

KEY ISSUE 3

Why Are Urban Areas Expanding?

- Suburban Expansion
- Suburban Segregation
- Urban Transportation

Learning Outcome 13.3.1

State three definitions of urban settlements.

In 1950, only 20 percent of Americans lived in suburbs compared to 40 percent in cities and 40 percent in small towns and rural areas. In 2000, after a half-century of rapid suburban growth, 50 percent of Americans lived in suburbs compared to only 30 percent in cities and 20 percent in small towns and rural areas.

Suburban Expansion

Until recently in the United States, as cities grew, they expanded by adding peripheral land. Now cities are surrounded by a collection of suburban jurisdictions whose residents prefer to remain legally independent of the large city.

THE PERIPHERAL MODEL

North American urban areas follow what Chauncey Harris (one of the creators of the multiple nuclei model) called the **peripheral model**. According to the peripheral model, an urban area consists of an inner city surrounded by large

suburban residential and business areas tied together by a beltway or ring road (Figure 13-26). Peripheral areas lack the severe physical, social, and economic problems of inner-city neighborhoods. But the peripheral model points to problems of sprawl and segregation that characterize many suburbs.

Around the beltway are nodes of consumer and business services called *edge cities*. Edge cities originated as suburban residences for people who worked in the central city, and then shopping malls were built to be near the residents. Now edge cities contain manufacturing centers spread out over a single story for more efficient operations and office parks where producer services cluster. Specialized nodes emerge in the edge cities—for example, a collection of hotels and warehouses around an airport, a large theme park, a distribution center near the junction of the beltway, and a major long-distance interstate highway.

DEFINING URBAN SETTLEMENTS

Several definitions have been created to characterize cities and their suburbs:

- A city is a legal entity.
- An urban area is a continuously built-up area.
- A metropolitan area is a functional area.

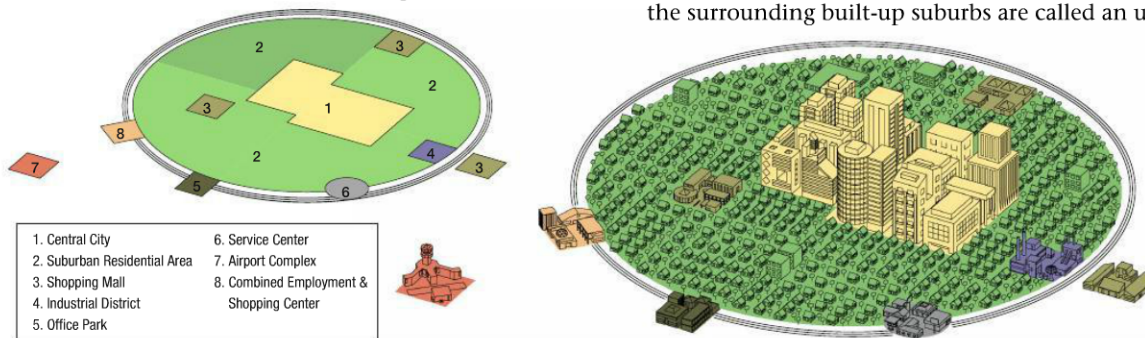
LEGAL DEFINITION OF CITY. The term *city* defines an urban settlement that has been legally incorporated into an independent, self-governing unit (Figure 13-27). In the United States, a city surrounded by suburbs is sometimes called a central city.

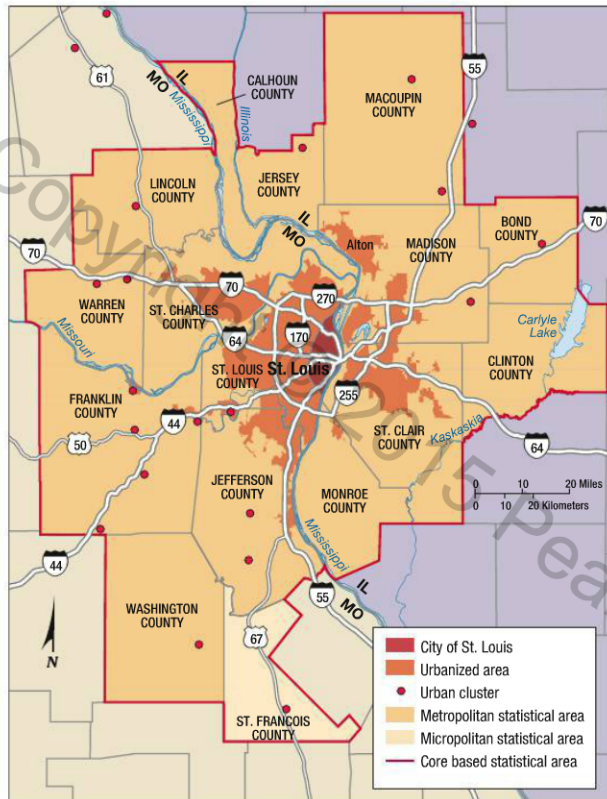
Virtually all countries have a local government system that recognizes cities as legal entities with fixed boundaries. A city has locally elected officials, the ability to raise taxes, and responsibility for providing essential services. The boundaries of the city define the geographic area within which the local government has legal authority.

