Title 24.85 have not been as effective as originally hoped.

While gathering information from these limited pilot studies, which reflect Portland's ability to attain URM upgrades, the committee also considered the effectiveness of various URM strengthening programs implemented in other jurisdictions. Data gathered from California jurisdictions indicate that cities with mandatory strengthening programs reported a compliance rate of better than 87%. By contrast, jurisdictions that used non-mandatory strategies to reduce the risk posed by URMs, such as passive triggers like those in Title 24.85, voluntary seismic strengthening initiatives, notification of owners, and placarding of buildings at seismic risk, achieved compliance rates ranging from 13%-31%.

Based on the Portland specific pilot studies, and the experience of other jurisdictions, the Retrofit Standards Committee finds that passive triggers by themselves have not proven effective in making timely progress towards achieving the goal of strengthening the buildings in the City's URM inventory, which would result in a more safe and resilient community in the event of an earthquake. The committee is therefore recommending that the current passive triggers within Title 24.85 be supplemented by "active triggers" that include mandatory strengthening requirements.

## Will Seismic Upgrades Improve the Safety of URM Buildings and be Cost Effective?

The effectiveness of seismic retrofits of URM buildings has been well documented in the aftermath of several earthquakes in the past. For example, the City of Los Angeles, launched the largest mandatory local government seismic retrofit program in the United States, when the City Council passed an ordinance in 1981. The law required structural upgrading or demolition of 14,000 unreinforced masonry buildings. In their 2009 report *Unreinforced Masonry Buildings and Earthquakes (FEMA P-774)* the Federal Emergency Management Agency has documented that:

> The 1994, Northridge earthquake caused strong ground motion over Los Angeles and other cities of the region and provided one of the first major tests of the performance of retrofitted

> unreinforced masonry (URM) buildings, and once again pointed out the vulnerability of URMs that have not been strengthened…. As would be expected, unretrofitted URM buildings performed worse, in general, than both reinforced masonry buildings and retrofitted URM buildings. As observed in previous earthquakes, many of these buildings suffered significant structural damage and posed serious risks to life safety.

The FEMA P-774 report made similar findings regarding the magnitude 6.5, 2003 San Simeon earthquake in central California:

> [Of the] 53 unreinforced masonry buildings in Paso Robles, the nearest affected city, none of the nine URM buildings that had been retrofitted experienced major damage. Many of the others were damaged so extensively that they were subsequently demolished. 'During earthquakes unreinforced masonry buildings that have not been retrofitted continue to be the most dangerous buildings in California.

Similar experiences have also been documented in more recent earthquakes in Christchurch, New Zealand.

Studies performed for the City of Portland demonstrated that seismic upgrades to URM buildings would be cost beneficial. In their 1995 *Earthquake Risk Analysis* report to the Portland Seismic Task Force, Goettel and Horner concluded that the benefits of seismic rehabilitation of URM buildings outweigh the costs of any such upgrades. For example, using values provided by FEMA, Goettel and Horner determined that URM buildings require only 1 occupant per 1,000 Sq. ft. for the life safety benefits to equal typical rehabilitations costs. This occupancy is equal to or lower than occupancy levels of most types of URM buildings, based on expected occupant density during business hours. The report concluded that seismic upgrades of URM buildings were the only construction type to show a positive life safety benefit to cost ratio.

The Goettel and Horner report also points out the importance of retrofitting URM building parapets. These parapets present a life-safety hazard at levels of ground motion as low as 0.10g, with widespread failures at 0.25g or higher. The persons at risk are primarily not the occupants of the building itself, but rather persons on the sidewalk or street outside the structure. The report concludes that parapet bracing is relatively inexpensive compared to whole-building retrofits, and that a significant portion of the life-safety risk of an unreinforced masonry buildings is posed by parapets. Goettel and Horner strongly recommend that parapet bracing be considered as a mandatory upgrade requirement, as it provides significant life-safety benefits at low cost.

## Overview of Recommendations

Based on evidence that the current passive triggers in Title 24.85 have not achieved a satisfactory level of seismic upgrade to Portland's URM building inventory, and that upgrades are a cost effective way to reduce seismic hazards posed by these structures, the Retrofit Standards Committee is recommending that the City of Portland adopt a mandatory seismic strengthening program for the City's URM buildings. The details of the proposed mandatory program are described in Section III, "Proposed Mandatory Seismic Strengthening Program."

In addition to the Mandatory Seismic Strengthening Program, the Committee is also recommending amendments to the existing passive triggers contained in Title 24.85. The recommended

amendments focus on the roof replacement, cost of improvement, and change of occupancy/use thresholds that trigger required seismic upgrades of URM structures where owners are making additions or alterations. These recommendations are detailed in Section V "Recommended Revisions to Existing requirements in Title 24.85"

Finally, the Retrofit Standards Committee is proposing that the City consider a number of additional measures to complement the Mandatory Strengthening and Title 24.85 code change recommendations. These include tiered enforcement provisions to ensure compliance with the proposed mandatory upgrade program, seismic risk notification requirements for tenancy changes and real estate transactions, developing a seismic rating system similar to the U.S. Resiliency Council's model, and additional public outreach and education efforts for building owners and the public. The Committee also called for additional efforts to specifically address the seismic upgrade challenges for historic URM structures, and to address the significant seismic hazards of other building types, such as non-ductile concrete buildings that also present a significant seismic risk. These additional recommendations can be found in Section V, "Recommendations for Special Building Types" and "Other Recommendations."

# III. Proposed Mandatory Seismic Strengthening Program

## Scope

The Retrofit Standards committee recommends that all unreinforced masonry buildings, with the exception of one and two family dwellings, are required to comply with the requirements of this mandatory seismic strengthening program unless more restrictive requirements or time frames under the provisions of Title 24.85 are triggered. If an alteration or addition changes the building's URM classification as defined in Table 1, the building must be upgraded to the requirements for the new URM Class.

Previously retrofitted buildings excluded from mandatory requirements: The committee considered URM buildings that have had previous seismic upgrades and recommends that buildings meeting the standards below should be exempted from the proposed mandatory requirements:

1) buildings in URM Class 3,4 and 5 that have previously undergone a full seismic upgrade to ASCE 31/41 (or equivalent standard);
2) URM buildings that have been fully upgraded to Seismic Zone 3 requirements under the Oregon Structural Specialty Code (OSSC) 1993 or later editions; or
3) buildings with currently approved Phased Seismic Agreements with the City of Portland for a full seismic upgrade as long as the building remains in the same or lower URM classification.

Recognizing the fact that it is neither practical nor financially feasible to retrofit all URM buildings to one standard, or within a single time frame, the Retrofit Standards Committee created a ranking or prioritization system based on factors such as the degree of risk posed by the building to its occupants and the public, the occupancy type and occupant load of the building, and the function of the building both before and after a seismic event. The committee also reviewed URM

classification systems used by various California jurisdictions in their mandatory upgrade programs, as well as a proposed classification system developed by the City of Seattle.

Based upon the above priority factors and these classification models, the Retrofit Standards committee developed a five-tier classification system. Classification ratings ranged from URM Class 1 representing highest risk critical structures, to URM Class 5 representing the lowest risk structures. Each URM Class was assigned a level of upgrade or retrofit associated with the targeted performance for the building, and a time frame to complete the upgrade. The proposal uses the American Society of Civil Engineers (ASCE) Standard 41-13 as the primary method of compliance.

General descriptions of the five URM classification categories are described below. Specific building classification and upgrade requirements are shown in Table 1. Time frames for mandatory upgrades for each classification are shown in Table 2.

