SECTION

II

LITERATURE SYNTHESIS

The purpose of this section is to divide the literature on sprawl into major fields and subfields of impact in an effort to synthesize the most important studies in a systematic way.

This effort identifies what researchers on the subject have considered and debated; what data have been used and how the data have been analyzed; and where the gaps in the state of knowledge are.

The section is divided into two parts. The first is a synthesis of the literature as described above. The second is a summary of the literature, including: (1) topical coverage, databases, methodologies, and deficiencies; and (2) alleged negative and positive effects of sprawl. Thus, the synthesis of the literature in the first part of the section serves as a basis for statistical summaries of literature by type, database, methodology, and category of impact in the second part of the chapter. The statistical summary is one of the first of its type. Although different literature citations could signal different emphases, it is believed that these citations and resulting emphases are correct in both direction and magnitude.

Analysis of the Literature

A search of the literature reveals that various commentators have attributed more than two dozen negative and more than one dozen positive impacts to sprawl. These impacts are set forth in Table 7. The list is not a scientific taxonomy; it does not include all the alleged effects of sprawl. Rather, in the judgment of those reviewing the literature, it includes some of sprawl's most significant impacts. Further, not all of the allegations can be substantiated; nor are they of equal importance. However, this inventory presents a comprehensive set of allegations based on the literature assembled here.

TABLE 7

ALLEGED NEGATIVE AND POSITIVE IMPACTS OF SPRAWL

Substantive Concern	***Alleged Negative Impacts***	***Alleged Positive Impacts***
Public-Private Capital and Operating Costs	Higher infrastructure costs Higher public operating costs More expensive private residential and nonresidential development costs More adverse public fiscal impacts Higher aggregate land costs	Lower public operating costs Less expensive private residential and nonresidential development costs Fosters efficient development of "leapfrogged" areas
Transportation and Travel Costs	More vehicle miles traveled (VMT) Longer travel times More automobile trips Higher household transportation spending Less cost-efficient and effective transit Higher social costs of travel	Shorter commuting times Less congestion Lower governmental costs for transportation Automobiles most efficient mode of transportation
Land/Natural Habitat Preservation	Loss of agricultural land Reduced farmland productivity Reduced farmland viability (water constraints) Loss of fragile environmental lands Reduced regional open space	Enhanced personal and public open space
Quality of Life	Aesthetically displeasing Weakened sense of community Greater stress Higher energy consumption More air pollution Lessened historic preservation	Preference for low-density living Lower crime rates Enhanced value or reduced costs of public and private goods Fosters greater economic well-being
Social Issues	Fosters suburban exclusion Fosters spatial mismatch Fosters residential segregation Worsens city fiscal stress Worsens inner-city deterioration	Fosters localized land use decisions Enhances municipal diversity and choice

The allegations have been classified into five substantive categories:

1) public/private capital and operating costs;
2) transportation and travel costs;
3) land/natural habitat preservation;
4) quality of life; and
5) social issues.

Each of the alleged negative and positive impacts found in the literature search under these groupings uses a common presentation format as follows:

1) *Topic.* What is the specific subject matter of the alleged cost or benefit?
2) *Allegation/Basis.* Synopsis of the alleged cost or benefit and the basis or logic of the supposed effect.
3) *Literature Synthesis.* Pertinent studies on the allegation are cited, either supporting or rebutting it. The presentation of the literature synthesis is accomplished using both text and a matrix. The matrix distinguishes:
   a) Whether or not the alleged factual condition exists under conditions of sprawl (or more generally whether development pattern affects the item in question).
   b) Whether or not the alleged factual condition—if it exists—has been significantly linked to sprawl (i.e., to development pattern).

For example, one allegation is that "sprawl generates more vehicle miles of travel than higher-density forms of development." The literature synthesis first notes whether there is, in fact, agreement among observers who comment on this subject. (There appears to be general agreement in this regard.)

The next observation addresses the question of whether there is agreement in the literature that the presence of greater vehicle miles of travel in low-density settlements is significantly related to sprawl. (There is, again, general agreement on the second count.) For simplification, these judgments are shown in the form of a matrix:

	+2 General Agreement	+1 Some Agreement	0 No Clear Outcome	–2 Substantial Disagreement
Does this condition notably exist?	X			
Is it strongly linked to sprawl?	X			

An "x" is placed in the matrix cell that contains the appropriate answer to the question on that line.

The above matrix is not a rigorous measuring instrument. It could have been produced in a variety of ways. Even as currently structured, there are areas of disagreement among reviewers on how to "slot" an item—i.e., whether there is "general agreement" or "some agreement" in the literature that the situation as described indeed exists. For that matter, there are also areas of disagreement on how convincing the literature is in linking identified development impacts to sprawl.

CHAPTER

3

Literature Synthesis

PUBLIC/PRIVATE CAPITAL AND OPERATING COSTS

Public capital and operating costs of sprawl refers to the construction of roads, water and sewer infrastructure, and public buildings, as well as the annual expenditures necessary to maintain them. These costs are incurred both in small enclaves in remote locations of the metropolitan areas where population is growing and in central cities from which some of the population growth is drawn. *Private* capital and operating costs of sprawl refers to the construction and occupancy costs of private housing and commercial and industrial space. Most of the literature discusses how metropolitan location and density/form of development cause these costs to vary.

Engineering-per capita analyses examine the costs of different types of development by applying such factors as cost per linear foot of roadway, expense per gallon of treated sewage, and police expenditures per resident or per employee.

Alternative growth analyses are broaderscale analyses that employ a series of land use, transportation, and infrastructure models to examine the effects of two differing growth scenarios on development costs. These models begin with per capita averages but extend them to capture the effects of variables that affect costs. For instance, water consumption is related not only to population growth but also to housing type, density, and the demographics of occupation of structures; housing costs are related to population growth and influences such as density, housing type, and location of development.

Regression analyses apply multivariate statistical tools to further refine linkages between growth and public-private capital and operating costs.

A final group of studies includes a number of *retrospective case studies.* These view the effects of the overlay of regulations inherent in managed growth on the costs of local housing. Each of these types of research techniques is found in the literature that is discussed below.

Sprawl's Alleged Negative Impacts

Higher Infrastructure Costs
Higher Public Operating Costs
More Expensive Private Residential and Nonresidential Development Costs
More Adverse Public Fiscal Impacts
Higher Aggregate Land Costs

Sprawl's Alleged Positive Impacts

Lower Public Operating Costs
Less Expensive Private Residential and Nonresidential Development Costs
Fosters Efficient Development of "Leapfrogged Areas"

SPRAWL'S ALLEGED NEGATIVE IMPACTS

Higher Infrastructure Costs

Allegation/Basis

Infrastructure of a wide scope—e.g., local and regional roads, water and sewer systems, and schools—is more expensive under sprawl than under compact development. This allegation alludes to infrastructure that is primarily public (i.e., state, county, or local government roads; public utility systems; and public schools) and occasionally private (i.e., privately owned utility systems and subdivision-level roads that are not dedicated to the public sector).

The effect of sprawl on the cost of infrastructure allegedly occurs for several reasons. At sprawl's lower development densities, various components of infrastructure that are linearly related (i.e., sidewalks, curbs, subdivision-level roadways, and water and sewer mains) serve a lesser increment of development than these components of infrastructure would serve at higher levels of density.

The segregation of land uses associated with sprawl further increases infrastructure costs. Segregation of land uses by residential and nonresidential types often means that parallel infrastructure systems have to be provided to individual residential and nonresidential locations. Further, sprawl's leapfrog development, which locates growth away from existing development, does not capitalize on pockets of surplus infrastructure capacity that may already be present in and around existing development. Finally, fragmented governance, a seemingly natural accompaniment to sprawl, often leads to duplicative city halls, police stations, courts, fire houses, schools, water/sewer treatment facilities, and so on.

Literature Synthesis

As shown earlier in Table 1, *The Costs of Sprawl* (RERC 1974) found that capital costs per unit were higher in the "lowdiversity sprawl" and "sprawl mix" neighborhood prototypes than they were in the "planned mix" or "high-density planned mix" prototypes. *The Costs of Sprawl* also found that capital expenses per unit were higher in detached housing (more pronounced under sprawl) than they were in attached housing (more pronounced under compact development). The first finding of *The Costs of Sprawl*, although criticized, has basically stood the test of time (Altshuler 1977); the second finding proved to be the undoing of the study (Windsor 1979).

Frank (1989) reanalyzed (using current cost numbers) several studies conducted between the 1950s and the 1980s that examined relationships between land use and infrastructure costs (including *The Costs of Sprawl).* Accounting for the limitations of *The Costs of Sprawl* study, he concluded that infrastructure costs were *highest* in situations of low density and for development located a considerable distance from centralized public services (conditions of sprawl). Infrastructure costs were *lowest* in situations of higher density and for development that was centrally and/or contiguously located (conditions of compact development). Duncan (1989) analyzed the infrastructure costs of multiple Florida residential and nonresidential developments with varying patterns of development. Costs were *higher* for those with *sprawl* characteristics than they were for those with compact development characteristics (see Table 8).

Infrastructure costs were highest in situations of low density and for development located a considerable distance from centralized public services.

The longest-run modeling of infrastructure costs under different development scenarios was performed by Burchell (1992-1997) in New Jersey and in other locations. The infrastructure models applied by Burchell relate development density and housing type to the demand for local/state roads and water/sewer infrastructure. The studies found that the *amount of land consumed* for development was *directly* related to lane-miles of road required for two-lane (local) and four-lane (state) roads. Thus, *density* of development was found to be *inversely* related to lane-miles of local and state roads and their attendant infrastructure costs. Housing type and, to a lesser extent, density were related to the amount of water and sewer services consumed (measured in gallons) by development. Almost all of the difference in residential water usage related to whether or not occupants of residential and nonresidential facilities watered their lawns. Lawn watering takes place primarily in single-family detached residences and high-value research and commercial headquarters uses. The difference in water usage among various commercial and industrial uses is also related to the service or product that is generated by the facility.

Larger and more significant than water/sewer usage are differences observed in water/sewer *infrastructure*, particularly as related to the number of feeder hookups from the trunk line that an individual land use requires. Higher density, the clustering of land uses, and attached housing and linked nonresidential uses all contribute to a reduced number of infrastructure feeder lines and reduced costs. A model sensitive to these differences, applied in New Jersey to alternative growth scenarios differentiated by sprawl-like versus more compact development patterns, showed the former's infrastructure costs to be considerably higher. The findings were basically similar in order of magnitude across most of the other locations analyzed by Burchell (Burchell and Listokin 1995a) (see earlier Tables 3 and 4). The findings were also comparable to those arrived at by Frank (1989) and Duncan (1989) in their studies (see Table 9).

Billions of dollars are spent annually on massive road infrastructure projects.
Source: U.S. Department of Housing and Urban Development.

TABLE 8

DUNCAN (1989)—FLORIDA GROWTH PATTERN STUDY: CAPITAL FACILITY COSTS UNDER SPRAWL VERSUS COMPACT DEVELOPMENT
(per dwelling unit; 1990 dollars)

Category of Capital Costs	Average of Case Studies under Sprawl Development[1]	Average of Case Studies under Compact Development[2]	Sprawl Versus Compact Development	
			Difference	*# / %*
Roads	$ 7,014	$ 2,784	(+) $4,230	60.3
Schools	6,079	5,625	(+) 454	7.4
Utilities	2,187	1,320	(+) 867	39.6
Other	661	672	(–) 11	1.7
TOTAL	$15,941	$10,401	(+) $5,540	36.7

Notes: 1. Sprawl development as defined here include the following patterns of "urban form" analyzed by the Florida study: "scattered," "linear," and "satellite." The capital cost figures shown in this table are averages of the Florida case studies characterized by the scattered, linear, and satellite patterns (i.e., Kendall Drive, Tampa Palms, University Boulevard, and Cantonment).