Population has declined since 1950 by more than one-half in the central cities of Buffalo, Cleveland, Detroit, Pittsburgh, and St. Louis, and by at least one-third in more than a dozen other cities. The number of tax-paying middle-class families and industries has invariably declined by much higher percentages in these cities.

URBAN AREA. In the United States, the central city and the surrounding built-up suburbs are called an urban area.

▼ **FIGURE 13-26 PERIPHERAL MODEL OF URBAN AREAS** The central city is surrounded by a beltway or ring road. Around the beltway are suburban residential areas and nodes, or edge cities, where consumer and business services and manufacturing cluster. (Adapted from Chauncey D. Harris, "The Nature of Cities and Urban Geography in the Last Half Century." Reprinted with permission from *Urban Geography*, vol. 18, no. 1 (1997), p. 17. © V. H. Winston & Son, Inc., 360 South Ocean Blvd., Palm Beach, FL 33480. All rights reserved.)





▲ FIGURE 13-27 DEFINITIONS OF ST LOUIS The City of St. Louis comprises only 6 percent of the land area and 11 percent of the population of the MSA.

An **urban area** consists of a dense core of census tracts, densely settled suburbs, and low-density land that links the dense suburbs with the core. The census recognizes two types of urban areas:

- An **urbanized area** is an urban area with at least 50,000 inhabitants.
- An **urban cluster** is an urban area with between 2,500 and 50,000 inhabitants.

The census identified 486 urbanized areas and 3,087 urban clusters in the United States in 2010. Approximately 70 percent of the U.S. population lived in one of the 486 urbanized areas, including about 30 percent in central cities and 40 percent in surrounding jurisdictions. Approximately 10 percent of the U.S. population lived in one of the 3,087 urban clusters. The census does not have a precise definition of suburbs, but they can be considered roughly equivalent to the urban clusters and the urbanized areas outside the central cities.

Working with urbanized areas is difficult because few statistics are available about them. Most data in the United States and other countries are collected for cities, counties, and other local government units, but urbanized areas do not correspond to government boundaries. The term *urban area* also has limited applicability because it does not accurately reflect the full influence that an urban settlement has in contemporary society.

METROPOLITAN STATISTICAL AREA. The area of influence of a city extends beyond legal boundaries and adjacent built-up jurisdictions. For example, commuters may travel a long distance to work and shop in the city or built-up suburbs. People in a wide area watch the city's television stations, read the city's newspapers, and support the city's sports teams. Therefore, we need another definition of urban settlement to account for its more extensive zone of influence.

The U.S. Bureau of the Census has created a method of measuring the functional area of a city, known as the **metropolitan statistical area (MSA)**. An MSA includes the following:

- An urbanized area with a population of at least 50,000
- The county within which the city is located
- Adjacent counties with a high population density and a large percentage of residents working in the central city's county (specifically, a county with a density of 25 persons per square mile and at least 50 percent working in the central city's county)

Studies of metropolitan areas in the United States are usually based on information about MSAs. MSAs are widely used because many statistics are published for counties, the basic MSA building block.

The Census Bureau had designated 366 MSAs as of 2012, encompassing 84 percent of the U.S. population. Older studies may refer to SMSAs, or standard metropolitan statistical areas, which the census used before 1983 to designate metropolitan areas in a manner similar to MSAs. An MSA is not a perfect tool for measuring the functional area of a city. One problem is that some MSAs include extensive land area that is not urban. For example, Great Smoky Mountains National Park is partly in the Knoxville, Tennessee, MSA; Sequoia National Park is in the Visalia-Porterville, California, MSA. MSAs comprise some 20 percent of total U.S. land area, compared to only 2 percent for urbanized areas. The urbanized area typically occupies only 10 percent of an MSA land area but contains nearly 90 percent of its population.

The census has also designated smaller urban areas as **micropolitan statistical areas (μSAs)**. A μSA includes an urbanized area of between 10,000 and 50,000 inhabitants, the county in which it is found, and adjacent counties tied to the city. The United States had 576 micropolitan statistical areas as of 2012, for the most part found around southern and western communities previously considered rural in character. About 10 percent of Americans live in micropolitan statistical areas. The 366 MSAs and 576 μSAs together are known as **core based statistical areas (CBSAs)**.

Recognizing that many MSAs and μSAs have close ties, the census had combined some of them into 128 **combined statistical areas (CSAs)** as of 2012. A CSA is defined as two or more contiguous CBSAs tied together by commuting patterns. The 125 CSAs plus the remaining 187 MSAs and 406 μSAs not combined into CSAs together are known as **primary census statistical areas (PCSAs)**.

Pause and Reflect 13.3.1

In what metropolitan or micropolitan statistical area do you live? Google [your city and state] statistical area.

OVERLAPPING METROPOLITAN AREAS

Learning Outcome 13.3.2:

Describe how metropolitan areas contain many local governments and overlap with each other.

