APPENDIX F
Assessing Vulnerability: Private Building and Value Exposure Estimates

This appendix discusses the number of buildings and dollars exposed to the hazards listed in the Local Hazard Mitigation Plan. For this appendix, ABAG created estimates of the number of buildings and the real value of property based upon 2005 County Tax Assessor's information. Since no other attempt to value the real property in the Bay Area has used this method, a thorough methodology is included in this appendix.

The numbers in this appendix are an estimate of the 2005 market value of private improvements. ABAG created these values ***only*** to provide estimates of property at risk in hazard areas. ***They do not represent scenarios of loss due to hazards, nor do they represent the replacement value (cost of repairing or replacing a structure) that would be damaged or destroyed during a hazard event. In addition, they do not include public and other nontaxable improvements, as assessors do not assess the value of these properties. Finally, they should not be used, by themselves, to compare the relative risk of earthquakes versus fire versus flooding in the Bay Area for they do not contain information on probability of occurrence for the various hazards, or the damage level associated with a particular use or building type given a level of hazard.***

Almost all of the assumptions made in this analysis tend to underestimate the number and value of buildings in the Bay Area. The single exception is the decision made to use 2005 market value of property, rather than escalating it for a period, and then deflating it due to the 2008-2009 recession. However, every indication is that the cost of labor for contractors has not dropped. Thus, it is likely that the number of private buildings and actual market value of private improvements in the region is much higher than the values provided in this Appendix. .

The final section of this appendix discusses the uses and limitations of these estimates when creating loss estimates for specific hazards based upon the probability of various hazards resulting in damage, as well as the percent loss expected to occur to selected building types in various categories of hazard.

Definitions of "High" Hazard Areas

Note that this appendix analyzes only buildings and their values in the high hazard areas, and makes no comment upon the probability of a hazard occurring in a given high hazard area. The probability of a high hazard area resulting in a disaster varies by hazard. See Appendix C for more information on these probabilities.

- **Fault Rupture Hazard** – There is no map of all active faults in the region that accurately describes their locations. As a substitute, this appendix uses the Alquist-Priolo Fault Rupture Study Zones to determine the threat of fault rupture. High hazard areas for this hazard therefore consist of the area in this Study Zone. These Zones are much wider than the actual fault traces, and therefore the number of buildings and their values in the high hazard areas is overestimated.

