Appendix B.
Sample Designs

METROPOLITAN SAMPLE DESIGN

Sample Areas

The 1998 American Housing Survey Metropolitan Sample (AHS-MS) provides information on 15 metropolitan areas interviewed as part of the American Housing Survey (AHS), which was conducted by the U.S. Census Bureau for the Department of Housing and Urban Development. These metropolitan areas are:

- Baltimore, MD
- Birmingham, AL
- Boston, MA-NH
- Cincinnati, OH-KY-IN
- Houston, TX
- Minneapolis-St. Paul, MN-WI
- Norfolk-Virginia Beach-Newport News, VA-NC
- Oakland, CA
- Providence-Pawtucket-Warwick, RI-MA
- Rochester, NY
- Salt Lake City, UT
- San Francisco, CA
- San Jose, CA
- Tampa-St. Petersburg, FL
- Washington DC-MD-VA

Most of these metropolitan areas are consistent with the 1993 Office of Management and Budget (OMB) definitions of the metropolitan statistical area (MSA), consolidated metropolitan statistical area (CMSA), or primary metropolitan statistical area (PMSA) with the following exceptions:

- Cincinnati, OH-KY-IN does not include: Brown County, OH; Gallatin, Grant, and Pendleton Counties, KY; and Ohio County, IN, from the 1993 OMB definition for the Cincinnati, OH-KY-IN PMSA.
- Providence-Pawtucket-Warwick, RI-MA does not include: Little Compton town, and Tiverton town in Newport County, RI; and Fall River City, Somerset town, Swansea town, and Wesport town in Bristol County, MA, from the 1993 OMB definition for the Providence-Fall River-Warwick, RI-MA MSA.
- Washington DC-MD-VA does not include Clark, Culpeper, King George, and Warren Counties, VA; and Berkeley and Jefferson Counties, WV, from the 1993 OMB definition for Washington, DC-MD-VA-WV PMSA.

Interview Schedules

The metropolitan areas selected for AHS-MS are scheduled to be interviewed on a rotating basis about once every 6 years. The Census Bureau collected 1998 AHS-MS data between March and November of 1998. Initially, the sample in each metropolitan area was uniformly distributed throughout nine panels (panels 3 through 11).

Due to budget constraints, panels were dropped in the following metropolitan areas in 1998:

- In Boston, all units in panels 5, 9, and 11
- In Houston, all units in panels 5, 7, 9, and 11
- In Salt Lake City, half of panel 11

The cases in the nine panels were assigned to four clusters to be sent out for interview. Cluster 1 was made up of panels 3, 4, and 5; cluster 2 was made up of panels 6, 7, 8, and 9; cluster 3 and cluster 4 were made up of panels 10 and 11, respectively. Interviewing for cluster 1 began around March 1, 1998; interviewing for cluster 2 began as early as May 1, but no later than June 1; interviewing for cluster 3 began as early as September 1, but no later than October 1; and interviewing for cluster 4 started as early as October 1, but no later than November 1. All interviewing was completed by November 16, 1998.

Sample Size

Table C summarizes the interview activity for each of the metropolitan areas in this report series. The table provides the response rate, the number of eligible units (comprised of completed interviews and noninterviews), and the number of units visited but ineligible for interview.

Sample Selection

The 1998 AHS-MS sample consists of the following types of housing units:

- Housing units selected from the 1990 census
- New construction in areas that issue building permits
- Housing units missed in the 1990 census
- Other housing units added since the 1990 census

Table C. **Interview Activity for the 1998 American Housing Survey Metropolitan Areas**

Metropolitan area	Response rate[1] (percent)	Eligible units			Ineligible units[3]
		Total	Interviewed	Not interviewed[2]	
1998 AHS-MS Total	**92**	**69,320**	**63,565**	**5,755**	**2,823**
Baltimore, MD	92	4,527	4,179	348	202
Birmingham, AL	95	4,773	4,524	249	291
Boston, MA-NH	87	4,377	3,816	561	149
Cincinnati, OH-KY-IN	94	4,835	4,525	310	206
Houston, TX	93	4,525	4,230	295	289
Minneapolis-St. Paul, MN-WI	91	4,611	4,191	420	183
Norfolk-Virginia Beach-Newport News, VA-NC	95	4,642	4,423	219	213
Oakland, CA	89	4,620	4,125	495	130
Providence-Pawtucket-Warwick, RI-MA	91	4,569	4,179	390	154
Rochester, NY	91	4,594	4,204	390	161
Salt Lake City, UT	96	4,707	4,541	166	169
San Francisco, CA	89	4,642	4,110	532	159
San Jose, CA	89	4,644	4,122	522	156
Tampa-St. Petersburg, FL	89	4,581	4,059	522	223
Washington DC-MD-VA	93	4,673	4,337	336	138