A county between two central cities may send a large number of commuters to jobs in each. In the northeastern United States, large metropolitan areas are so close together that they now form one continuous urban complex, extending from north of Boston to south of Washington, D.C. Geographer Jean Gottmann named this region **Megalopolis**, a Greek word meaning “great city”; others have called it the Boswash corridor (Figure 13-28).

Other continuous urban complexes exist in the United States—the southern Great Lakes between Chicago and Milwaukee on the west and Pittsburgh on the east, and southern California, from Los Angeles to Tijuana. Among important examples in other developed countries are the

German Ruhr (including the cities of Dortmund, Düsseldorf, and Essen), Randstad in the Netherlands (including the cities of Amsterdam, The Hague, and Rotterdam), and Japan’s Tokaido (including the cities of Tokyo and Yokohama).

Within Megalopolis, the downtown areas of individual cities such as Baltimore, New York, and Philadelphia retain distinctive identities, and the urban areas are visibly separated from each other by open space used as parks, military bases, and dairy or truck farms. But at the periphery of the urban areas, the boundaries overlap. Once considered two separate areas, Washington and Baltimore were combined into a single MSA after the 1990 census. Washingtonians visit the Inner Harbor in downtown Baltimore, and Baltimoreans attend major-league hockey and basketball games in downtown Washington. However, combining them into one MSA did not do justice to the distinctive character of the two cities, so the Census Bureau again divided them into two separate MSAs after the 2000 census but grouped them into one combined statistical area.



FIGURE 13-28

MEGALOPOLIS

Also known as the Boswash corridor, Megalopolis extends more than 700 kilometers (440 miles) from Boston on the northeast to Washington, D.C., on the southwest. Megalopolis contains one-fourth of the U.S. population on 2 percent of the country’s total land area.

LOCAL GOVERNMENT FRAGMENTATION

The fragmentation of local government in the United States makes it difficult to solve regional problems of traffic management, solid-waste disposal, and the building of affordable housing. According to the 2002 census, the United States had 87,525 local governments, including 3,034 counties, 19,429 cities, 16,504 townships, 13,506 school districts, and 35,052 special-purpose districts, such as police and fire. The larger metropolitan areas have thousands of local governments, with widely varying levels of wealth (Figure 13-29).

The large number of local government units has led to calls for a metropolitan government that could coordinate—if not replace—the numerous local governments in an urban area. Most U.S. metropolitan areas have a **council of government**, which is a cooperative agency consisting of representatives of the various local governments in the region. The council of government may be empowered to do some overall planning for the area that local governments cannot logically do. Strong metropolitan-wide governments have been established in a few places in North America. Two kinds exist:

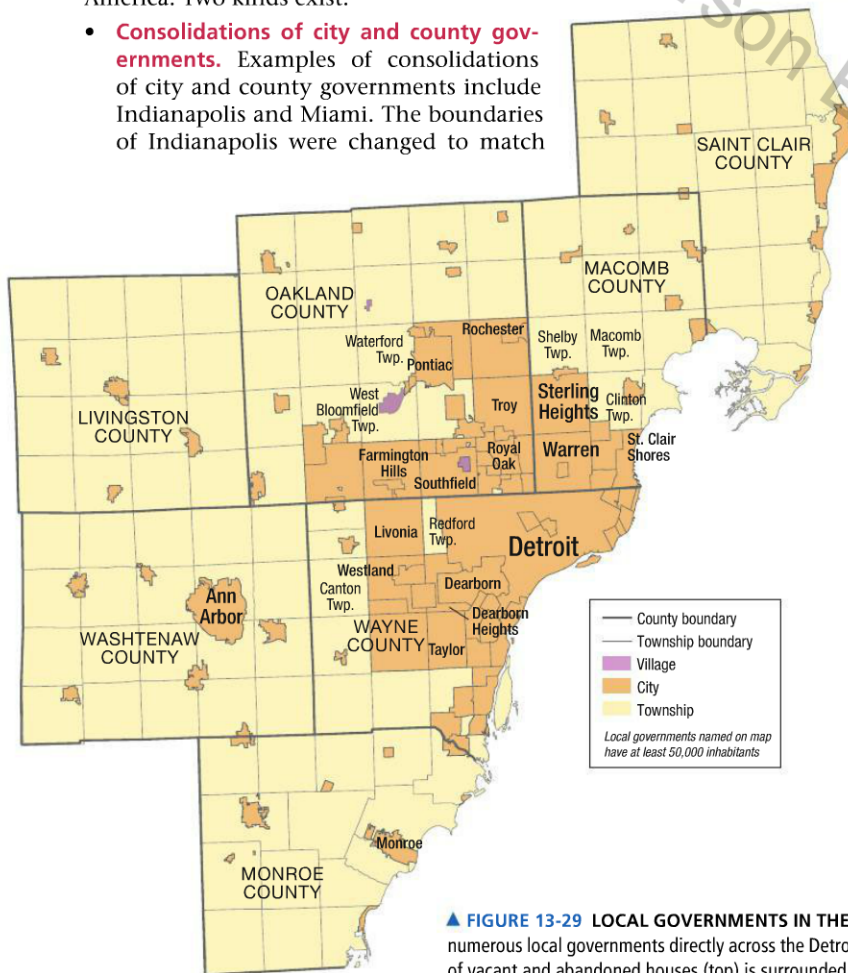
- **Consolidations of city and county governments.** Examples of consolidations of city and county governments include Indianapolis and Miami. The boundaries of Indianapolis were changed to match

those of Marion County, Indiana. Government functions that were handled separately by the city and the county now are combined into a joint operation in the same office building. In Florida, the city of Miami and surrounding Dade County have combined some services, but the city boundaries have not been changed to match those of the county.