- ♦ **Earthquake Shaking Potential –** Earthquake shaking hazard is divided into five categories of increasing shaking potential on the composite USGS Shaking Map (as described in Appendix C). The two categories of highest potential shaking are used to define the high hazard areas: peak accelerations of greater than 60% g with a 10% chance of being exceeded in the next 50 years.
- ♦ **Liquefaction Susceptibility –** Liquefaction is divided into five categories of increasing liquefaction susceptibility on the USGS Liquefaction Susceptibility Map (Witter and others, 2006). This map is similar to, and an update of, the Knudsen and others map (2000). The three categories of highest liquefaction susceptibility (very high, high, and moderate) are used to define the high hazard areas. In addition, the California Geological Survey (CGS) has mapped San Francisco and portions of Alameda, San Mateo, and Santa Clara counties. The USGS compilation is used for the analysis in this Appendix because it covers the entire Bay Area.
- ♦ **Earthquake-Induced Landslides –** These maps were mandated under the ***Seismic Hazards Mapping Act*** of 1990. Currently, CGS has mapped San Francisco and portions of Alameda, San Mateo, and Santa Clara counties. Therefore, for these hazard areas, the regional total will consist only of these four counties. The hazard area is defined as those areas that are within the study zones (and are therefore subject to the hazard).
- ♦ **Tsunamis –** These maps are currently being prepared and revised by the CalEMA. Maps have been delivered to the counties, but, as of mid-October 2009, ABAG did not have access to these maps. In addition, CalEMA has stated that the maps are to be used only for evacuation planning, not for this type of analysis. This omission does ***not*** mean that tsunamis are not a hazard in the region.
- ♦ **Flooding –** Areas within the 100-year flood zone (including due to wave action) are in the high hazard area based on FEMA mapping. Such maps are not available for San Francisco. ABAG has used the D-FIRM maps for seven of the counties. However, because the maps were not available, in mid-October 2009, the Q3 map was used in San Mateo County. These maps are not expected to be released until September 2010.
- ♦ **Rainfall-Induced Landslides –** Areas designated “mostly a landslide area” on the USGS Existing Landslide Map are considered to be in the high hazard area for rainfall-induced landslides. This assessment is consistent with the 2004-2005 analysis.
- ♦ **Wildfire Threat –** Wildfire threat is divided into five categories of increasing wildfire threat as described on the California Department of Forestry (CDF) Wildfire Threat Maps. The three categories of highest wildfire threat were used to define the high hazard areas. These areas typically occur further from urban areas that wildland urban interface (WUI) threat areas described below. While there is some overlap in the WUI threat and wildfire threat areas, wildfire is defined on the CDF maps as occurring in non-urban areas outside of city fire department jurisdictions. The most recent version of this map has been used.
- ♦ **Wildland-Urban-Interface Threat –** The high hazard areas are defined as any area within the WUI Threat Zone as described in the WUI Threat maps created by the California Department of Forestry. These hazard areas generally occur on the edge of urban areas. These maps were recently found to somewhat overestimate the amount of land in the threat area. Specifically, land that was urban and bordering the bay was included in the threat region when it should not have been, meaning that the amount of certain land types in this region (medium and high density residential, mixed use lands, all types of employment land

uses) is likely to be somewhat high. On the other hand, these maps may underestimate the WUI threat at the wildland edge. (The most recent version of this map is used.)

- **Drought –** While drought is a concern for the region, it is not a hazard that can be mapped in the traditional sense. There are no high hazard areas for this hazard, then. This appendix does, however, provide a discussion of the uses of water and potential effects of a drought for varying land uses (see section "Land Use Densities in Hazard Areas").
- **Dam Inundation Maps –** Any area subject to inundation from at least one dam is located in the high hazard area for Dam Inundation. These maps were created under the assumption that a dam would simply disappear, and therefore represent a worst case scenario. In addition, most of these maps are nearly 40 years old and do not reflect current land conditions that would direct the floodwaters.
- **Delta Levee Failure –** Failure of one or more Delta levees will have impacts far beyond the value of property inundated. Thus, the decision was made to not produce property numbers and values for these islands.

Exposed Value of Private Buildings

According to these ABAG estimates, the total market value of private improvements in the Bay Area was $1.064 trillion in 2005, 78.7% ($837.4 billion) of which was residential property, 13.4% ($142.3 billion) of which was commercial, and 7.9% ($84.2 billion) of which was industrial/other. This estimate includes only taxable properties that the assessor has assessed a value for, and does not include properties that are public or exempt from taxation. ***Table 1*** shows the value of these properties in each high hazard area for each county and across the region. The majority of value in the region is in Santa Clara, Alameda, and Contra Costa counties, which contain 57.0% of the region's value of improvements (that is, buildings).

Due to the 2008-2009 economic recession, which has been precipitated by a downturn in the housing market, there is no reasonable way to revise the 2005 values. The values escalated exponentially during the 2005-2007 period, and then crashed in the 2008-2009 period. Sales of properties have been reduced, with lower-value properties being sold, while many higher value properties are not going on the market. Thus, taking an average of the sales price of properties is not valid. In addition, while property values have dropped in the past two years, the costs of retrofit and repair have not changed. The decision has been made to continue to use the 2005 values in this plan, understanding that these numbers will need to be updated for the 2015 version of this MJ-LHMP.