## URM Class 1

Buildings in this URM classification **represent critical buildings and essential facilities**. Included in this category are Risk Category IV buildings as defined in the Oregon Structural Specialty Code such as hospitals, police stations, fire stations, emergency shelters, emergency operations and communication centers, as wells as buildings containing highly toxic materials that, if released, would pose a significant hazard to the public. Also included in this category are power generating stations, water treatment plants, and other facilities that provide utility service to critical buildings.

Due to the critical nature of these facilities, it is expected that buildings in this category, when retrofitted, would remain operational after a Design Level Earthquake and provide for a Life Safety Performance Level in the event of a Maximum Considered Earthquake. The performance objective specified is Basic Performance Objective Equivalent to New Buildings (BPON) as defined in the ASCE 41-13.

The Retrofit Standards Committee recommends that buildings in this category be retrofitted within a 10-year time frame. It is estimated that approximately 10 buildings would ultimately be required be retrofitted to URM Class 1 standards.

## URM Class 2

Buildings in this URM classification are generally **school buildings and other high occupancy structures** that represent a substantial hazard to human life in an event of a failure. Many of these buildings are designated as Risk Category III buildings in the Oregon Structural Specialty Code.

Due to the substantial life-safety risk posed by buildings in this URM Class, it is expected that, when they are retrofitted, URM Class 2 buildings would provide much greater reliability in terms of resisting collapse and limiting damage to the structure than a typical URM building, but not to the extent required for a structure designed to meet the Immediate Occupancy Performance Level for URM Class 1 buildings.

The performance level associated with structures in this category is set between Life Safety and Immediate Occupancy for a Design Level Earthquake, and between a Life Safety Performance Level and Collapse Prevention Level for a Maximum Considered Earthquake. The performance objective specified is Basic Performance Objective for Existing Buildings (BPOE) as defined in the ASCE 41-13

standard. The BPOE standard accepts a lower level of safety and a higher risk of collapse than that which would be provided by similar existing buildings evaluated and retrofitted to the Basic Performance Objective Equivalent to New Buildings (BPON). (BPON is the standard required of URM Class 1 buildings under this proposal.)

The Retrofit Standards Committee recommends that buildings in this category be retrofitted within a 20-year time frame. Based on the 1995 database of URM buildings there are fewer than 40 buildings in this category within the City of Portland.

## URM Class 3

Buildings in this URM classification **have over 300 occupants or are four stories or more in height, or are residential structures with greater than 100 units**. Because of their high occupancy levels, URM Class 3 buildings represent a high risk to human life in the event of a failure.

The retrofit standard assigned to this category is Life Safety Performance under a Design Level Earthquake and Collapse Prevention in the event of a Maximum Considered Earthquake using ASCE 41-13 Basic Performance Objective for Existing buildings (BPOE).

The Retrofit Standards Committee recommends that buildings in this category be retrofitted within a 25-year time frame with an additional five years allowed for demonstrable hardship. Currently, the URM database lists 264 buildings meeting the criteria of URM Class 3 buildings. Assuming less than 20% of the buildings have either been upgraded or demolished, it is expected that around 200 buildings require upgrading or strengthening in this category.

## URM Class 4

It is expected that a majority of URM buildings, other than those in URM Class 5, would fall under this category. Buildings in this category are typically non-critical structures. URM Class 4 buildings are one to three stories in height and have between 10-300 occupants.

The retrofit standard and the time frame assigned to buildings in this category are the same as that in URM Class 3. However, buildings that meet certain criteria are allowed to be retrofitted to a modified prescriptive method commonly referred to as “Bolts Plus” based on San Francisco’s retrofit ordinance. This modified method was proposed by Seattle for its Mandatory URM Strengthening Policy proposal. It requires retrofit of wall anchorage to ASCE 41-13 or current code standards, but addresses other structural deficiencies less comprehensively. Buildings using this modified prescriptive method are restricted to structures that have building characteristics generally shown to provide improved performance and an increased safety against collapse. Buildings that have characteristics such as vertical irregularities, substandard mortar strength, or lack enough lateral force resisting elements to provide adequate stability cannot use Bolts Plus retrofits unless these building deficiencies are improved first. (See Table 1, footnote 4 for all requirements.)

Currently approximately 800 buildings are listed in this category in the URM database. It is expected around 650 of these URM Class 4 buildings would require upgrading or strengthening.

## URM Class 5

Buildings in this URM class represent low risk, low occupancy structures. They are usually one and two story structures with an occupant load of 10 or less.

Because of the more limited risk of these buildings to the public, the committee proposed an upgrade standard that would quickly (within 10 years) mitigate falling hazards by bracing parapets and attaching exterior and bearing walls to floors and roof structures. Exterior walls are required to be braced only if they present a collapse hazard in a design earthquake for existing buildings (BSE-1).

Currently, approximately 700 buildings are listed in this category representing 40% of all buildings in the database.

## URM Building Classification and Upgrade Table

Table 1 on page 13 summarizes the URM building classifications and seismic upgrade required for each:

**Table 1: URM Building Classification and Upgrade Table (Except 1 and 2 Family Dwellings)**

| Seismic Risk | Classification | Description | Upgrade Level[2,3] | Approximate # of Buildings[4] |
|---|---|---|---|---|
| **Highest** ↓ | **URM Class 1** | Critical Buildings (Risk category[1] IV buildings, power generating stations serving critical facilities, water facilities, and other public utilities) | **Evaluation and Retrofit Level:** Tier 3 in accordance with ASCE 41<br>**Performance Objective:** BPON for Risk Category IV<br>**Structural Performance Objective**: Immediate Occupancy for BSE-1N and Life Safety for BSE-2N<br>**Non-Structural Performance Objective**: Operational for BSE-1N for all non-structural components assigned a component importance factor, Ip=1.5 as defined in ASCE 7-10 Chapter 13, as well as URM parapets, cornices, partitions and chimneys and hollow clay tile partitions. | **10** |
| | **URM Class 2** | A. All school buildings<br>B. Risk category[1] III buildings | **Evaluation and Retrofit Level:** Tier 3 in accordance with ASCE 41<br>**Performance Objective:** BPOE for Risk Category III<br>**Structural Performance Objective**: Damage Control for BSE-1E and Limited Safety for BSE-2E.<br>**Non-Structural Performance Objective:** Position Retention for BSE-1E for URM parapets, cornices and chimneys as well as unreinforced masonry or clay tile partitions along major routes of egress. | **(68) of which 38 are school buildings and 30 are public assembly buildings (mostly churches)** |
| | **URM Class 3** | A. Buildings ≥ 4 stories or<br>B. Buildings with ≥ 300 occupants or<br>C. Residential buildings with ≥ 100 units | **Evaluation and Retrofit Level:** Tier 2 deficiency only in accordance with ASCE 41 (unless Tier 3 required by ASCE 41)<br>**Performance Objective :** BPOE for Risk Category II<br>**Structural Performance Objective:** Life Safety for BSE-1E. When Tier 3 is required by ASCE 41, structural performance objective also includes Collapse Prevention for BSE-2E.<br>**Non-Structural Performance Objective**: Life Safety for BSE-1E for URM parapets, cornices and chimneys. | ▪ **(188)** Buildings ≥ 4 stories<br>▪ **(76)** Buildings ≥ 300 occupants |

Footnotes:

1. Risk category as defined in Oregon Structural Specialty Code, 2014 Table 1604.5. (See Appendix B)
2. ASCE 41 refers to latest edition of American Society of Civil Engineers standard ASCE 41. At the time of writing of this report the reference standard is ASCE 41-13.
3. Refer to the glossary of terms for definition of BPOE, BPON, BSE-1, and BSE-2 etc. Note that BSE-1E and BSE-2E are defined differently in this report than in ASCE 41.
4. The number of URM buildings was obtained from the 1995 City of Portland URM database. This URM database is currently being updated to verify its accuracy, reflect any seismic upgrades that may already have been undertaken at the structure, and to remove buildings that have been fully upgraded or demolished.