- **Federations.** Examples of federations include Toronto and other large Canadian cities. Toronto's metropolitan government was created in 1953, through a federation of 13 municipalities. A two-tier system of government existed until 1998, when the municipalities were amalgamated into a single government.

Pause and Reflect 13.3.2

Canada has a method of delineating urban and metropolitan areas of various sizes. If the Canadian side of Lake Ontario were colored in Figure 13-28, most of it would also be urban. What is the largest city and metropolitan area on the Canadian side of Lake Ontario?



▲ **FIGURE 13-29 LOCAL GOVERNMENTS IN THE DETROIT METROPOLITAN AREA** The map does not include numerous local governments directly across the Detroit River in Canada. The city of Detroit, which has a large number of vacant and abandoned houses (top) is surrounded by wealthy suburbs (bottom).

ANNEXATION

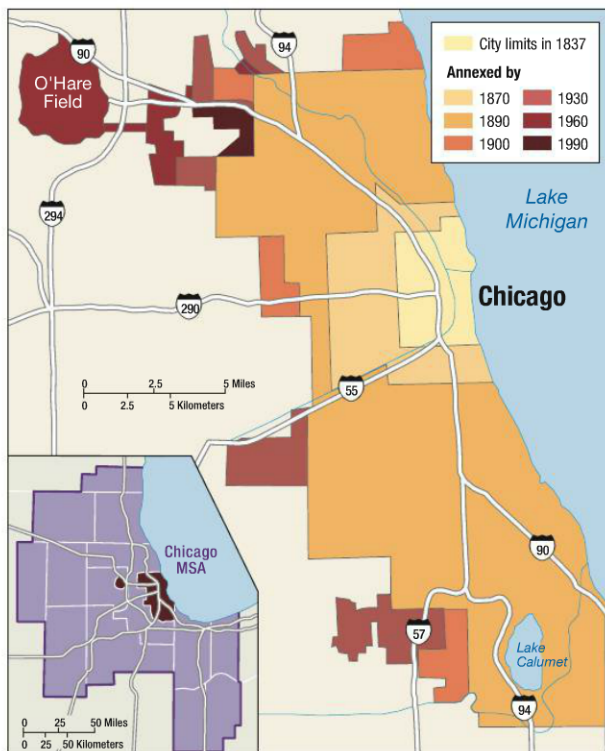
Learning Outcome 13.3.3

Understand historical and contemporary patterns of suburban expansion.

The process of legally adding land area to a city is **annexation**. Rules concerning annexation vary among states. Normally, land can be annexed to a city only if a majority of residents in the affected area vote in favor of the annexation.

Peripheral residents generally desired annexation in the nineteenth century because the city offered better services, such as water supply, sewage disposal, trash pickup, paved streets, public transportation, and police and fire protection. Thus, as U.S. cities grew rapidly in the nineteenth century, the legal boundaries frequently changed to accommodate newly developed areas. For example, the city of Chicago expanded from 26 square kilometers (10 square miles) in 1837 to 492 square kilometers (190 square miles) in 1900 (Figure 13-30).

Today, however, cities are less likely to annex peripheral land because the residents prefer to organize their own services rather than pay city taxes for them. Originally, some of these peripheral jurisdictions were small, isolated towns



▲ **FIGURE 13-30 ANNEXATION IN CHICAGO** During the nineteenth century, the city of Chicago grew rapidly through annexation of peripheral land. Relatively little land was annexed during the twentieth century; the major annexation was on the northwest side, for O'Hare Airport. The inset shows that the city of Chicago covers only a small portion of the Chicago metropolitan statistical area.

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that had a tradition of independent local government before being swallowed up by urban growth. Others are newly created communities whose residents wish to live close to the large city but not be legally part of it.

Pause and Reflect 13.3.3

The three largest cities in Ohio are Cincinnati, Cleveland, and Columbus. In 1950, Cincinnati's land area was 72 square miles, Cleveland's was 75 square miles, and Columbus's was 40 square miles. Which of the three cities has increased its land area substantially since 1950? Refer to each city's Wikipedia site to find the current land areas. What might account for the large increase?

