



Date: October 1, 2014

To: Regional Planning Committee

From: Danielle Hutchings Mieler
Earthquake and Hazards Program Coordinator

Subject: **Advancing Bay Area Resilience: ABAG's Integrated Approach**

Introduction

This memo describes ABAG's integrated approach to resilience planning and the evolution of the earthquake program over forty years at ABAG. As our program grows and becomes more closely aligned with the planning work at ABAG, we are seeking to change the name of the earthquake program to the resilience program and request Regional Planning Committee support for the name change and proposed direction of the program.

The overview of the program will be followed by an overview of current and future resilience projects focusing on housing, infrastructure, and regional resilience planning. The memo describes how these projects will inform the resilience component of Plan Bay Area. Finally this memo outlines a proposed regional policy agenda for the 25th anniversary of the Loma Prieta Earthquake and asks the Regional Planning Committee to recommend adoption of these policies. The policies are the foundation of a policy symposium planned to commemorate the earthquake and look towards future resilience building efforts.

Integrated Planning Approach

ABAG has been involved in hazards identification and risk mitigation planning since 1974. ABAG's contribution to hazard reduction has focused on convening local governments to jointly plan, share best practices, and develop regional assessments to build resilience. Staff develops and disseminates scientific information in understandable and accessible ways to facilitate good policy and planning decisions, provides model policies and programs for local governments to implement mitigation and recovery plans, and improves seismic resilience of housing through improved retrofits, better enforcement of codes, training and education, and financial incentives. In partnership with member cities and counties, ABAG contributes to the region's capacity to leverage climate and disaster resilience initiatives.

As the Earthquake Program celebrates forty years at ABAG, we examine our evolution and look forward to the future. In recent years this program has moved from a single focus on earthquake hazards towards examining the interaction between multiple hazards, and we think about natural hazards in an integrated way alongside other quality of life and sustainability planning activities. The program has begun to take a deeper dive into community and neighborhood scale planning and developing close partnerships with member cities and counties to implement strategies and best practices that have been identified over the previous decades.

In recent years, the concept of resilience as an encompassing framework for examining multiple hazards, their relationship to the broader region has begun to take hold. Beyond the traditional approach to natural hazards management, resilience depends not only on protecting assets, but building communities that prosper and thrive in the face of ongoing stressors and unexpected shocks. This broader framework helps us understand that the planning work we do at ABAG not only improves quality of life for Bay Area residents, but it improves our resilience as well.

With this shift to an integrated planning approach and in celebration of forty years of natural hazards planning, it is appropriate to change the name of the Earthquake and Hazards Program to the Resilience Program to better capture the breadth of our work and its relationship to other major regional planning initiatives under way. The pillars of this program are **research, planning, and action for a resilient Bay Area.**

Current and Future Resilience Projects

Staff will present the key findings and lessons from current resilience projects. Aspects of these projects demonstrate our integrated planning approach and will inform development of a Regional Resilience Plan, recently funded by FEMA. This plan will assist member cities and counties to update their local hazard mitigation plans and provide an opportunity for local planning that incorporates the strategies developed in recent ABAG resilience projects. The three year Regional Resilience Plan will be the primary vehicle for integrating resilience into the next update of Plan Bay Area.

Housing and Community Risk Project

The Bay Area Housing and Community Multiple Hazards Risk Assessment is a multi-agency project designed to understand the characteristics of San Francisco Bay Area housing and communities that increase vulnerability to earthquakes and flooding, identify and assess housing and community vulnerability at regional and community scales. The outcome of the project is a suite of strategies that reduce housing and community vulnerability to help the region meet resilience, sustainability, prosperity, and equity goals. This project addresses the intersection between vulnerable communities and fragile housing. It explores ways to avoid placing the burden of hazard vulnerability on already vulnerable populations while still meeting ambitious growth and sustainability goals throughout the region. (See attachment 1)

Infrastructure Resilience Project

The Infrastructure Resilience Project maps regional airports, transportation (highways & passenger rail), fuel, electricity, and water systems, and highlights their interaction with seismic hazards. The study illustrates how the systems operate and the potential consequence should the system be damaged. The key findings warrant keen attention from local, regional, and state actors to understand the regional impacts of damage to infrastructure systems and the interactions among systems. Key system vulnerabilities are identified to the region's fuel and transportation systems. (See attachment 2)

Regional Resilience Plan

Starting this fall, ABAG is planning the development of a Regional Resilience Plan which will combine a number of regional planning processes under a single umbrella to support long-term sustainability and livability. It is useful to consider integration of a Local Hazard Mitigation Plan, regional Climate Adaptation Plan (as successfully done in Baltimore), climate mitigation planning, and energy and resource conservation plans. Such a combined plan could be a comprehensive Regional Resilience Plan for the Bay Area. The Regional Resilience Plan would be one of several avenues to support the long-term regional vision laid out in ABAG's Plan Bay Area. Community goals to foster a sustainable, resilient Bay Area cannot be achieved without adequately addressing the hazards and risk that threaten the region.

Loma Prieta 25th Anniversary Policy Symposium

The 1989 Loma Prieta earthquake galvanized the region to make community safety an essential priority. The lives lost and communities damaged spurred the entire Bay Area – city by city, neighborhood by neighborhood – to organize for better emergency response, rebuild essential buildings and utility systems, and embed resilience into public policies and programs.

In the last 25 years, much action has been taken to improve regional resilience and bring communities together. But there is still more to do. With the anniversary of Loma Prieta, the Bay Area has a day in which to honor the past and remember those who were lost and celebrate the ways in which our cities rebounded in the wake of the disaster. But we also have an opportunity to look forward, and inaugurate planning for the next 25 years to renew our commitment to community resilience and build on the exemplary progress we have made together.

Symposium sponsors hope to inspire action required to improve the resilience of Bay Area communities. Meeting stakeholders will promote a public policy program to make the region more earthquake-safe by:

- Enacting statewide guidelines for the identification, evaluation, and retrofit of seismically unsafe soft-story apartment buildings;
- Developing a financial incentive program to promote seismic retrofit efforts for vulnerable soft-story apartment buildings;
- Encouraging cities to adopt building code improvements tailored for each community to ensure that building codes meet community performance expectations, and;
- Convening an alliance of utility, cities and regional agencies to examine disruption risks to regional utility systems, further assess system connections, and develop a regional strategy to foster lifeline resilience.

Symposium planning has been a collaborative effort bridging across many organizations. A steering committee has met since March 2014 to plan the day's discussions and engage leading-edge experts, cities, regional, state and federal agencies in a dialogue about the Bay Area's future. Multiple subcommittees have also devoted significant time and effort into planning every aspect of this event. Over the coming three years ABAG staff will continue to work with these partner organizations to advance these policies in alignment with ongoing work in Southern California. (See attachment 3)

Recommended Action

Staff recommends that the ABAG Regional Planning Committee:

- Support new resilience program and future direction.
- Recommend that ABAG Executive Board adopt the regional resilience policies promoted through the Loma Prieta 25th Anniversary policy symposium.