[1]The response rate is computed by dividing the number of unweighted interviews by the total number of cases eligible for interview and multiplying by 100.
[2]Sample units were visited but occupants were not at home after repeated visits or were unavailable for other reasons.
[3]Sample units were visited but did not provide information relevant to the housing inventory. This category includes sample units that were found not to be in the sampling frame.

The Census Bureau initially grouped the housing units enumerated in the 1990 Census of Population and Housing in the United States into census blocks and divided these blocks into two frames: the unit/group quarters frame and the area frame. Two criteria distinguished to which frame a census block belonged: (1) the completeness of addresses in the block; and (2) whether the block was in an area that issued building permits for new construction at the time of the 1990 census. Four situations arose:

1. Most addresses within the census block were complete, and the block was located in an area that issued permits for new construction. These blocks were placed in the unit/group quarters frame.

2. Most addresses within the census block were complete, and the block was located in an area that did not issue permits for new construction. These blocks were placed in the area frame.

3. There were not enough complete addresses within the census block, and the block was located in an area that issued permits for new construction. These blocks were placed in the area frame.

4. There were not enough complete addresses within the census block, and the block was located in an area that did not issue permits for new construction. These blocks were also placed in the area frame.

The unit/group quarters frame was split into the unit frame and the group quarters frame by removing all group quarters and placing them in a separate frame. In addition, to coordinate with another Census Bureau survey, a subset of census blocks in the unit frame which contained sample units selected by this other survey was moved to the area frame.

All new construction housing units that were built after the 1990 census in areas where construction of new homes was monitored by building permits were placed into a separate frame called the permit frame.

The Census Bureau selected a separate sample for each metropolitan area. Sampling operations for all frames were performed separately within a designated group of counties in each state. The size of the sample determined the overall sampling rate used to select the sample. Prior to the AHS-MS sample selection, other Census Bureau surveys sampled from each of the frames. Records selected by other surveys were removed from each of the frames to avoid having the same housing unit in sample for more than one survey. The Census Bureau selected the sample from the remaining records after adjusting the sampling ratio to reflect the removal of the other surveys' sample. Table D presents the percentage of AHS-MS sample drawn from each frame.

Unit frame. The Census Bureau stratified the 1990 census housing units by the central city and balance of the metropolitan area, by the rent or value of the unit, and by the number of rooms. A systematic sample of housing units was then selected across these strata.

Group quarters frame. In the first stage, the Census Bureau systematically sampled census blocks with a probability proportional to the group quarters measure of size. For institutional group quarters, the measure of size is always equal to one. For noninstitutional group quarters, the measure of size is a function of the number of people

Table D. **Percentage of 1998 AHS-MS Sample by Frame**

1998 AHS metropolitan areas	Unit frame	Group quarters frame	Permit frame	Area frame
Baltimore, MD	84.8	0.6	10.2	4.5
Birmingham, AL	69.3	0.1	11.1	19.6
Boston, MA-NH	90.2	0.1	5.3	4.5
Cincinnati, OH-KY-IN	63.7	0.1	8.8	27.4
Houston, TX	76.8	0.2	11.0	12.0
Minneapolis-St. Paul, MN-WI	79.9	0.4	13.5	6.2
Norfolk-Virginia Beach-Newport News, VA-NC	78.3	0.1	12.4	9.2
Oakland, CA	88.2	0.5	7.5	3.8
Providence-Pawtucket-Warwick, RI-MA	89.3	0.0	6.3	4.5
Rochester, NY	84.7	0.4	7.8	7.1
Salt Lake City, UT	80.9	0.2	17.1	1.8
San Francisco, CA	91.0	1.6	3.8	3.6
San Jose, CA	89.2	0.7	7.5	2.6
Tampa-St. Petersburg, FL	84.7	0.3	10.5	4.5
Washington, DC-MD-VA	78.1	0.3	12.9	8.7

living in the group quarters. Based upon a block's measure of size, clusters expected to yield four housing units were then sampled in the second stage. Field representatives monitored these group quarters and sampled housing units that came into existence after April 1, 1990.

