

*“People can't get out of their cars
unless we provide them with another
way to get where they're going.”*
— Smart Growth America

Trails & Greenways: Advancing the Smart Growth Agenda



Rails-to-Trails Conservancy

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Hugh Morris

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Abstract

Americans have designed and built an environment over the last half-century that, through land-use patterns and transportation facilities, makes non-automobile travel difficult. The result has been a reduction in non-motorized trip making and an increase in traffic congestion, air pollution, loss of open space and attendant decrease in our collective health.

How did we get here? Many organizations and individuals have spent the last few years exploring the evolution of our built environment. Most agree that the sprawling development that predominated the last fifty years has left an unpleasant legacy. We now confront a structural problem brought about by imbalanced growth and the infrastructure we have put in place to support that growth. Now, our development paradigm appears to be shifting through the onset of smart growth policies which seek to accommodate growth at a lower cost. The development of green infrastructure, such as trails and greenways, are an important element in the smart growth arsenal and can help us grow in a more balanced and sustainable way.

The benefits to a community of developing green infrastructure are vast. Trails and greenways provide facilities for recreation and physical fitness activities, increasingly important community assets as the Centers for Disease Control and Prevention reports that Americans grow heavier and unhealthier each year. Trails bring environmental benefits such as heat island mitigation, habitat preservation and storm water runoff purification. Natural infrastructure — soil, grass and trees — helps mitigate a variety of pollutants in built environments. And, by providing alternative transportation options, trails can have beneficial impacts on air quality and congestion. Trails in some urban areas are known to carry more than 1,000 commuter trips each day. These benefits are all the more robust when a region develops a system or network of trails rather than a singular facility.

This paper draws on existing research and case studies to provide comprehensive documentation of the benefits green infrastructure can bring to a community and a region, and the impact trails and

greenways have on advancing smart growth objectives. In addition, transportation planning theories of induced demand and system extent, as well as social justice issues associated with regional trail development, are explored.

The imbalance of our current built environment has led to communities largely devoid of walking and bicycling amenities. This paper asserts that it is a lack of opportunity — and place — to walk and bicycle, instead of a lack of desire on the part of residents, that has gotten us here. As this report documents, if you build it they will come, along with a wide range of benefits.



Stone Arch Bridge, Minneapolis, Minnesota. Photo: Robert Patten

I. Introduction

Does the development of green infrastructure,¹ such as trails and greenways, help to achieve smart growth objectives? The answer to this question is obvious: “Yes!” Smart growth is generally defined as growth that protects open space, revitalizes neighborhoods, makes housing more affordable and improves community quality of life (SGA, 2000). And, when residents of a community are asked what types of amenities would improve their quality of life, neighborhood facilities that enable walking and biking are consistently in the top tier.²

For the last decade, advocates of trails and greenways have been documenting the many benefits these facilities bring to a community, particularly in urban and suburban areas. These benefits are wide ranging and include small business stimulation, open space preservation, heat island mitigation, non-motorized trip making, increased physical fitness and generation of social capital.³

The U.S. is now several years into the anti-sprawl movement. The concept of smart growth has emerged as a collection of public policies designed to shift the course of development in a direction that reduces the negative impacts associated with growth and more efficiently uses the resources we have.

A community that invests in green infrastructure will see a return on its investment in the many dimensions listed above. Those dimensions, when taken as a package, fit neatly with smart growth objectives. However, the body of smart growth literature does not yet include a document detailing the ways that investing in a network of green infrastructure can enhance and ensure the success of smart growth in a community.

National environmental organizations such as the Sierra Club and the Natural Resources Defense Council have launched significant efforts to educate the public and policy makers on the negative impacts of sprawl development. Newer organizations such as Smart Growth America, Growth Management Leadership Alliance and the Sprawl Watch Clearinghouse have sprung up specifically to highlight the problems associated with sprawl and to advance solutions. Washington, D.C.-based associations that represent local policy makers such as the National Governors Association, the National League of Cities, the National Association of Counties and the Conference of Mayors have also focused resources on the problems caused by sprawl development patterns.

A common element emerges throughout the publications of these diverse groups: Public infrastructure oriented toward bicycling and walking is a key element in the solution to sprawl that they are advocating. For example:

- “Provide a variety of transportation choices: People can’t get out of their cars unless we provide them with another way to get where they’re going. More communities need safe and reliable public transportation, sidewalks and bike paths.”—“Welcome to Smart Growth America” *Smart Growth America*
- “New Community Design demands that communities be designed to promote walking and biking as fundamental modes of travel from one location to another, as well as for recreation and exercise purposes.”—“New Community Design to the Rescue” *National Governors Association*

Such statements tend to be as far as these organizations go with regard to bicycling and

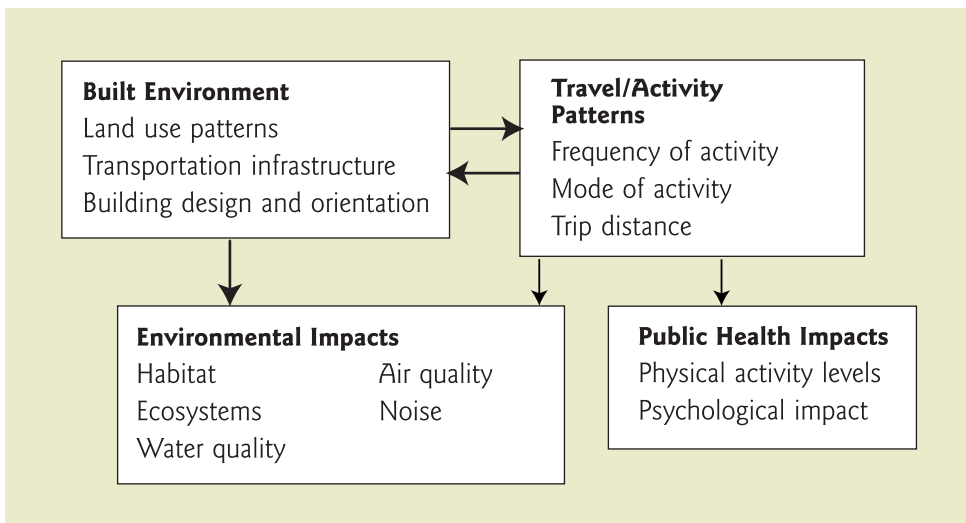
walking in the smart growth agenda, an acknowledgment of their necessity but no detail on impacts. To some degree, the benefits of an increased ability to walk and bicycle are clear. Indeed, for anyone who has spent time in Portland, Ore., it would be difficult to imagine that city without the emphasis they have given to non-automotive forms of travel. If we do not have to start our cars we, collectively, will end up with better air quality, reduced congestion and personal benefits from being more physically active. Transportation is a lynchpin issue in the smart growth quest to tame sprawl. As land uses become increasingly mixed and distances between trip origins and destinations are reduced, walking and bicycling become viable modes for making those trips, but the facilities need to be available in order for such trips to be made. Twenty-five percent of the trips we make now are less than one mile long yet 75 percent of those trips are made by motor vehicle (NGA, 2000). These trips are good candidates for non-motorized means, but the infrastructure for making the trip by foot or bicycle may not be in place.

While many of the benefits associated with

bicycling and walking are transportation related, there is a broad spectrum of benefits. As this paper describes, each of the policies advanced by smart growth principles, such as preserving open space and providing transportation choices, is aided by the creation of trails and greenways. We will also demonstrate that a regional trail network or system will make it more likely that these benefits are realized, that the magnitude of the benefits is increased and that the benefits are shared among a greater number of people. It is often difficult for local policy makers to adopt shifts in policy without detailed understanding of the benefits derived from those shifts and documentation to support those claims. This paper was developed to provide detailed findings regarding the benefits of the bicycle and pedestrian infrastructure and the design details that need to be in place for that infrastructure to be used. A combination of research articles and case studies are used to demonstrate and document the benefits and design elements that are needed to make this infrastructure successful.

The relationship between the way we develop our land and the transportation systems providing access to that land is fundamental to

Figure 1: Influence of the Built Environment on Travel/Activity Patterns and Attendant Human and Environmental Impacts



the problems associated with sprawl development patterns as well as the benefits that appear when the construct of those components shift. The essential relationship, shown in Figure 1, is that the built environment is comprised principally of land development and transportation infrastructure, and that these two components are self-reinforcing.

The resulting built environment impacts human activity patterns. The way we move about has numerous impacts, many of which can be considered health related and have a self-reinforcing relationship with activity patterns.⁴

The policies that smart growth advocates are promoting to shift us away from sprawl development patterns are aimed primarily at the land use and transportation elements shown in Figure 1. As the characteristics of land use and transportation investments shift, our activity patterns will change and the impacts of those activity patterns will shift.

The evidence needed to substantiate the importance and value of green infrastructure in advancing the smart growth agenda exists. This paper organizes the information and presents it as a comprehensive package with sufficient detail and references to allow local decision makers to confidently give priority to green infrastructure as part of their quest to make their community more livable, sustainable and healthy.

DEFINITIONS

A variety of terminology is used in the smart growth and green infrastructure fields. Below are the definitions we have chosen to use in this report.

Green Infrastructure: Green infrastructure has been defined several ways. Recently, Benedict and McMahon (2001) defined it as “an interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations.” The term *green* has more generically been used to refer to things that are environmentally friendly. In this paper, the term green infrastructure specifically includes infrastructure that is primarily used by humans for non-motorized travel and thus produces a variety of environmental benefits.

Livable Communities: Livable communities are places where we not only protect historic old neighborhoods, but where farms, green spaces and forests add vigor, context and beauty to the newest of suburbs; places where we work competitively, but spend less time in traffic and more time with our families, friends and neighbors (CGA, 2000).

Smart Growth: Smart Growth protects open space, revitalizes neighborhoods, makes housing more affordable and improves community quality of life. These objectives are realized through policies that give priority to improving services such as schools, roads, affordable housing and public transportation in existing communities rather than encouraging new housing, commercial development and new roads in the countryside (SGA, 2000).

Sprawl: Sprawl is dispersed development outside of compact urban and village centers, along highways and in rural countryside. Sprawl is typically characterized by unnecessary land consumption, low average densities in comparison with older centers, auto dependence, fragmented open space, wide gaps between development, a scattered appearance, separation of uses into distinct areas, repetitive one story commercial buildings surrounded by acres of parking and lack of public spaces and community centers (SWC, 2001).

Sustainable Development: Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987).

II. Background

My, how we've grown. Post-World War II growth in the United States has been substantial and not all aspects of the growth have been in lockstep with population increases. Figure 2 provides a snapshot of the relative growth in population, gross domestic product, households, vehicle ownership and vehicle use over the last 30 years. The graph and the following table make it clear: the rate of consumption in the U.S. has far outstripped population growth.