2. Compact development as defined here includes the following patterns of "urban form" analyzed by the Florida study: "contiguous" and "compact." The capital cost figures shown in this table are averages of the Florida case studies characterized by the contiguous and compact patterns (i.e., Countryside, Downtown Orlando, and Southpoint.)

Source: Memorandum from James Duncan and Associates to Robert W. Burchell and David Listokin, May 8, 1990; and James Duncan et al., *The Search for Efficient Urban Growth Patterns.* Report prepared for the Governor's Task Force on Urban Growth Patterns and the Florida Department of Community Affairs (Tallahassee, July 1989).

Other relevant research indicating higher infrastructure costs under conditions of sprawl includes Archer (1973) and Duensing (1977). Base data on infrastructure and its costs not related to development pattern, such as average capital outlays per single-family house or costs per linear foot of roadway, are provided by FACIR (1986), Fodor (1995), Nelson (1988), Nichols et al. (1991), and California OP&R (1982).

Carson, in a study on the costs of growth in Oregon, uses these prior studies to estimate the costs of growth in that state. Again, these costs were not related to specific development patterns (Carson 1998).

The above body of research which reflects, in part, an approach dating back to *The Costs of Sprawl*, has been criticized on several counts by Altshuler (1977) and Altshuler and Gomez-Ibanez (1993) for the following reasons:

1) The higher infrastructure costs found in instances of lower versus higher density (i.e., sprawl versus compact development) are not meaningful because the housing units and their attendant scale found under the different development alternatives (i.e., more detached housing under sprawl and more attached housing under compact development) are not comparable.

2) The higher infrastructure costs attributed to sprawl due to its leapfrog patterns will essentially be neutralized as areas that were initially passed over are ultimately developed. The next wave of growth will capitalize on the infrastructure in place. Thus, the higher initial costs will be recouped. "The cost of sprawl is the cost of supplying some infrastructure in advance of its eventual need and will ultimately be lower the more rapidly that infill takes place" (Altshuler and Gomez-Ibanez 1993, 72-73).
3) The higher infrastructure costs (under sprawl) attributed to the distance of development from central facilities does not consider potential economies of scale that could be realized in regionalized, oversized trunk lines or similarly located water/sewer treatment plants (Altshuler and Gomez-Ibanez 1993, 73). In other words, the added "costs of distance" because feeder lines are longer under sprawl are not significant if the feeder lines are attached to regionally located (and oversized) trunk lines and water/sewer plants.

Holding aside the above criticisms, at least one researcher, Richard Peiser, found the cost difference in infrastructure between sprawl and compact development patterns to be quite slight.

Peiser (1984) examined infrastructure costs for new residential development in two Texas "prototype" communities—one planned, the other unplanned. The planned and unplanned developments were located on 7,500-acre sites in Houston. The planned community was designed to accommodate a population of about 80,000 residents in 26,500 dwelling units and a workforce of 72,000 in 24 million square feet of office and industrial space. The development was largely self-contained and near existing development in the form of a large center. The unplanned development was located in a primary growth corridor at the urban fringe, typical of Houston's sprawl pattern (100- to 500-acre subdivisions, strip malls, and shopping centers). The Houston development was designed to accommodate about the same number of residents (80,000) and workers (72,000) as the planned development. In Peiser's model, the difference in capital expenses for the planned and unplanned scenarios was about 5 percent in favor of the planned development. The finding in the Peiser study that contradicts other findings in the field was the inclusion in overall planned development infrastructure savings of higher road costs associated with planned as opposed to unplanned development (Table 10).

TABLE 9
RELATIVE INFRASTRUCTURE COSTS OF SPRAWL VERSUS COMPACT DEVELOPMENT FROM THREE MAJOR STUDIES

		Compact Development Costs as Percent of Sprawl Development Costs: Findings from Three Major Studies			
Infrastructure Cost Category	Sprawl Development	Duncan Study (1989)	Frank Study (1989)	Burchell Studies (1992-1997)	Compact Development Costs: Synthesis from Three Major Studies (in percent, relative to sprawl)
Roads (local)	100%	40%	73%	74-88%	≈75%
Schools	100%	93%	99%	97%	≈95%
Utilities	100%	60%	66%	86-93%	≈80%

TABLE 10
Infrastructure Costs for Planned and Unplanned Development
The Peiser Model

Infrastructure Costs Component	Planned Development (for 80,000 residents) ($ in millions)	Unplanned Development (for 80,000 residents) ($ in millions)
Roads	$10.0	$8.0
Sewer	4.3	4.7
Water	9.2	11.8
Drainage	16.3	17.4
TOTAL	$39.8	$41.9

Source: Richard B. Peiser 1984

In sum, although there is general agreement that development density is linked to infrastructure costs, there is less agreement about the interrelationship between sprawl (as a less carefully defined development form) and infrastructure costs.

Literature Synthesis Matrix

	+2 General Agreement	+1 Some Agreement	0 No Clear Outcome	−2 Substantial Disagreement
Does this condition notably exist?	X			
Is it strongly linked to sprawl?		X		

Higher Public Operating Costs

Allegation/Basis

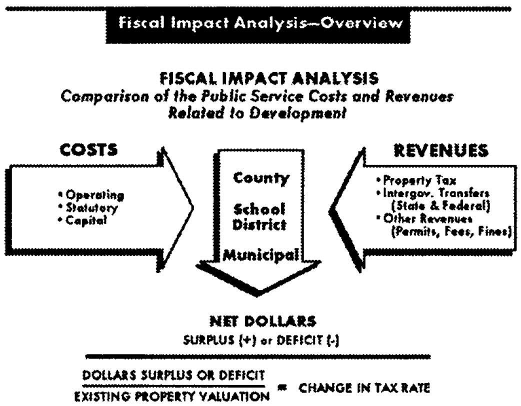
Sprawl generates greater local/school district operating costs than higher density forms of development. This allegation relates to splintered public local and educational agencies that provide duplicative administrative and operating services.

Literature Synthesis

Operating costs are those costs that accrue on a day-to-day basis and form the annual expenses of local government. These costs include public workers' salaries and benefits; normal expenditures for supplies, repairs, and replacement items; and debt service for capital facilities purchased or contracted for at the local government level (municipal and county). The literature is rich with descriptions of variations in local (county and municipal) costs as a function of jurisdiction size, wealth, growth rate, and density of development.

Generally speaking, per capita *local* costs are "U" shaped as a function of population size—i.e., they are expensive for jurisdictions with populations under 2,500 and over 50,000, with points of most efficiency in those locations where the population is between 10,000 and 25,000. School district per pupil costs increase with school district size. Districts with more than 3,000 pupils spend 20 to 30 percent more per pupil than districts of fewer than 1,000 pupils; districts of 1,000-3,000 pupils spend 10 percent more than districts of fewer than 1,000 pupils (Sternlieb and Burchell 1977; Burchell and Listokin 1996).

Both local (municipal and county) public service costs per capita and school district public service costs per pupil also vary directly with the wealth of the jurisdiction. The citizens of wealthier jurisdictions demand greater qualities and quantities of local and educational public services and are willing to pay for them (Burchell and Listokin 1996).



Fiscal impact analysis compares the public costs versus public revenues generated by growth.
Source: National Association of Home Builders.

Per capita local and school district costs also have been found to vary directly with density, and inversely with the growth rate of the jurisdiction. Generally speaking, the higher the density, the higher the per capita and per pupil costs; the faster the growth rate, the lower the per capita and per pupil costs (Ladd 1992). Two caveats are noteworthy, however. First, comparisons almost always are made between suburban- and urban-level densities and rarely between densities that reflect more- versus less-intense suburban development. Second, none of the analyses performed to date standardize the quality or quantity of public services delivered (Altshuler and Gomez-Ibanez 1993).

Thus, buried in the above findings is the fact that public services that are delivered in very large and dense local (municipal and county) jurisdictions are more complex and more individualized than those delivered in smaller, more sparsely populated jurisdictions. Foot patrol or two-person automobile police patrol takes the place of one-person automobile police patrol; full-time paid fire department employees take the place of volunteers; and significant numbers of special education teachers must be hired instead of contracting out special education services. All these examples point to the service differences that complicate comparison of costs in more intensely populated versus less intensely populated jurisdictions.

Local government costs nationally average about $700 per capita; school district costs average about $7,000 per pupil (*Census of Governments* 1997). Of the former, about 60 percent goes toward salaries and benefits, 35 percent toward other expenses, and 5 percent toward capital purposes. Of the latter, 70 percent goes toward salary and benefits, 20 percent toward other expenses, and 10 percent toward capital purposes.

Compact or managed growth, the opposite of sprawl development, may encourage more regionalism in school systems and more sharing of non-police, local public resources. It also reduces the amount of local roads and water/sewer utility lines and hookups that are *constructed* and paid for by local debt service and *maintained* and paid for out of annual operating budgets.

Burchell, in his analysis of the growth alternatives in the *Impact Assessment of the New Jersey State Development and Redevelopment Plan,* found that combined municipal and school district operational costs could be reduced by 2 percent annually under planned (compact) growth as opposed to trend (sprawl) growth (Burchell 1992a). Although the percentage seems small, the savings occur annually; they are not a one-time windfall, and the savings could potentially be applied nationally to local budgets that sum to $175 billion per year, and to school district budgets that sum nationally to $500 billion annually.

Service differences complicate the comparison of costs in more intensely populated versus less intensely populated jurisdictions.

In similar type studies in the Delaware Estuary, and in the state of Michigan, municipal costs were found to be 5-6 percent less annually under compact growth scenarios than they were under sprawl development.

Basically equivalent findings were arrived at earlier by James Duncan in Florida (Duncan 1989). Conflicting findings have been suggested, but not empirically tested, by Altshuler and Gomez-Ibanez (1993) and Gordon and Richardson (1997a). Altshuler and Gomez-Ibanez indicate that the inability to control for the quality and quantity of services under comparison renders most of these studies at best "time and location bound" by who is providing the services, the types of public services, and when they are provided. At worst, most of the studies cannot be used to draw appropriate conclusions, given their inability to differentiate between levels of service provided (Altshuler and Gomez-Ibanez 1993).

Gordon and Richardson indicate that Burchell's prospective alternative development scenarios allow no flexibility for the trend (sprawl) scenario to improve over time and no flexibility for the plan (compact growth) scenario to be worse than envisioned due to the lack of full compliance with this alternative (Gordon and Richardson 1997a).

Literature Synthesis Matrix

	+2 General Agreement	+1 Some Agreement	0 No Clear Outcome	–2 Substantial Disagreement
Does this condition notably exist?		X		
Is it strongly linked to sprawl?			X	

More Expensive Private Residential and Nonresidential Development Costs

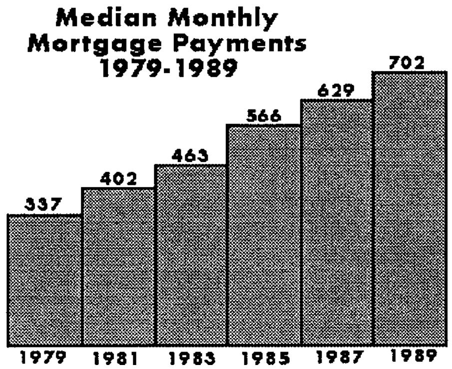
Allegation/Basis

Sprawl causes residential and nonresidential building and occupancy costs to rise due to the larger lot and structure sizes in locations where land is less expensive.