**Table 1: URM Building Classification and Upgrade Table (Except 1 and 2 Family Dwellings)**

| Seismic Risk | Classification | Description | Upgrade Level[2,3] | Approximate # of Buildings[4] |
|---|---|---|---|---|
|  Lowest | **URM Class 4** | All other URMs not categorized as URM Class 1, 2, 3, or 5. | **Evaluation and Retrofit Level:** Tier 2 deficiency only in accordance with ASCE 41 (unless Tier 3 is required by ASCE 41)<br>**Performance Objective :** BPOE for Risk Category II<br>**Structural Performance Objective:** Life Safety for BSE-1E. When Tier 3 is required by ASCE 41, structural performance objective also includes Collapse Prevention for BSE-2E.<br>**Non-Structural Performance Objective**: Life Safety for BSE-1E for URM parapets, cornices and chimneys.<br>**Exception: If a building conforms to or is brought up to the minimum requirements described in **footnote 5** below, then only the following elements are required to be upgraded per ASCE 41 for Life Safety performance under the BSE-1E and Collapse Prevention under the BSE-2E:<br>(a) brace URM parapets, cornices and chimneys;<br>(b) anchor URM walls to floors and roofs for out of plane loading;<br>(c) attach diaphragm to vertical elements to transfer in plane shear; and<br>(d) out-of-plane URM wall bracing if h/t ratio exceeds that reqd. by ASCE 41-13 Table 11-5. | ▪ **(736)** Non-critical, 2 and 3-story buildings with occupant load between 10-100 occupants and 1 story building with occupants 10-300 |
| | **URM Class 5** | 1 and 2-story buildings with 0-10 occupants. | **Performance Objective:** Limited Performance Objective<br>Only the following elements are required to be upgraded per ASCE 41 for Life Safety performance under the BSE-1E and Collapse Prevention under the BSE-2E :<br>(a) brace URM parapets, cornices and chimneys;<br>(b) anchor URM walls to floors and roofs for out of plane loading;<br>(c) attach diaphragm to vertical elements to transfer in plane shear; and<br>(d) out-of-plane URM wall bracing for URM walls with h/t ratio greater than 16 for one-story buildings or h/t ratio greater than 18 for the first story of a multi-story building, or h/t ratio greater than 14 for walls in top story of a multi-story building. | **(599)** 1-story buildings<br>**(110)** 2-story buildings |

**Footnotes (Continued):**

**5.** Minimum Requirements / Building Configurations when limited upgrade is applicable for URM Class 4 buildings:

a) The building does not have vertical irregularity type 5a or 5b (a "weak story") as defined is ASCE 7-10, Table 12.3-2.

b) The building has a mortar strength ($v_t$) of 30 psi or more for all masonry at an axial stress of 0 psi.

c) The building has diagonally sheathed or plywood diaphragms at all levels above the base of the building.

d) The building has or will be provided with a minimum of two lines of vertical elements of the lateral force resisting system parallel to each axis. Masonry walls shall have piers with a height to width ratio that does not exceed 2:1. Wall piers shall occupy not less than 40 percent of the wall's length for the wall to be considered as providing a line of resistance. Exception: If a design professional registered in Oregon can demonstrate that the flexural, shear and compressive strength Demand/Capacity ratio are equal to 2.0 or less for all walls when evaluated using ASCE 41.

## Program Implementation

The Bureau of Development Services has a database of URM buildings within the City of Portland. This database was originally created in 1995 but is currently being updated. It is expected that this update will be complete in the first quarter of 2016. Within six months of the adoption of the URM Retrofit Project recommendations by City Council, the Retrofit Standards Committee recommends that the Bureau of Development Services send a letter to building owners in this database informing them that their building is subject to the mandatory upgrade requirements proposed in Table 1. Building owners may also verify the status of their buildings by accessing the database online.

If an URM building is not included on the City's database, the building is still subject to the URM building seismic strengthening program and the owner is obligated to comply with the program requirements and timelines. The timelines in such cases will begin once the City has notified the owner by certified mail that the structure has been identified as a URM building.

If the building owner feels that their building has been erroneously classified as a URM building they may submit an appeal. The appeal must provide a justification as to why the identified building is not subject to the provisions of this ordinance. Such justification could include:

1) There is documentation that the URM building was demolished under permit from the city;
2) That a URM Class 3, 4, or 5 building has already been fully upgraded to ASCE 31/41 (or equivalent standard), or to Seismic Zone 3 requirements under the Oregon Structural Specialty Code (OSSC) 1993 or later editions. Voluntary upgrades, unpermitted work, or upgrades to a lesser standard are NOT considered sufficient to meet these requirements unless accompanied by an ASCE 31/41 report and a stamped letter from a registered design professional in Oregon. The letter must certify the building's URM classification and the basis of the determination that the building has been seismically upgraded to meet the above standards;
3) The URM building currently has a phased seismic agreement with the City of Portland and that the upgrades reviewed and permitted have been, or will be, completed within the time frame specified in the agreement as long as the building remains in the same or lower URM classification;
4) The URM building is currently permitted as a one or two family dwelling; or
5) The identified building is not a URM building. This must be accompanied by a letter from an engineer registered in Oregon identifying the construction type of the building and a statement as to why the building is not a URM structure.

All URM buildings subject to the mandatory upgrade requirements must complete the evaluation and upgrade requirements within the time frames specified in Table 2 below. As part of building evaluation in Step 1, a registered design professional in Oregon must certify the building's URM Classification and the basis for their determination. Buildings that have not received certified classification from a registered design professional in Oregon will be automatically classified as a URM Class 1 building.

If there is at any point a conflict between the upgrade or time frame requirements of Title 24.85 and the mandatory upgrade requirements contained in this proposal, the more stringent of the two requirements shall apply.

## Timelines for completing a URM retrofit and Intermediate Benchmarks

The Retrofits Standard committee recommends that all URM buildings must be seismically evaluated and upgraded within the time frames for each of the steps listed in Table 2, based on the determination of URM Class for each building. The timelines specified in Table 2 shall be effective from the date the building owner is notified that the building is a URM structure subject to the mandatory provisions.

**Table 2**

**Timeline for Seismic Upgrades and Intermediate Benchmarks[1]**

| | **STEP 1** **ASCE 41 Assessment[2] and Geotechnical Report[3]** | **STEP 2** **Parapet, cornice and chimney bracing and wall to roof attachment[,5]** | **STEP 3** **All bearing and exterior wall to floor attachments and out-of-plane wall strengthening[4,5]** | **STEP 4** **Seismic upgrade completed[4]** |
|---|---|---|---|---|
| **URM Class 1** | 3 years | - | - | 10 years |
| **URM Class 2** | 3 years | 10 years | - | 20 years |
| **URM Class 3** | 3 years | 10 years | 20 years | 25 years with up to an additional 5 years with demonstrable hardship |
| **URM Class 4** | 3 years | 10 years | 20 years | 25 years with up to an additional 5 years with demonstrable hardship |
| **URM Class 5** | 3 years | 10 years | 10 years | - |

**Footnotes**

1) The timelines specified in Table 2 shall be effective from the date the building owner is notified that the building is a URM structure subject to the mandatory provisions.
2) ASCE 41 assessment is a seismic evaluation including a Tier 1 and Tier 2 evaluation using ASCE 41 or equivalent prepared by a registered design professional in Oregon. If a building is confirmed to be URM Class 5 by a registered design professional in Oregon, no seismic evaluation will be required.
3) Structures located in High Liquefaction zones or soil class type E require a geotechnical report prepared by a licensed geotechnical or geologic engineer. This requirement for a geotechnical report does not apply to buildings in URM Class 5.
4) Permit must be applied for and issued at least one year prior to the due date for completion of the phase of the upgrade.
5) For URM Class 2, 3 and 4, the building owner may enter into an optional phased seismic agreement m with the City of Portland.