Vehicle miles of travel grew at more than twice the population growth rate. This is in part due to increased auto-ownership rates made necessary by the low-density development indicated in Table 1.

The reasons for this imbalance lie in the public policies adopted decades ago, the impacts of which have now manifested themselves into a collective impact we call sprawl. Table 2 provides a summary of the genesis of sprawl, the resulting consumer shift and the impacts of that shift. These initial policies were created as a response to the dramatic population increase that followed World War II and were intended to efficiently

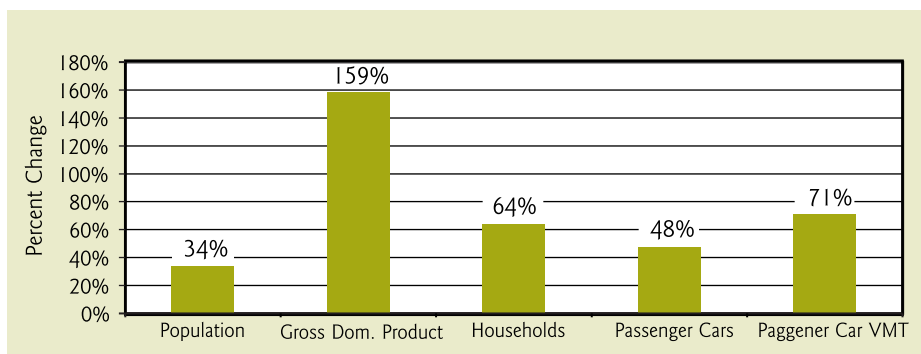
and effectively accommodate growth. The negative impacts of those policies took decades to manifest themselves.

Table 1: Change in Metropolitan Population and Developed Land Area 1970-1990.

Location	Percent Change in:	
	Population	Developed Land
Cleveland, OH	-11%	33%
Chicago, IL	4%	46%
New York, NY	8%	65%
Seattle, WA	38%	87%
Los Angeles, CA	45%	300%

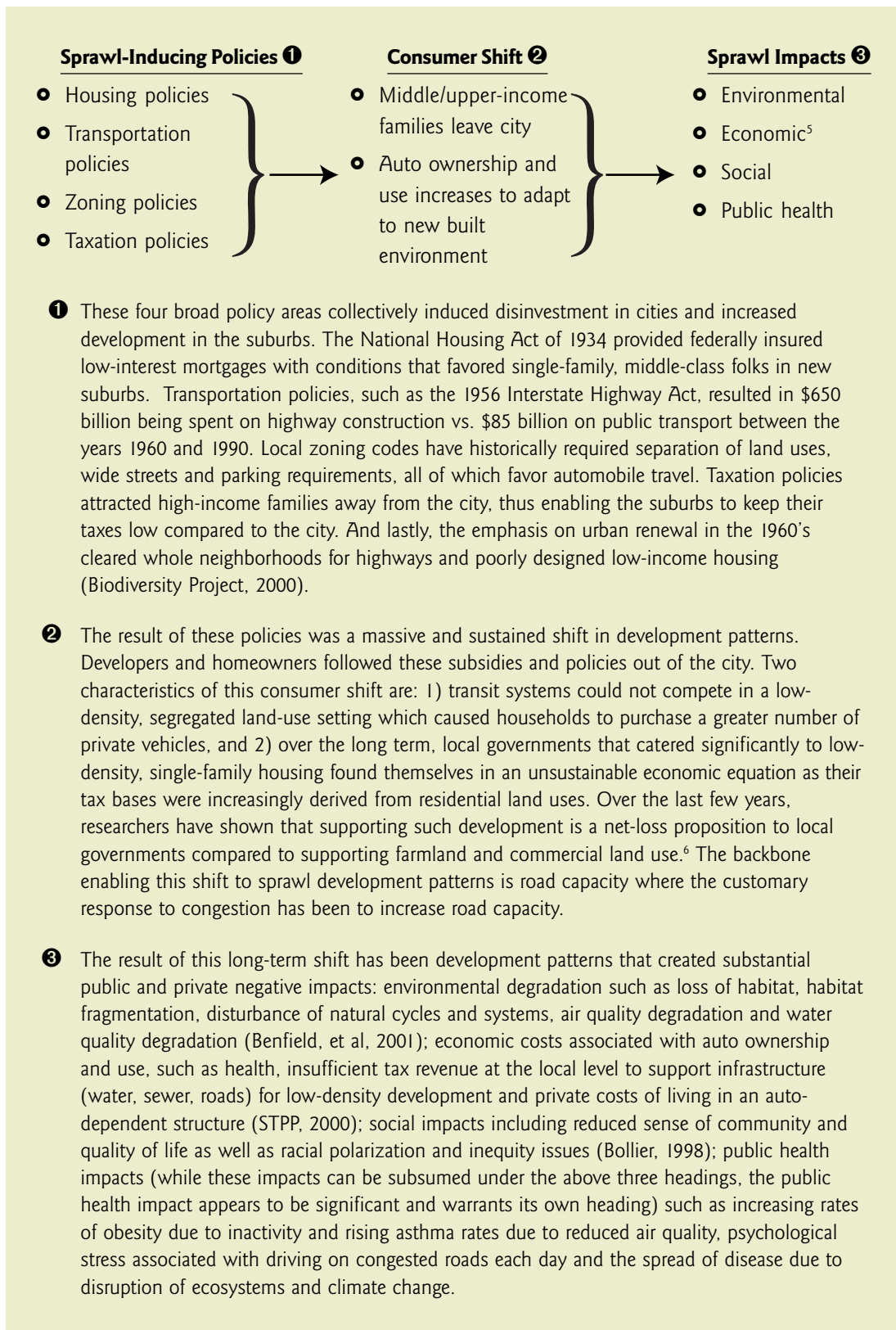
Source: Benfield et al. 1999.

Figure 2: Changes in U.S. Socio-Economic Growth: 1970–1999



Source: BTS, 2000.

Table 2: The Onset of Sprawl



The smart growth movement has emerged as a response and antidote to sprawl development growth patterns and the attendant impacts. There has, in essence, been a consumer backlash to the impacts, if not to the actual development practices, of the last fifty years. For example (SGA, 2002):

- A poll conducted by Smart Growth America found that 76 percent of respondents felt states should do more to manage and plan for new growth.
- Since 1997, eleven states have created statewide growth-related commissions.
- In 1999 more than 1,000 bills were introduced in state legislatures aimed at reforming land use regulations.
- On election day 2000, there were more than 550 growth-related measures on the ballot in 38 states.
- On election day 2000, there were 209 land

conservation measures on the ballot and 83 percent passed resulting in \$7.5 billion for land protection.

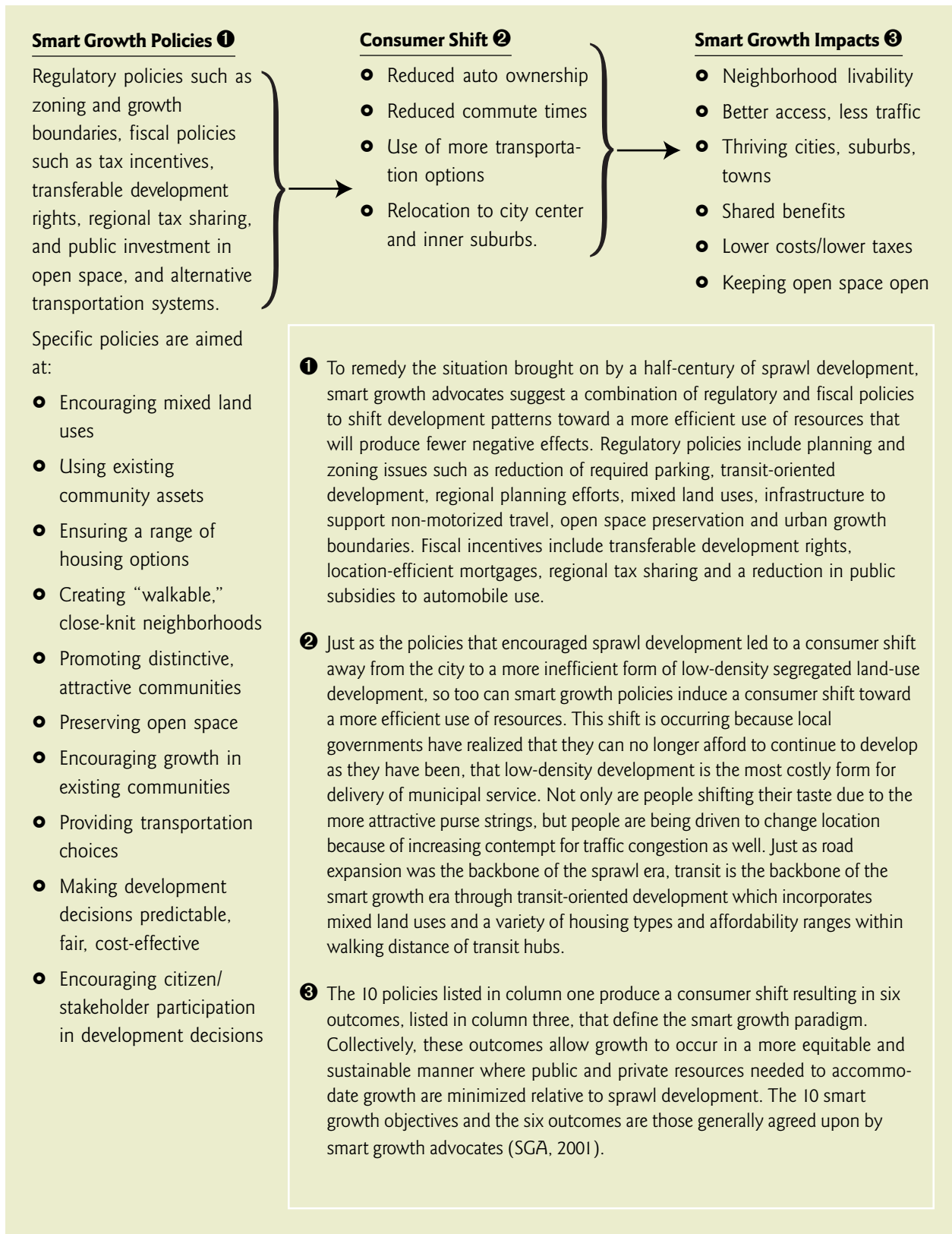
- In a 2000 poll by the Pew Center for Civic Journalism, sprawl ranked highly with crime and education as top concerns for voters.
- On election day 2001, 73 percent of the 113 ballot measures for open space conservation passed, resulting in \$905 million.

