

## USE OF MAPS TO SUPPORT THE 2010 UNITED STATES DECENNIAL CENSUS

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**Abstract:** The United States Census Bureau will conduct a national census in 2010 to count residents in over 100 million housing units. The primary purpose of the national census is to count the population for the purpose of apportioning the 435 seats within the U.S. House of Representatives amongst the 50 states.

This paper describes how the Census Bureau uses maps to plan, manage, and execute data collection, and to report census results. Maps help the Census Bureau maintain a national spatial database (the MAF/TIGER database), manage operations, and locate and record the locations of housing units. Maps are also employed to communicate census results to other government agencies and the public.

In the years preceding the 2010 Decennial Census, the Census Bureau partners with federal, state, local, and tribal governments to update boundaries for legal and statistical entities as well as roads and other features contained within the MAF/TIGER database. To facilitate these updates, the Census Bureau creates database extracts and large paper maps of Census Bureau data, which its partners can use for comparison with their own local data. Partners can indicate changes by directly modifying these products and returning them to the Census Bureau.

In addition to updates on maps from partner agencies, electronic maps provide a way for the Census Bureau to gather current housing unit locations prior to enumerating the population. Months before the census is conducted, enumerators verify the address of each housing unit, add or correct street information, and capture the location of the housing unit. They perform this operation using a GPS enabled handheld computer that includes a map display derived from MAF/TIGER.

Conducting the census is a complex operation requiring meticulous planning and operational oversight. Throughout the census, managers use a variety of large format paper maps to help them allocate work and track the progress of enumeration activities. During the enumeration and follow-up operations, Census Bureau workers carry small

paper maps into the field. They use these maps to locate and navigate to their assignments, organize their work, and record updates to housing unit locations.

Data collected during the 2010 Census are tabulated by a variety of geographic areas, and made available to the public. For a given geographic area, the responses from each housing unit located within that area are aggregated to create summary data for the entity. Spatial data files and maps routinely accompany statistical data products to provide geographic reference. Reference maps show locations of census statistical areas, along with the transportation network and legal boundaries such as city limits. The spatial data, data tabulations, and reference maps are employed by various users for a variety of purposes, including the update of congressional districts throughout the country. Thematic maps, such as population density maps, provide the public with a way to visualize census data by displaying it in a spatial context.

Maps play a vital role in spatial data maintenance, census data collection, and dissemination. This paper will explain the different maps used to support the 2010 Decennial Census, the requirements that went into their design, the challenges the Census Bureau faces, and the strategies it is investigating to support the next decennial census in 2020.

### **Paper text: Introduction**

The United States Census Bureau conducts a variety of operations to count the population and collect demographic data every 10 years. This enumeration is called the decennial census; the next one will occur in 2010. The number and style of census operations used to complete the enumeration varies geographically. Some examples of a few decennial census operations are the Address Canvassing operation, designed to locate housing units; the Update/Leave operation, which delivers census questionnaires in some parts of the country; and the Non-Response Follow-Up operation in which personal visits are made to households that did not respond during initial operations. Throughout the decennial census, the Census Bureau uses maps to plan operations, manage operations, collect data, and report results. To support these functions, three basic types of maps are designed. There are administrative reference maps, maps used to navigate to work units and make updates, and maps used by the public.

### **Administrative Reference maps**

Reference maps show office jurisdictions and operation-specific areas in context with physical features. These maps are generally large in size and designed to be used in Census Bureau offices that perform data collection operations.

### ***Applicant Geocoding Map***

Census data collection requires a large temporary work force. Prospective employees must be associated with a geographic location for a number of reasons. Assigning workers to offices near their homes reduces travel costs and takes full advantage of the employee's knowledge of his local area. During the hiring process, a computerized geocoding system and a large format map are used to assign each applicant to a specific census block. The geocoding system takes the applicant's home address and matches it against a mailing address database to assign the appropriate census block number. The Applicant Geocoding maps show the local street network, along with city or town boundaries, overlaid with a grid. Applicants study the map to find their home locations, and record the grid number in which they live on their applications. If the automated system is unable to geocode an applicant, the manually collected grid number from the Applicant Geocoding map is used to associate the applicant with a location. Geocoding applicants is a critical component for managing a temporary workforce of millions of applicants with a high turnover in a short period of time.