Examining the exposure by type of development (***Table 2***) reveals that residential properties make up the bulk of the exposed value in the region for every hazard. One can determine if properties are disproportionately exposed to hazards by comparing the percentage of value in each high hazard area to the overall percentage of value in the region. For example, if the percentage of exposed residential value for a particular hazard is higher than 78.7%, the value for all land, residential properties are disproportionately exposed to that hazard. Using this technique, one can determine that residential properties are disproportionately exposed to fault rupture, rainfall-induced landslides, and both wildfire and WUI fire threat. Commercial properties are disproportionately exposed to shaking, liquefaction, and flooding. All other properties are disproportionately exposed to fault rupture, liquefaction, rainfall induced landslides, wildfire threat, dam failure, and, especially, flooding.

TABLE 2 – Percentage of Estimated Value of Properties in High Hazard Areas* by Type

This table should be read as "Across the region, this percentage of the value in this high hazard area is this type of development."

	All Land	Fault Study Zone	Shaking Potential	Liquefaction Susceptibility	Liquefaction Study Zone	Earthquake-Induced Landslide Study Zone
Total Value	100.0%	100.0%	100.0%	100.0%	N/A	N/A
Residential	78.7%	83.6%	77.3%	73.4%	N/A	N/A
Commercial	13.4%	5.4%	15.2%	18.5%	N/A	N/A
Industrial/Other	7.9%	10.9%	7.4%	8.1%	N/A	N/A
	All Land	**100-Year FEMA Flood Zone**	**Rainfall-Induced Landslides**	**Wildfire Threat Area**	**WUI Threat Area**	**Dam Failure Inundation Area**
Total Value	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Residential	78.7%	57.0%	86.8%	81.4%	84.5%	70.4%
Commercial	13.4%	19.7%	8.4%	13.1%	5.7%	12.0%
Industrial/Other	7.9%	34.7%	9.7%	16.0%	6.7%	17.1%

*See Local Hazard Mitigation Plan Appendix F, pages 1-3, for definitions of high hazard areas and data limitations. **Note** – Regional data for liquefaction study zones and earthquake-induced landslide study zones are not available because the mapping is not complete.

Source: ABAG 2009.

Table 3 shows the percentage of value in each county that is exposed to the high hazard areas. By comparing hazards across the region (or by county), one can begin to understand the potential economic impacts of a hazard event. In this manner, it is clear that the highest exposure of vale to a hazard is in the high hazard areas for shaking potential, WUI threat, and liquefaction. 68.6% ($729.9 billion) of the value in the region is in the high hazard area for shaking, while 52.0% ($553.3 billion) is in a WUI threat area, and 48.4% ($511.1 billion) is in a high liquefaction susceptibility area. One would expect these three high hazard areas to contain the most value in the region, given that these same three high hazard areas contain the highest acreages of urban land in the region (see Appendix E, Figure 2). Of the other hazards, only dam inundation areas contain a significant portion of the value in the region (20.0%).

Table 3 also demonstrates some particular points of note. First, when compared to residential properties, nonresidential (especially commercial) properties generally have a higher percentage of value in high liquefaction susceptibility areas, both across the region and within most counties. This is consistent with the fact that much of the large industrial other non-residential areas are on bay fill right on the Bay shore. For that same reason, non-residential properties have a higher percentage of the value in the 100-year flood zones than do residential properties (although this varies by county). Also, nonresidential properties also have a much higher percentage of value exposed to dam inundation hazards than residential properties. Finally, residential properties have a much higher percentage of value exposed to fire hazards (wildfire and WUI threat) than do nonresidential properties for nearly every county and across the region.

Exposed Number of Private Buildings

According to the estimates (based on one building per assessors parcel), the total number of private buildings in the Bay Area is 1.78 million, 93.2% (1.66 million buildings) of which are residential buildings, 3.8% (68,098 buildings) of which are commercial buildings, and 3.0% (53,689 buildings) of which are industrial/other buildings. ***Table 4*** shows the number of buildings in each high hazard area (see pages 1-3 for definitions of high hazard areas) for each county and across the region. As with the value, the majority of buildings in the region are in Santa Clara, Alameda, and Contra Costa counties, which contain 59.1% of the region's buildings.