In essence, smart growth seeks to implement policies at the federal, state and local levels that will foster mixed land uses, compact design and a transportation system that makes a range of modes available and viable. Growth should produce housing with a range of affordability and should take place as infill development in existing communities. Table 3 provides a simplified look at the smart growth response to sprawl, highlights smart growth-oriented public policies, the associated nascent consumer shift and the results of that shift.



Capital Crescent Trail, Washington, D.C. Photo: Hugh Morris

Table 3: The Smart Growth Response to Sprawl



The above is a brief summary of the last half-century of U.S. development-related fiscal and regulatory policy, the resulting consumer shifts and the impacts of those shifts. Smart growth policies appear to be working (Benfield et al, 2001). For example, in cities that have invested significantly in transit, the share of that mode has been increasing over the last five years: driving has increased by 11 percent while transit use is up 21 percent (SGA, 2002). The use of the word “significant” here is intentional as it appears that a critical mass of transit infrastructure is required before a substantial mode shift occurs (Lewis, D. and F. Williams, 1999). Few areas, however, have chosen to invest significantly in green infrastructure, specifically

bicycle facilities, in a premeditated and systematic way that views such investment as integral to supporting smart growth objectives. Locations that have done so have seen mode shares for non-motorized travel increase as well (see Table 5, page 12). Smart growth advocates recognize the value of trails and greenways, sidewalks and bike lanes, but do not spend significant time substantiating their value to the overall success of the smart growth agenda. However, as the discussion that follows shows, investing in green infrastructure supports a broad range of smart growth objectives and needs to be considered a priority in the smart growth arsenal. The design attributes of trail facilities necessary to achieve the greatest impact are also reviewed.



Washington and Old Dominion Trail, Virginia. Photo: Hugh Morris

III. Discussion

So, how does the development of trails and greenways, particularly in urban areas, advance the smart growth agenda? A detailed and documented examination of the benefits of trails and greenways and how they support smart growth objectives follows. The primary benefits of urban trails and greenways are listed in Table 4.

The benefits of trails and greenways exist to some degree regardless of their design and setting. However, taking transportation planning concepts into account when designing trails can lead to increased usage rates of these facilities and thus many of the associated benefits will be increased.

Induced Travel Demand

Just as negative impacts of auto travel result from the creation and use of an extensive road network, it is possible that the creation of a more extensive bicycle and pedestrian infrastructure will lead to increased use of those modes of travel and all the positive public and private benefits that follow.

The concept of induced travel which, when applied to new road capacity, states that existing people will make new trips because the increase in road capacity (either as a new road creating a more direct link between two points or as widening of an existing congested road) has lowered the cost (in terms of time) of making that trip. This theory has been well researched as it applies to roads.⁷ The same argument of increased capacity on an existing facility (or a new facility) inducing use can be applied to

Table 4: Trail and Greenway Benefits

TRANSPORTATION benefits by facilitating non-motorized trip making and the attendant reduction in emissions, congestion, lost time, societal costs, public costs and personal costs.
ECONOMIC benefits through job creation for gear and services for local residents and tourists, increased property values from proximate location to a desired amenity and retention of industry due to increased quality of life for employees that leads to reduced employee turnover.
PUBLIC HEALTH benefits through increased physical activity levels and reduced auto emissions.
OPEN SPACE benefits through maintenance of wildlife habitat and heat island mitigation provided by tree canopy on the trail or greenway corridor.
EDUCATION benefits through interpretive signs regarding wildlife and historic aspects of corridors. Trails and greenways serve as outdoor classrooms and research has found that students who exercise tend to get better grades in school and experience fewer behavioral problems.
SOCIAL CAPITAL benefits through increased interaction among community members.

green infrastructure that supports non-motorized trip making and physical activity for recreation. If there was no safe, direct way to make a non-motorized trip before the development of a trail, the creation of a trail may induce some people to shift modes (Nelson and Allen, 1997). In the case of trails and greenways, however, the attendant impacts of new facilities and their use are both public and private and are more positive in nature than the same trip made by motor vehicle.

Induced or latent demand for non-motorized travel probably exists because a quarter of all trips are less than one mile in length, an acceptable distance for these non-motorized modes (NGA, 2000). There are few before-and-after studies with regard to implementation of bicycle facilities and the number of trips made, but those that exist support this hypothesis. Table 5 shows how Portland, Ore., significantly expanded its bicycle facility network (on- and off-road) between 1990 and 1999. As the city's investment in these facilities grew, so did their use. Note that during the same ten-year period, the region's population increased by 14 percent and auto use by 8 percent.

Similarly, the city of San Francisco, Calif. added 10.5 miles of on-road bicycle facilities over a period of three years. Before-and-after counts were taken in eight locations. The counts showed increases at all points ranging from 23

percent to 148 percent with an average of 50 percent.

This same principle of capacity expansion, providing a release for pent-up demand, can be applied to green infrastructure as well. Indeed, a Harris Poll from 1991 found that 49 percent of respondents would ride their bike to work if there were a safe route for them. Green infrastructure and trails in particular, have the ability to attract people out of their car for trip making because such trails can often provide a very direct route, a pleasant travel experience, a way to get exercise while making a trip and personal cost savings.

System Extent/Coverage (single trail vs. trail systems)

The second transportation theory that has bearing on the development and use of urban and regional trail systems is the concept of system extent or coverage. In essence, this theory states that there are certain synergies that emerge as a transit system, for example, grows from a single route to two interconnected lines. Take, for example, a transit system that consists of only one north-south line with five stops. The number of origin-destination (O-D) pairs that a person could connect with that line is 20. If a second route running east-west also with five stops is added that intersects the north-south route at

Table 5: Bicycle Facility Investment and Use in Portland, Ore.: 1990–1999

	1990	1995	1999
Network Miles	50	120	200
Funding (cumulative)	\$1 million	\$3 million	\$6 million
Bridge crossings*	1,500	3,000	5,500

Source: personal communication with Mia Birk, Alta Consulting, Portland, Ore.

*Usage rates were counted at three downtown bridge crossings which serve as choke points for travelers entering the downtown core.

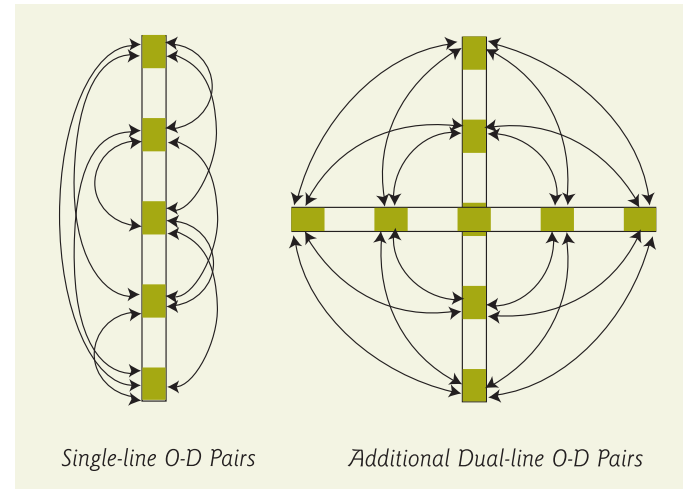
the midpoint, the number of origin-destination pairs jumps to 72 while the maximum travel distance to reach any of the added destinations is no farther than those on the original line (Figure 3). The system extent is further enhanced when consideration is given to how the trail system connects with sidewalks, on-road bike facilities and transit systems.

Trail and Greenway Impact on Smart Growth Objectives

The flow of events in Tables 2 and 3 show that a consumer shift results from a change in public policies. That sequence of events is condensed in the left hand box in Figure 4. The figure highlights the impact of trails and greenways in the sequence at the point where smart growth policies take hold, specifically the self-reinforcing impact that the concepts of induced demand and system extent have on the desired impacts of smart growth policies.

Under the induced demand and system coverage theory, injecting a more substantial bicycle and pedestrian facility network will create a shift from many of the negative consequences of auto use to the positive ones associated with

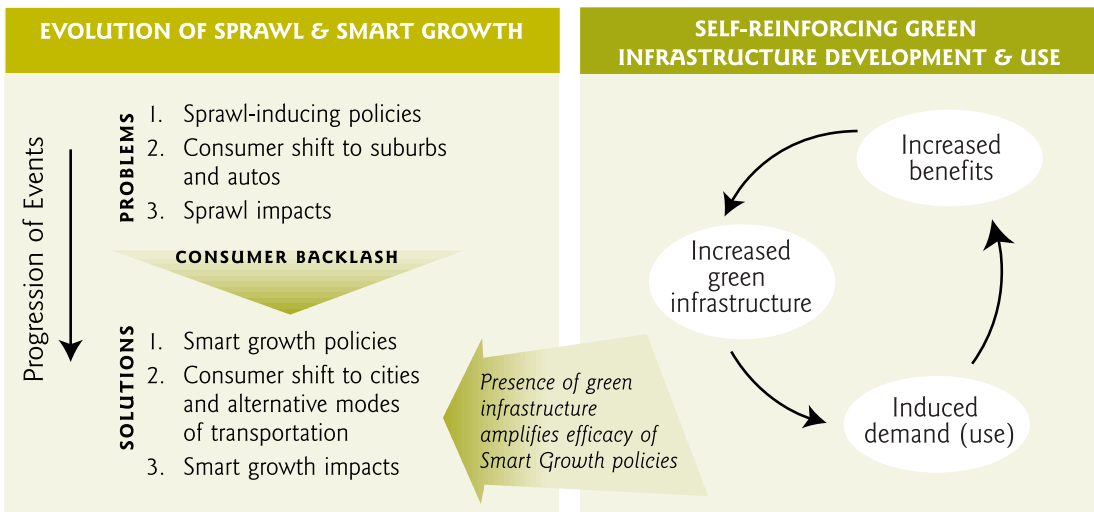
Figure 3: Transit Network Effect



non-motorized travel. These impacts are self-reinforcing and, as the smart growth paradigm takes root, will be reinforced by the broader shift in the built environment.

The policies set forth by Smart Growth America designed to produce a set of results defining smart growth are listed in Table 6. The table also details the impact that trails and greenways will have on obtaining each of the smart growth objectives.

Figure 4: The Impact of Trails and Greenways on Smart Growth Objectives



The impact of increased green infrastructure on the desired outcomes of smart growth objectives is evident, to one degree or another, on eight of the ten smart growth policies. Thus, the implementation of green infrastructure appears to be a logical and basic element in the move to smart growth. The magnitude of some of these impacts has been well researched over the past decade. The following section serves as a distillation of these quantified impacts that support the assertions made in Table 6.

Quantifying the Benefits of Green Infrastructure

There are two contexts from which benefits can be derived from trails and greenways. The first set is derived from the mere existence of the corridor. These benefits are primarily environmental such as air quality improvement, heat island mitigation, habitat preservation and storm-water runoff filtration.