Literature Synthesis

Development costs include land and improvement costs, and are impacted by the scale of each. Spacious single-family dwellings on large lots are usually the most expensive types of housing; similarly, spread-out, low-rise non-residential development on large parcels of land are the most expensive type of commercial and/or industrial development. Both are low-density examples of their respective development forms.

To the degree that density increases in residential development and floor-area-ratios increase in nonresidential development, holding all other structure/environmental amenities constant, residential and nonresidential development costs should decrease. Similarly, to the degree that structures are smaller, holding all other structure/environmental amenities constant, residential and nonresidential development costs will also be less.



Housing costs have been rising consistently during the past decade.
Source: U.S. Bureau of the Census.

Other factors that affect the costs of residential and nonresidential development include: 1) the amount of zoned land available for development, as determined by the local zoning ordinance; and 2) the time it takes development to engage and clear the permitting process (which is also largely determined by local land-use regulations). If land is limited or inappropriately zoned, residential and nonresidential development costs will rise. If government regulations are excessive, permitting time will increase, and the costs of development will also rise.

In the *Impact Assessment of the New Jersey State Development and Redevelopment Plan*, Burchell (1992a) found that if new development is contained around existing development and is also increased somewhat in terms of density and floor-area ratio, even with significant decreases in density to preserve lands at the periphery, overall residential and nonresidential development costs will be approximately 10 percent less per unit or per 1,000 square feet. Somewhat lesser savings (6-8%) emerged from studies conducted in Lexington, Kentucky (Burchell and Listokin 1994b), the Delaware Estuary (Burchell and Moskowitz 1995), and the state of Michigan (Burchell 1997a).

Other studies of residential development have produced essentially parallel findings on the effects of increased lot and structure size on housing costs. Downs (1973), Schafer (1975), Seidel (1978), and others have found that large-lot zoning and minimum building size increase the costs of new housing. This same type of analysis applied to nonresidential development—although not often looked at by researchers in the field—has produced similar findings (Burchell 1992-1997).

Some researchers have found that large-lot single-family zoning and minimum building sizes are associated with sprawl development. Smaller lot sizes (zero lot line) and different types and intensities of development (single-family attached and multifamily) are associated with compact development (Avin 1993; CH2M Hill 1993). Linking the above two sets of findings, the savings noted by housing type should then extend to these two polar development forms.

Large-lot single-family zoning and minimum building sizes are associated with sprawl development.

One cannot assume, however, that housing preference changes will accompany development pattern shifts. In other words, if compact development is opted for, and denser forms of housing comprise this type of development, it cannot be assumed that market preferences will correspondingly shift and families previously occupying less dense types of housing under sprawl will opt for the more intense development forms under compact development. Further, if there is a crossover between housing types, one must carry the occupancy profile of the former to the new type of housing unit. Otherwise, false conclusions could be drawn with regard to development cost savings associated with the often smaller and less intensely occupied housing of compact development, and with the annual fiscal impact savings resulting from this development form. A critical error was discovered by Windsor in his review of *The Costs of Sprawl* (Windsor 1979). According to Windsor, *The Costs of Sprawl* study failed to account for the fact that the characteristics of new townhouse occupants who switched from detached single-family occupancy (if they could be assumed to do so) would be closer to the characteristics of occupants of the units that they had left than to the characteristics of the occupants of units similar to their new housing. This lack of realization led to the erroneous conclusion that compact development (containing a larger percentage of townhouses) was less expensive to service than sprawl development (containing a larger percentage of single-family homes), when the same households that occupied the former would likely be the ones moving to the latter.

Literature Synthesis Matrix

	+2 General Agreement	+1 Some Agreement	0 No Clear Outcome	–2 Substantial Disagreement
Does this condition notably exist?		X		
Is it strongly linked to sprawl?			X	

More Adverse Public Fiscal Impacts

Allegation/Basis

Sprawl generates more adverse fiscal impacts than compact development because public operating costs are significantly higher and residential uses and attendant revenues do not compensate for these costs. Further, fragmented governments compete for land uses according to these land uses' fiscal superiority. Most "good" (from a local fiscal impact perspective) economic uses have been withdrawn from central cities and transplanted to suburban jurisdictions. Since there are not enough "good" land uses to go around, only the wealthiest jurisdictions truly benefit fiscally from these land uses.

Literature Synthesis

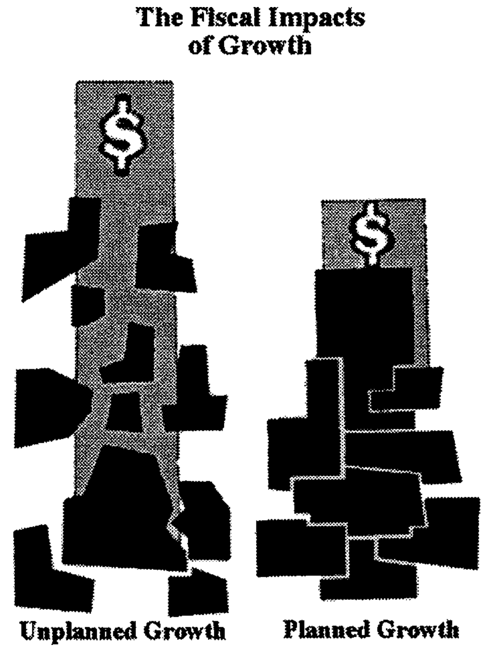
In analyzing the impacts of land uses, the notion that some types of land uses are better fiscally than others has become widely accepted. Nonresidential land uses, for the most part, have been shown to be more profitable than residential uses, and most standard forms of residential land uses less profitable (see Table 11). Further, within the nonresidential and residential sectors, varying degrees of advantage and disadvantage exist. Some land uses produce more revenues than costs; if service levels are maintained at the same level after development, taxes could be decreased. The reverse is also true. In some cases, costs exceed revenues and, all things being equal, taxes might have to be increased (Burchell and Listokin 1994a).

Position on the fiscal impact hierarchy depends on the type of unit (the size or intensity of use) within both residential and nonresidential classifications. Fiscal position also depends on the service district in which impact is being viewed. Often, for instance, a small condominium or age-restricted housing unit may be break-even or have a slightly positive or negative impact on the municipal service jurisdiction, yet both may be very positive fiscal ratables in the school district. On the other hand, larger townhouses may be just below break-even in the school district yet significantly negative in the municipal jurisdiction.

Fiscal impacts and observed differences under sprawl versus compact growth are dependent upon two different influences from development patterns. The first is the ability of the development pattern to influence *type* of development. To the degree that dwelling type can be changed by compact development in sub-state settings, the demographics and, consequently, the public service costs of development will change. The second is the ability of the development pattern to influence the intensity of development and geographic spread of new neighborhoods. If compact development can provide tighter development patterns, infrastructure provision will be less. So too will the annual debt service on capital costs for roads, water/sewer lines, and so on, as well as the annual costs of maintenance associated with these new facilities. The location where development takes place is also an important factor. If located near existing development, excess service capacity may be drawn upon. If development is skipped over, public service infrastructure will almost always have to be provided at costs greater than if existing facilities were extended.

If development is located near existing development, excess service capacity may be drawn upon.

Burchell's *Impact Assessment of the New Jersey State Development and Redevelopment Plan* (Burchell 1992a) employed a fiscal model to view the effects of trend versus planned development. The Rutgers fiscal impact model estimated the number of people, employees, and students that were generated under each of the development scenarios and projected their future costs and revenues to host public service jurisdictions. Although at the regional and state levels population and employment projections did not vary between alternatives, at the municipal level the



Unplanned growth is believed to result in greater costs to municipalities.
Source: Michigan Department of Natural Resources.

differences were significant. In the compact development case, urban communities with slack service capacity received more growth than rural areas with lesser amounts of public service infrastructure. The reduced infrastructure provision and potentially reduced annual maintenance on this infrastructure led to diminished fiscal impacts for this alternative.

Burchell's study in New Jersey found that by containing population and jobs in already developed areas and by creating or expanding centers in newly developing areas, the State Plan offers an annual $112 million [or 2 percent] fiscal advantage to municipalities. This advantage reflects the ability under plan to draw on usable excess operating capacity in already developed areas as well as efficiencies of service delivery. For instance, fewer lane-miles of local roads

TABLE 11

THE HIERARCHY OF LAND USES AND FISCAL IMPACTS

(+) **MUNICIPAL BREAK-EVEN**	RESEARCH OFFICE PARKS OFFICE PARKS INDUSTRIAL DEVELOPMENT HIGH-RISE/GARDEN APARTMENTS *(STUDIO/1 BEDROOM)* AGE-RESTRICTED HOUSING GARDEN CONDOMINIUMS *(1-2 BEDROOMS)* OPEN SPACE	
	RETAIL FACILITIES TOWNHOUSES *(2-3 BEDROOMS)* EXPENSIVE SINGLE-FAMILY HOMES *(3-4 BEDROOMS)*	(+) **SCHOOL DISTRICT BREAK-EVEN**
	TOWNHOUSES *(3-4 BEDROOMS)* INEXPENSIVE SINGLE-FAMILY HOMES *(3-4 BEDROOMS)* GARDEN APARTMENTS *(3+ BEDROOMS)* MOBILE HOMES *(UNRESTRICTED AS TO OCCUPANCY LOCALLY)*	(–)

Note: The above list contains too many disclaimers to include here. Suffice it to say that specific fiscal impacts of a land use must always be viewed in the context of other land uses' impacts and within the fiscal parameters of the jurisdiction in which the land use is being developed.

Source: Burchell, Robert W., "Fiscal Impact Analysis: State of the Art and State of the Practice."

will have to be built under plan, thus saving municipal public works maintenance and debt service costs.

Public school districts will realize a $286 million [or 2 percent] annual financial advantage under the State Plan, again a reflection of drawing on usable excess public school operating capacity and other service and fiscal efficiencies realized due to the redirection of population under the plan alternative. Thus, municipal and school district providers of public services could be ahead fiscally by close to $400 million annually under plan compared to trend, while meeting similar population demands for public services.

Under trend, the state's school districts will have to provide 288,000 net pupil spaces to the year 2010 (365,000 gross need less 77,000 usable excess spaces); for plan, the net need is lower at 278,000 pupil spaces based on excess space available in central cities. Overall, if new space had to be built to accommodate net new students, costs of new school facilities would be approximately $5.3 billion under trend and $5.1 billion under plan. Thus, $200 million (or approximately 3 percent) is potentially saved due to more excess capacity in closer-in areas being drawn upon by plan as opposed to lesser amounts of excess capacity available to trend in suburban and rural areas (Burchell 1992a).

Literature Synthesis Matrix

	+2 General Agreement	+1 Some Agreement	0 No Clear Outcome	–2 Substantial Disagreement
Does this condition notably exist?		X		
Is it strongly linked to sprawl?		X		

Higher Aggregate Land Costs

Allegation/Basis

Total land costs of urban settlements are higher under sprawl. This occurs even though the average price of land per acre may be lower, because a given total population occupies more suburban land than under higher density urban forms of growth.