### ***Local Census Office Map***

To conduct the various on-the-ground operations required during the decennial census, the Census Bureau is opening 494 temporary Local Census Offices (LCO) around the country where employees who conduct the 2010 Census will work. Managers in these offices use large format LCO maps to help them keep track of the work in their areas. The LCO wall map is centered on an individual LCO, and scaled so that the area will fit on a single large format page (36 by 42 inches). This map shows the location of roads, streams and other physical features within and around the area for which the office is responsible, and highlights the boundary of the LCO's jurisdiction. Local governmental units within each LCO are also identified. The maps are designed as a general reference map to help office workers and visitors orient to the local office's area of responsibility.

### ***Type of Enumeration Area Map***

A Type of Enumeration Area (TEA) map is a large format map that gives managers an overview of the type of work required for each part of the country. Prior to each decennial census the nation is divided into different types of enumeration areas based on how the Census Bureau plans to conduct the enumeration. Operations are conducted differently in different parts of the country to take advantage of the ability to deliver questionnaires by post and to minimize the amount of field work required. The goal is to distribute questionnaires by post wherever possible; however, in some areas it is more efficient and effective to conduct personal visits to deliver questionnaires and to obtain responses. For any particular field office, the enumeration method required for its area makes a great deal of difference in the number of employees required to complete the operation, the training they will require, and the time it will take to accomplish the work.

Therefore, all offices need to know which type of work they will be responsible for and where that work will take place. Many LCOs have more than one type of enumeration methodology to manage.

### ***Operation-Based Area Maps***

Throughout the census, operations are conducted based on the TEA, and follow-up operations are conducted to reach households that were initially missed. Since each separate operation requires a different style of work, the LCO area is divided into sub-areas that require relatively equal amounts of work for a given operation. This sub-area hierarchy usually consists of Field Operations Supervisor Districts (FOSD) containing Crew Leader Districts (CLD), which contain Assignment Areas (AA). Each AA is the area for which an individual field worker will be responsible for collecting data. The individual field workers are managed and assisted by Crew Leaders, who are in turn managed by Field Operations Supervisors (see Figure 1). The hierarchy is laid out on large format, operation-specific maps, so that these managers can keep track of their own work and the assignments their employees are working on. One map is created for each FOSD, centered and scaled appropriately, so that the FOSD will fit on a single large format page whenever possible. The boundary of the FOSD is depicted over a base map of roads and other physical features, with all CLDs outlined and labeled. Similarly, the CLD map shows an individual CLD over a base map, with the interior AAs identified. Figure 2 shows a portion of a CLD map with AAs filled in different colors. The thick purple line in the upper left-hand corner of the figure, indicates the edge of the CLD. These reference maps are used for general planning purposes, to locate the boundaries of the FOSDs/CLDs/AAs, assist in making assignments, and monitor operation progress.

### ***Workload Tracking Maps***

In addition to basic reference maps, census managers also use thematic maps to identify where work still needs to be accomplished. For example, a Mail Response Rate map is used to show the progress of census data collection during the enumeration process. A map is created daily for each county where questionnaire return is handled by the postal service. The map shows census tracts in different colors depending on each tract's Mail