The other category of benefits is derived from the use of the corridor by humans. These benefits include various transportation-related benefits such as air quality improvement, physical and mental health benefits derived from physical activity and economic impacts. It is these benefits that can be magnified if the concepts of induced use and system coverage are kept in mind because these concepts lead to increased usage which, in turn, leads to increased benefits. Increasing system extent also can ensure that the benefits are more equitably distributed among all residents of the region.

The following tables and associated discussions provide a quick reference to the transportation, health and economic benefits of trails and greenways as documented in existing research. These three topics are the most substantially researched of the benefits. Where possible, both usage rates and monetary values of the benefits are listed. The practice of monetizing external costs and benefits of human behavior is fraught with pitfalls and the results are often greeted with skepticism. Nonetheless, the practice has some value in that a sense of magnitude can often be gleaned.

Transportation Benefits

The impacts of making a trip by foot or bicycle are as varied as the impacts of making a trip by motor vehicle. The research cited in Table 7 provides some quantitative insight into how many people are likely to use a trail for trip making as well as the benefits derived from such trips.

Table 6: Impacts of Trails and Greenways on Smart Growth Objectives

Smart Growth Objective	Impact	Comment
❶ Mixed land uses	Direct	Trails and greenways, a form of open space, will inherently add to a mix of land uses.
❷ Using existing community assets	Direct	Many trails are built on abandoned or adjacent to active rail corridors or existing utility rights-of-way, making use of corridors that are already "used."
❸ Ensuring a range of housing options	Indirect/ Supportive	The Location-Efficient Mortgage concept allows homebuyers more purchasing power if they live near a transit line, thus allowing them to forgo the cost of additional cars. Trails can serve as transportation corridors, serving the same alternative transport function as a transit line.
❹ Creating "walkable," close-knit neighborhoods	Direct	Trails and greenways are used for walking, whether for exercise or for making a trip and also serve to bring residents into contact with one another.
❺ Promoting distinctive, attractive communities	Direct	Each trail and greenway is unique, reflecting the characteristics of the setting in which it is created and promoting its own history.
❻ Preserving open space	Direct	Trails and greenways are open space.
❼ Encouraging growth in existing communities	Direct	A variety of home ownership surveys show that people want trails near their homes. Thus, if trails and greenways are built in existing communities they may help attract and retain residents.
❽ Providing transportation choices	Direct	Many urban trails are used for trip making and thus provide a transportation choice to people living near them.
❾ Making development decisions predictable, fair, cost-effective	N/A	
❿ Encouraging citizen/stakeholder participation in development decisions	N/A	

Table 7: Transportation Benefits of Trails and Greenways

Indicator	Value	Reference
Use levels	Weekday user surveys on the Burke-Gilman Trail (Seattle, Wash.), the Pinellas Trail (Tampa, Fla. and several trails in the Washington, D.C. area show that from 35 percent to 45 percent of weekday trail users are making a trip. This percentage translates into 1,000 to 2,000 trips each day. Similar levels (36 percent) of users have been found to be making a trip on the Iron Horse Trail (San Francisco, Calif.)	TR News, 1995. EBRPD, 1998
Use frequency	The same surveys used in the above notation found that commuters used the trail more than three times per week on the Washington, D.C. trails and up to 5 times per week on the Pinellas Trail.	TR News, 1995.
User shed	Trails, like transit, have user sheds. Bicycle commuters on the Burke-Gilman Trail (Seattle, Wash.) tend to originate their trips fairly close to the trail: 38 percent from within ½ mile and 53 percent from within ¾ mile.	Shafizadeh and Niemeier, 1996.
Bike commuter tendency to seek trails	Survey research shows that bike commuters will choose a somewhat longer route so they can use a trail. These same commuters also tended to have longer commutes in general, indicating that people are willing to go further if they can do so on a trail.	Aultman-Hall, 1997.
Trips diverted from motor vehicles	One vehicle trip is eliminated for every two bicycle commute trips and one vehicle trip is eliminated for every five bicycle trips for trip purposes other than commute.	City of Seattle, Wash.
Time lag of impact	The Burke-Gilman Trail (Seattle, Wash.) opened in 1980. A 1985 user survey found that six percent of trail users were making a commuter trip. In 2000, a similar survey found that 32 percent were commuting and another six percent were on a shopping trip.	PSRC, 2000.
Air quality impact	Air quality impacts for the above Seattle, Wash. model are as follows: HC=5.00 grams/mi, CO=42.48 grams/mi and Nox=3.58 grams/mi. per vehicle trip avoided.	City of Seattle, Wash.
Value of trip diverted from motor vehicle to bicycle	Drawing on a variety of research, Litman calculated that a trip diverted from motor vehicle to bicycle has a value of \$3.58 for a 2.5-mile trip in an urban area during rush hour. The costs avoided include congestion, road, parking, gas, air pollution and noise pollution.	Litman, 1999.

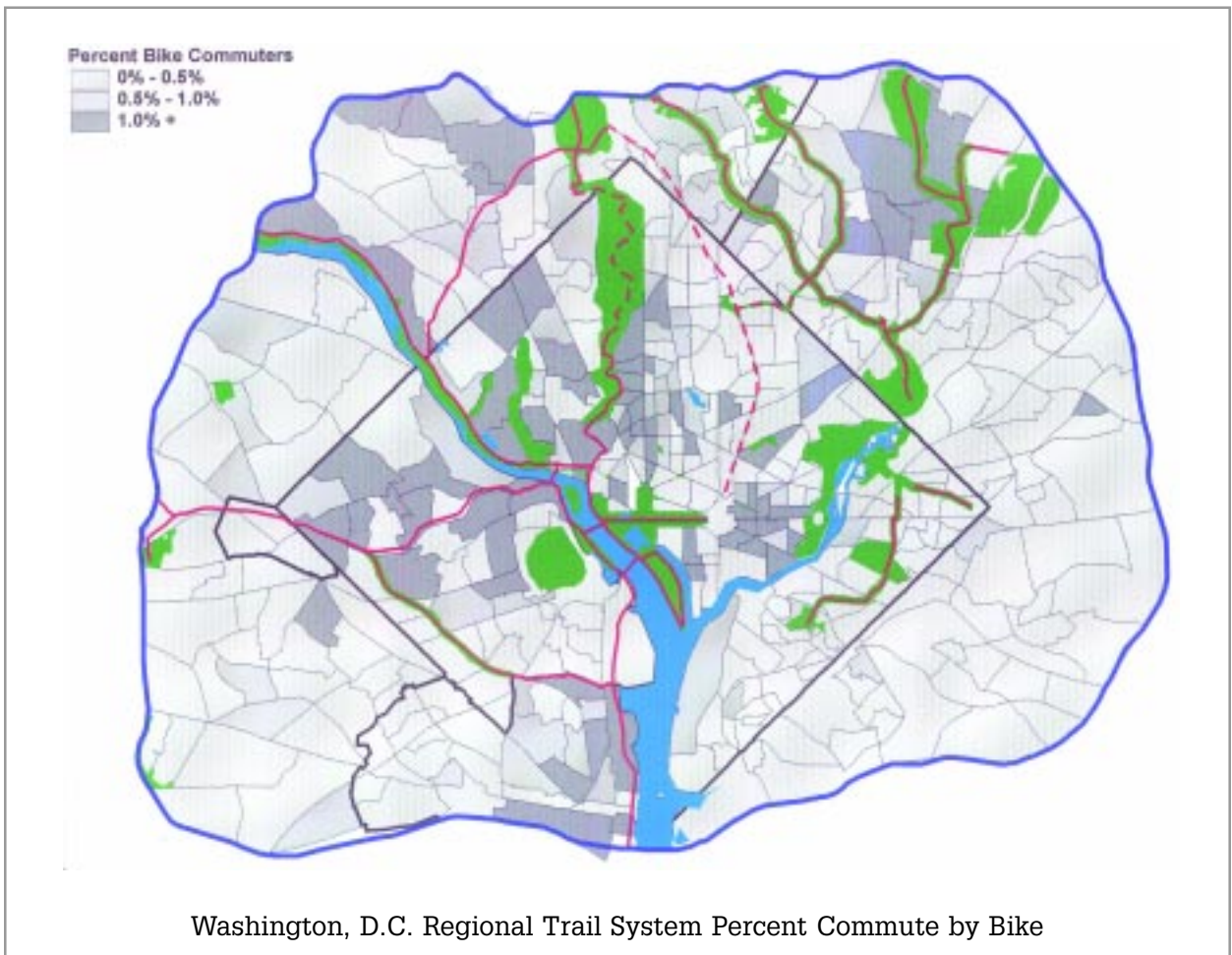
Discussion

It is possible, using some of the above elements, to calculate the value of the transportation trips made on urban trails. Using the low-end estimate of the average number of weekday trip makers (1,000 trips per day from Table 7), the assumptions of the Seattle Engineering Department on the number of single-occupant vehicle (SOV) trips avoided, and the value of a trip diverted from SOV as estimated by Litman (1999)⁸, an urban trail may create total savings (public and private) of \$1,790 per day or \$450,000 per year.

Transportation and land use planners have

long understood the relationship between land development and transportation investment, but it is only recently that the impact of the resulting built environment on human activity patterns, particularly with regard to non-motorized travel, have been explored. The amount of green infrastructure in a community impacts the ability of residents to make non-motorized trips. Figure 5 shows, in red, the trail system in the core area of the Washington, D.C. region. Also shown is the 1990 Census journey-to-work data by Census tract. Tracts with a greater percentage of bicycle work trips have darker shading. As the map illustrates, the tracts with the greatest rates of bicycle commuting tend to fall along the trails.

Figure 5: 1990 Census Journey-to-Work by Bicycle in Washington, D.C.



Health Benefits

Whether a person is on a trail to make a trip or for recreation purposes, he/she derives a health benefit from the physical activity. Research is just beginning to emerge on the impact that trails can have on physical activity levels and the barriers that exist to trail and greenway use. The research is summarized in Table 8. This research is being driven primarily by concern over sharply increased obesity rates.

