



## Bay Area Housing and Community Multiple Hazard Regional Assessment Approach

### Hazard Indicators

The assessment is considering three hazards: ground shaking, liquefaction, and flooding. The hazards as described below were selected because they will have different affects on housing and communities.

Hazard	Description
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"

Ground shaking hazard level was determined using two earthquake scenarios – a M 7.8 on the San Andreas fault and a M 6.9 on the Hayward fault. Previous research<sup>1</sup> indicates a significant threshold for housing damage (the number of homes likely to be red-tagged) at MMI VIII and above.

Liquefaction hazard levels were determined based on liquefaction susceptibility<sup>2</sup> combined with MMI using the correlation table below.<sup>3</sup> 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.

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

Current flooding is based on published National Flood Insurance Program (NFIP) rate maps. Future flooding is based on a three regional inundation maps developed by NOAA Coastal Services Center<sup>4</sup>. These three inundation maps are being used to represent different combinations of sea level rise and tide level, including the daily high tide (mean higher high water, MHHW) and a range of extreme tides that could occur during coastal storm surge events. The possible combinations are shown below:

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

<sup>2</sup> USGS Open-File Reports 00-444 and 2006-1037

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

<sup>4</sup> NOAA Sea Level Rise and Coastal Flooding Impacts Viewer, <http://csc.noaa.gov/digitalcoast/tools/slrviewer>



**Future flood risk mapping approach:**

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)

**Housing Vulnerability**

Regional housing vulnerability was determined based on the eight (8) potentially fragile building types (based location, units, stories, and age) commonly found in the Bay Area. The presence of vulnerable housing is indicated if 30% or more of housing units in a block group are a fragile building type located in a ground shaking, liquefaction, or flood hazard zone.

Hazard	Fragile Building Type*
Ground Shaking MMI XIII or above	Single family cripple wall
	Single family house over garage
	Unreinforced masonry
	Multi-family cripple wall
	Multi-family weak story or open front
	Multi-family non-ductile concrete
Moderate Liquefaction Hazard	Insufficient foundation to withstand liquefaction, e.g., less than 10 floors
High Liquefaction Hazard	
Current flood zone	All housing types
Future flooding with sea level rise	

\* Excluding mobile or manufactured homes, no available regional data sources

**Community Vulnerability**

Community vulnerability is based on ten (10) indicators selected based on the feasibility and appropriateness 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 an indicator-specific percentage of block group level defined by the MTC CoC. For example, block groups with greater than 10% of individuals over 75 years would receive a score of 1. For indicators that were not considered in the MTC CoC, the indicator-specific amount per block group was

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determined using the mean plus one standard deviation which was the approach used by the MTC CoC process. The total possible score each block group can receive ranges from 0 to 10.

Indicator	Measure	Percentage or amount per block group	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 < 5 yrs	Mean + 1 standard deviation	1
Age – Elderly	% elderly, > 75 years	>10%	1
<b>Total Possible Score</b>			<b>10</b>

### Part II. Combining Indicators

There are different ways to combine hazards, housing, and community vulnerability to inform a regional understanding of the ability to prepared for, respond to, and recover from earthquakes and flooding due to sea level rise and storm events. Below are the combinations of hazard, housing and community vulnerabilities assessed at the regional scale and what we anticipate they will show us.

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

**High Growth Area Community Profile Framework**

**Why are we developing community profiles?**

- Community profiles (3-10) will inform *strategy development* for existing housing and communities, redevelopment, and new development in areas designated for future growth.

**What will we include in the community profiles?**

- Information about housing and community vulnerability collected for the regional assessment:
  - Site-specific hazard exposure
  - Community characteristics
  - Fragile housing types
- Additional information that is not available at the regional scale:
  - Community assets such as fire stations, community centers
  - Community capacity - neighborhood groups, civic organizations, etc
  - Specific housing information, e.g. building material, retrofit status, mobile homes
  - Detailed community demographics
- Projected growth and development trends within high growth areas:
  - New housing units, jobs, transit, infrastructure, parks, etc.
  - Demographic trends and projections
  - Other planned growth

**How will we select community profile locations?**

- Areas that have different combinations of hazard exposure, fragile housing types, and community characteristics
- A mix of existing housing and planned future growth
- Availability of local data
- Local interest and willingness

Sample community profiles:

Location	Hazards			Housing Characteristics	Community Characteristics
	GS	LQ	Flood		
Community profile A	x	x	x	Unreinforced masonry, cripple wall; insufficient foundation to withstand liquefaction; not flood proof	Elderly, housing cost burdened, high renter-occupation, high percentage of children under 5
Community profile B	x			Multi-family weak story or open front, non-ductile concrete	Low income, high percentage of non-high school graduates, transportation cost burdened,