Attachment(s)

Attachment 1: Bay Area Housing and Community Multiple Hazards Risk Assessment

Attachment 2 : Infrastructure Resilience Overview

Attachment 3: Draft State and Regional Legislative Policy Agenda

Bay Area Housing and Community Multiple Hazards Risk Assessment

Introduction

The Bay Area Housing and Community Multiple Hazards Risk Assessment is a multi-agency project designed to understand the characteristics of housing and communities that increase their vulnerability to earthquakes and flooding. The assessment identifies and assesses housing and community vulnerability at regional and community scales, and develops strategies that reduce housing and community vulnerability to help the region meet resilience, sustainability, prosperity, and equity goals.

Previous research by ABAG found that a crucial factor of the region’s successful and speedy recovery from a seismic or flood event was keeping people in their homes. Multiple studies have shown that population loss after a disaster significantly slows recovery time. Fundamental to retaining residents is keeping housing intact. In the Bay Area, much of the older, more affordable housing stock is vulnerable to disasters. Housing rebuilding can take years and many residents may not have the resources to stay and rebuild if their homes are significantly damaged. Past disasters have also demonstrated that low-income or rental housing often gets demolished and rebuilt as market rate housing, permanently changing community and regional demographics. A key first step in improving regional resilience is to better understand the vulnerability of existing housing.

Not only is much of the region’s housing vulnerable, but vulnerable community members such as the elderly, low income residents, people without automobiles, or renters may lack access to the information and services, financial means, or physical capacity to prepare for and recover from hazard events. The problem is significantly exacerbated when communities with these characteristics live in weak housing stock. As the Bay Area grows, policies for housing and community resilience are needed where locally designated areas of focused growth, known as Priority Development Areas (PDAs), are at risk.

Vulnerability Assessment

Hazard Level

The three hazards under consideration are presented below. Each hazard has one or more level that will result in different amounts of impact on housing or communities.

Hazard	Level
Ground Shaking	MMI VIII or above
Liquefaction	Moderate Hazard
	High Hazard
Flooding	Current 100-year flood zone
	Future, sea level rise = 24”
	Future, sea level rise = 36”
	Future, sea level rise = 48”

Seismic Hazards – Liquefaction and Ground Shaking

Ground shaking hazard levels were determined using two earthquake scenarios – a M 7.8 on the San Andreas fault and a M 7.0 on the Hayward fault. Previous research¹ indicates a significant threshold for housing damage (the number of homes likely to be red-tagged) at MMI VIII and above.

Liquefaction hazard areas were determined based on liquefaction susceptibility² combined with MMI using the correlation table below.³ For the purpose of this project, we examined any Moderate or High liquefaction hazard areas from the two scenarios outlined above (a San Andreas or Hayward event) as they are the most likely to cause significant building damage.

¹ Shaken Awake! Estimates of Uninhabitable Dwelling Units and Peak Shelter Populations in Future Earthquakes Affecting the San Francisco Bay Region, ABAG, 1996

² USGS Open-File Reports 00-444 and 2006-1037

³ The Real Dirt on Liquefaction, A Guide to the Liquefaction Hazard in Future Earthquakes Affecting the San Francisco Bay Area, ABAG, 2001

Bay Area Housing and Community Multiple Hazards Risk Assessment

MMI Value	Liquefaction Susceptibility Category		
	Moderate	High	Very High
VII – Strong			Moderate Hazard
VIII – Very Strong	Moderate Hazard	Moderate Hazard	Moderate Hazard
IX – Violent	High Hazard	High Hazard	High Hazard
X – Very Violent	High Hazard	High Hazard	High Hazard

Flooding Hazards

Current flooding is based on published National Flood Insurance Program (NFIP) rate maps. Future flooding is based on a three inundation maps that represent different combinations of sea level rise and tide levels, including the daily high tide (mean higher high water, MHHW) and a wide range of extreme tides due to coastal storm surge. The possible combinations are shown below:

Sea Level Rise*	Water Level above MHHW	Extreme Tide Level						
		1-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
+0	0	12	18	24	30	36	42	48
+6	6	18	24	30	36	42	48	54
+12	12	24	30	36	42	48	54	60
+18	18	30	36	42	48	54	60	66
+24	24	36	42	48	54	60	66	72
+30	30	42	48	54		66	72	78
+36	36	48	54	60	66	72	78	84
+42	42	54	60	66	72	78	84	90
+48	48	60	66	72	78	84	90	96

* All values in inches above MHHW (NAVD88)

Table Map Key

Color Code	Map Scenario (inches above MHHW)
	24
	36
	48

Bay Area Housing and Community Multiple Hazards Risk Assessment

Housing Vulnerability

Housing vulnerability is based on the fragile building typologies tool which identifies locations of potentially vulnerable housing based on known combinations of indicators for vulnerability, including hazard, location, units, stories, and age that are associated with 8 building types commonly found in the Bay Area. Housing vulnerability is indicated if 30% or more of housing units in a block group fit the criteria for a fragile building type. See Appendix A for more detail on housing indicator development.

Hazard	Fragile Building Type	Concentration of Fragile Housing
Ground Shaking MMI XIII or above	Hillside	>30%
	Single family cripple wall	>30%
	Single family house over garage	>30%
	Unreinforced masonry	>30%
	Multi-family cripple wall	>30%
	Multi-family weak story or open front	>30%
	Multi-family non-ductile concrete	>30%
Moderate Liquefaction Hazard	Insufficient foundation to withstand liquefaction	>30%
High Liquefaction Hazard		>30%
Current flood zone	All housing types	>30%
Future flooding with sea level rise		>30%

Community Vulnerability

Community vulnerability is based on ten (10) selected indicators that are feasible and appropriate for application at the regional scale. Indicators were selected based on regionally relevant research and best professional judgment. Indicators were measured and scored using the approach developed by the Metropolitan Transportation Commission (MTC) to identify Communities of Concern (CoC). Individual block groups receive 1 point for each indicator that is greater than the indicator-specific level of significance. For example, block groups with greater than 10% of individuals over 75 years would receive a score of 1. The total score for each block group ranges from 0 to 10. See Appendix A for more detail on community indicator development.

Indicator	Measure	Level of Significance	Score
Housing cost burden	% household monthly housing >50% of gross monthly income	>15%	1
Transportation cost burden	% household monthly transportation costs >5% of gross monthly income	>15%	1
Home ownership	% not owner occupied housing	Mean + 1 standard deviation	1
Household income	% households with income less than <50% AMI	>30%	1
Education	% persons without a high school diploma > 18 years	Mean + 1 standard deviation	1
Racial/Cultural Composition	% non-white	>70%	1
Transit dependence	% households without a vehicle	>10%	1
Non-English speakers	% households where no one ≥ 15 speaks English well	>20%	1
Age - Young children	% young children < 16 yrs	>25%	1
Age – Elderly	% elderly, > 75 years	>10%	1
Total Possible Score			10

Applying Indicators Together

There are different ways to combine hazards, housing, and community vulnerability to inform a regional understanding of the ability to prepare for, respond to, and recover from earthquakes and flooding due to sea level rise and storm events. Below are the combinations of these characteristics that we mapped and what we anticipate they will show us.