Literature Synthesis

Most of the modeling efforts to date that involve prospective development futures have found that alternatives to "status quo" development patterns (i.e., sprawl), consume less overall land than the sprawl development pattern does. In New Jersey, Lexington (Kentucky), the Delaware Estuary, and Michigan, alternatives to sprawl consumed 20-40 percent less overall land (Burchell 1992-1997). In the San Francisco Bay area, alternatives to sprawl consumed 10-25 percent less overall land than did sprawl (Landis 1995). Thus, land consumed under sprawl has almost always been shown to be more than land consumed under compact growth patterns.

Further, in the Burchell (1992-1997) studies, because densities were increased to design levels under compact growth, housing costs decreased as a result of the reduction in land costs associated with this alternative. In other words, in situations where there were no growth restrictions, housing costs were higher under sprawl because land costs were higher. In the above four Burchell study locations, for example, housing costs

Land consumed under sprawl has almost always been shown to be more than land consumed under compact growth patterns.

under sprawl development were more due to the land component of these costs. This was true because under compact development, the majority of development taking place closer-in was subject to density increases of 10 to 30 percent. Total land costs of urban settlements have been found to be generally higher under the sprawl alternative.

(See also Land/Natural Habitat Preservation—Negative Impacts).

Literature Synthesis Matrix

	+2 General Agreement	+1 Some Agreement	0 No Clear Outcome	−2 Substantial Disagreement
Does this condition notably exist?		X		
Is it strongly linked to sprawl?		X		

SPRAWL'S ALLEGED POSITIVE IMPACTS

Lower Public Operating Costs

Allegation/Basis

Local and school district operating costs are lower under sprawl development because service demands and the costs of meeting these demands increase with higher densities (compact development).

Literature Synthesis

Gordon and Richardson express this argument, citing the research of Ladd:

> Ladd (1992) argued that except within a range of very low densities, per capita public service costs for traffic management, waste collection and disposal, and crime control, increase with higher densities. (Gordon and Richardson 1997a, 99)

Again, this is the type of research that has not standardized for the quality and quantity of public services delivered in jurisdictions of varying densities. Nonetheless, the above research indicates that without taking into account what services are delivered or who delivers them in a service district—operating costs, whatever they are comprised of, appear to be less in jurisdictions of low density than in jurisdictions of high density.

Operating costs appear to be less in jurisdictions of low density than in jurisdictions of high density.

However, comparisons of operating costs are usually made between locations of rural-suburban (1 to 3 units per acre) density and those of urban density (16 to 30 or more units per acre). These studies may well be measuring the differences in range and complexity of public services delivered in densely populated urban areas versus rural-suburban areas, where the public services delivered are very limited and much simpler.

Literature Synthesis Matrix

	+2 General Agreement	+1 Some Agreement	0 No Clear Outcome	−2 Substantial Disagreement
Does this condition notably exist?		X		
Is it strongly linked to sprawl?			X	

Less Expensive Private Residential and Nonresidential Development Costs

Allegation/Basis

Sprawl has lower housing costs because it does not limit the amount of development. Many managed approaches to growth seek also to control growth. Various forms of growth control limit housing production and drive up the costs of housing.

Literature Synthesis

Does the overlay of regulations inherent in managed growth drive up the cost of housing? A number of studies reveal that in the immediate area where growth restrictions exist, housing prices increase (Fischel 1990). Schwartz, Hansen, and Green (1981) followed the effects over time of the Petaluma (California) Plan which severely limited building permits, favoring dwellings with costly design features and developer-provided amenities and services to the community. Using a statistical (i.e., hedonic) pricing technique, the authors compared the price of a standard bundle of housing characteristics to the corresponding price in nearby Santa Rosa, which had not adopted growth controls during the period. The authors found that after several years, Petaluma's housing prices had risen 8 percent above those of Santa Rosa.

Schwartz, Zorn, and Hansen (1989) did a similar study of the growth controls in Davis, California, comparing house prices in Davis to those in a sample of other Sacramento suburbs. They found that growth controls caused house prices in Davis to be nine percent higher in 1980 than they would have been without them.

In Petaluma (Schwartz, Hansen, and Green 1981) and in Davis (Schwartz, Zorn, and Hansen 1989), the effects on the housing stock affordable to low- and moderate-income households relative to control areas were also monitored. In Petaluma, the authors found that the percentage of the housing stock that was affordable to low- and moderate-income households dropped significantly below that of a control group (Fischel 1990).

In Davis, on the other hand, growth controls required those who received building permits to construct some units earmarked for low-income occupants. Thus, the limited growth that did occur in Davis contained both low-income and high-income housing. According to Fischel (1990), however, an unanticipated offset to this apparent success occurred: the existing housing in Davis increased not only in price but in quality. Fischel's interpretation of this outcome was that older housing was filtering up rather than down.

Katz and Rosen (1987) analyzed 1,600 sales transactions of single-family houses during 1979 in 64 communities in the San Francisco Bay Area. Of these transactions, 179 involved houses located in communities where a building permit moratorium or binding rationing system had been recently, or was currently, in effect. According to Fischel (1990), this study is particularly valuable since, unlike the other California studies, it did not focus on just a single community. The authors found that the price of houses sold in the growth-controlled communities was *higher* than the price of houses sold in other communities. Where growth is *controlled* as opposed to *managed*, housing costs are higher.

Literature Synthesis Matrix

	+2 General Agreement	+1 Some Agreement	0 No Clear Outcome	–2 Substantial Disagreement
Does this condition notably exist?		X		
Is it strongly linked to sprawl?		X		

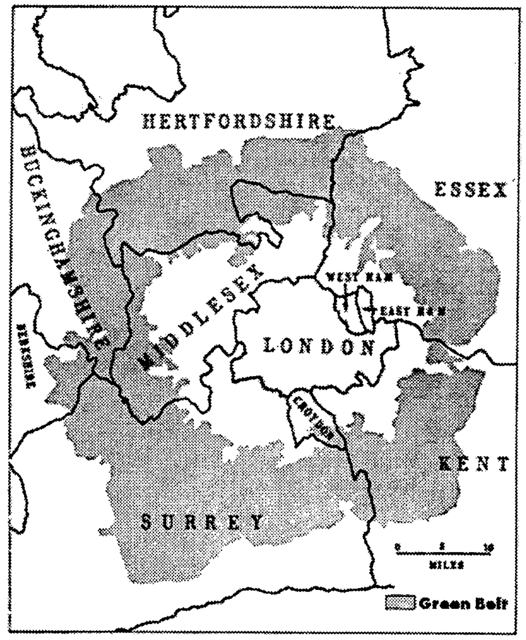
Fosters Efficient Development of "Leapfrogged" Areas

Allegation/Basis

Sprawl fosters efficient infill development. Sprawl permits appropriate, relatively high-density development of still vacant close-in sites late in the development period of a metropolitan area, without having either to demolish existing improvements on those sites at great cost, or to expend public funds buying such sites in advance and reserving them for later development. The "leapfrogging" aspect of sprawl leaves sizable tracts of land vacant and undeveloped. Parcels remain vacant long after the wave of current growth has passed them by. These parcels can be developed later as "infill" sites at relatively high densities, which are more appropriate to their more central locations. This process of deferred development is more efficient than first developing all peripheral land at low densities, and then tearing down the existing structures when the development market, reflecting the preferences of structure occupants, shifts to higher densities.

Literature Synthesis

This allegation is considered by Peiser (1984) and is also discussed by Altshuler and Gomez-Ibanez (1993). But it is often a highly neglected component of the analysis of infrastructure costs related to sprawl. Just as there are those who call for full costing methods to expand and account for the costs of sprawl to the private sector and to society as a whole, there are also those who believe that the secondary benefits of sprawl (i.e., its lagged infill economies) must be adequately tabulated in any accounting scheme related to development alternatives.



Greenbelts provide open space for recreational uses and for future infill development.
Source: Cartographic Laboratory of the University of Wisconsin.

In an accounting system, the land areas that are skipped over and initially not used become relatively inexpensive to access and service secondarily. Further, the potential for using these skipped-over lands as inner-ring open space also becomes apparent. Only Altshuler and Gomez-Ibanez (1993) have begun to address these issues.

Literature Synthesis Matrix

	+2 General Agreement	+1 Some Agreement	0 No Clear Outcome	–2 Substantial Disagreement
Does this condition notably exist?			X	
Is it strongly linked to sprawl?			X	

CHAPTER

4

Literature Synthesis

TRANSPORTATION AND TRAVEL COSTS

Transportation is a discipline unto itself with a vast number of monographs, journals, and other publications devoted to it. The body of literature considered here includes key transportation studies relevant to the current investigation of the costs and benefits of sprawl. Many of these studies are not about sprawl per se but contain information on changes in travel over time, which are then associated with coterminous development (e.g., decentralized suburbanization) or characteristics linked to coterminous development (e.g., low density and segregation of land uses), which in turn are related to travel criteria. Costs of travel are considered as well.

The changes in travel studies report on such characteristics as the number of total trips, the number of trips by type (e.g., work versus nonwork), and commutation distances and time.

In addition to the study and deciphering of gross travel statistics, the transportation literature looks at characteristics that both define development type and affect travel behavior. Here again, the characteristic most studied is density, particularly how density affects trip length, mode choice, and other transportation decisions.

To a much lesser extent, land-use characteristics other than density are examined with respect to their travel influences. Some studies consider the effect of leapfrog development on commuting times; other studies view the effect of integration of land uses on walking for internal trips and enhanced transit use for external trips.

A final component of the transportation literature establishes baseline figures on the costs of travel. Numerous site-specific investigations concentrate on user, governmental, and societal costs of travel and how they vary by travel mode (e.g., auto, transit, walking); type of trip (e.g., work versus shopping); time (off-peak versus at-peak hours); the physical environment (higher- versus lower-density); and other factors (e.g., single-occupancy vehicle [SOV] versus high-occupancy vehicle [HOV] trips).

Sprawl's Alleged Negative Impacts

More Vehicle Miles Traveled (VMT)
Longer Travel Times
More Automobile Trips
Higher Household Transportation Spending
Less Cost-Efficient and Effective Transit
Higher Social Costs of Travel

Sprawl's Alleged Positive Impacts

Shorter Commuting Times
Less Congestion
Lower Governmental Costs for Transportation
Automobiles Most Efficient Mode of Transportation

SPRAWL'S ALLEGED NEGATIVE IMPACTS

More Vehicle Miles Traveled (VMT)

Allegation/Basis

Sprawl generates more total miles of vehicle travel than more compact forms of development. Sprawl generates more travel because the places where people live, work, shop, and play are spread over a larger total area. Vehicle miles of travel also increase because sprawl developments are designed so that virtually the only way to make most trips is by automobile.

Literature Synthesis

There is no question that vehicle miles of travel are increasing. Vincent et al. (1994) found that on an annual basis, person miles of travel increased by 19 percent between 1983 and 1990, and vehicle miles of travel (VMT) increased at the even faster rate of 37 percent. Ray et al. (1994) found that the number and length of vehicle trips were increasing at an accelerating rate between 1977 and 1990.

Sprawl, which creates the longer travel distances and increases dependence on the automobile, is a major source of increased vehicle use.