**Rationale for upgrade timelines:** In assigning upgrade timelines, the Retrofit Standards Committee sought to balance the need to improve public safety with the need of building owners to amortize the cost of retrofits over time.

Because of their critical nature, and the need to have these buildings operational immediately after a seismic event, URM Class 1 buildings must be completely upgraded within 10 years of notification. For buildings in URM Classes 2-4 the Committee is recommending extended time frames for final completions of retrofits, with intermediate benchmarks to address the most pressing seismic safety concerns. The proposed timelines set a deadline of 20-25 years for completion of URM Class 2-4 building upgrades, with a possible 5 year extension for URM Class 3 and 4 structures where the owner can demonstrate a hardship. The upgrades specified for URM Class 5 buildings only require parapet bracing, attachment of exterior walls to the roof, and in some cases bracing the exterior walls for out-of-plane loading. For this reason, all URM Class 5 upgrades must be completed within 10 years

**Intermediate benchmarks:** To address falling hazards associated with URM buildings, the proposed mandatory upgrade program requires owners of URM Class 2-5 buildings to install parapet, cornice and chimney bracing and attach walls to the roof within 10 years of notification that the building falls within these classifications. The exterior and bearing walls must be attached to the floors of URM Class 2-5 buildings within 20 years, significantly mitigating the collapse hazard posed by these structures. Much of the work for parapet, cornice and chimney bracing can be done with minimal disruption to the tenants, and at relatively low cost to the building owners, making a shorter timeframe appropriate for these upgrades. As the attachment of walls to the floors may be more intrusive, a longer time frame was established to allow the building owners adequate time to incorporate these upgrades into their operational plans.

**Liquefaction and Type E soil considerations:** Liquefiable or poor soils can magnify the stresses imposed on buildings during an earthquake and significantly increase damage done to the structure. The Retrofits Standards Committee concluded that, in order to mitigate the hazards posed by liquefaction or poor soils, ground improvement measures or use of deep foundations would be necessary. These measures may not be practical or economically feasible for an existing building. Instead, the committee decided that a geotechnical report should be required as part of the building assessment (STEP 1) for URM buildings in high liquefaction zones or situated on type E soils. The report would verify if poor soils are a concern on a site-specific basis, and inform the owners of the risk to their URM building as a result. This evaluation will enable owners to make an informed economic decision as to whether the building should be upgraded or demolished. URM buildings in high liquefaction zones may not be susceptible to liquefaction in smaller seismic events but could still pose a danger to occupants and the public. Therefore, seismic upgrades based on their classification as noted previously are still warranted.

**Phased seismic agreement:** Owners of buildings in URM Class 2, 3 and 4 have an option to submit plans for seismic upgrades required under STEPS 3 and 4 at the time they are applying for permits required under STEP 2. This enables the owners to “lock in” the design and the applicable code standards in effect at the time of application for the entire upgrade project. If

the owners do not wish to use this option, and apply for separate permits at later dates, the upgrades required in STEPS 3 and 4 would need to conform to the codes in effect at the time of application for each step.

In order to use a phased approach to permitting seismic upgrades, the owner must enter into a legally binding agreement with the City of Portland that will be recorded on the property at the County having jurisdiction. The upgrade must be reviewed and approved by the City of Portland, and the approved plans will be part of the legal agreement. The upgrades must be completed within the time frames listed in Table 2. The building owner must enter into a phased seismic agreement during the STEP 2 permitting process.

**Upgrade timeline example:** If the program takes effect in 2016, assessments for a building in URM Class 4, along with a geotechnical report if the building is in a high liquefaction zone, must be completed by 2019. A permit for bracing the parapets, cornices and chimneys, as well as attachment of the walls to roof, and a phased agreement for remainder of the seismic upgrade work (if desired) must be obtained by 2025. Parapet, cornice and chimney bracing, as well as attachment of the walls to the roof must be completed and receive final inspection approval by 2026. A permit for attachment of the walls to the floors and out-of-plane wall strengthening must be obtained by 2035. The work must receive final inspection approval by 2036. A permit for any remaining seismic upgrades must be obtained by 2040. Those upgrades must receive final inspection approval by 2041. With demonstrable hardship, the completion date may be extended to year 2046.

# IV. Cost Analysis

Although not part of the charter of the Retrofits Standards Committee, the committee attempted to provide a broad framework of costs associated with the mandatory strengthening recommendations for the incentives committee to consider. These costs are not intended to be used to estimate the seismic retrofit costs for any particular building. Rather, they are intended to provide an order of magnitude of upgrade costs for use in developing finance and incentive programs to compliment the mandatory upgrade policy proposed in this report. Costs for individual buildings can vary widely based on the strengthening methods employed, size of building, architectural finishes present, identified deficiencies, specific building characteristics, etc. Retrofit cost estimates should therefore be developed by a contractor and engineer/design professional on a building specific basis.

The estimated costs in Table 3 are based on the Federal Emergency Management Agency (FEMA) publication *Typical Costs for Seismic Rehabilitation of Existing Buildings* second edition (FEMA -156) and the *Earthquake Risk Analysis* report by Goettel & Horner Inc., 1995. Costs associated with the upgrade standards for URM 4 and 5 were not available in the FEMA or Goettel & Horner reports. For these classifications, upgrade costs were estimated based on local experience retrofitting these types of URM buildings.

Costs contained in FEMA-156 represent a major nationwide data collection, compilation and interpretation effort and thus provides the best available description of the typical costs of seismic retrofits for buildings of all types. The retrofit costs reported in FEMA 156 include the cost of strengthening structural elements, non-structural mitigation costs such as light bracing of ceilings, lights etc., costs associated with restoration of architectural finishes, and other project costs such as insurance, project management, and architectural and engineering fees (estimated at 30% of the total project cost). The cost of relocation associated with retrofit work was also taken into account. The Retrofit Standards Committee used a relocation value of $9.00/Sq. ft. based on the Goettel and Horner Report adjusted for inflation (factor of 2.0) to arrive at a current relocation cost of $18.00/Sq. ft. For each URM classification, the retrofit costs reported in FEMA 156 were also adjusted to account for: 1) regional levels of seismicity; 2) regional costs of labor and materials; 3) the building size per FEMA-156; and 4) the increase in cost of construction from 1995 to the present.

Table 3 below represents an estimate of cost for buildings in each URM category and assumes that 20% of the buildings in each class have either been demolished or upgraded and thus do not need to be seismically retrofitted.