Permit frame. The Census Bureau selected sample units in the permit frame from a computerized list of new construction building permits issued in each metropolitan area. Housing units authorized by these permits were expected to be completed after April 1, 1990. In certain permit areas and for certain structure sizes, permits issued as early as January 1, 1989, were included. However, most permits included in sample were issued after September 1, 1989. Prior to sample selection, the list of permits was sorted by 1990 central city and balance of the metropolitan area, permit office, and the date the permit was issued. Clusters of approximate size four were selected and then were sampled down to one unit. Some of the original clusters were larger than four. These were sampled at 1 in 4.

Area frame. The Census Bureau sorted census blocks by central city and balance and by the percentage of renter-occupied housing units in the block. Each block was assigned a measure of size equivalent to total housing units in the block divided by four. A systematic sample of blocks was selected with a probability proportionate to the block's measure of size. Field representatives listed all housing units in these area frame sample blocks. Based upon a block's measure of size, clusters of an expected size of four housing units were then sampled from the field representatives' lists. These listings were also matched back to the 1990 census to obtain census data for the sample housing units. The sample drawn from the field representatives' listings for this frame includes housing units enumerated in the 1990 census, as well as housing units missed during the census or built since the 1990 census in blocks that did not monitor new construction by issuing building permits. In blocks that did issue building permits, nonmobile home housing units built since the 1990 census were screened out.

To reduce field listing costs, a subset of the blocks from the unit frame (that was moved to the area frame to coordinate with another survey) were matched to the census and the 1990 census list of housing units in this subset of blocks was created. These housing units were sorted by address within census block and a systematic sample of housing units (yielding approximately four units per block) was then selected from this sample of blocks. New construction since the 1990 census was captured in the permit frame since new construction in these blocks was covered by the building permit system.

1998 AHS-MS Telephone Interviewing

The previous approach for the AHS required a personal visit for the first interview. To keep costs down for the 1998 AHS-MS, part of the sample used the previous approach and the remainder used the telephone interview when possible. Telephone numbers were obtained for these cases by the matching of addresses to phone lists provided by a vendor.

Estimation

The 1998 AHS-MS produced estimates of housing inventory characteristics at the time of the interview (that is, the 1998 housing inventory) based on the sample in the metropolitan areas.

The sample housing units were weighted according to a multiple-stage ratio estimation procedure. Before implementing the ratio estimation procedure, the basic weight (that is, the inverse of the probability of selection) for each interviewed sample housing unit was adjusted to account for Type A noninterviews.

Type A noninterview adjustment. Type A noninterviews are:

- Sample units for which occupants were not home
- Sample units for which occupants refused to be interviewed
- Sample units for which occupants were unavailable for some other reason
- Vacant sample units for which data were not collected

The calculations for this adjustment included occupied and vacant units. The Census Bureau computed the Type A noninterview adjustment separately for the following:

1. All occupied housing units in the unit frame and housing units in the area unit frame with 1990 census data available.

   The adjustment for these units was calculated separately for owners in the central city, for owners in the balance of the metropolitan area, for renters in the

central city, and for renters in the balance of the metropolitan area. Housing units were placed into cells based upon the strata used in the unit frame sampling. All owner-occupied housing units were categorized into 76 cells by the number of rooms in the housing unit and the value of the housing unit at the time of the 1990 census. All renter-occupied housing units were categorized into 51 cells by the number of rooms in the housing unit and the rent paid for the housing unit at the time of the 1990 census.

2. Occupied housing units in the area frame with no data available from the 1990 census and housing units in the group quarters frame.

   Housing units were divided into two groups: housing units in the central city and housing units in the balance of the metropolitan area. Within the balance, housing units were placed in two categories based on frame. Units were subdivided in the central city and the balance depending upon the tenure status and whether the housing unit was a mobile home or not.