Examining the exposure by type of development (***Table 5***) reveals that residential properties make up the bulk of the exposed buildings in the region for every hazard, and make up over 90% of all exposed buildings for every hazard except flooding and wildfire hazards. By making the same comparison in ***Table 5*** that was made for ***Table 2,*** one can again compare the percentage of buildings in each high hazard area to the overall percentage of buildings in the region to determine if a type of building is disproportionately exposed to a hazard. In this manner, one can see that residential buildings are disproportionately exposed to fault rupture, and WUI threat. Commercial properties are disproportionately exposed to shaking, liquefaction (both liquefaction hazards), flooding, and dam inundation. All other properties are disproportionately exposed to liquefaction (both liquefaction hazards), both landslide hazards, and dam failure, but especially flooding and wildfire threat.

TABLE 5 – Percentage of Estimated Number of Private Buildings in High Hazard Areas* by Type

This table should be read as "Across the region, this percentage of the buildings in this high hazard area is this type of development."

	All Land	Fault Study Zone	Shaking Potential	Liquefaction Susceptibility	Liquefaction Study Zone	Earthquake-Induced Landslide Study Zone
Total Value	100.0%	100.0%	100.0%	100.0%	N/A	N/A
Residential	93.2%	95.0%	93.0%	91.8%	N/A	N/A
Commercial	3.8%	2.7%	4.2%	4.9%	N/A	N/A
Industrial	3.0%	2.3%	2.8%	3.3%	N/A	N/A
	All Land	**100-Year FEMA Flood Zone**	**Rainfall-Induced Landslides**	**Wildfire Threat Area**	**WUI Threat Area**	**Dam Failure Inundation Area**
Total Value	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Residential	93.2%	84.7%	92.6%	87.7%	94.9%	92.0%
Commercial	3.8%	6.9%	1.1%	1.4%	2.9%	4.4%
Industrial	3.0%	8.4%	6.3%	10.9%	2.2%	3.6%

* See Local Hazard Mitigation Plan Appendix F, pages 1-3, for definitions of high hazard areas and data limitations. **Note** – Regional data for liquefaction study zones and earthquake-induced landslide study zones are not available because the mapping is not complete.
Source: ABAG 2009.

Table 6 shows the percentage of buildings in each county that is exposed to the high hazard areas. The highest building exposure is in the high hazard areas for shaking potential, WUI threat, and liquefaction. Almost two thirds of the buildings (66.4% or 1.18 million properties) in the region are in the high hazard area for shaking, while 50.8% (906,355 buildings) are in a WUI threat area, and 48.0% (856,893 buildings) is in a high liquefaction susceptibility area. As with estimated value, these are again the same three high hazard areas that contain the highest acreages of urban land in the region (see LHMP Appendix E, Figure 2). Of the other hazards, only dam inundation areas contain a significant portion of the value in the region (19.2%). These results are highly consistent with the exposed values in hazard areas, with the percentages of buildings in the high hazard areas within a few percentage points of the percentage of exposed value.

No estimate of the *total* number of public and institutional buildings exists for the Bay Area. Exposure of many public and institutional critical facilities to hazards is described in Appendix C.

Definitions, Methodologies, and Information Sources

Definitions

For definitions of high hazard areas, pages 1-3.

The analysis in this section is based on three basic breakdowns of privately-owned property. *Other properties, such as schools, hospitals, municipal buildings, and institutional properties, are analyzed as critical facilities in Appendix C. While a limited number of local governments provided ABAG staff with the insured values of these structures, the data are insufficient to make a consistent estimate of the value of these structures.* The three categories of property analyzed are:

- **Residential and Mixed-Use –** including homes, condominiums, apartments, and mixed-use buildings with commercial on the ground floor.
- **Commercial and Recreational –** including retail, office, recreational, motels/hotels, research and development, and properties with mixed commercial and light industrial buildings.
- **Industrial and Other –** including light and heavy industrial, recycling, warehousing, communications, food processing, and other non-commercial and non-residential uses.