DENSITY GRADIENT

As you travel outward from the center of a city, you can watch the decline in the density at which people live (Figure 13-31). Inner-city apartments or row houses may pack as many as 250 dwellings on a hectare of land (100 dwellings per acre). Older suburbs have larger row houses, semidetached houses, and individual houses on small lots, at a density of about 10 houses per hectare (4 houses per acre). A detached house typically sits on a lot of 0.25 to 0.5 hectares (0.6 to 1.2 acres) in new suburbs and a lot of 1 hectare or greater (2.5 acres) on the fringe of the built-up area.

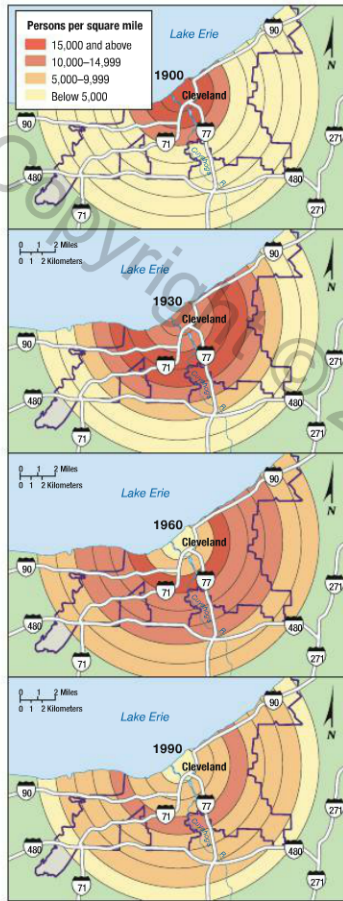
This density change in an urban area is called the **density gradient**. According to the density gradient, the number of houses per unit of land diminishes as distance from the center city increases. Two changes have affected the density gradient in recent years:

- **Fewer people living in the center.** The density gradient thus has a gap in the center, where few live.
- **Fewer differences in density within urban areas.** The number of people living on a hectare of land has decreased in the central residential areas through population decline and abandonment of old housing. At the same time, density has increased on the periphery through construction of apartment and town-house projects and diffusion of suburbs across a larger area.

These two changes flatten the density gradient and reduce the extremes of density between inner and outer areas traditionally found within cities.

THE COST OF SUBURBAN SPRAWL

A flattening of the density gradient for a metropolitan area means that its people and services are spread out over a larger area. U.S. suburbs are characterized by **sprawl**, which is the progressive spread of development over the landscape. When private developers select new housing sites, they seek cheap land that can easily be prepared for construction—land often not contiguous to the existing built-up area (Figure 13-32). Sprawl is also fostered by the desire of many families to own large tracts of land.



▶ **FIGURE 13-31 DENSITY GRADIENT IN CLEVELAND** In 1900, the population was highly clustered in and near the central business district (CBD). By 1930 and 1960, the population was spreading, leaving the original core less dense. By 1990, the population was distributed over a much larger area, the variation in the density among different rings was much less, and the area's lowest densities existed in the rings near the CBD. The current boundary of the city of Cleveland is shown. (First three maps adapted from Avery M. Guest, "Population Suburbanization in American Metropolitan Areas, 1940–1970," *Geographical Analysis* 7 (1975): 267–283, table 4. Used by permission of the publisher.)

As long as demand for single-family detached houses remains high, land on the fringe of urban areas will be converted from open space to residential land use. Land is not transformed immediately from farms to housing developments. Instead, developers buy farms for future construction of houses by individual builders. Developers frequently reject land adjacent to built-up areas in favor of detached isolated sites, depending on the price and physical attributes of the alternatives. The peripheries of U.S. cities therefore look like Swiss cheese, with pockets of development and gaps of open space.

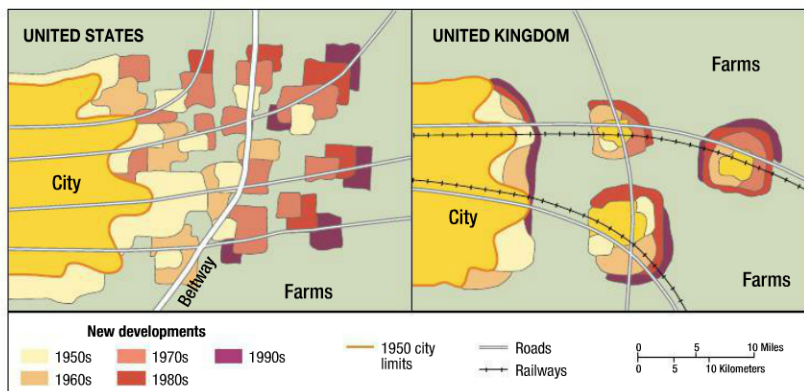
Urban sprawl has some undesirable traits. Roads and utilities must be extended to connect isolated new developments to nearby built-up areas. The cost of these new roads and utilities may be funded by taxes, or the developer may install the services and pass on the cost to new residents through higher home prices. Sprawl also wastes land. Some

prime agricultural land may be lost through construction of isolated housing developments. In the interim, other sites lie fallow while speculators await the most profitable time to build homes on them. In reality, sprawl has little impact on the total farmland in the United States, but it does reduce the ability of city dwellers to get to the country for recreation, and it can affect the supply of local dairy products and vegetables. Low-density suburbs also waste more energy, especially because motor vehicles are required for most trips.