Discussion

One overlap between transportation and health stems from the mode that children use to get to school. Today, about 10 percent of kids between the ages of five and 15 walk to school. This is down from more than 50 percent in the 1960s. This decline is perhaps one reason why obesity rates in children have risen dramatically in the last twenty years. From the mid-1970s to the mid-1990s, the percentage of trips that

Table 8: Health Benefits of Trails and Greenways

Indicator	Value	Reference
Trail impact on exercise rates	Brownson et al found that 5 percent of trail users indicated that they had increased their amount of walking since they began using the trail.	Brownson, et al. 2000.
Barriers to use	Study of households around the Minuteman Trail in Boston, Mass. found that household usage rate tended to increase as the number of barriers to trail access declined. Identified barriers include distance from trail, inclines and busy streets.	Troped, 2001.
Impact of proximity on use rates	Lindsey et al studied seven trails in Indiana and found that 1) 74 percent of users of the Monon Trail live within four miles of the trail, and 2) for all seven trails, at least 70 percent of users indicated that their participation in some form of physical activity is increased due to the trail.	Lindsey et al, 2001.
Use rates by socio-economic use stratification	Brownson et al found that women, persons with more education and those with higher incomes tended to be more regular users of trails. However, women and persons with less education were more than twice as likely to have increased their amount of walking since they began using the trails. Troped found that females and age were inversely related to amount of trail use.	Brownson, et al, 2001. 2000.Troped, 2001.
Cost of poor air quality	Total costs associated with motor vehicle emissions range from \$28b to \$531b for health and \$2.5b to \$4.6b for crops	USEPA, 2001
Cost of obesity	Increasing participation in regular moderate activity among the more than 88 million inactive Americans over age 15 could reduce annual national medical costs by \$76 billion in 2000 dollars.	Pratt et al. 2000.

children made on foot declined from about 15 percent to 10 percent. During the same period, the percentage of children who were considered overweight rose from six percent to 14 percent (STPP, 2000).

Economic Benefits

The economic impacts of trails are the most studied aspect of their benefits. Moore (1998) itemizes 33 trail economic impact studies. Several of the most relevant studies are summarized below. The economic impact of trails can be classified into two categories: 1) business activity and 2) residential real estate.

Table 9: Economic Benefits of Trails and Greenways

Indicator	Value	Reference
Business activity	Moore conducted one of the first and still most widely cited trail economic impact studies. He studied three rail-trails (two suburban/rural and one urban). The more rural trails had average user expenditures of \$9.21 and \$11.0,2 and the urban trail with significantly more users, \$3.97(1992 dollars). The economic activity of each of three trails was more than \$1.2 million annually.	Moore, 1992
Cost-benefit comparison	This study found that the costs to operate and maintain the trail in 1993 were \$191,893, while the tax revenue garnered from trail-related economic activity was \$303,750.	MDNR, 1994
Job creation	This is one of the only studies to use IM-PLAN, a computerized input-output analysis program to analyze the economic impacts of trail users. The study found that the economic activity of the Ghost Town Trail supported 4.7 jobs in the region based on the 66,000 annual visitors to the trail.	Strauss, 1996
Real estate values	A half dozen trail studies have consistently found that the majority of people owning homes along a trail (as well as real estate agents) believe that the presence of a trail near their home will make it easier to sell. These two studies are the only two that have quantified that perception. In a new housing development, lots immediately adjacent to the trail sold for \$2,800 (nine percent) more per lot than those not adjacent. The lots adjacent to the trail also sold faster. Real property near but not immediately adjacent to the Burke-Gilman Trail (Seattle, WA) was easier to sell and sold for an average of six percent more. Property immediately adjacent to the trail was only slightly easier to sell and sold for no more than a one percent premium.	Moore, 1992 NPS, 1995 Brown County, 1998 SED, 1987

Discussion

Though the smart growth impacts listed in the third column of Table 3 do not expressly mention economic development, the topic permeates the list. Trails and greenways support a variety of small business such as bike shops, cafes, as bed and breakfasts. The creation of such enterprises advances neighborhood livability, access, and helps to maintain a thriving city. These small businesses help create unique neighborhoods and provide work options for persons in a variety of life stages.

Unquantified Benefits

The above discusses the three primary and most heavily studied aspects of trails and greenways. Other benefits, both public and private, also accrue from the preservation or creation of open space when a trail or greenway is created. For example, many urban areas experience the heat island effect where the dark surfaces that make up our roads and rooftops absorb heat and can cause urban areas to suffer temperatures that are approximately eight degrees Fahrenheit higher than the surrounding area. One method of mitigating that effect is to maintain as much foliage as possible, a benefit of trails and greenways. This leads to reduced power consumption because less air conditioning is desired (Estes, 1999).

Though less concretely established, trails and greenways help promote an increase in social capital. Face-to-face interaction with neighbors has been shown to increase a sense of community and reduce crime because neighbors who know each other are more likely to look out for each other and each other's children.



Cape Cod Rail-Trail, Mass.

A Note on Equity and Green Infrastructure Investment⁹

The imbalance between the built environment and available travel options ignores the needs of nearly one-third of Americans who don't drive because they are too young, too old, or cannot manage a car for some other reason. The impacts of this imbalance appear to fall disproportionately on the low income, minority, youth and elderly. Two of the more significant impacts are health and finance related.

Health

Health impacts are of two varieties: death and injuries caused by pedestrian-car collisions and the reduction of exercise caused by the decline in non-motorized transport. The environment we have built is dangerous for children. Between 1995 and 1999 4,815 children were killed by cars while they were walking or biking. The distribution of these deaths is not equal. For example, in California in 1996, African American and Latino children made up 46 percent of the population, yet they suffered 62 percent of deaths by car while they were walking or biking.

As mentioned earlier, there is significant impact on our health from the way we have built our communities. In cities where the infrastructure and land use development are such that non-motorized trips are possible, weight gain and its attendant health impacts, such as an increase in diabetes, are substantially less. In Memphis, the average person walks 40 yards each day and 42 percent of the population is overweight. In San Francisco, which has significant transit options coupled with a built environment that is dense enough to encourage non-motorized travel, the average person walks 400 yards per day and 25 percent of the population is considered overweight. This impact is particularly acute in children. There has been a significant decline over the last several decades in the number of children who walk or bike to

school. Again, it is minority children who suffer the most with 12 percent of African American and Latino children being overweight compared with nine percent of white and other ethnicities.

Monetary

The way our transportation infrastructure and land development is currently designed has significant monetary cost to households. The transportation share of the average household budget now ranks second to shelter, consuming 17.9 cents of every dollar spent compared to 19.0 cents for shelter. There are even some metro areas, such as Houston, Pittsburgh, Atlanta, St. Louis and Tampa, where household expenditures for transportation exceed shelter. Low-income households are hit particularly hard by this arrangement, with the lowest household income quintile spending 36 percent of their budget on transportation compared with 19 percent for the middle quintile and 14 percent for the highest quintile. The long-term impact of this expenditure pattern is significant: Spending money on a home helps to build wealth while spending money on a car does not.

Equitable Distribution of Facilities

The development of trails and greenways can help alleviate conflicts with motor vehicles and obesity, but investment in such facilities has not always been equally distributed with regard to race and income. While this trend may be changing (Figures 6 and 7 on page 22 show the racial and income distributions by Census tracts for the Washington, D.C. region along with the locations of trails), the results show that, to date, such infrastructure has tended to have been built in the whiter, wealthier neighborhoods.

Figure 6: 1990 Census Income by Census Tract in Washington, D.C.

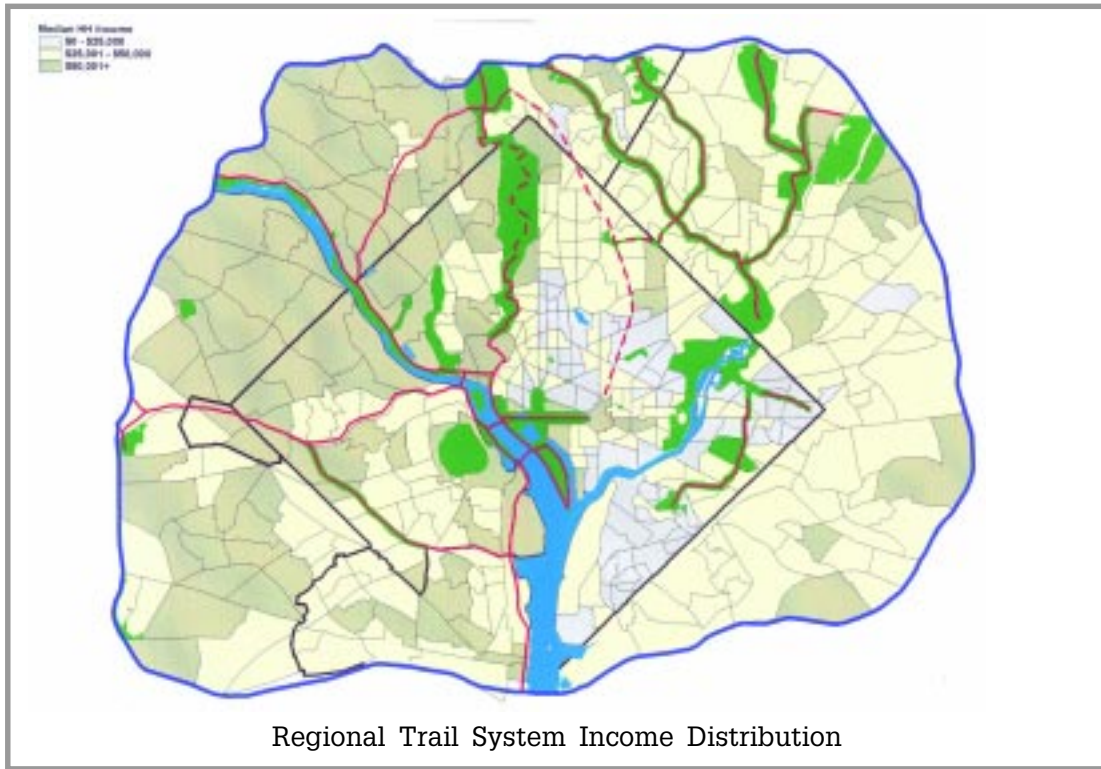
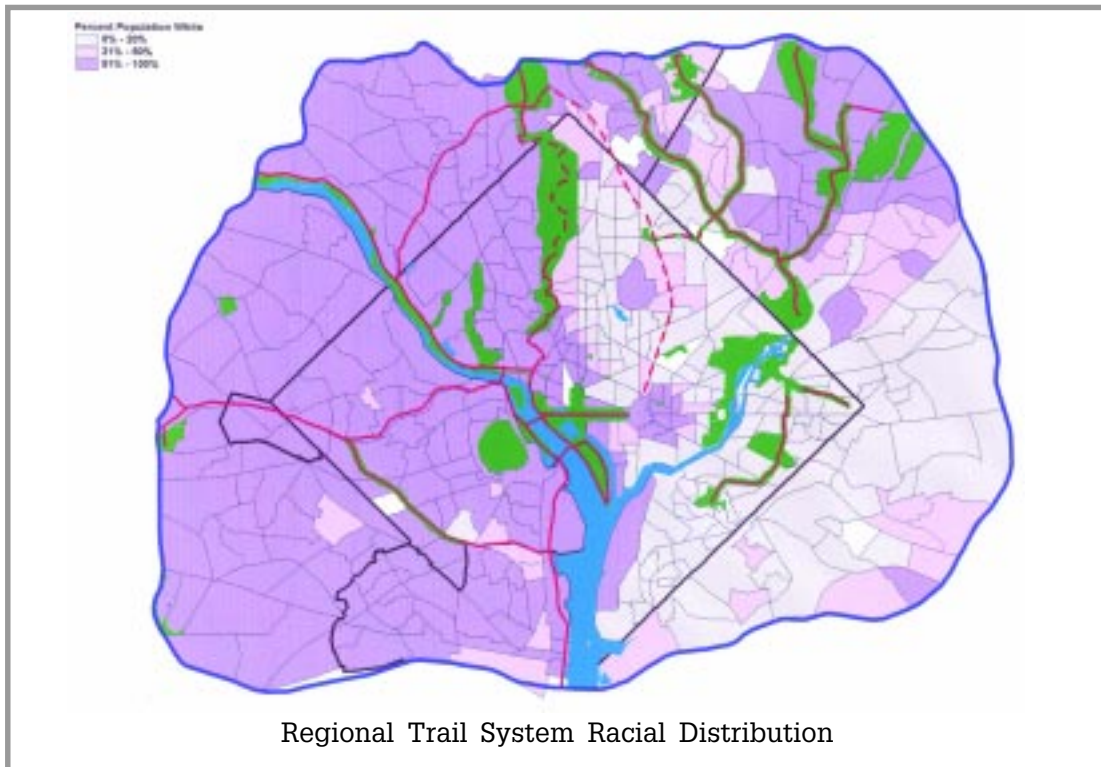