The categories of land use for the properties were obtained from the 2005 Existing Land Use Map (Perkins and others, 2005) and assessor's land use information for the parcel.

Exposure Estimates Methodology and Information Sources

Creating the Parcel Layers

Estimates of market value of private buildings were based upon County Tax Assessors' information, collected on a parcel level for every parcel in the region. For the majority of counties, this information came with parcel maps for the county, allowing for the use of Geographic Information Systems (GIS) technology to assign spatial qualities to the attributes. There were three counties, however, in which GIS parcel layers (data tables with spatial information) were unavailable for the complete county. The exposure estimates are summarized by land use type based upon the 2005 Existing Land Use Map (see Appendix E), which was used to assign standardized land uses to each of the parcels. Parcel data tables (with no spatial information) were available for all nine counties in the region.

For the three counties without assessors' parcel layers, different methods were used to assemble the parcel layers.

- In Santa Clara County, a complete GIS parcel layer was created with parcel layers obtained from a number of cities in the county (San Jose, Milpitas, Santa Clara, Palo Alto, and Cupertino). In areas where there were still no parcels, a 2003 GIS parcel layer was obtained from the Santa Clara Valley Transit Authority and was used to fill in missing areas in the GIS parcel layer.
- In Alameda County, GIS parcel layers were collected for every city except the cities of Alameda and Albany. There were no other parcel layers available for the county, and so the parcel layer remained incomplete for Alameda County (approximately 93% complete).
- In Solano County, GIS parcel layers were collected from the three largest cities in the county (Vacaville, Fairfield, and Vallejo). There were no other parcel layers available for the county, and so the parcel layer remained incomplete for Solano County (approximately 50% complete). The available parcel layers, however, do capture roughly two-thirds of the urban area (and thus most of the improvement value) in that county.

Since the resulting parcel layer was incomplete for Alameda and Solano Counties, two additional steps were taken to increase the accuracy of the following estimates for these two counties.

1. Parcel records were geocoded (assigned spatial data based upon addresses) to create a point layer for all parcels that were not included in the available parcel layers for the county.
2. These geocoded points were added to the point parcel layer for that county to create a more accurate estimate of the number and value of the buildings in the hazard areas.

This does not mean that the combined tables are a complete list of all parcels in these counties for two reasons. First, geocoding is often inaccurate with some of the parcels due to bad address or zip code information. In addition, many parcels cannot be geocoded because there are no addresses for the parcel or the reference street layer does not have a street present on it.

- In Alameda County, all parcels in the cities of Alameda and Albany were geocoded to create a point layer for these cities. Using this method, 84% of the parcel records in Alameda and Albany were successfully included.
- In Solano County, a similar procedure was used. However, in this county, only 57% of the parcel records outside of the cities of Vacaville, Fairfield, and Vallejo were successfully included.

Thus, for both of these counties, not all parcels were assigned spatial data, resulting in the estimates of the number of buildings and value of improvements being low when compared to the actual number of buildings and value of improvements. This underestimate is more severe in Solano County than Alameda County). In effect, the geocoding effort lessened, but did not remove, the underestimation of parcels and value.

In order to determine whether a parcel was in a hazard area, the point at the geographical center ("centroid") of the parcel was determined in GIS and "joined" (spatially linked) to the hazard area layers used in this LHMP. When geocoding was required, the point used for "joining" with the hazard layer is the location of the address, which is in the center of the street in front of the parcel.