**Table 3**

**Seismic Retrofit Cost estimate by URM Class**

| URM CLASS | Upgrade Standard | Total Bldg. Area (million Sq. ft.) in URM Class | Construction Cost[1] | | Total Costs[2] | |
|---|---|---|---|---|---|---|
| | | | Cost/Sq. ft. | Total[3] (million) | Cost/Sq. ft. | Total[3] (million) |
| Class 1 | Immediate occupancy | 0.05 | $70.32 | **$2.6** | $109.26 | **$4.4** |
| Class 2 | Damage Control | 3.17 | $48.39 | **$123** | $81 | **$205** |
| Class 3 | Life Safety | 13.25 | $38.43 | **$407** | $67.42 | **$715** |
| Class 4 | Modified Bolts Plus | 8.51 | $25 [4] | **$170** | $50 [4] | **$341** |
| Class 5 | Parapet/Wall Bracing | 5.09 | $20 [4] | **$82** | $20 [4] | **$82** |

Footnotes:

1. Construction costs include structural costs, non-structural costs and restoration costs based on FEMA-156
2. Total costs include Construction costs plus other costs which are taken as 30% of construction plus relocation costs of $18/Sq. ft.
3. Assumes that 20% of the buildings in each class have either been demolished or upgraded and thus do not need to be seismically retrofitted
4. Estimated costs based on local experience and not from a published value.

**Cost recommendations:** Retrofit Standards Committee recommends appointing a committee or to engage the services of a professional firm to develop accurate cost estimates for seismic upgrades for the mandatory strengthening program. The estimates presented above are very

rough estimates and are to be used only as guidelines to frame the order of magnitude of the costs involved with implementing the mandatory strengthening program.

# V. Recommendations

## Mandatory Seismic Strengthening Program Recommendations

A. **Mandatory seismic strengthening program:** The URM Retrofit Standards Committee recommends that the Seismic Retrofit Project Policy Committee refer the proposed mandatory seismic strengthening program as described in section II of this report to Portland City Council for consideration and adoption.

B. **Enforcement:** A method ensuring that property owners comply with the mandatory seismic strengthening requirements will be needed. The Committee recommends that a tiered system of penalties including fines, withholding of future permits, placarding the buildings, revocation of occupancy certificates etc. be developed and adopted.

C. **Cost estimates for the mandatory strengthening program:** The Retrofit Standards Committee recommends that the URM Seismic Retrofit Project appoint an additional committee or engage the services of a professional firm to develop accurate seismic upgrade cost estimates for retrofits required for the 5 building classes under this proposed mandatory strengthening program. The Seismic Retrofit Standards Committee has provided cost estimates using FEMA 156 data and the 1995 Earthquake Risk Analysis report by Goettel & Horner Inc. in section IV of this report. However, these are rough cost estimates and accurate cost data will be essential to informing the Incentives Committee recommendations and informing the public and City Council about the costs associated with the proposal.

## Recommended Revisions to Existing Requirements in Title 24.85

In addition to the mandatory strengthening requirements (active triggers) discussed in previous sections, the Retrofits Standards Committee recommends that the existing regulations in Title 24.85 be tightened to remove loopholes and enhance some triggers as they relate to URM buildings to achieve better and faster compliance through existing regulations. Irrespective of the disposition of the mandatory requirements, the Retrofit Standards Committee recommends that the Policy Committee recommend, and the City Council adopt, the following revisions to Title 24.85:

D. **Existing requirement:** Section 24.85.065 (A) Roof Repair or Replacement – When greater than 50% of roof covering in an URM building is repaired or replaced within a five year period the building structural roof system, anchorage and parapets are required to be repaired or rehabilitated such that the wall anchorage for both in-plane and out-of-plane forces at the roof and parapet bracing conform to ASCE -31.

**Proposed revision:** Revise Section 24.85.065(A) to change the five year window to fifteen years.

E. **Existing requirement:** Section 24.85.065(B): When costs of alterations or repair which requires a building permit in a two year time period exceeds costs listed in table below, entire building shall be improved to resist seismic forces to meet ASCE 31 improvement standard.

| **Table 24.85C** | |
|---|---|
| **Building Description** | **Cost of Alteration or Repair** |
| Single Story Building | $40 per square foot |
| Building Two Stories or greater | $30 per square foot |

**Proposed revision**: Revise Section 24.85.065 and Table 24.85-C as follows: When costs associated with building alterations or repair exceed the levels listed in the table below in a *five* year time period *or fifteen year time period*, the entire building shall be improved to resist seismic forces to meet ASCE 41 improvement standard.

| **Table 24.85-C** | | |
|---|---|---|
| Building Description | **Cost of Alteration/ Repair in a Five year time period** | **Cost of Alteration/ Repair in a Fifteen year time period** |
| Single Story Building | $40 per square foot | 2x Five year costs |
| Building Two Stories or greater | $30 per square foot | 2x Five year costs |
| Special building hazard: Buildings in relative hazard categories 5 or with vertical or plan irregularities | $30 per square foot | 2x Five year costs |

**Note:** The costs listed above are those currently specified by Title 24.85. These costs are adjusted annually based on the cost of construction index. For 15 Year Alteration/Repair the Five Year Costs are set at the date of Council adoption.

F. **Existing requirement:** Section 24.85.040 requires a seismic upgrade due to a change in occupancy or use when (a) More than 33% of the building area undergoes a change in occupancy to higher hazard classification; (b) There is an increase in occupant load by more than 149 persons; (c) There is an occupancy change to the same or lower hazard

classification if the occupant load is increased by more than 149 persons; or (d) The occupancy changes to an essential facility.

**Proposed revision:** Revise Section 24.85.040 to add separate triggers for URM buildings only such that seismic upgrades are required when (a) More than 33% of the building area undergoes a change in occupancy to higher hazard classification; (b) There is an increase in occupant load by more than 99 persons; (c) There is an occupancy change to the same or lower hazard classification if the occupant load is increased by more than 99 persons; (d) The occupancy changes to an essential facility.

The above recommendation did not have unanimous support of the committee but was the recommendation of the majority. The recommendation of the minority is to either eliminate the 33% of the area trigger in item (a) above or change the area trigger to only apply to buildings greater than 10,000 Sq. Ft. The reasoning for this is that the current provision in Title 24.85 is not calibrated for smaller buildings. Currently small buildings are very limited in terms of the actual square footage of area they can change, even though it often results in only a few added occupants. The main concern is to limit the number of people exposed to seismic hazard posed by URM buildings which Title 24.85 has taken into account with the 150 Occupants added trigger.

## Recommendations for Special Building Types

G. **Historic buildings:** Historic buildings serve as cultural landmarks that need to be preserved. However historic buildings with unreinforced masonry construction are subject to the same seismic hazards as other non-historic URM buildings. In order to preserve these buildings and protect the public, it is important that they be rehabilitated for seismic loads. Innovative mitigation methods, flexibility in compliance timeframes, and acceptance of designs that improve critical safety, should be encouraged to make sure these buildings are retained and preserved. Further discussion and engagement of the historic building community is required to develop innovative mitigation methods, funding of seismic upgrades, and incentives to promote seismic strengthening

H. **Non-URM hazardous building types:** While URM buildings pose a special and significant hazard in a seismic event, it is the opinion of the Committee that other building types such as non-ductile concrete buildings, precast concrete, and buildings with concrete frame and masonry infill also pose a significant hazard to the public. The committee strongly recommends that City council consider providing funding to create an inventory of these vulnerable building types and develop seismic retrofit policies similar to that for URM buildings.

## Other Recommendations:

I. **Tenant notification:** It is recommended that policies be adopted which would require the owners of buildings listed in the updated database of URM buildings to notify their tenants and any prospective renters that the building is a URM structure that has traditionally not performed well in an earthquake. A seismic evaluation report must be completed and made available to the tenants. It is hoped that, through market pressure, seismic upgrades can be achieved in many of these structures.

J. **Real estate transfer disclosure:** The Committee recommends that the danger of URM buildings should also be disclosed at the time of sale or lease. It is hoped that, through market pressures, upgrades can be made to many of these structures.