Figure 7: 1990 Census Race by Census Tract in Washington, D.C.



Part IV: A Visual Representation of Benefits and Design Attributes

The following series of photographs demonstrates the design and land use features that need to be present for a community to derive maximum benefits from a trail and greenway system. Each of the benefits associated with the development and use of trails are illustrated with photographs of the Capital Crescent Trail and the Washington & Old Dominion (W&OD) Trail, both in the Washington, D.C. region. These illustrations could have been made using photographs from a variety of trails from around the country but a more compelling case is made when all benefits are illustrated with a single trail and thus underscore the ability of a single facility to deliver multiple benefits.

Transportation		
	Capital Crescent Trail	Washington & Old Dominion Trail
<p>Trip Makers People use trails and greenways to make trips. Sometimes the facility is used to make the whole trip or as a way to access a transit station.</p>		
<p>Access Points The more access points a trail or greenway has the more people will be able to access the facility easily. Access points can be for people arriving at the trail by car, foot or bicycle.</p>		

Transportation

Capital Crescent Trail

Washington & Old Dominion Trail

Signs

Signs of all kinds are useful to trail users. System-wide maps as well as specific directional signs are useful for letting people know where they are, how to get to their destination and what destinations are possible to reach from the facility.



Destination Infrastructure

A trip by any mode is like a chain and each step is a link. If a link is faulty the strength of the entire chain is in jeopardy. Likewise, with non-motorized trip making; a lack of parking can jeopardize the trip.



Transit Connection

Green infrastructure can help connect people to transit facilities, extending the normal capture range from about 1/3 mile to 2 miles if safe and secure bicycle parking is provided.



Discussion:

The benefits of making a non-motorized trip are manifold. There are personal benefits, such as getting some exercise and saving money on gasoline, tolls and parking. There also are public benefits such as reduced congestion, energy consumption and air pollution. Many of the urban trails that connect a variety of land uses have an asphalt surface, gentle curves and grades and appropriate facilities at the destination, carry a large number of trip makers. The Pinellas Trail in Tampa, Florida, the Burke-Gilman Trail in Seattle, the Minuteman Trail in Boston, and several trails in the Washington, D.C. region, consistently show that one-third of weekday users are making a trip. This percentage represents 1,000 to 2,000 trips each day being made on these trails. Frequent access points to the trail, such as those shown above, allow more people to conveniently use the facility. Signs indicating exit points to various community resources help people figure out how to use the trail for trip making. Connections to transit facilities are also beneficial because the capture area for the transit facility is expanded. Given that 40% of daily auto trips are to a destination less than two miles away, there appears to be a large potential market for non-motorized trips if the infrastructure is there to accommodate them.

Recreation

Capital Crescent Trail

Washington & Old Dominion Trail

Recreation

Trails and greenways are primarily used for recreation and can easily accommodate a wide range of uses.



Parallel Tread

One design method for accommodating a wide range of uses is to develop a parallel tread for runners or equestrians. This can provide a surface most desired by those use types and help to reduce trail-user conflicts by segregating user types.



Connections to Community Facilities

Green infrastructure can connect people to other types of recreational facilities such as swimming pools and basketball courts.



Discussion:

Multi-use trails can accommodate a wide variety of users such as bikers, walkers, joggers, inline skaters and equestrians. Inline skaters tend to only use trails that have an asphalt or concrete surface while equestrians prefer a soft surface. One study from the Minnesota Department of Natural Resources found that trail use increased by as much as one third when a hard surface is used because of the inline skaters. Whatever form the recreation takes, individual physical fitness benefits accrue. Using the trail may be only part of the recreation outing as many trails allow people to access other community recreation facilities such as parks, playgrounds and pools.

Economic Enhancement

Capital Crescent Trail

Washington & Old Dominion Trail

Business Access

Many businesses located near trails see an increase in business from trail users. Businesses located near a trail allow people to make non-motorized trips.



Residential Access

People who live near trails have easy access that facilitates their use of the trail for both recreation and trip making.









Discussion:

The economic impact of trails and greenways is perhaps the most studied benefit such facilities bring to a community. Studies have been conducted over a twelve-year period in numerous geographic locations and have revealed that the economic benefits are twofold. Businesses that provide services to trail users have seen revenue increase once the trail was built. These include restaurants, lodging facilities and bike shops. Some trails that are considered destinations in their own right also have economic impact from other support services such as motor fuel. One study of three trails found that each trail was responsible for an average annual economic impact of \$1.5 million. The makeup of this economic activity varies depending on the location of the trail. For example, urban trails that are used primarily by nearby residents for recreation and trip making have a greater number of users who tend to spend less, purchasing primarily refreshments. Longer, more rural trails that are a destination in their own right tend to attract fewer users but generate greater spending per user.

Another type of economic impact is on residential property values. While it is difficult to accurately assess the impact of anything on the value of real estate, studies have shown that close proximity of a trail to a residence tends to make the property easier to sell and may have a modest positive impact on the value of the home. Strong anecdotal evidence points to a positive influence. Real estate agents frequently advertise the fact that a home is near a trail. They would not be doing this if they thought such action would jeopardize the price of the home or the ability to sell it. Over time, as more people who like to use the trail move closer to it, the usage rates increase, particularly for trip making

Habitat Preservation

	Capital Crescent Trail	Washington & Old Dominion Trail
<p>Trees Trail and greenway corridors tend to be wider than the trails they contain and thus offer an opportunity to develop a rich variation in natural habitat. From a substantial tree canopy...</p>		
<p>Wildlife/Flowers ...to wildflowers, these corridors hold an abundance of wildlife.</p>		
<p>Buffer/Riparian Many trails and greenways are built along rivers and streams. This allows the facility to act as a buffer between the waterway and the human environment.</p>		

Discussion:

The environmental value of preserving a corridor has many facets. Urban areas tend to suffer from the “heat island” effect when city temperatures can be as much as 10 degrees higher than surrounding areas due to the dark surfaces of roads and roofs which absorb heat. Trail and greenway corridors that maintain significant foliage can help offset this effect. Corridors also serve as habitat for rare plant life such as native prairie grasses and are used as living quarters for a variety of animals.

Trails and greenways also can provide watershed benefits by absorbing and filtering rain water runoff before it enters a stream.

Social Capital

Capital Crescent Trail

Washington & Old Dominion Trail

Interaction

Trails and greenways are often used as gathering spots and facilitate spontaneous social interaction as people come upon their neighbors on the trail.



Art

More and more trails are integrating art into the facility either for its own sake or as a way to camouflage what might otherwise be a rather industrial-looking component of the trail.



No photo available

Discussion:

One impact of sprawl development has been a decrease in random social interaction between known and unknown people. As people go directly from their house to their car to their destination the opportunity for spontaneous social interchange is eliminated. Green infrastructure provides opportunities for such spontaneous interaction to occur, perhaps replacing the role the front porch once played in allowing spontaneous interaction between neighbors.

Multi-Use Corridor

Capital Crescent Trail

Washington & Old Dominion Trail

Utility Above Ground

Long, skinny stretches of land are ideal not only for trails but for all kinds of utilities. Some run above ground, such as electrical wires...



Utility Below Ground

...while others run below ground, such as fiber optic cables.

No subsurface utility use in Capital Crescent corridor.



Discussion:

Trail and greenway corridors can be useful to a variety of enterprises. Not only can they accommodate trails that provide all the benefits listed above, but utilities such as telephone, sewer, water, gas and fiber optic have all used trail corridors to transmit their products. Such use can be beneficial to the corridor owner, who can receive monetary or in-kind benefits from the utility company. Though not accommodated on the Capital Crescent Trail or Washington & Old Dominion Trail corridors, trails made from rail corridors also can continue to be used for train service. More than sixty such rail-with-trail corridors now exist in the United States. Such shared use is now being considered for part of the Capital Crescent Trail.

Original Corridor Attributes

Capital Crescent Trail

Washington & Old Dominion Trail

History

Many corridors containing trails, particularly rail-trails, have an interesting historical component that appeals to many people. Trails will often highlight this aspect of the history through interpretive signs.



Original Railroad Infrastructure

Many rail-trails utilize the original infrastructure from the railroad such as tunnels and mileage markers...



...to bridges and railroad cars used as rest stops.



Discussion:

Many trails and greenways, rail-trails in particular, have historical attributes that attract people and can be used to make the trail an interesting place to be. The original bridges and tunnels are often the most difficult and costly elements of a trail project, but they also serve to galvanize supporters during the development state and serve as an attraction point once the project is complete. Trails made from rail corridors often connect place of significant historical interest, such as battlefields, and thus opportunities exist for interpretive signs highlighting these historic events. Also, reuse of original bridges and tunnels is a form of recycling.