Total Number of Buildings Exposed

While the number of buildings is occasionally included in assessor's parcel information, this information is very incomplete and may also be inaccurate, as identifying the number of buildings is not the focus of the assessor's work. Instead, for all parcels where a positive assessed improvement value indicated that a building was present on the parcel, it was assumed that there was one building per parcel. While this assumption is accurate for most single family homes (which comprise the majority of Bay Area development), it is also introduces several sources of error. First, all apartment, condominium, office, and industrial complexes that are considered to be one parcel by the assessor may actually be composed of several buildings. In addition, many single-family parcels consist of in-law units or detached garages, which are also separate buildings. Finally, many condominiums, although they are in one building, are considered to be separate parcels. The first two inaccuracies suggest that the assumption of one building per parcel will underestimate the number of buildings exposed to a hazard, and the last suggests that the assumption will overestimate the number of buildings exposed to a hazard. Overall, the first two inaccuracies are much more common, meaning that the number of buildings exposed to a hazard is likely to be higher than the statistics presented here.

To determine the number of parcels (and estimated buildings) in a hazard area, the centroid for each parcel was joined to the hazard layer. Parcels were counted for each hazard category for each county.

Total Value of Improvements Exposed

Exposure estimates were created using the assessed value of improvements for every parcel. In California, however, the assessed value of a property is rarely equal to the real market value of the property. Proposition 13, passed in 1978, limits the amount of value that the assessor can claim real property to be worth. Specifically, after a property is sold, the assessor can only raise the assessed value of the property at a maximum of 2% per year, even if the market inflates the value significantly more than 2%. Once the property is sold again, the assessor can use that sales price as the new assessed value. Thus the assessed value is equal to the real market value only in the year when the property is sold. The longer it has been since the property was sold, the larger discrepancy that will exist between the assessed value and the real market value of the property (with the assessed value generally much lower than the market value). While this is a significant problem for all properties, it is likely an even larger problem for nonresidential properties, which have very low turnover when compared with residential properties.

ABAG's estimates adjusted for the above situation by estimating the real market value based upon the assessed value of the property, the last sales price, and the last sales date, as well as the land use for the property (as obtained from the 2005 Existing Land Use Map and assessor's land use information for the parcel). The assessed values were obtained directly from the County Assessor for four counties – Contra Costa, Marin, San Francisco, and San Mateo. For the remaining five counties, the data were purchased from First American Real Estate Solutions (Metroscan). Sales information was not always available, and the adjustment process accounted for this fact.

Estimating the Real Value

1. If a property had no sales information or was sold before 1976 (the effective date of Proposition 13), the assessed value of improvements was assumed to be the correct market value in 1976. This assumption was made because properties with no sales information were likely sold before the quality of information was at current standards (and thus before 1976). This assumption may have had the effect of over-inflating values for properties with no sales date information if they were sold after 1976. The assessed value was inflated by an index based upon its land use category (see below) to 2005 current market value.
2. If a property had all sales information and was sold after 1976, the sales price was adjusted by the ratio of improvements to land value to obtain the market value of the improvements for the year of the sale. This value was then inflated by an index based upon the parcel land use category (see below) to 2005 current market value. If there was no ratio of improvements for the parcel, the median ratio of improvements to land value for the land use category in that county was used to estimate the improvement value for the year of the sale (which was then inflated by the index).

Inflation Indices

The first land use category included all residential properties: single-family homes, multi-family homes, apartment buildings, mixed-use (residential/commercial) buildings, mobile parks, and group quarters. The index for residential properties was created using the average single-family home sales price from 1989-2005 by county, and a single-family home market trend index for 1976-1989 by subregion (1-4 counties). These data were provided by the Real Estate Research Council of Northern California in the Northern California Real Estate Reports (1990, 1996, 2005).

The second category was for all other properties, including commercial, industrial, and any other type of property that had an improvement value for the parcel. This index was created from the Consumer Price Index (CPI) for the entire region. This index generally inflated the assessed value at a considerably smaller rate than the single-family home index, reflecting the rapidly inflating housing market in the Bay Area.