The question is what proportion of the growth in VMT is due to sprawl versus other factors, such as a higher rate of women participating in the workforce, the baby boom generation being at the peak driving years, or rising incomes that allow every licensed driver in a household to own a car. Three factors have contributed about equally to the growth in VMT—changing demographics, growing dependence on the automobile, and longer travel distances (Dunphy et al. 1997). Thus, sprawl, which creates the longer travel distances and increases dependence on the automobile, is a major source of increased vehicle use.

Numerous studies have linked lower vehicle miles of travel with more compact mixed-use developments. In a 1990 analysis of the San Francisco Bay area and a 1994 study of 28 California communities, Holtzclaw found that residents of the denser neighborhoods drove fewer miles per year. In a second study, where Holtzclaw (1994) controlled for the levels of transit service and vehicle ownership, a doubling of residential densities was associated with 16 percent fewer vehicle miles of travel. Other research by Harvey (1990), 1000 Friends of Oregon (1996), and the Urban Land Institute (Dunphy et al. 1997) confirm that as densities increase, per capita vehicle miles of travel decline.

The interspersing of residents, employment, shopping, and other functions can also reduce VMT, by allowing shorter trips and the use of non-vehicle modes. An empirical analysis by Frank and Pivo (1994) in the Puget Sound region and a simulation of the Trenton region undertaken in central New Jersey by the Middlesex, Somerset, Mercer Regional Council (1990) show that greater land-use mixes (with a higher jobs-housing balance) decrease trip distances and automobile mode shares.

Commute Profile

	1983	1990	1995	'83 - '95 % Change
Average Work Trip Length (Miles)	8.5	10.6	11.6	36.5
Average Work Travel Time (Minutes)	18.2	19.7	20.7	13.7
Average Work Trip Speed (MPH)	28	32.3	33.6	20

The daily commute length increased 36.5 percent from 1983 to 1995; the trend is continuing.
Source: Federal Highway Administration.

The segregation of uses and a leapfrog development pattern were both linked to increased travel in a recent Cervero (Cervero and Wu 1996) study of dispersed subcenters in the San Francisco Bay area. Between 1980 and 1990, the workers at these subcenters experienced a 23 percent increase in average commuting VMT. Cervero attributes 80 percent of the increase to longer distances between home and work.

Simulations of alternate growth patterns have also shown that sprawl development produces more VMT than more compact development. A simulation by Metro (1994) of growth in the Portland, Oregon metropolitan area compared a "Growing Out" scenario with new development continuing at current types and densities with a "Growing Up" scenario that kept all growth within the existing urban growth boundary by reducing lot sizes and introducing more multifamily housing. Average daily VMT was estimated to be 15 percent higher in the "Growing Out" scenario than in "Growing Up."

Gordon and Richardson (1997a), however, do not agree that VMT would be reduced by more compact development. They contend that market forces embodied in sprawl may ultimately result in *less* VMT as households and businesses locate near one another. They further argue, based on Crane's (1996) theoretical analysis of travel on the grid street networks of neo-traditional development, that this neo-traditional, or compact, type of development may produce more VMT due to the ease of automobile travel. But Ewing (1997) points out that the demand for activities is relatively inelastic and residents of more compact, neo-traditional developments are unlikely to drive more simply because of better street design. A preponderance of evidence contradicts Gordon and Richardson's claim that sprawl is not a factor contributing to increased VMT.

Market forces embodied in sprawl may ultimately result in less VMT as households and businesses locate near one another.

Literature Synthesis Matrix

	+2 General Agreement	+1 Some Agreement	0 No Clear Outcome	–2 Substantial Disagreement
Does this condition notably exist?	X			
Is it strongly linked to sprawl?	X			

Longer Travel Times

Allegation/Basis

Sprawl requires that more time be spent traveling than do more compact forms of development. The greater dispersion of activities in sprawl makes it necessary to spend more time traveling between activities than in more compact, mixed-use areas where trips are shorter and can serve multiple purposes. Workers in mixed-use settings can eat lunch or run errands at noon without using significant amounts of time for travel. Residents of compact neighborhoods can meet many of their needs at community shopping centers.

Literature Synthesis

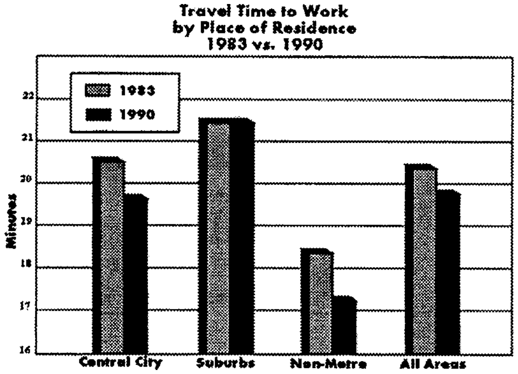
The evidence is mixed on the effects of sprawl on total travel times. Ewing (1995c) has shown that total travel time varies with regional accessibility. His Florida study found that residents of areas with high levels of access to a mix of uses including jobs, schools, shopping, and other services spent up to 40 minutes less per day in vehicular travel than residents in less accessible neighborhoods. Time was saved by linking trips into tours and by making shorter trips. Dunphy et al. (1997), on the other hand, also report that according to surveys, people are willing to accept longer travel times to work and shopping in order to have the quality of housing they desire. Thus, the segregation of land uses and less expensive land at the periphery—two characteristics of sprawl—can increase travel times, whereas mixed-use developments, wherever they are located, appear to decrease travel times.

Others contend that travel times do not increase with sprawl because more trips are made by the automobile, the fastest mode of travel, and people and activities adjust over time to keep travel times relatively constant (Gordon and Richardson 1997a). A study by the European Conference of Ministers of Transport (1994) found that people in four cities with very different urban structures (Wismar, West Germany; Delft, The Netherlands; Zurich, Switzerland; and Perth, Australia) made about the same number of trips and spent about the same amount of time traveling even though modal shares differed significantly. The average time spent traveling ranged only from 62 to 69 minutes.

Purvis (1994) reported that travel time budgets remained fairly constant in the San Francisco Bay Area between 1960 and 1990. In the latest survey, the number of trips per person declined, but travel times remained constant because of the longer duration of trips. Purvis says the results are comparable to those in other metropolitan areas and consistent with the travel time budget studies of the 1970s and 1980s.

Residents of areas with high levels of access to a mix of uses including jobs, schools, shopping, and other services spent 40 minutes less per day in vehicular travel than residents of the least accessible neighborhoods.

Overall, the evidence is not clear about the relationship between sprawl and households' total travel times. On the one hand, some metropolitan-wide data suggest that people have fairly constant travel time budgets. On the other hand, a finer level of analysis indicates that the outward expansion of urban areas and the segregation of uses has boosted the amount of time some households spend traveling to their daily activities.



Suburban residents spend more time commuting to work than central city residents.
Source: Federal Highway Administration.

(See also Positive Impacts—Shorter Commuting Times, for a discussion of the mixed evidence on work trip duration under sprawl.)

Literature Synthesis Matrix

	+2 *General Agreement*	+1 *Some Agreement*	0 *No Clear Outcome*	–2 *Substantial Disagreement*
Does this condition notably exist?			X	
Is it strongly linked to sprawl?			X	

More Automobile Trips

Allegation/Basis

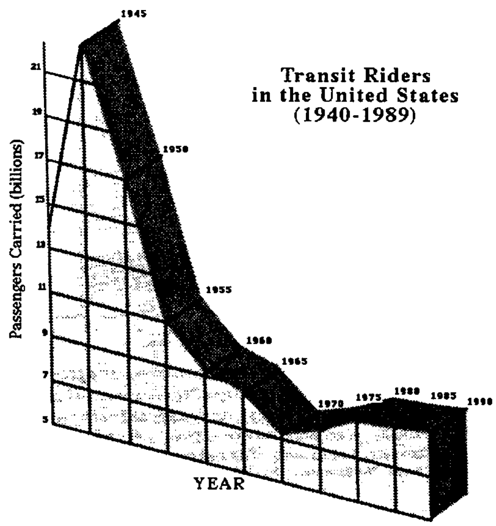
A greater share of trips are made by car and a lesser share by transit, walking, and bicycling in sprawled development than in more compact development. This assertion is almost true by definition since one of the defining characteristics of sprawl is that motor vehicles are the dominant mode of transportation. Sprawl, with its low densities and spatial segregation of uses, requires that virtually all trips be made by automobile, whereas residents of areas with higher densities and a greater mix of uses have the option of riding transit, biking, or walking.

Literature Synthesis

An extensive literature shows that when development is more compact and land uses are mixed, transit and walking mode shares rise and vehicle mode shares decline. Research for TCRP H-1 (Parsons Brinckerhoff 1996c) shows that residents of denser, more mixed-use neighborhoods were more likely to go by transit or to walk for all types of trips. Another part of this project showed that higher residential densities in rail corridors and higher employment densities in the CBDs increase rail use (Parsons Brinckerhoff 1996b).

Empirical research by Cervero (1986, 1989), Cervero and Gorham (1995), Dunphy and Fisher (1994), Frank and Pivo (1994), Handy (1992, 1995), Kenworthy and Newman (1993), and Kitamura et al. (1994) confirm that higher density, more pedestrian-friendly neighborhoods and employment centers support travel by non-automotive modes. Kenworthy and Newman compared the rates of growth in central, inner, and outer neighborhoods in the United States (where those with higher incomes move to the edge) and Australia (where those with lower incomes move to the edge) and found that automobile travel was growing rapidly in the outer areas of cities in both counties. Their conclusion:

> It is clear that the level of automobile use is not simply a matter of how wealthy people are, but is also heavily dependent on the structure of the city and whether transport options are available other than the automobile. Thus as cities become more dispersed and lower in density towards the edges, the level of compulsory automobile use rises markedly, regardless of income level. (Kenworthy and Newman 1993, 12)



Transit ridership fell dramatically after World War II. The automobile accounts for the decline.
Source: American Public Transit Association, *Transit Fact Book 1990.*

Even Gordon and Richardson (1997a, 99) agree that "...the spreading out of cities reduces markets for conventional public transit (especially fixed rail, which is spatially inflexible and usually oriented to downtown)..."

Residents of denser, mixed-use neighborhoods were more likely to use transit or to walk for all types of trips.

Literature Synthesis Matrix

	+2 General Agreement	+1 Some Agreement	0 No Clear Outcome	–2 Substantial Disagreement
Does this condition notably exist?	X			
Is it strongly linked to sprawl?	X			

Higher Household Transportation Spending

Allegation/Basis

Households living in sprawl developments must spend higher fractions of their incomes for transportation. Households under sprawl spend more for transportation than those in higher density forms of development because the residents of sprawl areas travel greater distances and make more of their trips in automobiles.

Literature Synthesis

That household spending on transportation is higher under sprawl would appear to be a logical consequence of the greater miles of travel and more travel by the automobile. However, only a few studies directly address the issue of household costs for transportation under different development scenarios.

Holtzclaw (1994) concludes that residents of denser, more transit-friendly neighborhoods are able to spend a smaller share of their budgets on travel due to greater use of transit and walking. The impact is especially great if households can reduce their automobile ownership levels because of the viability of other modes of travel. However, it is unclear whether the lower transportation costs are a direct or indirect result of sprawl, due to the types of people who choose to live in the denser, more transit-friendly neighborhoods.

Residents of denser, more transit-friendly neighborhoods are able to spend a smaller share of their budgets on travel due to greater use of transit and walking.

The current literature suggests that sprawl has higher transportation costs, but more studies are needed to substantiate this conclusion.