Regional Scale Screening

Hazard(s)	=	Areas potentially exposed to ground shaking, liquefaction, current and future flooding
Hazard(s) + Community Vulnerability	=	Communities At Risk Communities exposed to hazards that are less able to prepare, respond and recover
Hazard(s) + Vulnerable Housing	=	Fragile Housing Housing that will likely be damaged if exposed to a hazard
Community At Risk + Fragile Housing	=	Communities At Risk in Fragile Housing Communities that are less able to prepare, respond and recover that are potentially living in fragile housing

Maps showing communities at risk, fragile housing, and communities at risk in fragile housing are shown on the following pages.

The team also developed Community Profiles of eight Bay Area communities that exhibit unique combinations of hazards, housing vulnerability, community vulnerability, and areas designated for future housing growth. Through meetings with the designated jurisdictions, more detailed vulnerability profiles were developed on these eight communities and assumptions about the presence of fragile housing types and community vulnerability were ground-truthed at a more detailed scale. These profiles also helped the team refine hazard mapping and better understand qualitative factors that affect community resilience, such as community groups and community cohesion.

The assessment phase can be summarized by the following key vulnerability statements (see Appendix B for more detailed explanation of each vulnerability statement):

- Ground shaking can damage cripple wall and house-over-garage single-family homes
- Ground shaking can damage weak story, concrete and cripple wall multi-family housing
- Housing is generally built to life safety rather than shelter-in-place standards
- Most foundations cannot withstand liquefaction
- Most houses cannot withstand any amount of flooding
- Houses with habitable space or critical equipment below-grade are at risk from flooding
- Many community members have limited access to resources
- Housing affordability is an existing challenge that could hinder recovery
- Renters have limited ability to improve their housing resilience
- Many community members have limited or inadequate information about hazards
- Information on elderly and very young community members is limited

Strategy Development

The next step of the project was to develop policy and planning strategies as well as implementation options that can help local jurisdictions address the identified vulnerabilities that were responsive to the outcomes of the assessment step. Strategies encompass policy, planning, coordination, education, and programmatic tools to decrease vulnerability and increase resilience in housing and communities. Strategies are twofold – those that are geared towards improving existing housing and community vulnerability and those geared towards safe and smart new growth in high hazard areas.

Thirty-nine strategies were developed for the project and range in type and level of implementation including strategies that will “unlock” or serve as prerequisites to other strategies; those that require state initiated research, regulations, or support; those that address issues that cross jurisdictions and therefore require or could benefit from regional coordination; strategies



that can be initiated locally; and those strategies best implemented in coordination with community based organizations and neighborhood nonprofits.

Strategies can address where to build to avoid highest hazard areas; retrofitting fragile housing in seismic areas; increasing building standards for new construction in seismic hazard zones; addressing flooding hazards for both existing and new housing; providing policy tools that can be used in conjunction with financing mechanisms identified and explained in the financing mechanism table also developed for this project to assist with costs associated with hazard abatement; pre-disaster planning for recovery; and building community capacity.

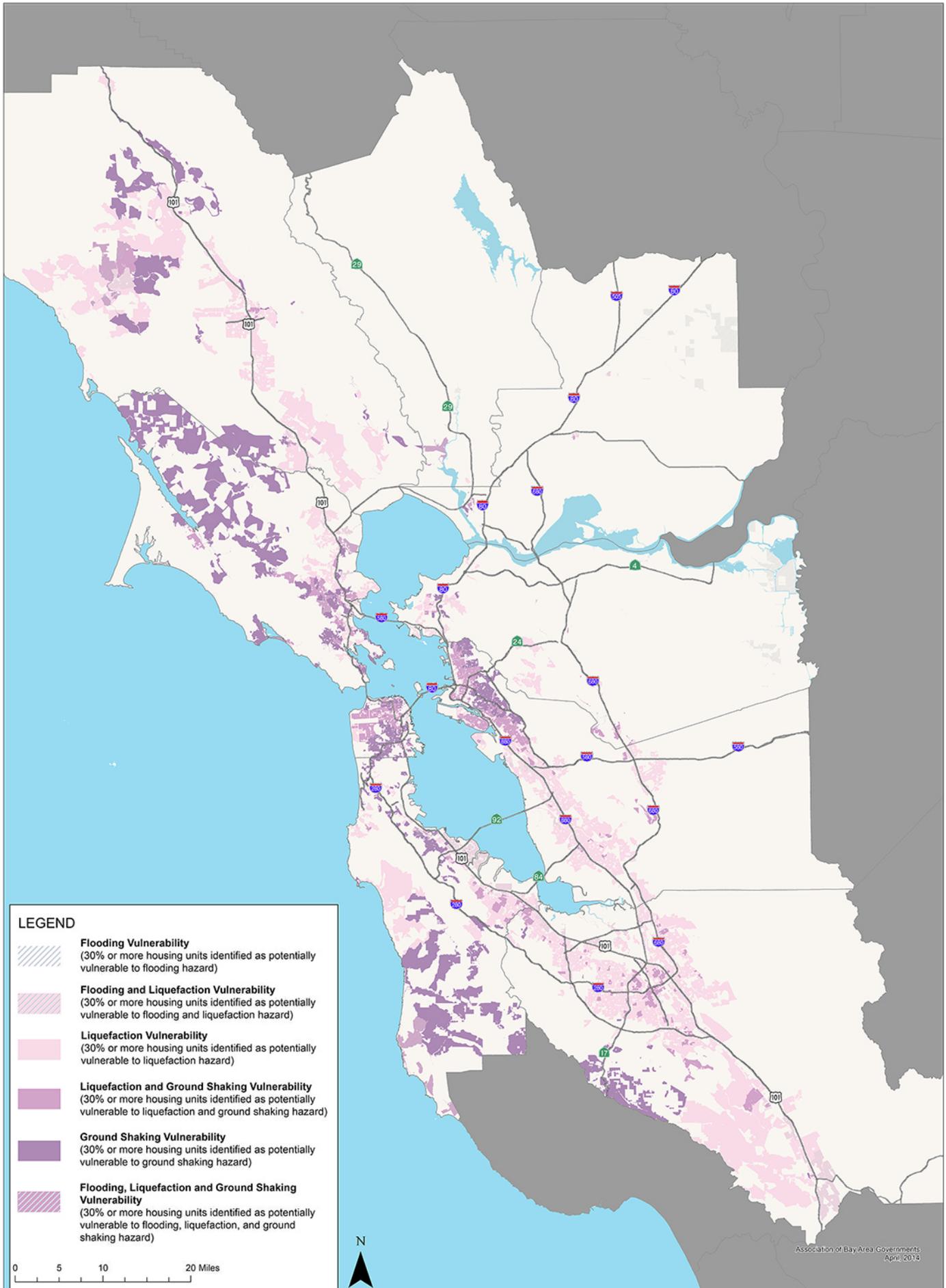
Strategies will be disseminated by EPA, ABAG, and BCDC to local jurisdictions. The strategies will be supported by ABAG's Regional Resilience Plan (Multi-Jurisdictional Hazard Mitigation Plan update), scheduled to be adopted in March 2016. The assessment and strategies will also be incorporated into the next Plan Bay Area, the region's long-range integrated transportation and land use strategy designed to reduce greenhouse gas emissions and meet the requirements of California's SB 375, which calls on each of the state's 18 metropolitan areas to develop a Sustainable Communities Strategy to accommodate future population growth and reduce greenhouse gas emissions through more efficient land use planning. The Bay Area's first Plan Bay Area was adopted in July of 2013. The complete list of strategies can be found in Appendix C.