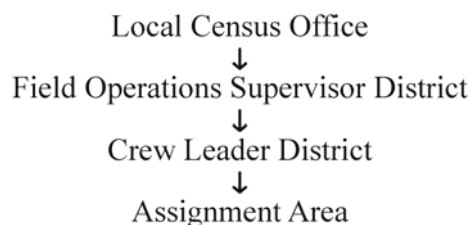


Figure 1. Local Census Office Operational Area Hierarchy

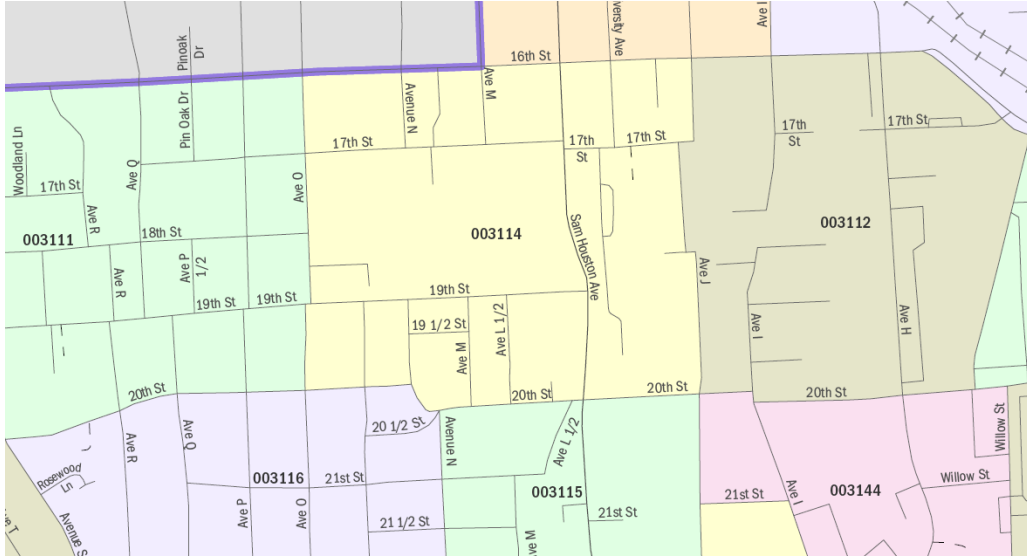


Figure 2. Portion of a Crew Leader District map showing Assignment Area boundaries

Response Rate. The Mail Response Rate is determined by dividing the total number of questionnaires returned for a given tract, by the total number of housing units in that tract. The maps are updated daily and made available on the internet. As questionnaires are received, the response rate map changes, making this an important tool for both census managers and local officials, as it helps them easily identify areas where the mail response rate is low prior to the conclusion of census taking activities.

### Enumeration/Annotation Maps

Maps for locating work units and collecting updates are used in the field. These maps are small in size (11 by 17 inches) so they can be easily carried and annotated outside an office. Enumerators work in assignment areas (AAs) which are subdivided into collection blocks. Three types of maps are created for each individual AA unit of work, and designed to be used as a package to help the enumerator complete the work in an AA: a locator map designed to help the field worker navigate to the AA; an overview map displaying the layout of collection blocks within the AA; and detailed maps of each collection block, which can be annotated. The maps are designed with black and white symbols, so that they can be printed on local office laser printers and photocopied.

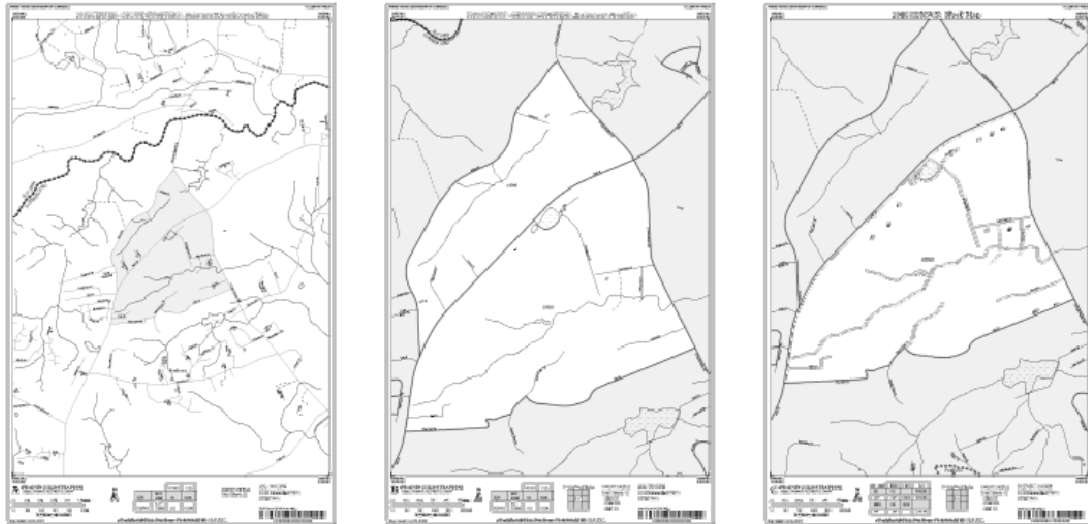


Figure 3. Enumeration Maps

***AA Locator Map***

The AA Locator map is centered on an individual AA and scaled so that a large amount of the surrounding area can be seen. These maps are designed to fit on a single page. The outline of the AA is shown over a base map, which includes roads and other physical features to help the user orient himself and navigate to the area (see Figure 3, left).

***AA Map***

An AA map shows an overview of the AA at a larger scale than the AA Locator map. The map shows the layout of the collection blocks inside the AA. The field worker plans his route through the blocks he needs to work by reviewing this overview map. He also keeps track of the work he has finished and what is left to complete by crossing off the portions of the AA he has worked on the map (see Figure 3, center).