Trial estimates included a separate index for multi-family housing, using the rental CPI for the entire Bay Area from 1982-2005, and the Housing CPI for 1976-1982. This index was later not used largely because, in the Bay Area, the rental market is not as profitable as the real estate investment market. This trend means that the rental CPI for the region was likely to underestimate the value of the properties. Thus, investors in rental housing are treating this investment as a housing investment with expectations of future gains in line with the overall regional real estate market, rather than as income properties with a market value based on rental income. A single-family market index was more reflective of that fact.

Almost all of the assumptions made in this analysis underestimated the value of buildings in the Bay Area. The CPI inflator for non-residential properties is also probably low because real estate has traditionally gone up in value faster than the other commodities in that index. It is likely that the actual market value of private improvements in the region is much higher.

Applications and Limitations of the Estimates of Market Value and Comparisons to Other Loss Exposure Estimates

The above numbers are only an estimate of the 2005 market value of private improvements. ABAG created these values only to provide estimates of property at risk in hazard areas. They do not represent scenarios of loss due to hazards, nor do they represent the replacement value (cost of repairing or replacing a structure) that would be damaged or destroyed during a hazard event. In addition, they do not represent public and other nontaxable improvements, as assessors do not assess the value of these properties.

At least three studies have estimated the value of improvements in the Bay Area in order to develop loss estimates for hazard events: (1) FEMA's HAZUS model, (2) independent work by Risk Management Solutions (RMS), (3) Kircher and others (2006) in the estimate of losses due to a repeat of the 1906 earthquake. The first two estimates calculate the engineered replacement value based on an estimated square footage of building stock (based on census data of population) multiplied by an average cost per square foot for various types of construction (from Means). Kircher and others modified the HAZUS values based on an "average" ratio between the RMS and HAZUS default values. ***Table 7*** compares these replacement values from HAZUS, Kircher and others, and RMS, with the market value estimates used in this analysis. The values in this appendix are generally significantly higher than the other estimates.

When losses occur, replacement value is a better estimator of actual losses than fair market value. If these market values were converted to replacement values, they would increase for at least two reasons. First, replacement value assumes replacing structures, which typically costs more than the fair market value of the old structure. Second, even in a localized emergency, there are market factors that increase the price of materials and labor further as they are in short supply relative to the demand. Kircher and others estimated that, in a 1906 event, this would inflate losses by approximately 30%. Thus, to convert the numbers in this appendix for use in loss estimates would require that two multipliers be used – the first to convert market value to replacement value in a non-disaster climate, and a second to convert non-disaster replacement value to disaster replacement value. These two multipliers could easily increase the loss exposures by 50%.

Loss Estimates – The Next Step

One of the most useful ways to examine Bay Area risk is to estimate the total losses that might be expected from a variety of hazards over a given period, such as 100 years, or to change those losses to an average annual exposure. The principal use for such estimates by a local government in the Bay Area is likely to be to determine the costs of ***not*** mitigating a hazard to compare against the costs and benefits of hazard mitigation.

To obtain these loss estimates, one needs the probability of the event occurring. For example, in a 100-year, one could assume that one flood would completely inundate the 100-year floodplain or that the wildfires of the last 50 years would occur twice. During the same interval, various earthquake scenarios would have a fixed probability of occurring.

One also needs the probability of the event resulting in damage to a particular location. In this case, those hazards that have various levels of severity (such as wildfire threat, earthquake shaking and liquefaction) will have various probabilities of damage based on whether the hazard is very high, high, or moderate.