Conclusions

This project uses a scalable, multi-jurisdictional, cross-discipline approach to assess and address the issues of planning for housing and community vulnerability to multiple hazards. Project participants and funding sources include The US Geological Survey (USGS), US Environmental Protection Agency (EPA), and Federal Emergency Management Agency (FEMA) as well as the California Strategic Growth Council (SGC). Two regional agencies, ABAG's Earthquake and Hazards Program and Planning and Research Department and BCDC's Adapting to Rising Tides program led the project. AECOM also provided significant support in the development of project strategies.

This project highlighted many issues previously unaddressed in the Bay Area. Primarily, the intersection between vulnerable communities and fragile housing was long suspected, but had never been made explicit. Resilience building should focus on this intersection as well as actively avoiding placing an undue burden of hazard vulnerability on already vulnerable populations while still meeting ambitious growth and sustainability goals throughout the region. Though this study exposed the particular vulnerability profile of housing and community within the Bay Area and developed a toolkit for how to address this vulnerability, much work remains in the realm of implementation. The ABAG/BCDC team is actively pursuing opportunities to make the work more meaningful to the 110 member cities and counties within the Bay Area.

BAY AREA HOUSING AND COMMUNITY MULTIPLE HAZARD RISK ASSESSMENT



LEGEND

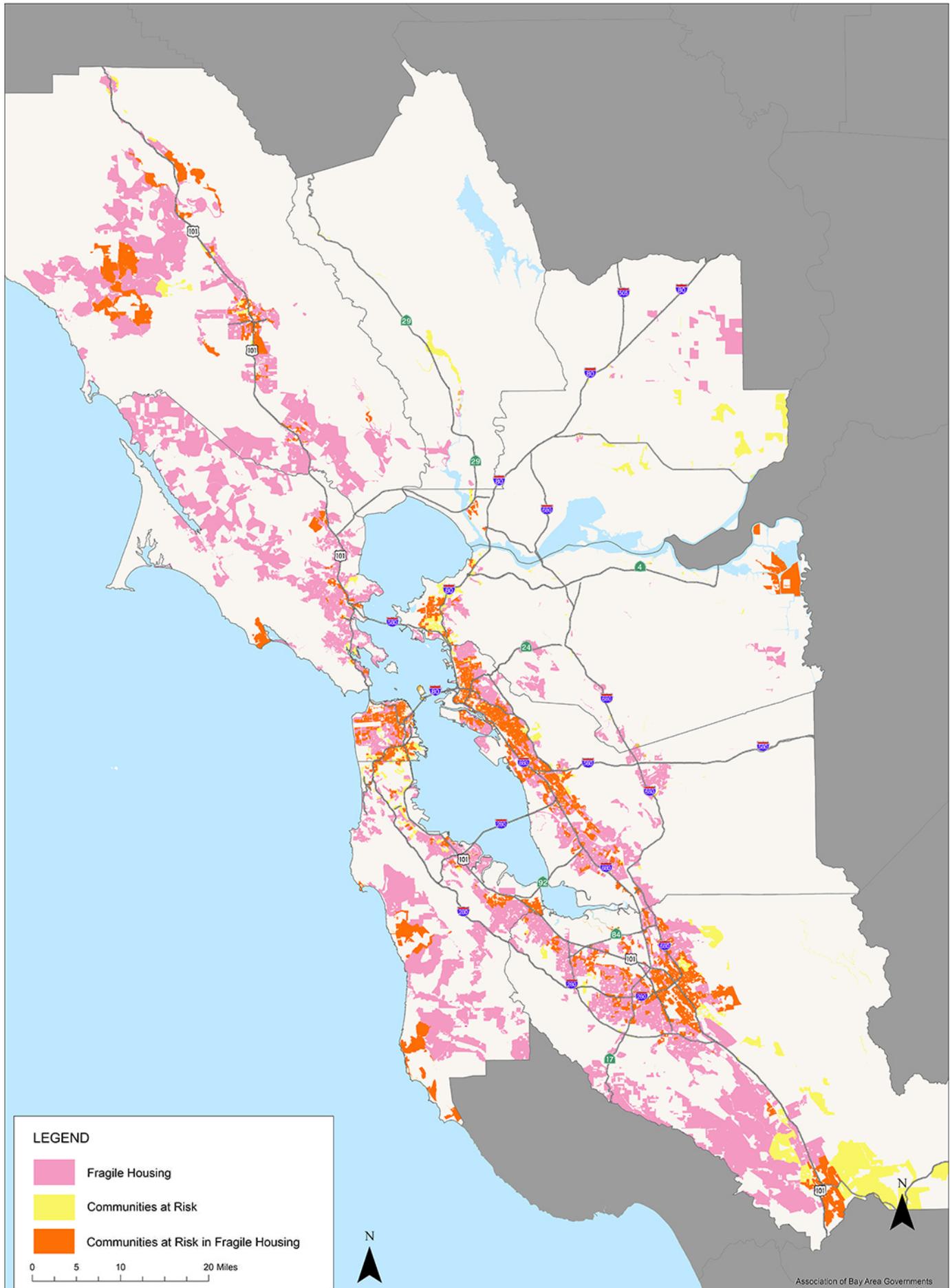
-  **Flooding Vulnerability**
(30% or more housing units identified as potentially vulnerable to flooding hazard)
-  **Flooding and Liquefaction Vulnerability**
(30% or more housing units identified as potentially vulnerable to flooding and liquefaction hazard)
-  **Liquefaction Vulnerability**
(30% or more housing units identified as potentially vulnerable to liquefaction hazard)
-  **Liquefaction and Ground Shaking Vulnerability**
(30% or more housing units identified as potentially vulnerable to liquefaction and ground shaking hazard)
-  **Ground Shaking Vulnerability**
(30% or more housing units identified as potentially vulnerable to ground shaking hazard)
-  **Flooding, Liquefaction and Ground Shaking Vulnerability**
(30% or more housing units identified as potentially vulnerable to flooding, liquefaction, and ground shaking hazard)

0 5 10 20 Miles



Association of Bay Area Governments
April 2014

BAY AREA HOUSING AND COMMUNITY MULTIPLE HAZARD RISK ASSESSMENT



LEGEND

- Fragile Housing
- Communities at Risk
- Communities at Risk in Fragile Housing

0 5 10 20 Miles

Association of Bay Area Governments
May, 2014

Item 7 Attachment 1

Appendix A: Detailed Indicator Criteria Tables

Fragile Building Typologies Screening Tool

This fragile building typology is designed only to narrow down the residential building stock using regionally available data to indicate areas where vulnerable building types may be found. This tool screens only what we have deemed as the most fragile common housing structure types found within the Bay Area. These criteria are flagging only poor structural and geologic performance (i.e., those conditions most likely to be red-tagged and require either demolition or extensive and lengthy repairs), so we have flagged only characteristics that might point to typologies with broad building deficiencies, rather than calculated overstress in a particular structural element. This system considers critical *combinations* of material, system, etc. that indicate high fragility. As key data such as structure type (wood frame, concrete, etc.) is not available, we have used proxies such as size and location that are associated with the most common structural and geologic deficiencies.