***Collection Block Map***

A Collection Block map is centered on an individual collection block. Blocks are the smallest census enumeration areas. They are normally bounded by streets, but can be bounded by other physical features, particularly in rural areas. In addition to the outline of the block and the identification of surrounding blocks, this map shows the location of housing units on a base map of streets, streams, and other physical features. Users can record new housing unit locations, and update the names or positions of roads that do not appear correctly on the map. The annotations the user makes are sent to a central processing facility to be scanned and incorporated into the Census Bureau's spatial database (see Figure 3, right).

### ***Electronic Alternative***

To make digitizing easier and more accurate, the Census Bureau conducted the largest of its 2010 Census operations using electronic maps on a hand held computer (HHC), rather than paper maps. The HHC contains an electronic map that can be used to navigate to an AA, see an overview of the blocks in an AA, and view and collect data for individual blocks. The HHC has the ability to collect housing unit locations using a Global Positioning System (GPS). There are a number of advantages to using the HHC over paper maps. The HHC is easier to carry than large binders full of 11 by 17 inch maps. The GPS can provide more accurate housing unit locations and feature updates than manually collected data. Updates collected on the HHC can be uploaded wirelessly from the field to a centralized computer and quickly integrated into the Census Bureau database, eliminating the need to store, transport, scan, and digitize paper maps. Some disadvantages include a limited viewing area and the need for electricity to charge the equipment.

### **Partnership Program Maps**

The Census Bureau collects some data from local governments and other interested groups through partnership programs. Some programs enable these partners to verify that the Census Bureau's spatial data are correct prior to use in collection or tabulation of population data. The exchange of data occurs in a variety of formats, and maps are one of the tools made available to partnership program participants to provide spatial data about their respective local areas to the Census Bureau. For example, the Boundary and Annexation Survey (BAS) provides a mechanism for local governments to provide details regarding changes to the boundaries of legal jurisdictions. Unless boundaries are up-to-date in the Census Bureau's database, tabulation of census results for a city or town will not accurately reflect the current status of that geographic area.

### ***Boundary and Annexation Survey (BAS)***

BAS participants use maps in several different formats to collect the boundary and feature updates. Participants can use Census Bureau provided software on their own computers. The software includes spatial files and is designed to present users with a map of their areas, allow them to make changes to their boundaries with accompanying documentation that describes the legal changes, and submit the results to the Census Bureau. Alternatively, local governments experienced in the use of geographic information systems (GIS) can choose to receive Census Bureau data as GIS files, which they can modify in their own GIS and return to the Census Bureau electronically. Participants can also choose to provide updates by annotating paper maps, which are then scanned and integrated into the Census Bureau's database.

Paper BAS maps are large format maps, centered on the geographic extent of an individual governmental unit, and scaled to provide enough area outside the entity of interest to allow the user to draw in annexations. A base map of roads and other physical features is overlaid with the political boundaries of the participant's area and the surrounding area.

### ***Other Partnership Programs***

Other types of boundaries, such as school district boundaries, voting district boundaries, state legislative district boundaries, and some statistical area boundaries are collected from state and local partners using maps and software packages similar to those used in the BAS program. Paper-style maps are made available either in hard-copy format, or in Adobe Portable Document Format (PDF) for viewing on a computer.

### **Publication Maps**

Following decennial data collection and tabulation, the Census Bureau publishes maps to accompany the data tables. These include reference maps and thematic maps. Reference maps depict the boundaries of legal and statistical geographic areas by which population and housing data are tabulated and their relationships to one another. Thematic maps display census data in a spatial context.

### ***Redistricting Maps***

The very first map to be produced as a result of the 2010 Census will be the Reapportionment Map. Based on the data collected during the 2010 Census, seats in Congress will be reapportioned among the states to reflect changes in population distribution. The reapportionment map shows the entire U.S. with states that have gained seats in Congress shown in one color, states that have lost seats shown in a different color, and states with no change shown in white. For each state that has changed, the number of seats gained or lost is also listed. This map helps the state governments plan for congressional redistricting work.

Following the reapportionment map, the Census Bureau provides two different styles of redistricting maps to each state to support the delineation of new congressional districts; County Block Maps, and Voting District/State Legislative District Maps. These maps accompany detailed demographic data for the states. State governments use the demographic data and redistricting maps to help them delineate new congressional districts.