3. All occupied housing units from the 1990-based permit frame.

   Once again, the housing units were divided into two groups by central city and the balance of the metropolitan area. Within central city and balance, the housing units were further subdivided by tenure status at the time of the interview. Finally, the housing units were split on whether or not they had been constructed within the 4 years preceeding this survey yielding a total of eight cells.

4. All vacant/usual residence elsewhere housing units.

   The housing units were divided into two groups by central city and the balance of the metropolitan area.

   Within a given cell, the Type A noninterview adjustment factor was equal to the following ratio:

$$\frac{\text{Weighted count of interviewed housing units} + \text{Weighted count of Type A noninterviewed housing units}}{\text{Weighted count of interviewed housing units}}$$

Ratio estimation procedure for the unit frame. The Census Bureau computed a unit frame ratio estimation factor for all housing units in the unit frame. This factor was computed separately for all sample housing units within each unit frame noninterview cell mentioned previously. This ratio estimation procedure was introduced to correct the probabilities of selection for samples in each of the strata used in the sample selection of the unit frame. Prior to the AHS-MS sample selection within each metropolitan area, housing units already selected for other Census Bureau surveys were deleted from the unit frame. The same probability of selection was then applied to the remaining units to select the AHS-MS sample. Since the number of housing units deleted from the AHS-MS unit frame was not necessarily proportional among all strata, some variation between strata in the actual probability of selection was introduced during the sample selection process. The unit frame ratio estimation factor for each cell was equivalent to:

$$\frac{\text{1990 census count of housing units from the unit frame in the corresponding cell}}{\text{AHS-MS sample estimate of housing units in the unit frame in 1990 in the corresponding cell}}$$

For each metropolitan area, the numerators of the factors were obtained from the 1990 Census of Population and Housing.

The denominators of these factors come from weighted estimates of all the AHS-MS housing units in existence at the time of the 1990 census from the unit frame, using the weights available at the time of calculation (that is, the product of the basic weight and the Type A noninterview adjustment factor). The computed unit frame ratio estimation factor is then multiplied by the existing weight for each sample housing unit within the corresponding ratio estimation cells.

Mobile home ratio estimation. To adjust for undercoverage of mobile homes, the Census Bureau applied the following ratio estimation procedure in all areas:

$$\frac{\text{Independent estimate of mobile homes for the corresponding geographic subdivision of the metropolitan area}}{\text{Sample estimate of mobile homes for the corresponding geographic subdivision of the metropolitan area}}$$

The numerator of this ratio was determined using data from the 1980 and the 1990 censuses. Based on the increase or decrease in the number of mobile homes between 1980 and 1990, the Census Bureau estimated the total number of mobile homes in the survey year 1998. The denominator was obtained using the existing weight of AHS-MS sample mobile home units (that is, the product of the basic weight and the weighting factor).

Independent total housing unit ratio estimation. For the ratio estimation procedure described below, each metropolitan area was subdivided into geographic areas consisting of individual counties or a combination of counties.

The ratio estimation procedure reduced the sampling error for most statistics below what would have been obtained by simply weighting the results of the sample by the inverse of the probability of selection. Since the housing population of the sample differed somewhat by chance from the metropolitan area as a whole, one can expect

that the sample housing population, or different portions of it, is brought into agreement with known good estimates of the metropolitan area housing population.

The Census Bureau applied the following ratio estimation procedure in all areas:

$$\frac{\text{Independent estimate of the total housing inventory (excluding mobile homes) for the corresponding geographic subdivision of the metropolitan area}}{\text{Sample estimate of the total housing inventory (excluding mobile homes) for the corresponding geographic subdivision of the metropolitan area}}$$

The numerator of this ratio was determined by making adjustments to the 1990 census data to account for residential new construction as well as losses to the housing inventory. These estimates were generated at the county level and combined to form geographic subdivisions. For a more detailed description of the determination of these numbers, refer to a description of a similar process at the state level in the *Current Population Report,* Series P-25, no. 1123. The denominator was obtained using the existing weight of AHS-MS sample units, excluding mobile homes (that is, the product of the basic weight and the weighting factors).

The computed ratio estimation factors were then applied to all appropriate housing units in the corresponding geographic area of each metropolitan area, and the resulting product was used as the final weight for tabulation purposes.