These indicators are focused on housing stock only, and do not consider infrastructure and demographics. As different hazards interact with building types differently, we are dealing separately with geologic hazards including liquefaction, ground shaking, and flooding.

Hazard	Hazard Level	Location	Units ³	Stories ³	Age ^{3,4}	Conclusion	Notes
Ground Shaking	MMI VIII ² or above	Hillside	N/A	N/A	N/A	Possible landslide hazard	Hillside homes may also have structural damage due to ground shaking
		Not hillside	1-2 unit	N/A	Built before 1940	Possible cripple wall	Bedroom communities, rare in city centers and dense suburbs ¹ Older, more established regions such as SF, Napa, and Alameda counties ²
				2-3 stories	Built between 1920 and 1970	Possible house over garage	Dense pre-1950's suburbs like Western SF Post 1950's suburbs with attached multicar garages ¹ Highly prevalent in more recently urbanized areas such as Santa Clara and Contra Costa counties ²
			Multi-unit	3-5 stories	Built before 1920	Possible cripple wall	Pre-1920's neighborhoods ¹
		Built before 1933	Possible unreinforced masonry		1% of total regional housing stock, most significant in San Francisco and Alameda counties ²		
		Built before mid-1970s	Possible weak story or open front		Pre-1950: mixed or high density suburban neighborhoods (Berkeley,		

Bay Area Housing and Community Multiple Hazards Risk Assessment

							SF) Post-1950: also found in large subdivision developments (Fremont, Hayward) ¹ Pre-1940: Significant in older cities – over 10% in SF Post-1940: Fairly prevalent, especially in San Mateo county ²
				3 stories or above	Built between 1950 and 1971	Possible non-ductile concrete	High-density suburban neighborhoods ¹
Liquefaction	Moderate or High Hazard	N/A	N/A	Less than 10	N/A	Possible catastrophic foundation damage	Structural irregularities may also influence performance of buildings in liquefaction areas. New construction may follow new guidelines to limit these irregularities; more research is needed
Flooding	24”, 36”, or 48” flooding or FEMA 100-year flood plain	N/A	All	All	All	Possible loss of habitability after flooding	Mobile homes may be more susceptible to significant damage; however mobile home data is difficult to find at a regional level. Wave action may also influence damage.

¹David Bonowitz notes, 1/21/14

²Shaken Awake! Estimates of Uninhabitable Dwelling Units and Peak Shelter Populations in Future Earthquakes Affecting the San Francisco Bay Region, ABAG, 1996

³County Assessor Data

⁴American Community Survey

Bay Area Housing and Community Multiple Hazards Risk Assessment

Community Risk Vulnerability Indicators

Dimension of Vulnerability	Measure	Thresholds	Level of significance	Data Source	Data Scale	Effect on Vulnerability	Type of Action Informed: Prepare Respond Recover	Reference	Score
<i>Household Capacity</i>									
Housing cost burden	% households monthly housing costs relative to income	>50% of gross monthly income	>15%	U.S. Census Bureau, 2006-2010 American Community Survey 5-Year Estimates	Block group	↑	Prep, Resp, Rec	2, 4, 7, 8	1
Transportation cost burden	% households monthly transportation costs relative to income	>5% of gross monthly income	>15%	Metropolitan Transportation Commission; U.S. Census Bureau, 2006-2010 American Community Survey 5-Year Estimates	Census tract	↑	Prep, Resp, Rec	8 (pgs 6-10)	1
Home ownership	% non-owner occupied housing	N/A	Mean - 1 standard deviation	U.S. Census Bureau, 2010 Census, Summary File 1	Block group	↓	Prep, Resp, Rec	1, 2, 3, 6, 7	1
<i>Socioeconomic Status</i>									
Household income	% households with income less than <50% AMI (RHNA)	N/A	>30%	U.S. Census Bureau, 2006-2010 American Community Survey 5-Year Estimates	Block group	↑	Prep, Resp, Rec	1, 3, 8	1
Education	% persons without a high school diploma > 18 years	N/A	Mean + 1 standard deviation	U.S. Census Bureau, 2006-2010 American Community Survey 5-Year Estimates	Census tract	↓	Prep, Resp, Rec	1, 2, 3, 6, 7	
<i>Community Capacity</i>									
Racial/Cultural Composition	% non-white	N/A	>70%	U.S. Census Bureau, 2010 Census, Summary File 1	Block group	↑	Prep, Resp, Rec	7, 8	1
<i>Information and Mobility Challenges</i>									

Bay Area Housing and Community Multiple Hazards Risk Assessment

Transit dependence	% households without a vehicle	N/A	>10%	U.S. Census Bureau, 2010 Census, Summary File 1	Block group	↑	Prep/Resp	1, 3, 5, 7, 8	1
Non-English speakers	% households where no one ≥ 15 speaks English well	N/A	>20%	U.S. Census Bureau, 2010 Census, Summary File 1	Block group	↑	Prep/Resp	1, 3, 6, 8	1
Age - Young children	% young children < 5 yrs	N/A	Mean + 1 standard deviation	U.S. Census Bureau, 2010 Census, Summary File 1	Block group	↑	Prep/Resp	3, 6, 7, 8	1
Age - Elderly	% elderly, > 75 years	N/A	>10%	U.S. Census Bureau, 2010 Census, Summary File 1	Block group	↑	Prep/Resp	3, 6, 7, 8	1

- 1) Cumulative Impacts: Changing Regulatory Culture to Address Environmental Injustice and Environmental Racism, Communities for a Better Environment, 2009
- 2) Resilience Capacity Index, Kathryn A. Foster, University of Buffalo Regional Institute, State University of New York, <http://brr.berkeley.edu/rci/>
- 3) Mapping Our Future: A work plan for public engagement & equity in Climate Adaptation Planning in the San Francisco Bay Area, Bay Localize for the Joint Policy Committee, 2013
- 4) STAR Community Rating System, Version 1.0, October 2012 (subset of objectives and measurable outcomes)
- 5) California Department of Public Health (CDPH) Climate Health Indicators
- 6) Cumulative Impact Indicators, Equity Issue Brief: Advancing Environmental Justice through Sustainability Planning, Pastor et al. for the Sustainable Communities Initiative
- 7) Life and Death from Unnatural Causes, Health and Social Inequity in Alameda County, Aug. 2008
- 8) MTC Communities of Concern

Appendix B: Key Issue Statements

Key issue: Ground shaking can damage cripple wall and house-over-garage single-family homes