A Note on Trail Design Considerations

Just as demand for auto and transit use is based on the variety and density of land uses and surrounding design factors, the level of use and purpose of use of a trail is determined by many of the same factors:

- **Number of competing facilities in the region:** If multiple facilities exist in relatively close proximity to one another and connect the same origins and destinations, they may compete for the quantity of users in the area. If users perceive one facility to be more crowded than another, they may switch to using the other.
- **Number of people living/working within proximate distance of the facility:** Some research has shown that people are more likely to use a trail or greenway if the facility is within a mile or so of their residence. This is particularly true for commute trips. This behavior is consistent with transit user sheds which typically find that transit users live within a 10 to 15 minute walk of the transit stop. Beyond that distance, the mode, transit or trail, loses efficiency.
- **Mix of land uses around the facility:** If a trail is surrounded by only one land-use type, such as residential, trail users can only use the trail for the trip purpose of visiting a friend. However, if the trail also connects to employment centers, schools, libraries and shopping areas, trip makers can use the trail for accessing those land-use types as well.
- **Number of access points to the facility:** If a trail were designed so that it connected a variety of land-use types but the only access points to the trail were at the end points and not along the way, only those land uses at the end points would be viable destinations. Trails such as the heavily used W&OD in suburban Washington, D.C.,

have access points into the surrounding neighborhood roughly every 100 yards.

- **Length of the facility:** The longer a trail is, the more community resources it can connect.
- **Trail system/network vs. single facility:** As the discussion on system extent pointed out, a network of interconnecting trails is substantially more useful for trip making because it has the ability to connect people to more places.
- **Trail surface, signs, site lines and maintenance:** Design characteristics of the trail itself are important. Bike commuters like to go fast and that is best achieved on an asphalt trail with minimal grade and gentle curves.
- **Facilities at destination to secure bike and change attire:** A chain is only as strong as its weakest link and the use of a trail for trip making is no exception. If there is no place to safely park one's bike at the end of the trip then the trip will not be made. Also important is a place for the commuter to wash and change.

V. Summary and Conclusions

The transportation-land use connection is now fairly well established. Certain constructs, such as low-density development, segregated land uses and lack of transportation options, conspire to favor the automobile. Conversely, higher density development, mixed land uses and a variety of transportation options make transit and facilities for walking and bicycling viable options for people when they want to get to their desired destination. For a variety of reasons (health concerns, environmental concerns, cost savings and a more productive use of time) people will often choose alternative modes if given the choice. One thing is clear: The success any community may have in reducing single-occupant vehicle auto travel is dependent on alternative means of travel being available and viable. Various non-auto means of travel even support each other as people often bike or walk to a transit stop.

Many of the benefits that a community can expect from the development of green infrastructure have, at their core, the ability of a person to make a trip by non-motorized means. These benefits will not materialize unless the appropriate land use and infrastructure are present.

The current low rates of non-motorized trip making appear to exist not because of lack of desire, but rather because of the lack of infrastructure that supports non-motorized trips. Green infrastructure, bike lanes, sidewalks, trails and greenways provide the infrastructure that makes non-motorized trips not only possible, but enjoyable. The benefits of these facilities reach far beyond benefits of non-motorized trip making and include health, heat island mitigation and storm water runoff filtration to name a few. All in all, this collection of benefits substantially furthers a community's drive to grow smartly.



Capital Crescent Trail, Washington, D.C. Photo: Hugh Morris

References

General References

- AFT, 1986. "Density-Related Public Costs." American Farmland Trust. Washington, D.C.
- AFT, 1992. "Does Farmland Protection Pay? The Cost of Community Services in Three Massachusetts Towns." American Farmland Trust. Washington, D.C.
- Aschauer, D., 1991. "Transportation Spending and Economic Growth: The Effects of Transit and Highway Expenditures." American Public Transit Association. September.
- Benfield, F. K. et al, 2001. "Solving Sprawl: Models of Smart Growth Communities Across America." Natural Resources Defense Council. Washington, D.C.
- Biodiversity Project, 2000. "Making the Biodiversity-Sprawl Connection." Biodiversity Project. Madison, Wis.
- Birk, M., 2000. Personal communication.
- Bollier, D. 1998. "How Smart Growth Can Stop Sprawl: A Fledgling Citizen Movement Expands." Essential Books. Washington, D.C.
- BTS, 2000. "Pocket Guide to Transportation." U.S. Department of Transportation, Bureau of Transportation Statistics. December.
- Bullard, R. D., et al. Ed. 2000. "Sprawl City: Race, Politics, and Planning in Atlanta." Island Press. Washington, D.C.
- Burchell, R. 1992. "Impact Assessment of the New Jersey Interim State Development and Redevelopment Plan." New Jersey Office of State Planning.
- CDC, 2001. "How Land Use and Transportation Systems Impact Public Health: A Literature Review of the Relationship Between Physical Activity and Built Form." Centers for Disease Control and Prevention. Atlanta, Ga.
- EJRC, 2000. "Transport Equity." A Newsletter of the Environmental Justice Resource Center, Clark Atlanta University. Atlanta, Ga. Vol. 3, No. 1. Fall/Winter.
- Garvin, A., and G. Berens. 1997. "Urban Parks and Opens Space." Urban Land Institute. Washington, D.C.
- Harnik, P. "Inside City Parks." Urban Land Institute, Washington, D.C. 1999.
- JCCI, 2000. "Quality of Life in Jacksonville: Indicators for Progress." Jacksonville Community Council, Inc. Jacksonville, Fla. December.
- JCSC, Date unknown. "Measuring Progress: Profiles of City and County Indicator Programs." Joint Center for Sustainable Communities. National Association of Counties. Washington, D.C. The U.S. Conference of Mayors. Washington, D.C.
- Myers, P. and R. Puentes, 2001. "Growth at the Ballot Box: Electing the Shape of Communities in November 2000." The Brookings Institution, Washington, D.C.
- Nelson, A. and D. Allen, 1997. "If You Build Them, Commuters Will Use Them: Cross-Sectional Analysis of Commuters and Bicycle Facilities." Proceedings from the Transportation Research Board Annual Meeting. See: <http://www.enhancements.org/trb/1578-10.pdf>
- Newman, P.W.G. et al., 1996. "Human Settlements." Australian State of the Environment Report, Department of Environment, Sport, and Territories, Australian Government Publishing Service, Canberra.
- Newman, P. and J. Kenworthy, 1999. "Sustainability and Cities: Overcoming Automobile Dependence." Island Press. Washington, D.C.

- NGA, 2000. "In the Fast Lane: Delivering More Transportation Choices to Break Gridlock." National Governors Association. Washington, D.C.
See: <http://www.nga.org/cda/files/001129TRANSREPORT.pdf>
- Porter, D. R., 2000. "The Practice of Sustainable Development." Urban Land Institute. Washington, D.C.
- Putnam, R. D. 2000. "Bowling Alone: The Collapse and Revival of American Community." Simon and Schuster. New York, NY.
- Roberts, I., et al. Date Unknown. "Pedaling Health: Health Benefits of a Modal Transport Shift." Department of Transport of South Australia.
- SGA, 2000. "Greetings from Smart Growth America: Americans Want Smarter Growth. Here's How to Get There." Smart Growth America. Washington, D.C.
- SS, 1998. "Indicators of Sustainable Community: A Status Report on Long-Term Cultural, Economic, and Environmental Health for Seattle/King County." Sustainable Seattle. Seattle, Wash.
- STTP, 2000. "Mean Streets 2000." Surface Transportation Policy Project. Washington, D.C.
- STTP, 2001. "Driven to Spend." Surface Transportation Policy Project. Washington, D.C.
- Suarez, R. 1999. "The Old Neighborhood: What We Lost in the Great Suburban Migration: 1966-1999." The Free Press, Simon and Schuster, New York, NY.
- USIWGSDI, 1998. "Sustainable Development in the United States: An Experimental Set of Indicators." U.S. Interagency Working Group on Sustainable Development Indicators. Washington, D.C. 1998.
- Washington Post, 2001. "Suburbia's Road to Weight Gain: Land-Use Designs Discourage Pounding the Pavement, Some Say." The Washington Post, Metro Section, page C1. Washington, D.C. January 21.

References by Topic

AIR QUALITY

- City of Seattle, Wash. Bike Spot Program (CM-1140(17)) and Burke-Gilman Trail Expansion Air Quality Analysis.
- Welzenbach, K. D., 1996. "Analysis of the 1995 Bicycle Survey of Suburban Bike Trails." Chicago Area Transportation Study. Working Paper #96-08. June.

ECONOMIC

- Brown County. 1998. "Recreation Trails, Crime, and Property Values: Brown County's Mountain Bay Trail and the Proposed Fox River Trail." Brown County Wisconsin Planning Commission. July.
- Farber, S. 1999. "An Economic Impact Study for the Allegheny Trail Alliance." Pennsylvania Economic League, Inc. January.
- Greer, D. 2000. "Omaha Recreational Trails: Their Effect on Property Values and Public Safety." University of Nebraska at Omaha, Recreation and Leisure Studies Program. June.
See: <http://www.americantrails.org/resources/adjacent/OmahaStudy.html>
- MDNR, 1994. "Analysis of Economic Impacts of the Northern Central Rail Trail." Maryland Department of Natural Resources, Maryland Greenways Commission.
See: <http://ntl.bts.gov/DOCS/430.html>
- Moore, R. L. 1998. "The Economic Impact and Uses of Long-Distance Trails." U.S. Department of Interior, National Park Service.

Moore, R. L., et al. 1992. "The Impact of Rail-Trails: A Study of the Users and Property Owners from Three Trails." Rivers, Trails and Conservation Assistance Program, National Park Service. Washington, D.C.

NPS, 1995. "Economic Impacts of Protecting Rivers, Trails and Greenway Corridors." National Park Service, Rivers and Trails Conservation Assistance Program.

See: http://www.nps.gov/pwro/rtca/econ_all.pdf

OGT, 1998. "Thinking Green: A Guide to the Benefits and Costs of Greenways and Trails." Florida Department of Environmental Protection, Office of Greenways and Trails.

See: <http://www.dep.state.fl.us/gwt/publications/publications/thinkgreen.pdf>

SED. 1987. "Evaluation of the Burke-Gilman Trail's Effect on Property Values and Crime." Seattle, Wash. Engineering Department, Office of Planning. May.

Strauss, C. H. and B. Lord. 1996. "Economic Impact of Ghost Town Trail in the Indiana and Cambria Counties Region." Indiana County Parks, Indiana, Penn. October.

ENVIRONMENT

BP, 2000. "Making the Biodiversity-Sprawl Connection." Biodiversity Project. Madison, Wis.

Estes, M. et al. 1999. "The Urban Heat Island Phenomenon and Potential Mitigation Strategies."

See: <http://www.asu.edu/caed/proceedings99/ESTES/ESTES.HTM>

Rosenfeld, R. et al. "Painting the Town White-and Green."