K. **Building placards:** The Retrofit Standards Committee recommends that the Policy Committee consider a requirement to place a placard on URM buildings that have not been seismically upgraded. The placard would identify the building as a URM structure that it is potentially hazardous in the event of the earthquake. It is hoped that, through market pressure, seismic upgrades can be achieved in many of these structures. Conversely, URM buildings that have been fully upgraded may also have signs or placards placed identifying them as seismically upgraded buildings. This would provide an incentive or a marketing attribute for building owners who can potentially receive higher rents through market pressures.

L. **Seismic rating system:** The Committee recommends that Portland adopt a seismic rating system similar to the system developed by the U.S. Resiliency Council. The objective of the rating system would be: (1) to make buildings more resilient and usable after an expected seismic event; and (2) to help communicate seismic risk to the general public.

M. **Education:** The Committee recommends that funding be provided to develop an educational program for all residents, but also targeted outreach to building owners and tenants, focused on the importance of a seismic retrofit policy for public safety and economic and social vitality.

# VI. Appendices

## Appendix A: Glossary of Terms

A. **ASCE 41** means the most current version of the Seismic Evaluation and Retrofit of Existing Buildings standard published by the American Society of Civil Engineers and the Structural Engineering Institute. At the time of this proposal, the current standard is ASCE 41-13.

B. **ASCE 41 Evaluation** means the process of evaluating an existing building for the potential earthquake-related risk to human life posed by that building, or building component, and the documentation of that evaluation, performed and written according to the provisions of ASCE 41.

C. **ASCE 41-BPOE Improvement Standard** means the Tier 1 and Tier 2 Deficiency-based retrofit using the Basic Performance Objective for Existing Buildings (BPOE) as defined in ASCE 41, unless a Tier 3 evaluation is required by ASCE 41.

D. **ASCE 41-BPON Improvement Standard** means Tier 3 Retrofit using the Basic Performance Objective Equivalent to New Buildings (BPON) as defined in ASCE 41

E. **BPOE-** Basic Performance Objective for Existing Buildings: A series of defined Performance Objectives based on a building's Risk Category meant for evaluation and retrofit of existing buildings; See Table 2-1 of ASCE 41.

F. **BPON-** Basic Performance Objective Equivalent to New Building Standards: A series of defined Performance Objectives based on a building's Risk Category meant for evaluation and retrofit of existing buildings to achieve a level of performance commensurate with the intended performance of buildings designed to a standard for new construction; See Table 2-2 of ASCE 41.

G. **BSE-1E:** Basic Safety Earthquake-1 for use with the Basic Performance Objective for Existing Buildings, taken as a seismic hazard with a 20% probability of exceedance in 50 years, except that the design spectral response acceleration parameters $Sx_s$ and $Sx_1$ for BSE-1E seismic hazard level shall not be taken as less than 75 percent of the respective design spectra response acceleration parameters obtained from BSE-1N seismic hazard level and need not be greater than BSE-2N at a site.

H. **BSE-1N:** Basic Safety Earthquake-1 for use with the Basic Performance Objective Equivalent to New Buildings Standards, taken as two-thirds of the BSE- 2N.

I. **BSE-2E:** Basic Safety Earthquake-2 for use with the Basic Performance Objective for Existing Buildings, taken as a seismic hazard with a 5% probability of exceedance in 50 years, except that the design spectral response acceleration parameters of $Sx_s$ and $Sx_1$ for BSE-2E seismic hazard level shall not be taken as less than 75 percent of the respective design spectra

response acceleration parameters obtained from BSE- 2N Seismic hazard level and may not be greater than BSE-2N at a site.

J. **BSE-2N:** Basic Safety Earthquake-2 for use with the Basic Performance Objective Equivalent to New Buildings Standards, taken as the ground shaking based on Risk-Targeted Maximum Considered Earthquake ($MCE_R$) per ASCE 7 at a site.

K. **Design Earthquake** means an earthquake for the evaluation or retrofit of a building that has ground shaking criteria in ASCE 41-13 associated with the targeted performance level and objective.

L. **Maximum Considered Earthquake** means an extreme seismic hazard level set forth in ASCE 7 and determined for the orientation that results in the largest maximum response to horizontal ground motions and with adjustments for a targeted risk.

M. **Oregon Structural Specialty Code (OSSC)** means the provisions of the State of Oregon Structural Specialty Code as adopted by City of Portland Code Section 24.10.040 A.

N. **Risk Category:** A categorization of a building for determination of earthquake performance based on Oregon Structural Specialty Code (OSSC).

O. **Unreinforced Masonry (URM)** means adobe, burned clay, concrete or sand-lime brick, hollow clay or concrete block, hollow clay tile, rubble and cut stone and unburned clay masonry that does not satisfy the definition of reinforced masonry as defined herein. Plain unreinforced concrete shall not be considered unreinforced masonry for the purpose of this Chapter.

P. **Unreinforced Masonry Bearing Wall** means a URM wall that provides vertical support for a floor or roof for which the total superimposed vertical load exceeds - 100 pounds per lineal foot of wall.

Q. **Unreinforced Masonry Bearing Wall Building** means a building that contains at least one URM bearing wall.

# Appendix B: OSSC Risk Category Table

**TABLE 1604.5**
**RISK CATEGORY OF BUILDINGS AND OTHER STRUCTURES**

| RISK CATEGORY | NATURE OF OCCUPANCY |
|---|---|
| I | Buildings and other structures that represent a low hazard to human life in the event of failure, including but not limited to:<br>• Agricultural facilities.<br>• Certain temporary facilities.<br>• Minor storage facilities. |
| II | Buildings and other structures except those listed in Risk Categories I, III and IV |
| III | Buildings and other structures that represent a substantial hazard to human life in the event of failure, including but not limited to:<br>• Buildings and other structures whose primary occupancy is public assembly with an occupant load greater than 300.<br>• Buildings and other structures containing elementary school, secondary school or day care facilities with an occupant load greater than 250.<br>• Buildings and other structures containing adult education facilities, such as colleges and universities, with an occupant load greater than 500.<br>• Group I-2 occupancies with an occupant load of 50 or more resident care recipients but not having surgery or emergency treatment facilities.<br>• Group I-3 occupancies.<br>• Any other occupancy with an occupant load greater than 5,000[a].<br>• Power-generating stations, water treatment facilities for potable water, waste water treatment facilities and other public utility facilities not included in Risk Category IV.<br>• Buildings and other structures not included in Risk Category IV containing quantities of toxic or explosive materials that:<br>Exceed maximum allowable quantities per control area as given in Table 307.1(1) or 307.1(2) or per outdoor control area in accordance with the *Fire Code*; and<br>Are sufficient to pose a threat to the public if released [b]. |
| IV | Buildings and other structures designated as essential facilities, including but not limited to:<br>• Group I-2 occupancies having surgery or emergency treatment facilities.<br>• Fire, rescue, ambulance and police stations and emergency vehicle garages.<br>• Designated earthquake, hurricane or other emergency shelters.<br>• Designated emergency preparedness, communications and operations centers and other facilities required for emergency response.<br>• Power-generating stations and other public utility facilities required as emergency backup facilities for Risk Category IV structures.<br>• Buildings and other structures containing quantities of highly toxic materials that:<br>Exceed maximum allowable quantities per control area as given in Table 307.1(2) or per outdoor control area in accordance with the *Fire Code*; and<br>Are sufficient to pose a threat to the public if released [b].<br>• Aviation control towers, air traffic control centers and emergency aircraft hangars.<br>• Buildings and other structures having critical national defense functions.<br>• Water storage facilities and pump structures required to maintain water pressure for fire suppression. |