Many established residential neighborhoods have single-family homes that could be significantly damaged during an earthquake. These include homes with short unreinforced walls that raise the first floor 1-5 feet above ground level (i.e., cripple walls) and those that are two or more stories with garages or other large openings on the first floor. Renters and owners of single-family homes that are not retrofitted, and those that do not have hazard insurance, may be displaced from their existing neighborhood and could have a difficult time rebuilding or finding a replacement home. Some residents may also struggle to find housing that is affordable near the jobs, schools, medical facilities, and other services they rely on. (Strategies: 1-4, 8, 12, 18-22, 40)

Key issue: Ground shaking can damage weak story, concrete and cripple wall multi-family housing

There are a number of multi-family housing types that can collapse if not properly retrofitted. This includes those with parking or retail on the ground floor (i.e., weak story or open front), that are built from concrete that is not properly reinforced (i.e., non-ductile), or those that have short unreinforced walls that raise the first floor 1-5 feet above ground level (i.e., cripple walls). Depending on the number of units, damage to multi-family housing can displace a large number of residents that may then struggle to find housing that is affordable near jobs, schools, medical facilities, and other services they rely on. In addition, multi-family housing does not always receive an equitable share of state or federal financial and technical assistance during recovery efforts and therefore may not always be rebuilt in a timely manner. (Strategies: 1-4, 8, 12, 18-22, 40)

Key issue: Housing is generally built to life safety rather than shelter-in-place standards

Newly constructed housing built to life safety standards can still be damaged during an earthquake. For example modern building codes generally do not address liquefaction risk since it is not a life safety consideration. The result is that some residents will not be able to shelter-in-place or remain in their homes, and that extensive repairs or rebuilding may be required. (Strategies: 23-27, 37)

Key issue: Most foundations cannot withstand liquefaction

Homes located where soils are susceptible to liquefaction, for example along the Bay shoreline or on fill, may experience significant enough damage during an earthquake to become uninhabitable. Most single- and multi-family homes under 10 stories are unlikely to have foundations stable enough to withstand liquefaction even if they can withstand ground shaking. (Strategies: 1-3, 12, 24)

Key issue: Most houses cannot withstand any amount of flooding

If exposed to flooding, most housing built in the Bay Area will be damaged as current construction materials, siting and design standards do not consider potential exposure to either water or salt. As sea level rises existing and future housing of all types within FEMA identified Special Flood Hazard Areas (SFHAs) will be at greater risk of flooding, and housing in low-lying areas not currently at risk may begin to experience flooding. (Strategies: 1-3, 28-32)

Key issue: Houses with habitable space or critical equipment below-grade are at risk from flooding

Homes with habitable living space or critical building equipment below-grade are likely to be significantly damaged by flooding. Neighborhoods with existing drainage issues, for example that experience street or basement flooding during current rainfall events or when groundwater levels are high, will be at even greater risk as the Bay rises. (Strategies: 1-3, 28-32)

Key issue: Many community members have limited access to resources

Many Bay Area residents that live in areas at risk from natural disasters are resource constrained. This includes households that are low and very low income, households of all income levels that are housing and transportation cost burdened, and transit dependent households that do not own a car. Resource-limited households are less able to prepare for natural disasters, and if displaced from damaged homes will likely struggle to find housing that is affordable and near to the jobs, schools, medical facilities, and other services they rely on. (Strategies: 5, 8, 35, 39, 40)

Key issue: Housing affordability is an existing challenge that could hinder recovery



Housing affordability for both renters and owners is an existing challenge in the Bay Area that will compound the number of community members displaced by a natural disaster. Much of the region is housing cost burdened already, spending 30% or more of income on housing. For others, the amount spent on housing is fairly stable either through rent-control policies or because they own their homes and their property tax burden is unchanging. Loss or damage of housing that results in increased costs to either renters or home-owners will likely increase the number of permanently displaced Bay Area residents as finding housing that is affordable and near jobs, schools, medical facilities, and other services they rely on will be challenging. (Strategies: 3, 5, 8, 35, 38, 40)

Key issue: Renters have limited ability to improve their housing resilience

Many Bay Area residents that live in areas at risk from natural disasters are renters. Renters have a limited ability to improve the housing they live in and often do not have hazard insurance to protect themselves and their belongings in case of a disaster. Communities with a large number of renters, and in particular resource-limited renters, will need to assist these residents both during a disaster, for example with shelter-in-place facilities, as well as post-disaster with finding interim, affordable housing to avoid the permanent displacement of renters from communities due to damaged housing. (Strategies: 3, 5, 8, 21, 37, 38)

Key issue: Many community members have limited or inadequate information about hazards

Access to timely, correct, and meaningful information both before and after a natural disaster can be challenging in all communities and can be a particular challenge in communities that are ethnically and culturally diverse, and where there is a large number of households where English is not the primary language spoken. Additionally, in the Bay Area many of these same community members are resource-constrained renters who are often living in overcrowded housing. Damage to housing during a natural disaster can lead to a significant amount of displacement and a struggle to find housing that is affordable and near enough to jobs, schools, medical facilities, and other services. (Strategies: 3, 39, 40)

Key issue: Information on elderly and very young community members is limited

Up-to-date and easily accessible information about the number of elderly and very young living in a community can be challenging to find, particularly during a disaster when it is most needed. It can be difficult to evacuate these community members, especially if they need specialized equipment or supervision, and shelter-in-place facilities need to be prepared to both house them safely and maintain communication with concerned family members. (Strategies: 3, 35, 37, 39, 40)

Bay Area Housing and Community Multiple Hazards Risk Assessment

Appendix C: Housing and Community Risk Draft Strategy List

Scale	#	Strategy Name	Strategy Snapshot
<p>The following strategies involve complex research or regulations that require initiative or buy-in from the state. Local jurisdictions should be aware of issues that need to be guided by the state and support state action on these areas. These strategies are generally prerequisites for actions at the local level, or they greatly assist jurisdictions in developing and implementing specific actions.</p>			
S	1	Complete seismic hazard mapping of urban and urbanizing areas	The California Geological Survey (CGS) is encouraged to complete mapping of seismic hazard zones for the portions of the Bay Area that are not currently mapped or in the process of being mapped with priority given to urban and urbanizing areas.
S	2	Evaluate current guidelines and the “state of practice” for mapping, evaluating and mitigating seismic hazards, particularly multi-hazard areas	Through its authority under the State Seismic Hazard Mapping Act, encourage the California Geological Survey (CGS) to work with regional and local agencies and the geology/geotechnical community in the Bay Area to evaluate current guidelines, as well as the current state of practice, for mapping, evaluating and mitigating seismic hazards, particularly in areas of expected growth that are also vulnerable to tsunami, flooding and permanent inundation.
S	3	Develop education program(s) to encourage homeowners and renters to purchase of hazard insurance	Create targeted education programs that encourage homeowners and renters to better understand their risk and make more informed decisions about the purchase of earthquake and flood insurance. This includes education about retrofitting versus insurance, understanding the site-specific hazards of their building, helping them understand what the costs versus benefits are of purchasing insurance, and what is and is not covered by hazard insurance policies.
S	4	Improve the quality assurance of non-engineered retrofits by developing a statewide retrofitting license for contractors	Increase the number of skilled contractors, contractor knowledge, owner assurance and trust in their retrofit, and consistency in retrofit quality between jurisdictions by developing a statewide program to train and license contractors in seismic retrofits.
S	5	Protect affordable housing during recovery	Develop policies that protect affordable housing from being damaged by a natural disaster, mandate that affordable housing that is damaged be rebuilt as affordable housing, ensure funding streams are available for rebuilding damaged affordable housing, and encourage building new affordable housing to ensure that low-income residents are able to stay in the region.
<p>The following strategies require initiative greater than a single jurisdiction can provide because the issues extend beyond jurisdictional boundaries. In some cases, local action doesn’t make sense without regional cooperation or coordination. In many cases, this regional work will then spur community-specific actions at the local level with policy, assistance, or information-sharing.</p>			
R	6	Establish a cooperative shoreline management program	Coordinate between government agencies, organizations, and land owners to establish and maintain a cooperative shoreline management program. This cooperative program could identify strategies for shared decision making and funding to reduce current and future flood risks in a manner that benefits and balances issues of equity, economy, and environment.
R	7	Develop guidelines for the siting and design of transit stations and transit service to reduce transit disruptions	Metropolitan Transportation Commission (MTC), county congestion management agencies, local jurisdictions, and transit providers such as Bay Area Rapid Transit or the Water Emergency