Literature Synthesis Matrix

	+2 General Agreement	+1 Some Agreement	0 No Clear Outcome	–2 Substantial Disagreement
Does this condition notably exist?			X	
Is it strongly linked to sprawl?			X	

Less Cost-Efficient and Effective Transit

Allegation/Basis

Sprawl reduces the cost-efficiency and effectiveness of transit service compared to more compact development. Transit service is not as efficient or effective in sprawl development because of the dispersion of origins and destinations. The higher ridership generated by denser developments improves the cost-efficiency (cost per vehicle mile) and effectiveness (passenger-miles per line-mile) of transit.

Literature Synthesis

Research for TCRP H-1 has shown that the use of light rail and commuter rail increases when more people live in the rail corridor and work in the central business district. Because density boosts ridership, the cost per vehicle mile declines and the passenger-miles per line-mile of transit increase. For example, consider a ten-mile light rail line serving a corridor with a medium residential density gradient and 100,000 employees in the CBD. If the residential density gradient were to increase by 1 to 4 persons per acre throughout the length of the line, the cost per vehicle mile would decline by about 5 percent and the effectiveness would increase by about 26 percent. Adding 50,000 jobs to the CBD and increasing employment densities would lower costs per vehicle mile by about 9 percent and increase effectiveness by 44 percent (Parsons Brinckerhoff 1996b, 1996d).

Transit service is not as efficient or effective in sprawl development because of the dispersion of origins and destinations.

As the section in this report on More Automobile Trips also shows, higher densities support higher bus use. Pushkarev and Zupan (1977) and a number of other authors have identified thresholds at which transit use substantially increases. Frank and Pivo (1994), using data from the Puget Sound region, identify thresholds of 50 to 70 employees and 9 to 13 persons per gross acre for work trips and 75 employees and 18 persons per gross acre for shopping trips. Due to the increase in ridership at these densities, the cost-efficiency and effectiveness of transit service increases.

Most suburbs do not have the densities necessary to make effective use of mass transit. *Source:* Courtesy CUPR Press.

Of course, development patterns are not the only factor affecting the efficiency and effectiveness of transit. The level of transit use is also related to the quality of the transit service and the ease of access (i.e., walking environment, park-and-ride facilities). Costs are also related to wages and other aspects of transit operations.

Literature Synthesis Matrix

	+2 General Agreement	+1 Some Agreement	0 No Clear Outcome	−2 Substantial Disagreement
Does this condition notably exist?	X			
Is it strongly linked to sprawl?		X		

Higher Social Costs of Travel

Allegation/Basis

Travel in sprawl development generates higher social costs than in more compact development. Social costs include air and water pollution, waste, barrier effects, noise, and the costs of parking and accidents that are not paid by the transportation user. Because more travel is by automobile in sprawled development, these cost rise.

Literature Synthesis

Various studies of the full costs of travel have found that social costs are highest per passenger mile for single-occupant vehicles, the dominant mode of travel under sprawl conditions. Studies using similar methods and location-specific data for Boulder, Colorado; Boston, Massachusetts; and Portland, Maine report that 16 to 17 percent of the costs per passenger mile for single-occupant vehicles (SOV) are social costs, whereas only 1 to 7 percent of the total costs for transit use and a negligible share of the costs for walking and bicycling are social costs (Apogee Research 1994; Parsons Brinckerhoff 1996a). Todd Litman's (1995) study estimating the national costs of travel reports that social costs represent a higher share of total costs due to different assumptions. He finds that 43 percent of the cost per passenger mile by SOV is a societal cost compared to 6 percent of the cost per passenger mile by transit.

Previous studies examined the social costs of travel from both a trip and a national perspective. The issue of whether the total costs of travel vary with the type of development, however, has not been studied systematically.

Various studies of the full cost of travel have found that social costs are highest per passenger mile for the single-occupant vehicle, the dominant mode of travel under sprawl conditions.

Literature Synthesis Matrix

	+2 General Agreement	+1 Some Agreement	0 No Clear Outcome	−2 Substantial Disagreement
Does this condition notably exist?		X		
Is it strongly linked to sprawl?		X		

SPRAWL'S ALLEGED POSITIVE IMPACTS

Shorter Commuting Times

Allegation/Basis

Commuting times are reduced in sprawl development, compared to those in more dense settings. The suburban-to-suburban commute, which characterizes sprawl, is shorter in time, if not in distance, than commuter trips between suburbs and central cities, due to higher speeds of travel. In addition, more trips are made by automobile, especially the single-occupant vehicle, the fastest and most direct mode of travel.

Literature Synthesis

Gordon and Richardson (1997a) argue that businesses follow people to the suburbs, thereby making trips to work shorter as measured in time, not in distance. The correction is not instantaneous, but over time, businesses move to suburban locations near workers, creating a new equilibrium with shorter work times. Although some people have longer trips, especially during the adjustment period, on average, commuting times have not increased due to sprawl.

Pisarski (1992a) found that average work trip times in the U.S. increased by only 40 seconds in the 1980s. Gordon, Richardson, and Jun (1991) and Levinson and Kumar (1994) found that work travel times remained stable over time in the core counties of the 20 largest metropolitan areas and in the Washington, D.C., metropolitan area, respectively. Dueker et al. (1983), Zimmer (1985), Gordon, Kumar, and Richardson (1989), and Dubin (1991) all found that the suburbanization of jobs has shortened commuting times, although not necessarily distances.

The suburbanization of jobs has shortened commuting times, although not necessarily distances.

But, there is contrary evidence. Vincent et al. (1994) analyzed the National Personal Transportation Survey Data for 1990 and found that commute times for residents of urbanized areas outside of central cities were longer than those for central city residents. The average peak period commute length for suburbanites was 21.6 minutes, compared to 18.9 minutes for central city residents. Likewise, the average length of off-peak commutes for suburbanites was 19.7 minutes compared to 17.2 minutes for central city residents. Pisarski (1992a) further reports that suburbanites had much greater increases in commute times between 1980 and 1990 than central city residents. The average travel time for suburban residents who commuted either to suburban or central city locations increased by 14 percent over the period, while the average commute time for a central city resident increased by only 5 to 7 percent.

The extreme outward extension of urban areas may have also increased travel times. Davis (1993) found that the average commute of exurbanites in the Portland metropolitan area was seven minutes longer than that of suburbanites, holding constant occupations, household structure, and other factors affecting commuting times.

Commute times for residents of urbanized areas outside of central cities were longer than those of central city residents.

Thus, researchers have drawn substantially different conclusions, sometimes utilizing the same data sets. Most of their studies addressed issues other than the effects of sprawl versus compact development on commuting time, however, leaving the results unclear.

Literature Synthesis Matrix

	+2 General Agreement	+1 Some Agreement	0 No Clear Outcome	−2 Substantial Disagreement
Does this condition notably exist?			X	
Is it strongly linked to sprawl?			X	

Less Congestion

Allegation/Basis

Sprawl reduces congestion by spreading trips out over more routes. Sprawl has improved travel by spreading out origins and destinations and utilizing the capacity of suburban roads and highways. The shift to suburban destinations has relieved traffic on the routes to the city center.

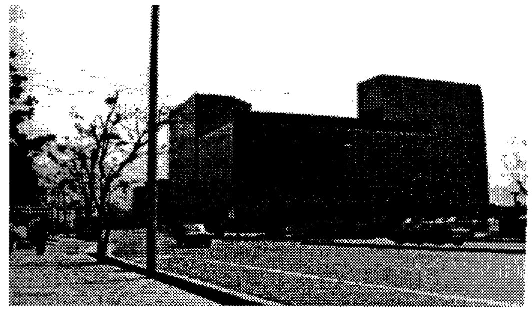
Literature Synthesis

Gordon and Richardson (1994c) claim that suburbanization has reduced congestion, citing the lack of growth in travel times. Specifically, they say:

> [S]uburbanization has been the dominant and successful mechanism for reducing congestion. It has shifted road and highway demand to less congested routes and away from core areas. All of the available recent data from national surveys on self-reported trip lengths and/or durations corroborate this view. (Gordon and Richardson 1994c, 1)

They argue that, over time, people and firms make adjustments in their locations to keep travel times from growing. The spreading out of urban areas has kept congestion from overwhelming urban areas, as some have predicted.

Cervero (1986, 1989), however, found that congestion has followed jobs to the suburbs. Since jobs have moved to areas where there is little, if any, transit service, people have no choice but to drive to these jobs. This increase in traffic has used up all the available highway capacity near suburban activity centers, creating congestion in these areas. An index developed by the Texas Transportation Institute indicates that congestion (defined as the ratio of freeway and arterial VMT to capacity) worsened in 47 out of 50 major U.S. cities between 1982 and 1991. Two of the cities where congestion decreased, Houston and Phoenix, made sizable investments in highway capacity during the time period. This research points to a factor other than development pattern which contributes to congestion, namely, investment in transportation. In most areas, highway capacity additions have not kept pace with the growth in traffic, due to lack of funds, opposition to road building, environmental regulations, and other factors (Dunphy et al. 1997).



Suburban office parks usually front wider, less congested roadways than their central city counterparts.
Source: Courtesy CUPR Press.

Congestion worsened in 47 out of 50 major cities between 1982 and 1991.

Simulations also show that in addition to the pattern of development, roadway networks and capacity, congestion levels depend upon opportunities to use alternative transportation modes. The LUTRAQ analysis of alternate development patterns for a suburban county in the Portland, Oregon metropolitan area, for example, forecast the least congestion for a pattern of sprawled development with substantial investments in additional highway capacity and transportation demand reduction measures, such as pricing. Compact transit-oriented development focused on an expanded transit system, using the same transportation demand measures, had the second lowest levels of congestion. Building highways in sprawl development without controlling travel demand had higher levels of congestion than either of these two alternatives (1000 Friends of Oregon 1996).

Because researchers disagree about how to measure congestion, they also disagree about whether congestion is getting better or worse. Regardless, both sides agree that suburbanization is one of the major factors affecting congestion levels.

Literature Synthesis Matrix

	+2 General Agreement	+1 Some Agreement	0 No Clear Outcome	–2 Substantial Disagreement
Does this condition notably exist?			X	
Is it strongly linked to sprawl?	X			

Lower Governmental Costs for Transportation

Allegation/Basis

Much of the cost of building and operating highways and streets, the dominant mode of travel under sprawl, is paid for by users, through gas taxes and licensing fees. In contrast, transit users pay a lower share of the costs of building and operating transit systems, especially rail systems. Thus sprawl, with its emphasis on highway investment, requires less subsidization of transportation systems even when governmental costs, such as highway patrols and publicly provided parking, are considered.

Literature Synthesis

Considerable disagreement exists about whether transit or automobile governmental subsidies are higher, as evidenced by the debate between Gordon and Richardson (1997a) and Ewing (1997). Although government subsidies are a visible part of transit budgets, there is much dissension about what constitutes a subsidy for highways. As Deluchi notes:

> There is a good deal of argument about whether motor vehicle users "pay" fully for government-provided infrastructure and services (i.e., Lee 1994: Green 1995). This disagreement, of course, results from different opinions about what should count as a public-sector cost of motor vehicle use, and what should count as a payment by motor vehicle users for motor vehicle use. (Deluchi 1996, 43)

There is a good deal of argument about whether motor vehicle users "pay" fully for government-provided infrastructure and services.