TABLE 7 – Comparison of ABAG Market Value of Private Improvements to Other Sources of Replacement Value for Use in Loss Estimates (in Millions of Dollars)

Residential Properties	Assessed Improvement Value	HAZUS	Kircher and others	RMS	ABAG Estimated Market Value
Alameda	62,038	100,936	111,030	112,203	153,329
Contra Costa	49,243	74,902	82,392	74,759	124,098
Marin	17,425	24,338	26,772	25,961	39,450
Napa	5,568	9,126	10,039	10,166	14,502
San Francisco	21,446	56,633	62,296	72,001	71,802
San Mateo	40,728	57,814	63,595	64,316	116,238
Santa Clara	71,099	123,200	135,520	153,773	193,968
Solano	12,680	25,519	28,071	23,606	47,601
Sonoma	22,129	35,203	38,723	31,243	76,472
Total	302,356	507,671	558,438	568,028	837,460

Employment Properties	Assessed Improvement Value	HAZUS	Kircher and others	RMS	ABAG Estimated Market Value
Alameda	19,843	26,169	52,338	45,735	34,443
Contra Costa	19,357	10,207	20,414	19,687	47,771
Marin	3,197	4,639	9,278	8,217	8,588
Napa	1,105	2,270	4,540	3,641	6,879
San Francisco	20,898	18,941	37,882	40,334	26,392
San Mateo	10,665	10,353	20,706	21,410	29,699
Santa Clara	27,073	23,896	47,792	54,865	53,167
Solano	1,904	3,375	6,750	5,793	6,563
Sonoma	4,660	6,067	12,134	9,426	13,080
Total	108,702	105,917	211,834	209,108	226,582

All Properties	Assessed Improvement Value	HAZUS	Kircher and others	RMS	ABAG Estimated Market Value
Alameda	85,398	123,271	155,700	157,938	187,772
Contra Costa	73,607	85,109	102,807	94,446	171,869
Marin	22,211	28,977	36,050	34,178	48,038
Napa	10,077	11,396	14,579	13,807	21,381
San Francisco	44,290	75,574	100,179	112,335	98,194
San Mateo	53,679	68,167	84,301	85,726	145,937
Santa Clara	104,329	147,096	183,312	208,638	247,135
Solano	16,124	28,894	34,820	29,399	54,164
Sonoma	28,675	41,270	50,858	40,669	89,552
Total	438,390	609,754	762,606	777,136	1,064,042

Finally, one needs an estimate of the damage to property that might occur should an event happen. For example, if an area is burned in a wildfire, it is reasonable to assume that the entire building and its contents are 100% destroyed. On the other hand, if a building is flooded, it is damaged but not destroyed. In the most complex case, if a building is shaking in an earthquake, it may be undamaged or completely destroyed or anything in between based on the type and quality of building construction.

Published loss estimates are becoming increasingly sophisticated as the information on probability and damage becomes increasingly well understood based on statistics and other information from past disasters. However, the estimates are typically published for the State, a region, or a county, not for a particular city or neighborhood. The reason for the reluctance of modelers to publish more generic loss estimates is that the data become increasingly unreliable at more local levels. The data on building numbers and values included in this report should greatly improve future estimates.

ABAG could use existing software and modeling to produce loss estimates for the various hazards in the region. Even the data produced for this appendix would improve existing loss estimates. For example, the losses estimated by Kircher and others might be assumed to be low by approximately one-third based on the information in ***Table 7***, above. However, other information, such as the precise location and number of soft-story multifamily residential buildings and retrofitted and unretrofitted unreinforced masonry buildings is equally important.

The recommendation of this appendix is that future Bay Area loss estimates be conducted on a parcel-by-parcel basis and aggregated to census tracts and cities. To accomplish this goal, ABAG will seek funding to collect and improve building inventory information and use it to prepare loss estimates for use by cities, counties, and special districts for benefit-cost-analysis of hazard mitigation programs. The focus of these efforts will be on buildings that are statistically more vulnerable in earthquakes (both unretrofitted and retrofitted to a minimal standard): unreinforced masonry buildings, soft-story multifamily residential buildings, tilt-up concrete buildings, and non-ductile concrete frame buildings.

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