Bay Area Housing and Community Multiple Hazards Risk Assessment

		after an event	Transportation Authority to work together or separately to develop guidelines for the siting and design of transit stations and transit service to reduce transit disruptions after a flooding or seismic event.
R	8	Encourage innovative insurance solutions at the state and federal levels, and in partnership with the private sector (all hazards)	Lobby and advocate for the expansion of state- and federally-mandated catastrophe insurance programs, such as the California Earthquake Authority. Better insurance solutions could enhance mitigation efforts by offering incentives such building permit rebates, lower premiums or deductibles for retrofitted homes, state-level tax incentives, and state and federal grants to fortify homes and business.
R	9	Advocate for changes to federal and state programs to improve multi-family rebuilding efforts	Lobby at the state and federal levels to ensure multi-family housing receive a fair and equitable share of financial and technical assistance during rebuilding and recovery efforts.
R	10	Decrease reliance on grid-supplied power	Lessen household energy demands on the grid through energy efficiency and/or on-site energy generation or storage to promote buildings that will maintain livable conditions in the event of extended loss of power or heating fuel. This can be done through incentives for residential energy efficiency retrofits, weatherization projects, building design standards that promote energy load reductions, and on-site generated electricity or bi-direction energy sources.
R	11	Host a regional “Smart and Safe” growth design competition	Develop a region-wide design competition to promote innovative approaches to design and build high-density, mixed-use community development or redevelopment in a safe and smart manner in areas that are susceptible to multiple hazards.
<p>The following strategies can be initiated and implemented at a local jurisdictional level. In many cases, initiation and/or implementation would be easier, or advantageous to the region with coordination or assistance from a regional body such as ABAG; however this partnership is not a prerequisite for action.</p>			
<p><i>The following strategy greatly benefits the efficacy of the following strategies and should be considered a prerequisite for strategies 12-23</i></p>			
L	12	Develop locally-specific seismic hazard maps	Develop locally-specific seismic hazard maps to improve upon mapping resolution, support more informed and nuanced decision making about development and hazard mitigation, and also consider the correlation of seismic hazards with other hazard related risks such as wildfire, tsunami, flood, and permanent inundation.
<p><i>The following strategies all address where to build to avoid the highest hazard areas. Strategies 14-17 provide specific actions that can be used to meet the goals of strategies 12 and 13. Strategy 11 should be used as a prerequisite to determine the highest hazard areas within a jurisdiction.</i></p>			
L	13	Increase protection of critical facilities and lifelines	Require critical infrastructure and public-service facilities to be located or relocated outside the high hazard areas, or that seismic- and flood-related mitigation and other protective measures be undertaken to enhance the structural integrity, overall performance, and functionality of facilities that must be located within high hazard areas through updating general and specific plans, zoning codes, development guidelines, and building codes. Emphasis should be given to ensuring the continuity of operations of critical facilities and lifelines essential to helping residents remain in their homes following a disaster and facilitating and expediting

Bay Area Housing and Community Multiple Hazards Risk Assessment

			community and regional post-disaster recovery.
L	14	Reduce or prohibit development of housing in the most hazardous areas while ensuring equity and beneficial use of these areas	Reduce or prohibit development in high hazard areas, incentivize relocation out of these areas, and reduce or prohibit rebuilding after a disaster. This strategy also works to create beneficial uses, such as open space, flood mitigation and recreation, for non-developable high hazard lands.
L	15	Establish overlay zoning districts to help facilitate safe and smart new development	Establish overlay zoning districts to cluster new development into lower hazard areas on a particular site while also establishing special conditions for development in high hazard areas.
L	16	Establish a Transfer of Development Rights program to redirect development from high hazard areas to preferred, low hazard areas	Amend local development codes to establish a Transfer of Development Rights (TDR) program, which could place permanent conservation or hazard mitigation easements on properties in high hazard areas, to prevent or minimize the vulnerability of new development to seismic and flood hazards.
L	17	Adopt Community Benefit Agreement policies to ensure more resilient communities	Adopt policies requiring Community Benefits Agreements (CBAs), which are legally binding contracts with developers that set forth tangible benefits a community will receive from a development/redevelopment project, as a tool to improve community resilience and capacity to recover from a disaster. These benefits might include construction of parks or public gathering spaces, community health or medical facilities, shelter in place facilities, etc.
<p><i>The following strategies address the retrofit of fragile housing in seismic hazard areas. Strategy 11 should be considered a prerequisite to identify high hazard areas, and strategy 17 should be considered a prerequisite for strategies 18 and 19. Strategies 18 and 19 should be considered prerequisites for strategy 20, as locally appropriate.</i></p>			
L	18	Create a fragile housing inventory	Create and maintain a database that includes the type and location of fragile housing by building type and housing tenure (owner vs. renter), and the property's retrofit status. This would include developing and sustaining standardized, transferrable procedures for collecting and managing data. The inventory should contain, at a minimum, unreinforced masonry buildings, soft-story buildings, and non-ductile concrete buildings.
L	19	Develop soft story retrofit program	Develop a retrofit program to address soft story housing in areas where it makes up a significant of a jurisdiction's housing stock. Pair programs with financing tools and incentives. Consider different incentives and financing tools for more vulnerable communities, such as low-income residents or renters.
L	20	Develop cripple wall retrofit program	Develop a retrofit program to address cripple wall housing in areas where it makes up a significant of a jurisdiction's housing stock. Pair programs with financing tools and incentives. Consider different incentives and financing tools for more vulnerable communities, such as low-income residents or renters.
L	21	Require hazard disclosure for renters	Develop policies that require residential property managers and landlords to disclose hazard risk information to renters in a manner similar to that required when residential properties are sold, as well as information about whether the property is included in a fragile housing inventory.
L	22	Expand requirements triggered by	Develop and adopt special repair and upgrade standards for existing buildings that are not typically part of hazardous building