NATIONAL SAMPLE DESIGN

Sample Size

The 1997 national data are from a sample of housing units interviewed between August and November 1997. The same basic sample of housing units is interviewed every 2 years until a new sample is selected. The Census Bureau updated the sample by adding newly constructed housing units and units discovered through coverage improvement efforts every enumeration. For the 1997 American Housing Survey-National (AHS-N), approximately 53,100 sample housing units were selected for interview. About 2,200 of these units were found to be ineligible because the unit no longer existed or because the units did not meet the AHS-N definition of a housing unit.

Of the 50,900 eligible sample units, about 5,000 were classified (both occupied and vacant housing units), as Type A noninterviews because (a) no one was at home after repeated visits, (b) the respondent refused to be interviewed, or (c) the interviewer was unable to find the unit. This classification produced a 90-percent overall response rate.

Sample Selection

The Census Bureau has interviewed the current sample of housing units since 1985. First, the United States was divided into areas made up of counties or groups of counties and independent cities known as primary sampling units (PSUs). A sample of these PSUs was selected. Then a sample of housing units was selected within these PSUs.

Selection of sample areas. The sample for AHS is spread over 394 PSUs. These PSUs cover 878 counties and independent cities with coverage in all 50 states and the District of Columbia.

If there were over 100,000 housing units in a PSU at the time of selection, the PSU is known as a self-representing PSU, because it was removed from the probability sampling operation. It was in sample with certainty. The sample from the PSU represents only that PSU. There are 170 self-representing PSUs.

The Census Bureau grouped the remaining PSUs and selected one PSU per group, proportional to the number of housing units in the PSU, to represent all PSUs in the group. These selected PSUs are referred to as nonself-representing PSUs. The sample nonself-representing PSUs for AHS are a subsample of the Current Population Survey's (CPS) sample areas based on the 1980 census.

Selection of sample housing units. The AHS sample consists of the following types of units in the sampled PSUs:

- Housing units selected from the 1980 census
- New construction in areas requiring building permits
- Housing units missed in the 1980 census
- Other housing units added since the 1980 census

Housing units selected from the 1980 census. The Census Bureau picked a systematic sample so every unit had a 1 in 2,148 chance of being included in the AHS.

In areas where addresses are complete (at least 96 percent of units having a house number and street name) and permits are required for new construction, housing units receiving 1980 census long-form questionnaires were sorted by the following items:

- PSU
- Central city, urbanized area, urban outside urbanized area, rural
- Owner, renter, vacant for rent, vacant for sale, other types of vacants
- Number of rooms
- Value of home or gross rent
- Mobile home or not a mobile home

In areas where addresses are not complete or permits are not required for new construction, land areas were sorted using a formula incorporating the following items:

- PSU
- Central city, urbanized area, urban outside urbanized area, rural

- Median value of home
- Number of children under 6 years old
- Number of elderly people
- Number of owner-occupied homes
- Number of mobile homes
- Number of homes lacking some plumbing
- Number of owner-occupied homes whose value is below $45,000
- Number of renter-occupied homes with rent below $200
- Number of Black and Hispanic people
- Number of 1-room homes

New construction in areas requiring building permits. In areas that require building permits for new construction, the Census Bureau selected a sample of permits. These permits do not cover mobile homes or conversion of older buildings to residential use.

Housing units missed in the 1980 census. The Census Bureau conducted a special study that identified units at addresses missed or inadequately defined in the 1980 census. A sample of these identified units was selected.

Housing units added since the 1980 census. If extra units are added in buildings or mobile home parks where AHS already has sample units, a sample of these extra units was selected. To find when whole buildings are built (in addition to building permits, mentioned above) or are converted from nonresidential to residential use, the Census Bureau listed all residential buildings in a sample of areas around the country, any additional buildings, and selected a sample of their units.

Estimation

Each housing unit in the AHS sample represents itself and over 2,000 other units. The exact number it represents is its "weight." The weight was calculated in five steps. The purpose of these steps is to minimize both sampling errors and errors from incomplete data. The result of the steps is also to force consistency with some major categories of data in other Census Bureau surveys, Therefore, figures on these categories do not actually depend on the AHS sample, but on the other surveys.

1. **Basic weight.** The Census Bureau assigned each unit a weight to reflect its probability of selection. With rare exceptions, this weight is 2,148.