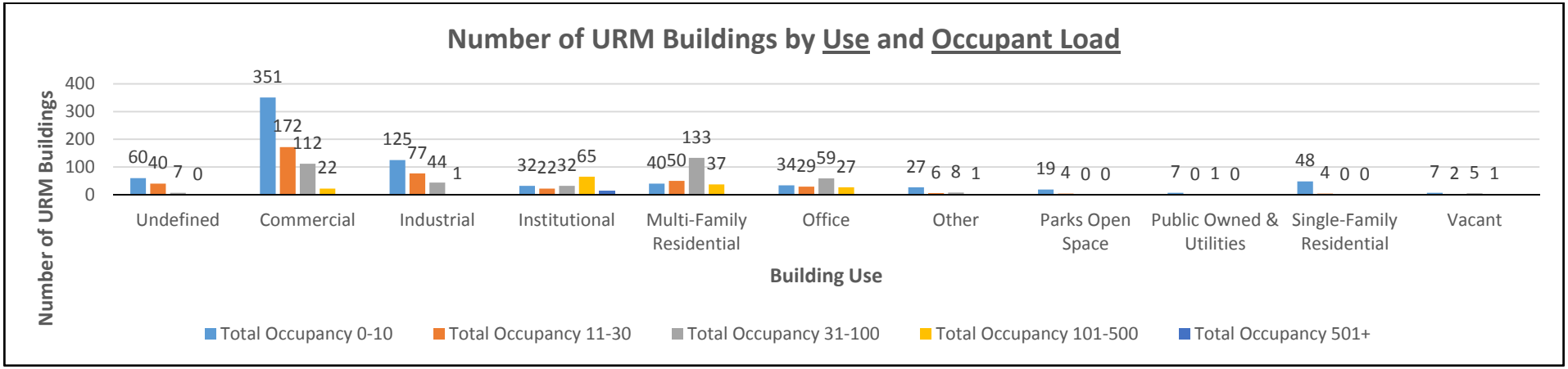
# Appendix C: Mandatory Seismic Upgrade Timelines from Other Jurisdictions

| CITY | Priority Classification | Assessment | Submit Plans | Complete Within | Comments |
|---|---|---|---|---|---|
| **Seattle** | **Critical Risk** (Schools and critical facilities)<br><br>**High Risk** (Buildings greater than 3 stories on poor soil or with more than 100 occupants)<br><br>**Medium Risk** (All other URMs) | 1 year<br><br>1 year<br><br>1 year | 2 year<br><br>2 years<br><br>3 years | 7 years<br><br>10 years<br><br>13 years | These are proposed policy recommendations that have not yet been adopted by City of Seattle |
| **Berkeley, CA** | **Risk Category 1** (Critical buildings, including government administration buildings)<br>**RC-2** (Buildings with occupant load greater than 300 or Residential with 100 or more units)<br>**RC 3** (Buildings with occupant load greater than 100 or Residential with 50 or more units)<br>**RC 4** (Buildings with occupant load greater than 50 or Residential with fewer than 50 units)<br>**RC 5** (Buildings with occupant load less than 50 or Residential with 20 or less units)<br>**RC 6** (nonresidential building used less than (20) hours per week, or any building with a masonry veneer of at least 10 feet in height or with a masonry parapet exceeding a1-1/2) ratio or masonry in-fill located in a high pedestrian traffic corridor | 2 years<br><br>2 years<br><br>2 years<br><br>2 years<br><br>2 years<br><br>2 years | | 3 year<br><br>4 years<br><br>5 years<br><br>6 years<br><br>7 years<br><br>10 years | Upgraded to UCBC 97 Appendix Chapter 1<br><br>Owner required to notify tenant and prospective buyers that building was potentially hazardous and subject to the retrofit program and an evaluation report was available |
| **Beverly Hills, CA** | **High Risk**<br>**Medium Risk**<br>**Low Risk** | 270 days for all | 1 year from being notified | 2 yrs.<br>For wall anchors; completed construction within 1 year of notice. | Owner required to notify tenant and prospective buyers that building was subject to the retrofit program and an evaluation report was available. |

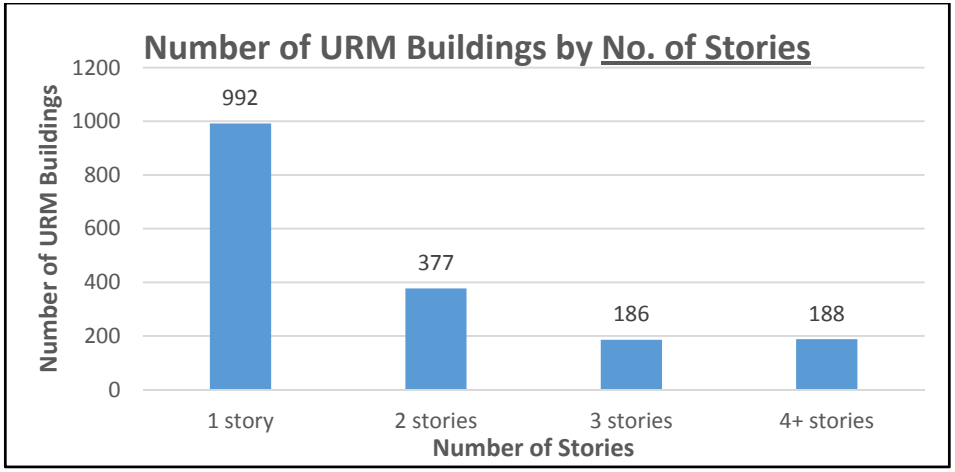
| CITY | Priority Classification | Assessment | Submit Plans | Complete Within | Comments |
|---|---|---|---|---|---|
| **Fremont, CA** | | | For full compliance:<br>26 months<br><br>For Phased compliance: 26 months | For full compliance:<br>Approx. 6yrs<br><br>For Phased compliance :<br>Wall & parapet anchors: 4yrs<br>Complete structural repairs: 7 years | |
| **Livermore, CA** | **Category 1** ( Buildings with mortar strength less than 30 psi)<br><br>**Category II** Buildings over 1 story and with 50 or more occupants<br><br>**Category III** : everything else | <br><br>20 months<br><br>26 months | Approx. 3 years<br><br>Approx. 20 months<br><br>Approx. 10 years | Approx. 4 years<br><br>Approx. 6 years<br><br>Approx. 11 years | |
| **Los Angeles** | **4 risk groups based on occupant load** | | Complete structural alterations: 1 Year<br><br>Wall anchor installation 180 days | Complete structural Alterations: 3 years<br><br>Wall anchor installation 180 days | |
| **Oakland** | **3 risk categories** | | 1-3 years for URM bearing walls and 3-5 years for URM infill or URM veneer Buildings | 2-4 years for URM bearing walls and 5-7 years for URM infill or URM veneer Buildings | Bolts Plus<br>Additional incentives to upgrade to UCBC |
| **San Francisco** | **Risk Level 1** (schools, Buildings with occupant load greater than 300 or 3 stories on poor soil)<br><br>**Risk Level 2** (non-level 1 on poor soil in certain mapped locations)<br><br>**Risk Level 3** (buildings in level 2 mapped areas not on poor soil)<br><br>**Risk Level 4** (all other URM's) | | 2 years<br><br>2 ½ years<br><br>8 years<br><br>11 Years | 3 ½ years<br><br>5 years<br><br>11 years<br><br>13 years | |

| CITY | Priority Classification | Assessment | Submit Plans | Complete Within | Comments |
|---|---|---|---|---|---|
| **Salt Lake City** | **3 story, high hazard schools** | | | 5 years | |
| | **Other high hazard schools** | | | 10 years | |
| | **2 story, appreciable hazard school** | | | 15 years | |
| | **Other appreciable hazard schools** | | | 20 years | |
| **SB 1057 Task force** | **Essential facilities and hospitals** | | | 15 years | |
| | **Parapet bracing, signage and other appendages** | | | 15 years | |