Most federal and state funding of highways derives from the gas taxes and registration fees that are dedicated to highways. However, as Hanson (1992) Litman (1995), and Dunphy (1997) point out, local governments finance a considerable share of road costs with property and sales taxes.

None of the costs of travel studies have analyzed whether governmental costs vary depending upon the type of development.

Literature Synthesis Matrix

	+2 General Agreement	+1 Some Agreement	0 No Clear Outcome	–2 Substantial Disagreement
Does this condition notably exist?			X	
Is it strongly linked to sprawl?			X	

Automobiles Most Efficient Mode of Transportation

Allegation/Basis

Automobiles are the most efficient mode of transportation in sprawl. The low-density, dispersed patterns of sprawl development were designed for automobile access and make the automobile the most efficient means of travel for many trips.

Literature Synthesis

An analysis of the total cost of travel for ten diverse, prototypical trips in Boulder, Colorado showed that the automobile is clearly the *least* costly means of travel for trips between dispersed, low-density destinations even when estimates of user, governmental, and social costs are totaled. Although the cost per passenger mile of the single-occupant automobile is higher than the cost of any other mode during peak times, automobiles are more efficient for many off-peak trips because they can take direct routes, are faster, and allow drivers to avoid waiting times. Getting to destinations that require bus transfers, taking trips that link many destinations, or taking trips involving more than one person are often most efficiently done in the automobile.

Only the automobile can offer the convenience of door-to-door transportation.
Source: Thomas Johnston, AIA. Courtesy American Planning Association.

Literature Synthesis Matrix

	+2 General Agreement	+1 Some Agreement	0 No Clear Outcome	–2 Substantial Disagreement
Does this condition notably exist?		X		
Is it strongly linked to sprawl?	X			

CHAPTER

5

Literature Synthesis

LAND/NATURAL HABITAT PRESERVATION

This subset of the literature includes, as a starting point, investigations about overall land consumption trends and the threats to such fragile lands as wetlands and prime agricultural acreage. Numerous studies deal specifically with how different development patterns affect land and natural habitat preservation.

Following this overview, the chapter examines the evidence on reduced farmland productivity and viability resulting from proximate suburban development. Do invading suburban land uses threaten cropland harvests, and does this phenomenon reduce the value of land for farming?

Finally, do skipped-over lands destroy the possibility of garnering meaningful regional open space, or does this pattern leave for future development land interstices that can be used for small-scale, community, or personal open space at a later period?

Because there is a view that Americans are wasteful in their use of land for development and that land savings are an "obvious" outcome of some forms of managed growth, there is less empirical research that focuses on the topic of preservation and sprawl.

Sprawl's Alleged Negative Impacts

Loss of Agricultural Land
Reduced Farmland Productivity
Reduced Farmland Viability
Loss of Fragile Environmental Lands
Reduced Regional Open Space

Sprawl's Alleged Positive Impacts

Enhanced Personal and Public Open Space

SPRAWL'S ALLEGED NEGATIVE IMPACTS

Loss of Agricultural Land

Allegation/Basis

Sprawl removes more prime agricultural land from farming use than other more compact forms of development. Three reasons are usually cited. First, the low-density uses inherent in sprawl's residential development patterns require more space for the direct placement of dwelling units than the higher-density uses under compact development. Second, the scatteration of dwelling units across the landscape far from the edges of built-up settlements renders the agricultural use of much of the land adjacent to the scattered dwellings inefficient and under intense development pressures. Third, the prospect of obtaining high prices for land motivates farmers and land speculators to assemble large parcels of farmland because these lands are contiguous and can be bought in bulk.

Literature Synthesis

Multiple studies have documented the significant loss of agricultural lands to the current development process. These studies range from national reviews of the loss of farmlands and farms over time, such as the National Agricultural Lands study (1981) and the American Farmland

Farms near metropolitan areas are increasingly facing intense development pressures.
Source: Peter Dunning. Courtesy American Farmland Trust.

Trust's *Farming on the Edge* (1994), to regional/state investigations of a similar type (i.e., Nelson [1992b] in Oregon and Adelaja et al. [1989] in New Jersey). There is substantial disagreement, however, about whether this loss of agricultural land has created significant social costs. To some observers, it appears that there is no shortage of prime agricultural land in the United States, since the nation has often produced crop surpluses (Gordon and Richardson 1997a), and 2,000 of the 3,000 counties in the United States can still be counted as rural and undeveloped (Burchell and Shad 1997). Yet, demands for food are rising sharply as living standards increase in once-poor locations throughout the world. Prices of major agricultural crops have increased substantially in just the last few years. Hence, the argument is made that in the long run, the world will need all the food production capacity it can muster (Ewing 1997).

On the domestic front, there are widespread policy initiatives that seek to preserve farmland as much with the goal of maintaining a diverse economy as any other reason. Many states (e.g., Maryland, New Jersey, and Vermont) and other levels of government (e.g., Lancaster County, Pennsylvania) have adopted programs in recent years, ranging from the purchase of development rights to the enactment of "right to farm" laws, in order to foster land, particularly farmland, preservation (Nelson 1992b).

Numerous growth management plans—attempting to reverse sprawl—include farmland preservation as an objective (Maine 1988; Vermont 1988; New Jersey 1991). They address preservation as a goal of planned development, not merely an attempt to curtail sprawl. The limited empirical investigations of sprawl's impact on "consuming" farmland—and in opposition, the impact of alternatives to sprawl on farmland—that have been done were performed by Burchell (1992-1997) in New Jersey, Lexington (Kentucky), the Delaware Estuary, Michigan, and South Carolina, and by Landis (1995) in the San Francisco Bay area. These analyses employed land consumption models at the minor civil subdivision level to view differences between trend development or "business as usual" scenarios and more environmentally conscious land development approaches. The business-as-usual scenarios embodied sprawl-like characteristics; the latter, more compact, planned development characteristics. These models allowed future projections of households and jobs to be converted to the demand for residential and nonresidential structures, and ultimately to demand for residential and nonresidential land, with allowances for spillover to adjacent municipalities and to unincorporated areas.

In both the Burchell and Landis studies, historical rates of farmland takings were applied to land consumed under existing development patterns, and the goal of farmland retention was applied under the alternative development patterns. (A similar procedure was used for environmental land consumption comparisons.) In the Burchell studies, agricultural lands included such categories as cropland that is harvested, lands in permanent pasture, and woodlands that could be used for agricultural purposes. Fragile environmental lands encompassed floodplains and wetlands, acreage with steep slopes or with critical habitat designation, aquifer recharge areas, critical sensitive watersheds, and stream buffers (Burchell 1992-1997).

Numerous growth management plans include farmland preservation as an objective.

The models, employing different densities, development locations, and occasionally different housing types under the alternatives for future growth, calculated the total agricultural (and fragile environmental lands) that would be consumed. Burchell's results showed savings in the consumption of agricultural acreage of roughly 20 percent in South Carolina, Michigan, and Lexington under plan versus trend development; savings of about 30 percent in the Delaware Estuary; and savings of 40 percent in New Jersey (Burchell 1992-1997). (See Tables 3 and 4 for details.) Landis's results in the San Francisco Bay Area were even more pronounced. His "scenario C" (compact growth) saved nearly 50% of farmland acreage and steep-sloped areas, and close to 100% of wetland areas (Landis 1995, 449).

Literature Synthesis Matrix

	+2 General Agreement	+1 Some Agreement	0 No Clear Outcome	−2 Substantial Disagreement
Does this condition notably exist?	X			
Is it strongly linked to sprawl?	X			

Reduced Farmland Productivity

Allegation/Basis

The productivity of land being farmed near scattered sprawl settlements is reduced by the difficulty of conducting efficient farming operations near residential subdivisions. Subdividing land into small lots for residential purposes inhibits farmers' ability to operate on large contiguous land parcels and thereby reduces the efficiency of mechanized agricultural operations. Furthermore, under sprawl development, subdivisions and farms may be interspersed, and residents often object to the odors, noise, truck traffic, and other local conditions associated with active agricultural uses. When this contiguous development occurs, local governments sometimes opt to impose restrictions on farming. These conditions bring about an "impermanence syndrome" that is antithetical to sustained farmland productivity.

Literature Synthesis

There is an extensive literature on constraints to farming in urbanizing locations (Lisansky 1986; Lopez et al. 1988; Nelson 1992b). In rural areas that can be readily developed, high land values often shift farmers' "objective function" from agricultural operations to capital gains from real estate sales. Real estate sales, in turn, reduce the average farm size, thus limiting the realization of economies of scale—a characteristic of U.S. agriculture. A variety of other restraints on farmland productivity have also been imposed, ranging from restrictive regulations to recurring vandalism. All of these factors generate an "impermanence syndrome"—a

Increasing numbers of farms have been sold and converted into sprawl development.
Source: Peter Dunning. Courtesy American Farmland Trust.

reluctance by the farmer to invest in new technology and farm infrastructure. Land remains idle, awaiting conversion to other uses. Studies involving sprawl development allege that this impermanence syndrome is deleterious to farmland productivity (AFT 1997).

The direct relationship of sprawl development patterns to farmland consumption was examined by Burchell (1992a) in the state of New Jersey. In addition to projecting the total farmland that would be lost under sprawl versus planned development, the New Jersey analysis identified the quality of farmland that would likely be consumed—"prime," "marginal," or "poor." The New Jersey

No analysis to date has examined how development pattern (i.e., sprawl versus compact) would affect the productivity of farmland that remains in agricultural use.

analysis showed that not only would continued sprawl development draw down more farmland, but since better quality farmland is the most amenable for development (in that it is flatter, drains better, and so on), the loss of farmland to sprawl would be concentrated in the "prime" and "marginal" categories. Farmland consumption under planned development would be less overall and wholly contained in the subprime or "poor" farmland category.

The Burchell (1992a) New Jersey study thus considered the association of farmland quality and development patterns—but only from a farmland consumption perspective. No analysis to date has examined how development pattern (i.e., sprawl versus compact) would affect the productivity of farmland that remains in agricultural use.

Literature Synthesis Matrix

	+2 General Agreement	+1 Some Agreement	0 No Clear Outcome	–2 Substantial Disagreement
Does this condition notably exist?		X		
Is it strongly linked to sprawl?			X	

Reduced Farmland Viability (Water Constraints)

Allegation/Basis

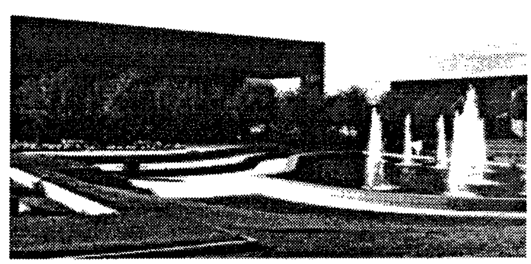
Growth through sprawl causes great expansion in the demand for water for urban uses, and thereby reduces the amount of water available for agriculture. The reduction in available water is especially significant in the southwestern regions where sustained shortages of water exist. However, agriculture currently uses much more water than urban settlements in many states where farming depends upon irrigation, such as Arizona, California, Colorado, Oklahoma, and Texas. As urban settlements expand in these areas, more water will have to be diverted from agriculture to supply the basic human needs of the resident population. This diversion will restrict the operation of farming in such areas. Furthermore, single-family property owners and corporate commercial facilities often use vast amounts of water for lawn sprinkling, an excessive use of this natural resource that is needed for food production.