See: <http://eetd.lbl.gov/HeatIsland/PUBS/>

HEALTH

Anderen, L. B. et al, 2000. "All-Cause Mortality Associated with Physical Activity During Leisure Time, Work, Sports, and Cycling to Work." Archives of Internal Medicine, American Medical Association. Washington, D.C.

See: <http://www.archinternmed.com>

Brownson, R.C., et al. 2000. "Promoting Physical Activity in Rural Communities: Walking Trail Access, Use, and Effects." *American Journal of Preventive Medicine*. Vol. 18, No. 3. April.

See: <http://www.elsevier.com>

Brownson, R. C., et al. 2001. "Environmental and Policy Determinants of Physical Activity in the United States." *American Journal of Public Health*. Vol. 19, No. 12. December.

See: http://www.apha.org/news/press/2001_journal/dec01.htm

Frank, L. and P. Engelke. "How Land Use and Transportation Systems Impact Public Health: A literature review of the relationship between physical activity and built form." Centers for Disease Control and Prevention, Physical Activity and Health Branch. Atlanta, Ga.

See: <http://www.cdc.gov/nccdphp/dnpa/pdf/aces-workingpaper1.pdf>

Frank, L. and P. Engelke. "How Land Use and Transportation Systems Impact Public Health: An annotated bibliography." Centers for Disease Control and Prevention, Physical Activity and Health Branch. Atlanta, Ga.

See: <http://www.cdc.gov/nccdphp/dnpa/pdf/aces-workingpaper2.pdf>

Hellmich, N. 2002. "Houston, We Have a Problem: City Again Named Fattest in U.S." *South Sound Living*. January 4.

See: <http://www.news.theolympian.com>

Killingsworth, R. and J. Lamming, 2001. "Development and Public Health: Could our development patterns be affecting our personal health?" *Urban Land*. July.

See: http://www.lgc.org/freepub/land_use/articles/devlop_and_publichealth.html

Lindsey et al. 2001. "Summary Report, Indiana Trails Study: A Study of Trails in 6 Indiana Cities." Indiana University, Eppley Institute for Parks and Public Lands. November.

See: <http://www.indiana.edu/~eppley/trails/>

Meriweather, H. 2002. "Feet Forward to a Healthier City, Region." *Detroit Free Press*. February. Editorial Section, Page 3E.
See: <http://www.detroitfreepress.com>

Roberts, I., et al. "Pedalling Health: Health Benefits of a Modal Transport Shift."
See: <http://www.bikefed.org/PDF/Cyhealth.pdf>

Sallis et al. 1999. "Effects of Health-Related Physical Education on Academic Achievement: Project SPARK." *Research Quarterly for Exercise and Sport*. Vol. 70, #2.

Troped, P. J., et al. 2001. "Associations Between Self-Reported and Objective Physical Environmental Factors and Use of a Community Rail-Trail." American Health Foundation and Academic Press, *Preventive Medicine* No. Vol. 32, No 191-200.
See: www.idealibrary.com <http://www.idealibrary.com>

USDOHH, 2001. "The Surgeon General's Call to Action to Prevent and Decrease Overweight and Obesity: 2001." U.S. Department of Health and Human Services, Public Health Service, Office of the Surgeon General. Rockville, Md.

USEPA, 2001. "Our Built and Natural Environments: A Technical Review of the Interactions Between Land Use, Transportation, and Environmental Quality." U. S. Environmental Protection Agency. Publication #EPA-231-R-01-002. Washington, D.C.
See: <http://www.smartgrowth.org>

Wolford Symons, C. 1997. "Bridging Student Health Risks and Academic Achievement Through Comprehensive School Health Programs." *Research Quarterly for Exercise and Sport*. Vol. 67, #6.

INDUCED TRAVEL

Fulton, L. M., et al, 2000. "A Statistical Analysis of Induced Travel Effects in the U.S. Mid-Atlantic Region." *Journal of Transportation and Statistics*, Vol. 3, No. 1.
See: <http://www.bts.gov/jts/V3N1/fulton.pdf>

Noland, Robert B., and Lewison L. Lem, 2000. "Induced Travel: A Review of Recent Literature and the Implications for Transportation and Environmental Policy", paper to be presented at the European Transport Conference, September.
See: <http://www.cts.cv.ic.ac.uk/staff/wp2-noland.pdf>

OPEN SPACE

Benedict, M. and E. McMahon, 2002. "Green Infrastructure: Smart Conservation for the 21st Century." *Sprawl Watch Clearinghouse*. Washington, D.C.

Barrette, M. 2001. "Parks and the City: Frederick Law Olmstead Started it All." *Planning Magazine*, American Planning Association. August.
See: <http://www.planning.org>

ENN, 1999. "Team Probes Atlanta Heat Island." *Environmental News Network*. March 24.
See: <http://www.enn.com>

SMART GROWTH

Benfield, F. K. et al, 1999. "Once There Were Greenfields: How Urban Sprawl is Undermining America's Environment, Economy and Social Fabric." *Natural Resources Defense Council*. Washington, D.C.

Benfield, F. K. et al, 2001. "Solving Sprawl: Models of Smart Growth Communities Across America." *Natural Resources Defense Council*. Washington, D.C.

Bollier, D. 1998. "How Smart Growth Can Stop Sprawl: A Fledgling Citizen Movement Expands." *Essential Books*. Washington, D.C.

Galster, G., et al, 2001. "Wrestling Sprawl to the Ground: Defining and Measuring an Elusive Concept." *Housing Policy Debate*, Vol. 12, Issue 4. Fannie Mae Foundation. Washington, D.C.

ICMA, 2002. "Getting to Smart Growth: 100 Policies for Implementation." International City/County Management Association. Washington, D.C.

NAHB, 2000. "Smart Growth: Building Better Places to Live, Work, and Play." National Association of Home Builders, Washington, D.C.

See: http://www.nahb.com/main_features/smart.pdf

Newman, P. and J. Kenworthy, 1999. "Sustainability and Cities: Overcoming Automobile Dependence." Island Press. Washington, D.C.

SGA, 2000. "Greetings From Smart Growth America: Americans Want Smarter Growth, Here's How to Get There." Smart Growth America. Washington, D.C.

SOCIAL CAPITAL AND SOCIAL EQUITY

FNSGLV, 1999. "Opportunities for Smarter Growth: Social Equity and the Smart Growth Movement." Funder's Network for Smart Growth and Livable Communities. Translation Paper #1. December.

Lindsey, G. et al. 2001. "Access, Equity, and Urban Greenways: An Exploratory Investigation." *The Professional Geographer*, Vol. 53, No. 3. Association of American Geographers. Washington, D.C. August.

Putnam, R. 2000. "Bowling Alone: The Collapse and Revival of American Community." Simon and Schuster. New York, NY.

Suarez, R. 1999. "The Old Neighborhood: What We Lost in the Great Suburban Migration: 1966-1999." Free Press. Simon and Schuster. New York, NY.

TRANSPORTATION

Aultman-Hall, L. et al. 1997. "Analysis of Bicycle Commuter Routes Using Geographic Information Systems: Implications for Bicycle Planning." *Transportation Research Record No. 1578*. Transportation Research Board. Washington, D.C.

See: <http://www.enhancements.org/trb/1578-13.pdf>

EBRPD, 1998. "Iron Horse Regional Trail: Trail Use Study." East Bay Regional Park District, Oakland, Calif.

Litman, T. 1999. "Quantifying the Benefits of Non-Motorized Transport for Achieving TDM Objectives." Victoria Transportation Policy Institute. Victoria, British Columbia. December.

Nelson, A. C. and D. Allen. 1997. "If You Build Them, Commuters Will Use Them: Association Between Bicycle Facilities and Bicycle Commuting." *Transportation Research Record*. Transportation Research Board. Washington, D.C.

See: <http://www.enhancements.org/trr/1578-10.pdf>

PSRC, 2000. "Puget Sound Trends: Burke-Gilman/Lake Sammamish Trail Use." Puget Sound Regional Council, No. T14, November.

See: <http://www.psrc.org/datapubs/pubs/trends/t14trend.pdf>

Shafizadeh, K. and D. Niemeier. 1997. "Bicycle Journey-to-Work: Travel Behavior Characteristics and Spatial Attributes." *Transportation Research Record No. 1578*. Transportation Research Board. Washington, D.C.

See: <http://www.enhancements.org/trr/1578-11.pdf>

TRNews, 1995. "Off-Road but On Track: Using Bicycle and Pedestrian Trails for Transportation." TR News No. 178. May-June. *Transportation Research Record*. Transportation Research Board. Washington, D.C.

See: http://www4.trb.org/trb/onlinepubs/nsf/web/tr_news

Endnotes

1. Some organizations, such as the Conservation Fund, define green infrastructure as “a network of open space, woodlands, wildlife habitat, parks, and other natural areas.” In this report we expand that definition to include “green” or environmentally beneficial infrastructure that facilitates non-motorized travel and recreation such as trails and greenways. See “Definitions” on page five.
2. As reported in Garvin (1997, p 27), 1995 surveys by America LIVES, Inc. and InterCommunications, Inc., revealed that home buyers desired open space and walking and biking paths among the top four factors that they viewed as very or extremely important. Another 1995 poll by the Regional Plan Association revealed two elements to satisfaction in quality of life are low crime and open space/greenery.
3. Social capital is the concept that social networks have value just as physical capital (a manufacturing plant) and human capital (workers) do. Social capital therefore refers to the connections between people (social networks and the values they embody, such as trustworthiness between neighbors).
4. This description and the graphical representation shown in Figure 1 are derived from “How Land Use and Transportation Systems Impact Public Health” by Frank and Engleke for the Centers for Disease Control and Prevention and “Our Built and Natural Environment,” USEPA.
5. To be sure, the road system we have developed has brought a vast array of positive economic benefits as well. See, for example, Aschauer, 1991.
6. Studies by the American Farmland Trust (AFT 1986 and 1992) have found that, on average, land uses such as farms, forest and open space have a positive net impact on local government budgets of \$0.49 versus a negative net impact of -\$0.25 on the dollar for residential developments. Other research has shown that the cost of delivering municipal services to residential development varies substantially based on dwelling units per acre (Burchell, 1992).
7. See two articles listed under Induced Travel in the section on References by Topic.
8. Much has been written in the past five years about the total cost of transportation. Researchers have attempted to develop cost estimates for different modes of transport under a variety of circumstances (peak, off-peak, urban and rural), for costs ranging from user costs to government costs and external costs such as noise and air pollution. This issue is of concern because vehicle drivers pay only a fraction of the costs associated with ownership and operation of a vehicle. The costs are spread over several parties and thus no one feels the entire burden.

*The purpose of Rails-to-Trails Conservancy
is to enrich America's communities
and countryside by creating
a nationwide network of public trails
from former rail lines and connecting corridors.*



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