County Block Maps are large format, large scale maps. Of all the maps distributed with the census results, these maps show the most detail. The maps focus on the smallest geographic entities for which the Census Bureau presents data, the census block. All blocks within a county are outlined and identified over a base map of roads, other



physical features, and statistical and political boundaries. The intent of this map series is to produce a map for each county, on the smallest possible number of map sheets, at the maximum practical scale. Because of the detail included on the maps, each county generally requires multiple pages. Each county is covered by one or more parent map sheets at a single scale and, when necessary, by inset maps at larger scales. For entities that are mapped on two or more map sheets, an index map showing the map sheet configuration is also produced.

The Voting District/State Legislative District Maps are similar county-based reference maps, but are designed to show an overview of the existing voting districts and/or state legislative districts within a county. Voting districts and state legislative districts are identified over a base map of roads and other physical features. Fewer features are labeled on these maps, and labels are liberally suppressed when necessary in order to fit the subject county onto as few sheets possible. If more detail regarding the exact boundaries of a voting district is required, the user can refer to the County Block Map or one of the Census Bureau's detailed digital sources. This overview of existing voting districts and state legislative districts provides a high-level reference to supplement the extremely detailed County Block Map.

### ***General Reference Maps***

Since all census data are associated with a geographic area, reference maps are designed to help data users understand the relationships between different areas. A variety of reference maps is necessary to meet the needs of all data users.

The State-based County Outline map series consists of a page size map of each state or state equivalent showing the boundaries and names of the counties or statistically equivalent areas in effect for the 2010 Census tabulation. In addition to the state-based map series a national wall sized map showing all state and county boundaries accompanies the data tabulations.

When using data for smaller areas like cities and towns, users can refer to the page size County Subdivision maps that accompany the release of data tables (available in printed reports as well as on-line in PDF). These maps show the outline of all counties and county subdivisions in a state and identify them by name. The maps give users a quick understanding of the relative placement of the areas whose data they are examining.

Providing a spatial reference for smaller geographic areas requires a more detailed, larger-scale reference map. The Census Tract Maps are county-based maps that show the boundaries and codes for Census Tracts over a typical base map of physical features. Political boundaries and names are included for context. The scale of these maps is optimized to keep the number of map sheets for each county to a minimum, but the scale

and number of sheets varies based on the size of the county and the complexity of the subject geography.

***Governmental Unit Maps, a more detailed Reference Map Series***

Census Bureau data are tabulated for a large variety of legal and statistical geographic areas, such as states, counties, places, and census tracts. Data also are tabulated for intersections of geographic areas, such as the portion of a city within a county or the portion of a census tract within a city. A comprehensive map showing relationships between geographic areas provides the spatial reference necessary for performing detailed analysis of census data. Because they are generally well-known, governmental units provide the base for these maps. The Governmental Unit maps are similar to the redistricting-oriented County Block maps mentioned above. They are large format, large scale maps centered on a particular legal or statistical area, such as a county, city, or town. These maps show all legal and statistical areas for which the Census Bureau presents data over a base map of roads, and other physical features. The intent of this map series is to produce a detailed map for each entity, on the smallest possible number of map sheets, at the maximum practical scale that will allow all geographic area boundaries to be depicted. Maps are made available to the public on paper or as PDFs.

Reference maps allow users to update or examine the extent or boundaries of areas for which the Census Bureau publishes data tabulations and visualize their physical relationships to one another.

***Thematic Maps***

Thematic maps are maps displaying data about a specific subject. Thematic maps include any type of map that concentrates on a single data theme. Based on the results of the decennial census, the Census Bureau creates a variety of thematic maps focusing on population distribution and demographic characteristics. The Reapportionment map mentioned above is a good example of a thematic map based on census results. Other examples include the State Profile Map series, the Center of Population maps, and atlases such as “Mapping Census 2000: The Geography of U.S. Diversity,” and “Census Atlas of the United States.”