Literature Synthesis

Multiple studies have examined how development in more arid locations, especially in the West and Southwest United States, is drawing down the water supply, potentially in conflict with the irrigation needs of agriculture. The literature has not examined the specific association of sprawl and farmland viability with respect to water supply. This would involve a multi-linked analysis of:

1) how development affects water demand;
2) whether development's consumption of water would differ under sprawl versus other forms of development in these areas; and
3) the relationship of steps (1) and (2) to the amount of water supply for agricultural and residential settlements in given locations, compared to the total supply available there.

Although a fully linked analysis such as the one described above has not been undertaken, some research has been undertaken on water demand relevant to steps (1) and (2). For instance, the Army Corps of Engineers incorporates in its water demand forecasting model, among other factors, the magnitude of lawn sprinkling, which is likely to be higher under sprawl versus compact development (Consultants 1980). The Hittman water demand model includes housing density as one factor—a variable clearly different under sprawl versus more compact development. In a similar vein, the multivariable IWR-Main water forecasting model (Baumann and Dziegielewski 1990) incorporates in its multiple coefficients development density and the number of housing units by type (detached versus attached)—variables that differ under sprawl versus compact development.



Development, both residential and nonresidential, demands more water than its agricultural predecessors and neighbors. *Source:* Courtesy CUPR Press.

The Burchell (1992a, 1992b) analysis of trend versus plan development in New Jersey considered how water demand influenced water consumption under these two scenarios and incorporated some of the variables (i.e., housing type) noted above. Burchell found only small differences in water demand by development scenario; from 1990 to 2010, the increase in statewide water demand was projected to be 60.1 million gallons per day (MGPD) for trend, versus 58.0 MGPD for plan. This analysis did not, however, relate the 2-MGPD variation finding to the demands on water supply for residential development versus agricultural uses in New Jersey. Water supply is not a development-constraining issue in New Jersey—as it is in more arid regions of the United States.

Literature Synthesis Matrix

	+2 General Agreement	+1 Some Agreement	0 No Clear Outcome	−2 Substantial Disagreement
Does this condition notably exist?			X	
Is it strongly linked to sprawl?			X	

Loss of Fragile Environmental Lands

Allegation/Basis

More frail lands are destroyed by sprawl than by more compact settlement patterns. Because sprawl spreads urban development over a much larger area than more compact settlement patterns, it inherently consumes more land. Because land development under sprawl is not centrally planned or supervised, there is a greater probability that fragile environmental lands will be converted to residential and other uses. Local governments are likely to misjudge the consequences of environmental degradation because they are not concerned with the overall balance between environmentally sensitive lands and developing land uses in the region as a whole.

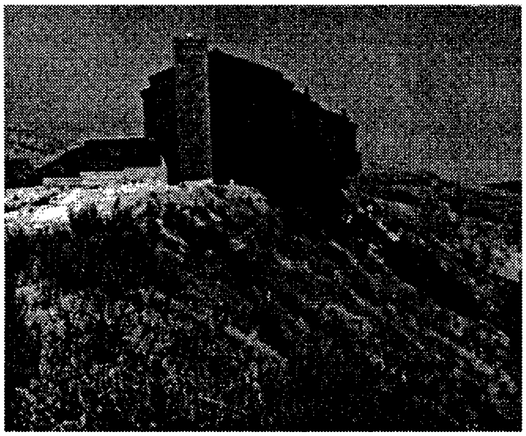
Literature Synthesis

Several studies document losses of, and threats to, fragile lands. Dahl (1990) estimates that since colonial times the United States (48 lower states) has lost about 110 million acres of wetlands—about 55 percent of the starting wetlands inventory. The Michigan Society of Planning Officials (MSPO) estimates that 20 percent of Michigan's forested, wetland, and steeply sloped areas was lost to development between 1970 and 1990 (MSPO 1995).

Numerous growth management plans—attempting to reverse sprawl—have evaluated how managed versus traditional development patterns would affect fragile lands. These plans include the Orlando, Florida, *Urban Area Growth Management Program* (Orlando, FL 1981), the *Evaluation of City of San Diego Growth Management Program* (1978), and *the Report of the Year 2020 Panel of Experts (*Chesapeake Bay Executive Council 1988). The Orlando study examined how managed growth versus a "continuation of past trends" would affect the preservation of wetlands and flood plains. It projected a saving under managed growth of almost 20 percent in the inventory of these fragile environmental lands (i.e., 20 percent less acreage lost).

The Michigan Society of Planning Officials (MSPO) estimates that 20 percent of Michigan's forested, wetland, and steeply sloped areas were lost to development between 1970 and 1990.

Analyses of sprawl's impact on fragile lands have been conducted by Burchell (1992-1997) in New Jersey, Lexington (Kentucky), Delaware Estuary, and Michigan. Similar studies were also done by Landis in the San Francisco Bay area. Burchell found that plan (compact) versus trend (sprawl-like) development would reduce consumption of fragile environmental lands by almost one-fifth.



Homes are being built on unsuitable and unsafe, but available and less-expensive lands.
Source: U.S. Department of Agriculture, Soil Conservation Service.

The range of the saving was from 12 to 27 percent, depending on the starting level and location (see Tables 3 and 4). Landis found even larger land savings under his compact growth scenario. His findings were calculated separately for steep slopes and wetland areas (Landis 1995).

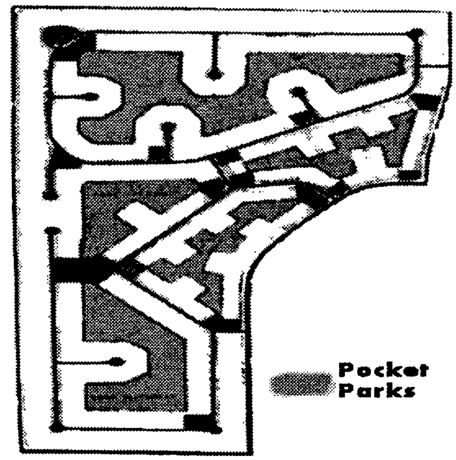
Literature Synthesis Matrix

	+2 General Agreement	+1 Some Agreement	0 No Clear Outcome	−2 Substantial Disagreement
Does this condition notably exist?	X			
Is it strongly linked to sprawl?	X			

Reduced Regional Open Space

Allegation/Basis

The setting aside of open space for public use by residents of an entire region may be "underfinanced" in sprawl-dominated areas, compared to those with more regionally oriented governance structures. Municipal governments, motivated by fiscal pressures to provide benefits only for their own residents, may be unwilling to devote resources to creating facilities for use by persons throughout a region.



Many neighborhoods incorporate pocket parks, accessible only to their residents, instead of relying on regional open space.
Source: Florida Department of Community Affairs

Literature Synthesis

There is scant literature dealing with this issue explicitly; it is difficult to determine whether a substantial consensus exists. The only literature that does exist finds that very large-scale developments and conservation developments, both generally "nonsprawl" in nature, frequently have significant set-asides for contiguous open space. Most of the local ordinances of the 1970s and the new countywide community general development plans of the 1980s called for mandatory provisions of continuous open space as an alternative to traditional subdivision development (Burchell, Listokin, and Dolphin 1994).

Very large-scale developments and conservation developments, both often of a nonsprawl nature, frequently have significant setasides for contiguous open space.

Arendt (1994a) points to a movement away from golf course communities to open space communities that give the private and public sectors a greater chance to share in the land resources. The Sterling Forest Corporation, potential developers of a 17,500-acre site in Tuxedo, New York, pledged 75% of the land would remain as some form of private/public open space (Sterling Forest Corporation 1995). Much of the site was later bought by federal and state governments.

Literature Synthesis Matrix

	+2 General Agreement	+1 Some Agreement	0 No Clear Outcome	–2 Substantial Disagreement
Does this condition notably exist?	X			
Is it strongly linked to sprawl?	X			

SPRAWL'S ALLEGED POSITIVE IMPACTS

Enhanced Personal and Public Open Space

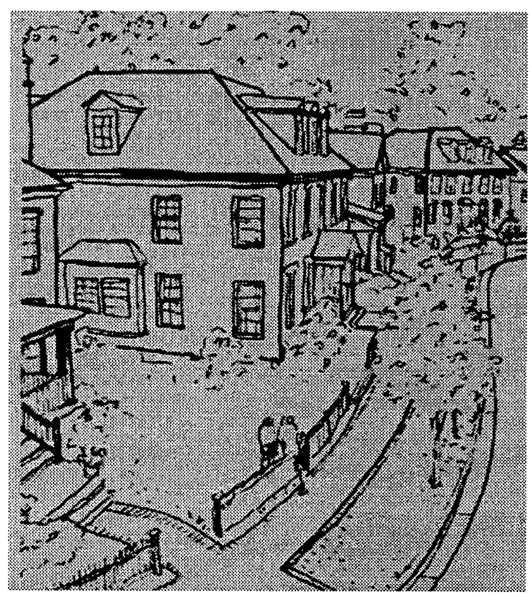
Allegation/Basis

(a) *Sprawl provides more open space directly accessible to individual households in the form of larger private yards attached to their dwellings than is possible via more compact forms of settlement.* The average lot size in sprawl settlement patterns is much larger than in more compact forms of settlement, and a higher fraction of dwellings have individual yards. Therefore, more households have direct access to their own private open space, and the space is larger, on average, than the equivalent in more compact settlements.

(b) *Sprawl's leapfrog development provides both larger amounts of, and more accessible, open space without significant public expenditures, by leaving large unsettled sites "inboard" of the farthestout urban subdivisions.* This provides aesthetic and recreational benefits to the public without requiring use of taxpayers' funds.

Literature Synthesis

Personal open space continues to be high on the list of the desires of most Americans (Fannie Mae 1995). In surveys conducted by the Federal National Mortgage Agency, prospective home buyers want not only yards, but yards on all sides. In the mid-1990s, according to the most current surveys of buying preference, single-family detached housing was more popular than it was a decade ago. Much of the appeal is related to occupants' dislike of the instability or fee structure of condominium associations. But at least some of the appeal is related to the desire for more, rather than less, personal open space (Fannie Mae 1994).



Large yards on all sides of the house appeal to suburban home buyers.
Source: Copyright 1997. The Georgia Conservancy. All rights reserved.

Although a potential for innercity/suburban open space appears to be the result of skipped-over lands, rarely does this happen in either developed or redeveloping neighborhoods.

A very limited literature indicates that the skipped-over development patterns of sprawl create parcels of land that can be used for inner-suburban or urban open space as this becomes a local priority. Except in the wealthiest and most resilient of inner suburbs, open space is almost never a choice or option of local government. Most governments in these localities are pressed for fiscal resources and dispose of these land parcels to the highest bidder. Thus, the opposite to what is popularly assumed to be a trend often takes place. Through the local variance process, the lands frequently are given a higher intensity residential or nonresidential use designation. The abutting properties, rather than receiving permanently improved open space, are subject to more intensive and occasionally disruptive land uses, which can pay more in taxes than either existing neighboring uses or the previously undeveloped vacant land. Thus, although a potential for inner-city/suburban open space appears to be the result of skipped-over lands, rarely does new open space materialize in either developed or redeveloping neighborhoods (Downs 1994).

Literature Synthesis Matrix

	+2 *General Agreement*	+1 *Some Agreement*	0 *No Clear Outcome*	−2 *Substantial Disagreement*
Does this condition notably exist?		X		
Is it strongly linked to sprawl?			X	