The supply of land for the construction of new housing is more severely restricted in European urban areas than in the United States. Officials attack sprawl by designating areas of mandatory open space. London, Birmingham, and several other British cities are surrounded by **greenbelts**, or rings of open space. New housing is built either in older suburbs inside the greenbelts or in planned extensions to small towns and new towns beyond the greenbelts. However, restriction of the supply of land on the urban periphery has driven up house prices in Europe.

Several U.S. states have taken strong steps in the past few years to curb sprawl, reduce traffic congestion, and reverse inner-city decline. The goal is to produce a pattern of compact and contiguous development and protect rural land for agriculture, recreation, and wildlife. Legislation and regulations to limit suburban sprawl and preserve farmland has been called **smart growth**. Oregon and Tennessee have defined growth boundaries within which new development must occur. Cities can annex only lands that have been included in the urban growth areas. New Jersey, Rhode Island, and Washington were also early leaders in enacting strong state-level smart-growth initiatives. Maryland's smart-growth law discourages the state from funding new highways and other projects that would extend suburban sprawl and destroy farmland. State money must be spent to "fill in" already urbanized areas.

▼ **FIGURE 13-32 SUBURBAN DEVELOPMENT PATTERNS IN THE UNITED KINGDOM AND THE UNITED STATES** The United States has much more sprawl than the United Kingdom. In the United Kingdom, new housing is more likely to be concentrated in new towns or planned extensions of existing small towns (right), whereas in the United States, growth occurs in discontinuous developments.



Segregation in the Suburbs

Learning Outcome 13.3.4

Explain two ways in which suburbs are segregated.

Public opinion polls in the United States show people's strong desire for suburban living. In most polls, more than 90 percent of respondents prefer the suburbs to the inner city. It is no surprise then that the suburban population has grown much faster than the overall population in the United States.

Suburbs offer varied attractions—a detached single-family dwelling rather than a row house or an apartment, private land surrounding the house, space to park cars, and a greater opportunity for home ownership. A suburban house provides space and privacy, a daily retreat from the stress of urban living. Families with children are especially attracted to suburbs, which offer more space for play and protection from the high crime rates and heavy traffic that characterize inner-city life. As incomes rose in the twentieth century, first in the United States and more recently in other developed countries, more families were able to afford to buy suburban homes.

The modern residential suburb is segregated in two ways:

- **Segregated social classes.** Housing in a given suburban community is usually built for people of a single social class, with others excluded by virtue of the cost, size, or location of the housing. Segregation by race and ethnicity also persists in some suburbs (see Chapter 7).
- **Segregated land uses.** Residents are separated from commercial and manufacturing activities that are confined to compact, distinct areas.

RESIDENTIAL SEGREGATION

The homogeneous suburb was a twentieth-century phenomenon. Before then, activities and classes in a city were more likely to be separated vertically rather than horizontally. In a typical urban building, shops were on the street level, with the shop owner or another well-to-do family living on one or two floors above the shop. Poorer people lived on the higher levels or in the basement, the least attractive parts of the building. The basement was dark and damp, and before the elevator was invented, the higher levels could be reached only by climbing many flights of stairs. Wealthy families lived in houses with space available in the basement or attic to accommodate servants.

Once cities spread out over much larger areas, the old pattern of vertical separation was replaced by territorial segregation. Large sections of the city were developed with houses of similar interior dimension, lot size, and cost, appealing to people with similar incomes and lifestyles. Zoning ordinances, developed in Europe and North America in the early decades of the twentieth century, encouraged



▲ **FIGURE 13-33 HOUSING SEGREGATION: GATED COMMUNITY** Dana Point, California, a Los Angeles suburb, has a gated community called Lantern Bay.

spatial separation. They prevented the mixing of land uses within the same district. In particular, single-family houses, apartments, industry, and commerce were kept apart because the location of one activity near another was considered unhealthy and inefficient.

The strongest criticism of U.S. residential suburbs is that low-income people and minorities are unable to live in them because of the high cost of the housing and the unfriendliness of established residents. Suburban communities discourage the entry of those with lower incomes and minorities because of fear that property values will decline if the high-status composition of the neighborhood is altered. Legal devices, such as requiring each house to sit on a large lot and the prohibition of apartments, prevent low-income families from living in many suburbs. Fences are built around some housing areas, and visitors must check in at a gate house to enter (Figure 13-33).