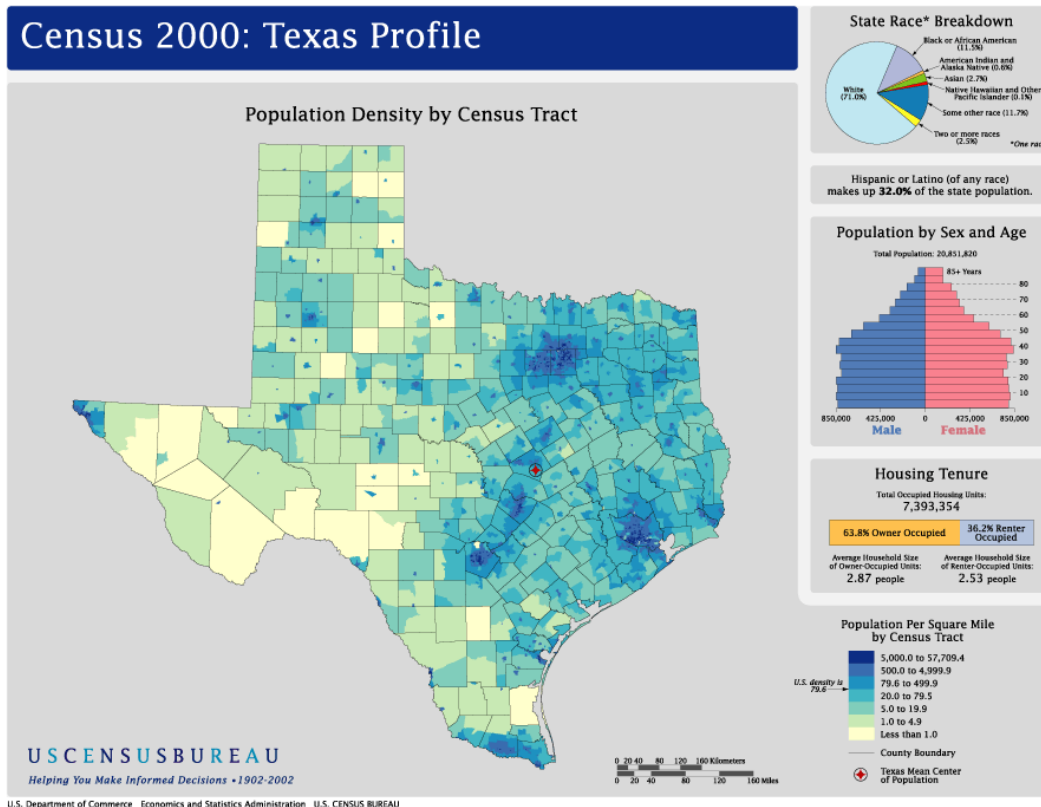


Figure 4. State Profile Map

State Profile Maps are small, one page, maps showing selected demographic characteristics for each state. The product consists of a choropleth map depicting the population density by census tract within a state, surrounded by a population pyramid and graphs showing housing tenure and the state's racial breakdown. The maps accompany state-based tables that present an overview of general demographic characteristics. The map and tables together provide an easy-to-access quick reference source for basic census data at the state level (See Figure 4).

After the decennial census, the Census Bureau creates maps illustrating the geographic mean and median centers of population for the public. One particular map portrays the change in the mean center of population over time, illustrating the population growth in the western part of the country since 1790.

Another product shows the population distribution nationally using white dots to represent groups of people. The U.S. land area is shown in black so that the dots look as if they were lights. White dots coalesce in dense areas, making it easy for users to pick out urban centers.

### ***Post-census Area Reference Maps***

Statistical entities such as Urban Areas, and Metropolitan and Micropolitan Statistical Areas, as well as legal areas will be re-defined based on census results after all the data from the 2010 Census have been tabulated. Once the new areas are delineated, the Census Bureau will provide new data tabulations to the public based on the revised boundaries for these areas. Reference maps in various formats will be created to accompany those post-census tabulations. National wall maps show the layout of the areas in relationship to one another, while page size individual area outline maps show the new areas with their underlying features identified. The maps provide the spatial context within which the public can interpret the new data tabulations.

### **Detailed and Generalized Spatial Files**

The Census Bureau creates generalized spatial files to use in its thematic mapping efforts and web-based mapping applications. The Census Bureau makes these files available for download by the public, which allows users to create their own thematic maps based on the 2010 Census data. Public users can also obtain detailed spatial files derived from the Census Bureau's database to create maps or perform spatial analysis with their own geographic information system software.

### **Conclusion**

The Census Bureau supports the 2010 Census effort with a variety of digital maps, paper maps, and electronic spatial files. While planning for the 2020 Census, the Bureau will assess various user needs when deciding what type of maps to generate. While continuing to improve its electronic maps, the Census Bureau's Geography staff persists in providing spatial data and maps in a variety of formats to meet the requirements of a diverse user community.