Bay Area Housing and Community Multiple Hazards Risk Assessment

		major upgrades and repairs to existing buildings to address seismic and flood-related hazards.	abatement programs and are also potential candidates for conversion to mixed-use or higher-density residential use in areas of expected growth. This strategy focuses on reducing the risks posed by existing hazardous buildings by addressing both seismic and flood-related hazards at the time of upgrade (such as a mixed-use or residential conversion) or major repairs following a disaster.
<p><i>The following strategies aim to increase the building standards for new construction in seismic hazard zones. Strategy 11 should be considered a prerequisite to identify high hazard areas, and is especially crucial for strategies 22 and 23. In some cases, these strategies may also apply to major renovations of existing buildings.</i></p>			
L	23	Assign higher seismic importance factor to new large scale residential buildings.	Amend the local building code to enhance structural and nonstructural design requirements for new large scale residential buildings by adoption of increased seismic Importance Factor to improve their seismic performance level.
L	24	Enhance minimum design requirements for new small scale residential building foundations in liquefaction zones	Amend the local building code to require enhanced foundation design requirements for new small-scale residential development (e.g. single or two-family dwellings) as well as for significant modifications to existing small-scale residential development in order to limit foundation damage due to liquefaction.
L	25	Restrict use of significant structural irregularities in residential buildings	Amend the local building code to restrict the use of structural irregularities in the design of new residential construction as well as existing residential construction subject to significant modification in areas with high or moderate shaking and liquefaction potential.
L	26	Enhance minimum requirements for non-structural anchorage and bracing of interior partition walls in residential buildings	Amend the local building code to include enhanced non-structural anchorage and bracing requirements for interior partition walls in existing residential buildings in areas with shaking potential.
L	27	Require utility connections to buildings that accommodate displacement in earthquakes	Amend the local building code to require that utility connections to buildings have adequate allowance for displacement in earthquakes.
<p><i>The following strategies address flooding hazards and can be used to protect both existing and new housing.</i></p>			
L	28	Participate in FEMA's Community Rating System	Participate in FEMA's Community Rating System (CRS), a voluntary incentive program that recognizes and encourages community floodplain management activities which exceed the minimum National Flood Insurance Program (NFIP) requirements.
L	29	Reduce flood risk through integrated shoreline and watershed management	Develop a program to work with public and private landowners to decrease the risk of flooding by advancing engineered and nature-based shoreline protection improvement projects in coordination with watershed management projects that reduce and/or store runoff during rainfall events and improve the condition in the floodplain.
L	30	Increase standards in local floodplain management ordinances beyond the minimum requirements of FEMA's NFIP program	Adopt a floodplain management ordinance that exceeds the minimum requirements of the NFIP to reduce potential risk from flood events that exceed the 100-year (1% annual chance) event. A strong floodplain management ordinance will ensure that land use decisions more fully take into account current flood risks based on available information and assessments, as well as considering more extreme events and/or future flood risk that may accrue as sea level rises.
L	31	Require flood-proof construction methods and techniques within and	Amend general plans to require flood-proof construction techniques in structures in special flood hazard zones, high hazard zones, and

Bay Area Housing and Community Multiple Hazards Risk Assessment

		adjacent to SFHAs	adjacent areas. Requiring flood-proofing techniques in these special flood hazard and high hazard zones could reduce the potential of damage to structure and its contents the event of a flood. Requiring the same level of flood-proofing in areas adjacent to these zones could reduce the potential for damage in areas that may be flooded in the future with sea level rise, or by flood events that exceed the FEMA 1% annual chance (100-year) flood elevation.
L	32	Revise minimum building elevation standards and maximum building height-limits for new development	Revise building standards to require that habitable building space and sensitive building components be elevated above current and future flood levels. At the same time, maximum building height limits could be updated to reduce conflicts where these codes are applied together.
<i>The following strategies provide policy tools that can be used in conjunction with financing mechanisms laid out in the financing mechanism table to assist with costs associated with hazard abatement</i>			
L	33	Create geologic hazard abatement districts (GHADS) to fund hazard mitigation	Establish Geologic Hazard Abatement Districts (GHADs) as a mechanism for raising funds and defining responsibility for the prevention, mitigation, abatement or control of geologic hazards, including landslides, land subsidence, soil erosion, earthquake, fault movement or any other natural or unnatural movement of land or earth. GHAD related projects can include the mitigation or abatement of structural hazards that are partly or wholly caused by geologic hazards and they can include flood control structures. Once established, GHADs are an independent political subdivision of the State and have similar authorities as local governments, including: taxing and bonding ability, certain legal immunity, and an ability to exercise eminent domain.
L	34	Create Mello-Roos Community Facilities Districts to provide financing to property owners for resiliency improvements	Collaboration among local governments and property owners to form a district in which property owners opt in to participate, wherein the district would use capital raised by issuing bonds to make resiliency improvements, which is paid back through a property tax assessment.
<i>The following strategies are actions that jurisdictions can take place prior to a disaster that will assist in keeping residents in their homes after a disaster occurs. Many of the previous strategies that are aimed at limiting damage should be considered prerequisites for these strategies, as they will lessen the need for a protracted recovery experience.</i>			
L	35	Create a pre-disaster rebuild and recovery plan	Make decisions and implement as policy, such as when, where, and how rebuilding will occur after a natural disaster, which areas will be rebuilt according to existing plans and codes and which will be re-planned, whether rebuilt homes will be encouraged or required to be more likely to withstand the effects of future hazard events, and who will be in charge of coordinating and overseeing the recovery process through the development of a pre-disaster recovery plan.
L	36	Revise local plans and development codes to allow temporary land uses to facilitate and expedite post-disaster recovery	Revise local plans and development codes to permit interim or temporary land uses to support critical public facilities to facilitate and expedite recovery after a disaster event.
L	37	Develop and implement a shelter-in-place program	Develop a comprehensive shelter-in-place program to allow residents to remain in their homes after a disaster. Establish engineering criteria to determine shelter-in-place capacity, develop acceptable habitability standards for sheltering-in-place, and prepare and adopt regulations that allow for the use of these

Bay Area Housing and Community Multiple Hazards Risk Assessment

			standards in a declared housing emergency period. Also develop plans for implementing the program, such as public training materials, coordinating with post-disaster evaluation procedures, and setting up neighborhood support centers.
L	38	Ensure rental units are re-built after loss or damage from natural disasters	Develop policies to ensure that rental units damaged during a natural disaster are replaced in kind (with a similar number/type) during rebuilding and recovery rather than being converted to owner-occupied properties.
<i>The following strategies represent strategies that can be implemented most effectively with close coordination with neighborhood nonprofits and community organizations</i>			
N	39	Create a community capacity inventory	Develop a community capacity inventory by first defining the elements that should be included (such as critical facilities and community services), and then developing and sustaining standardized, transferrable procedures for collecting and managing data. Partnerships with NGOs such as Code for America could yield an open-source, collaborative format for collecting and sharing this information.
N	40	Disseminate best available hazard and climate risk information through community-based organizations and non-traditional partners	Seek opportunities to expand existing, successful community-based programs (e.g. programs on crime, blight, education or other important community issues) in order to better communicate hazard and climate risk information to community members.