Pause and Reflect 13.3.4

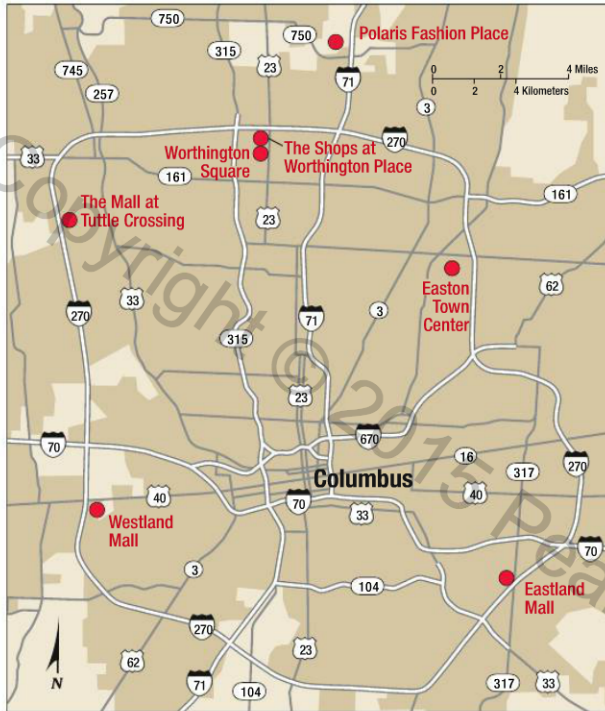
Are you able to walk from your home to consumer services? What do you think explains the spatial pattern of residential and commercial land uses in the area where you live?

SUBURBANIZATION OF BUSINESSES

Many nonresidential activities have moved to the suburbs. A number of factors account for this long-established and continuing trend:

- Consumer services have moved to suburbs because most of their customers live there.
- Business services and manufacturers have moved to suburbs because land is cheaper and more plentiful there.

A large node of business and consumer services in the suburbs of an urban area is known as an **edge city**. Edge cities are planned around freeway exits and are designed to be navigable only in motor vehicles.



▲ **FIGURE 13-34 SHOPPING MALLS NEAR COLUMBUS, OHIO** The malls surround the city near the beltway. (right) Easton Town Center is the largest mall in the Columbus area.

SUBURBANIZATION OF CONSUMER SERVICES. Suburban residential growth has fostered change in traditional retailing patterns (Figure 13-34). Historically, urban residents bought food and other daily necessities at small neighborhood shops in the midst of housing areas and shopped in the CBD for other products. But since the end of World War II, downtown sales have not increased, whereas suburban sales have risen at an annual rate of 5 percent. Downtown sales have stagnated because suburban residents who live far from the CBD don't make the long journey there. At the same time, small corner shops do not exist in the midst of newer residential suburbs. The low density of residential construction discourages people from walking to stores, and restrictive zoning practices often exclude shops from residential areas.

Instead, retailing has been increasingly concentrated in planned suburban shopping malls of varying sizes. Corner shops have been replaced by supermarkets in small shopping centers. Larger malls contain department stores and specialty shops traditionally located only in the CBD. Generous parking lots surround the stores. A shopping mall is built by a developer, who buys the land, builds the structures, and leases space to individual merchants. Typically, a merchant's rent is a percentage of sales revenue.

Shopping malls require as many as 40 hectares (100 acres) of land and are frequently near key road junctions,



such as the interchange of two interstate highways. Some shopping malls are elaborate multilevel structures exceeding 100,000 square meters (1 million square feet), with more than 100 stores arranged along covered walkways, and surrounded by an extensive parking area. The key to a successful large shopping mall is the inclusion of one or more anchors, usually large department stores. Most consumers go to a mall to shop at an anchor and, while there, patronize the smaller shops. In smaller shopping centers, the anchor is frequently a supermarket or discount store.

Malls have become centers for activities in suburban areas that lack other types of community facilities. Retired people go to malls for safe, vigorous walking exercise, or they sit on a bench to watch the passing scene. Teenagers arrive after school to meet their friends. Concerts and exhibitions are frequently set up in malls.

SUBURBANIZATION OF BUSINESS SERVICES AND FACTORIES. Offices that do not require face-to-face contact are increasingly moving to suburbs, where rents are lower than in the CBD. Executives can drive on uncongested roads to their offices from their homes in nearby suburbs and park their cars without charge. For other employees, though, suburban office locations can pose a hardship. Secretaries, custodians, and other lower-status office workers may not have cars, and public transportation may not serve the site. Other office workers might miss the stimulation and animation of a central location, particularly at lunchtime.

Factories and warehouses have migrated to suburbia for more space, cheaper land, and better truck access. Modern factories and warehouses demand more land because they spread their conveyor belts, forklift trucks, loading docks, and machinery over a single level for efficient operation. Suburban locations also facilitate truck shipments by providing good access to main highways and no central city traffic congestion, which is important because industries increasingly receive inputs and distribute products by truck.

Urban Transportation

Learning Outcome 13.3.5

Describe the impact of motor vehicles in urban areas.

People do not travel aimlessly; their trips have a precise point of origin, destination, and purpose. More than half of all trips are work related—commuting between work and home, business travel, or deliveries. Shopping or other personal business and social journeys each account for approximately one-fourth of all trips. Together, all these trips produce congestion in urban areas. Congestion imposes costs on individuals and businesses by delaying arrival at destinations, and the high concentration of slowly moving vehicles produces increased air pollution.