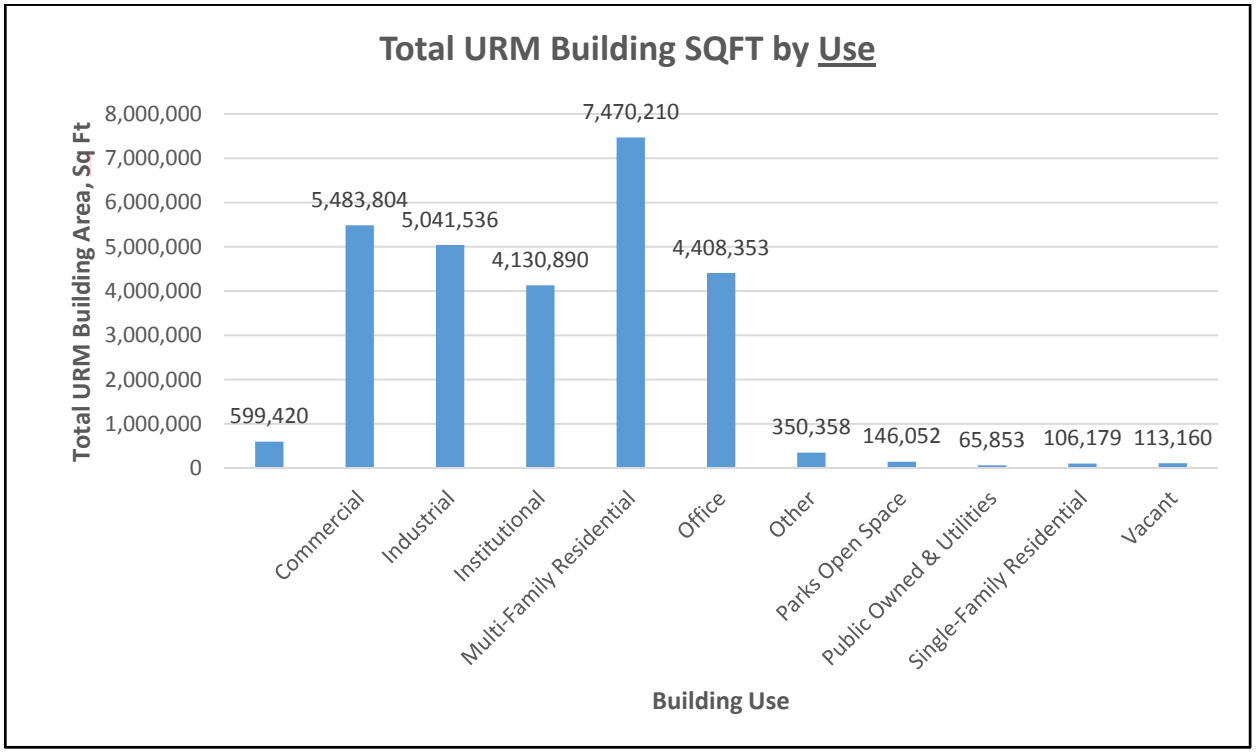
# Appendix D: Data from Existing (1995) URM Database



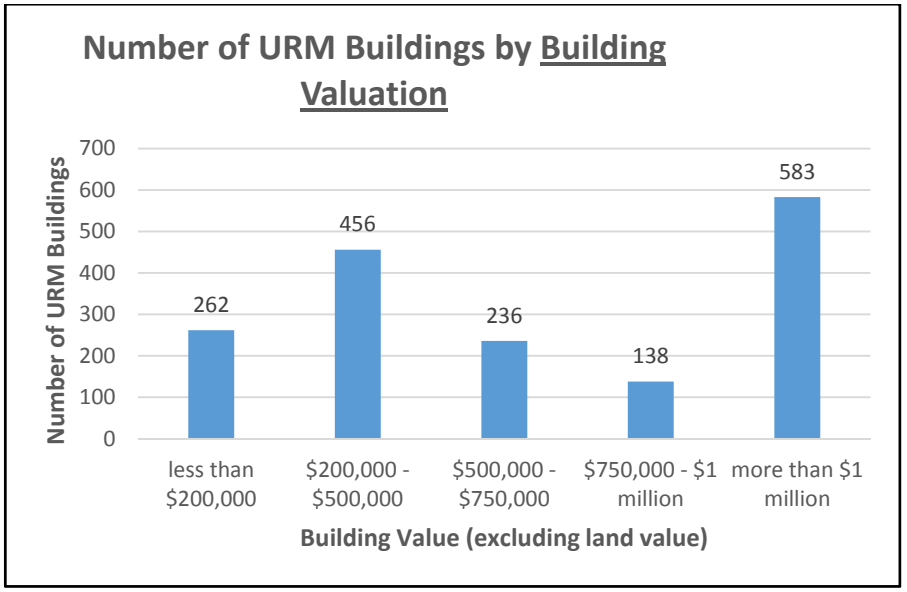

| | Total Occupancy | | | | | |
|---|---|---|---|---|---|---|
| **General Building Use** | **0-10** | **11-30** | **31-100** | **101-500** | **501+** | **Grand Total** |
| Undefined | 60 | 40 | 7 | 0 | 0 | 107 |
| Commercial | 351 | 172 | 112 | 22 | 0 | 657 |
| Industrial | 125 | 77 | 44 | 1 | 0 | 247 |
| Institutional | 32 | 22 | 32 | 65 | 14 | 165 |
| Multi-Family Residential | 40 | 50 | 133 | 37 | 0 | 260 |
| Office | 34 | 29 | 59 | 27 | 0 | 149 |
| Other | 27 | 6 | 8 | 1 | 0 | 42 |
| Parks Open Space | 19 | 4 | 0 | 0 | 0 | 23 |
| Public Owned & Utilities | 7 | 0 | 1 | 0 | 0 | 8 |
| Single-Family Residential | 48 | 4 | 0 | 0 | 0 | 52 |
| Vacant | 7 | 2 | 5 | 1 | 0 | 15 |
| **Grand Total** | **750** | **406** | **401** | **154** | **14** | **1725** |




| Number of Stories | Number of buildings |
|---|---|
| 1 story | 992 |
| 2 stories | 377 |
| 3 stories | 186 |
| 4+ stories | 188 |
| **Grand Total** | **1743** |




| General Building Use | Total SQFT |
|---|---|
| | 599,420 |
| Commercial | 5,483,804 |
| Industrial | 5,041,536 |
| Institutional | 4,130,890 |
| Multi-Family Residential | 7,470,210 |
| Office | 4,408,353 |
| Other | 350,358 |
| Parks Open Space | 146,052 |
| Public Owned & Utilities | 65,853 |
| Single-Family Residential | 106,179 |
| Vacant | 113,160 |
| **Grand Total** | **27,915,815** |




| Building Value | Number of URM Buildings |
|---|---|
| less than $200,000 | 262 |
| $200,000 - $500,000 | 456 |
| $500,000 - $750,000 | 236 |
| $750,000 - $1 million | 138 |
| more than $1 million | 583 |
| **Grand Total** | **1675** |

## Number of Historic URM Buildings by Status

| Historic Status | Number of Buildings |
|---|---|
| National Landmark | 118 |
| Local Landmarks | 45 |
| Within District (Contributing) | 174 |
| Within District (Non-Contributing) | 41 |
| **Grand Total** | **378** |