2. **Noninterview adjustment.** An adjustment was made for refusals and occupied units where no one was home. The calculations for this adjustment do not include units the Census Bureau could not locate. The earlier weight was multiplied by the following factor:

$$\frac{\text{Interviewed units + Units not interviewed}}{\text{Interviewed units}}$$

It is assumed the units missed are similar in some ways to the units interviewed for AHS.

This adjustment is done separately for groups defined by cross-classifying the following data items if prior year data for the indicated items is available:

- Four census regions
- Central city, suburb, or nonmetropolitan
- Urban or rural
- Mobile home or not a mobile home
- Owner/for sale or renter/for rent
- Number of units in structure*
- Number of rooms*
- Occupied, vacant year round, or seasonal/migratory vacant*

(*If known from a previous survey; otherwise, the Census Bureau substituted whether or not units were drawn from building permits for these items.)

For seasonal/migratory vacants and year-round vacants other than those for rent or for sale, units were cross-classified only by census region and central city/suburb/nonmetropolitan.

PSU adjustment. The Census Bureau adjusted for differences that existed in 1980 between the number of 1980 census housing units estimated from the AHS sample of nonself-representing (NSR) PSUs and the 1980 census counts outside the self-representing PSUs. The earlier weight was multiplied by the following factor:

$$\frac{\text{1980 census housing units in all areas that could have been chosen as nonself-representing PSUs}}{\text{1980 census housing units estimated from the AHS sample of nonself-representing PSUs}}$$

This adjustment is done separately for groups defined by cross-classifying:

- Owner, renter, or vacant (four census regions)
- Central city, suburb, or nonmetropolitan
- Urban or rural
- Hispanic or non-Hispanic householder (only in South and West regions)
- Black or non-Black householder (only in South region)

New construction adjustment. The Census Bureau adjusted for known deficiencies in sampling new construction by multiplying the earlier weight by the following factor:

$$\frac{\text{Independent estimate}}{\text{AHS sample estimate}}$$

This adjustment is done separately for groups defined by cross-classifying:

- Four census regions
- Mobile home or not a mobile home

- Number of units in structure
- Year built (pre-1980 and 5-year categories after 1980 as shown in the publication)

Independent estimates are based on the Census Bureau's Survey of Construction and Survey of Mobile Home Placements. Note that final AHS figures for the categories above are not really based on the AHS sample findings, but on the independent sources.

Demographic adjustment. Comparability among the surveys was ensured by multiplying the earlier weight by the following factor:

$$\frac{\text{Independent estimate}}{\text{AHS sample estimate}}$$

This adjustment is done in two steps for occupied units. First, the factors were computed and applied for the Hispanic or non-Hispanic groups defined by cross-classifying:

- Four census regions
- Owner or renter
- Hispanic or non-Hispanic householder
- Husband-wife, other male householder, or other female householder
- Age of householder

Next, the demographic adjustment is repeated with the same cells, except classified by the Black or non-Black groups, rather than the Hispanic or non-Hispanic groups.

Vacant for sale, vacant for rent, other year-round vacant and seasonal/migratory vacant units were cross-classified only by the four census regions and central city, suburb, or nonmetropolitan.

The percentage of occupied and vacant units was based on the AHS itself. The distribution within occupied and vacant units is from the Census Bureau's Current Population Survey for occupied units, and from the Housing Vacancy Survey for vacant units. The grand total number of all housing units in the United States is based on the 1990 census adjusted to account for new and lost units. Note that final AHS figures for the categories above are not really based on the AHS sample findings, but on the independent sources.

Repetitions. The new construction and demographic adjustments were repeated to help match both sets of independent estimates simultaneously. These adjustments were repeated until every cell's factor is between 0.98 and 1.02 or the change in each factor from one repetition to the next is fewer than 0.015.

Small cells. In each step of weighting, many items were cross-classified; so some cells may have few cases. When a cell is too small (fewer than 30 cases for the noninterview adjustment or fewer than 50 cases for the demographic adjustment) or the adjustment factor is too extreme (greater than 1.5 for the noninterview adjustment or outside a range of 0.5 to 2.0 for the demographic adjustment) the Census Bureau combined the cell with one or more other cells that are similar in most respects. Cells for the PSU adjustment or the new construction adjustment were not combined.