Historically, the growth of suburbs was constrained by poor transportation. People lived in crowded cities because they had to be within walking distance of shops and places of employment. The invention of the railroad in the nineteenth century enabled people to live in suburbs and work in the central city. Cities then built railroads at street level (called trolleys, streetcars, or trams) and underground (subways) to accommodate commuters. Many so-called streetcar suburbs built in the nineteenth century still exist and retain unique visual identities. They consist of houses and shops clustered near a station or former streetcar stop at a much higher density than is found in newer suburbs.

MOTOR VEHICLES

The suburban explosion in the twentieth century relied on motor vehicles rather than railroads, especially in the United States. Rail lines restricted nineteenth-century suburban development to narrow ribbons within walking distance of the stations. Cars and trucks permitted large-scale development of suburbs at greater distances from the center, in the gaps between the rail lines. Motor vehicle drivers have much greater flexibility in their choice of residence than was ever before possible.

Motor vehicle ownership is nearly universal among American households, with the exception of some poor families, older individuals, and people living in the centers of large cities such as New York. More than 95 percent of all trips within U.S. cities are made by car, compared to fewer than 5 percent by bus or rail. Outside the big cities, public transportation service is extremely rare or nonexistent. The U.S. government has encouraged the use of cars and trucks by paying 90 percent of the cost of limited-access, high-speed interstate highways, which stretch for 74,000 kilometers (46,000

miles) across the country. The use of motor vehicles is also supported by policies that keep the price of fuel below the level found in Europe.

The motor vehicle is an important user of land in the city (Figure 13-35). An average city allocates about one-fourth of its land to roads and parking lots. Multilane freeways cut a 23-meter (75-foot) path through the heart of a city, and elaborate interchanges consume even more space. Valuable land in the central city is devoted to parking cars and trucks, although expensive underground and multi-story parking structures can reduce the amount of ground-level space needed. European and Japanese cities have been especially disrupted by attempts to insert new roads and parking areas in or near the medieval central areas.

CONTROLLING VEHICLES. The future health of urban areas depends on relieving traffic congestion. Geographic tools, including the Global Positioning System (GPS) and electronic mapping, are playing central roles in the design of intelligent transportation systems, either through increasing road capacity or through reducing demand.

The current generation of innovative techniques to increase road capacity is aimed at providing drivers with information so that they can make intelligent decisions about avoiding congestion. Information about traffic congestion is transmitted through computers, handheld devices, and vehicle monitors. Traffic hot spots are displayed on electronic maps and images, using information collected through sensors in the roadbeds and cameras placed at strategic locations. An individual wishing to know about a particular route can program an electronic device to receive a congestion alert and to suggest alternatives. Radio stations in urban areas broadcast reports to advise motorists of accidents or especially congested highways.

Demand to use congested roads is being reduced in a number of ways:

- **Congestion charges.** In London, motorists must pay a congestion charge of up to £12 (\$18) to drive into

▼ **FIGURE 13-35 URBAN EXPRESSWAY** San Francisco, like most other U.S. cities, had major expressways constructed into the center of the city.





▲ FIGURE 13-36 LONDON CONGESTION CHARGE The sign warns motorists that they must pay a charge to drive into Central London at certain times.

the central area between 7 A.M. and 6 P.M. Monday through Friday (Figure 13-36). A similar system exists in Stockholm, where the charge varies depending on the time of day.

- **Tolls.** In Toronto and several California cities, motorists are charged higher tolls to drive on freeways during congested times than at other times. A transponder attached to a vehicle records the time of day it is on the highway. A monthly bill sent to the vehicle's owner reflects the differential tolls.
- **Permits.** In Singapore, to be permitted to drive downtown during the busiest times of the day, a motorist must buy a license and demonstrate ownership of a parking space. The government limits the number of licenses and charges high tolls to drive downtown. Several cities in China intend to require permits to drive in congested areas.



▲ FIGURE 13-37 DRIVERLESS CAR Google has developed technology enabling vehicles to be driven by sensors, electronic maps, and cameras.

- **Bans.** Cars have been banned from portions of the central areas of a number of European cities, including Copenhagen, Munich, Vienna, and Zurich.

Future intelligent transportation systems are likely to increase capacity through hands-free driving (Figure 13-37). A motorist will drive to a freeway entrance, where the vehicle will be subjected to a thorough diagnostic (taking a half-second) to ensure that it has enough fuel and is in good operating condition. A menu will offer a choice of predetermined destinations, such as “home” or “office,” or a destination can be programmed by hand.

Pause and Reflect 13.3.5

Which methods of easing congestion appear to you to be most likely to be successful?

A release will send the vehicle accelerating automatically on the entrance ramp onto the freeway. Sensors in the bumpers and fenders, attached to radar or GPS, will alert vehicle systems to accelerate, brake, or steer, as needed. With such a system, spacing between vehicles can be as little as 2 meters. While a vehicle is automatically controlled, the “driver” will be able to swivel the seat to a workstation to make phone calls, check e-mail, or surf the Internet; read; watch television; or nap. When the vehicle nears the programmed freeway exit, a tone will warn that the driver will have to take back control. The vehicle will halt on the exit ramp until the driver firmly presses the brake to release the “autodrive” system, much as cruise control is currently disengaged.