“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
September 2002
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Cover photo: Capital Crescent Trail, Bethesda, Maryland. Photo: 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.
I. Introduction

Does the development of green infrastructure, 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.

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.

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”
- “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”

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

<table>
<thead>
<tr>
<th>Built Environment</th>
<th>Travel/Activity Patterns</th>
<th>Environmental Impacts</th>
<th>Public Health Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land use patterns</td>
<td>Frequency of activity</td>
<td>Habitat</td>
<td>Physical activity levels</td>
</tr>
<tr>
<td>Transportation infrastructure</td>
<td>Mode of activity</td>
<td>Air quality</td>
<td>Psychological impact</td>
</tr>
<tr>
<td>Building design and orientation</td>
<td>Trip distance</td>
<td>Ecosystems</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water quality</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Location</th>
<th>Percent Change in:</th>
<th>Percent Change in:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Population</td>
<td>Developed Land</td>
</tr>
<tr>
<td>Cleveland, OH</td>
<td>-11%</td>
<td>33%</td>
</tr>
<tr>
<td>Chicago, IL</td>
<td>4%</td>
<td>46%</td>
</tr>
<tr>
<td>New York, NY</td>
<td>8%</td>
<td>65%</td>
</tr>
<tr>
<td>Seattle, WA</td>
<td>38%</td>
<td>87%</td>
</tr>
<tr>
<td>Los Angeles, CA</td>
<td>45%</td>
<td>300%</td>
</tr>
</tbody>
</table>

Source: Benfield et al. 1999.

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

Table 2: The Onset of Sprawl

<table>
<thead>
<tr>
<th>Sprawl-Inducing Policies ➊</th>
<th>Consumer Shift ➋</th>
<th>Sprawl Impacts ➌</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing policies</td>
<td>Middle/upper-income families leave city</td>
<td>Environmental</td>
</tr>
<tr>
<td>Transportation policies</td>
<td>Auto ownership and use increases to adapt to new built environment</td>
<td>Economic</td>
</tr>
<tr>
<td>Zoning policies</td>
<td></td>
<td>Social</td>
</tr>
<tr>
<td>Taxation policies</td>
<td></td>
<td>Public health</td>
</tr>
</tbody>
</table>

These four broad policy areas collectively induced disinvestment in cities and increased development in the suburbs. The National Housing Act of 1934 provided federally insured low-interest mortgages with conditions that favored single-family, middle-class folks in new suburbs. Transportation policies, such as the 1956 Interstate Highway Act, resulted in $650 billion being spent on highway construction vs. $85 billion on public transport between the years 1960 and 1990. Local zoning codes have historically required separation of land uses, wide streets and parking requirements, all of which favor automobile travel. Taxation policies attracted high-income families away from the city, thus enabling the suburbs to keep their taxes low compared to the city. And lastly, the emphasis on urban renewal in the 1960’s cleared whole neighborhoods for highways and poorly designed low-income housing (Biodiversity Project, 2000).

The result of these policies was a massive and sustained shift in development patterns. Developers and homeowners followed these subsidies and policies out of the city. Two characteristics of this consumer shift are: 1) transit systems could not compete in a low-density, segregated land-use setting which caused households to purchase a greater number of private vehicles, and 2) over the long term, local governments that catered significantly to low-density, single-family housing found themselves in an unsustainable economic equation as their tax bases were increasingly derived from residential land uses. Over the last few years, researchers have shown that supporting such development is a net-loss proposition to local governments compared to supporting farmland and commercial land use. The backbone enabling this shift to sprawl development patterns is road capacity where the customary response to congestion has been to increase road capacity.

The result of this long-term shift has been development patterns that created substantial public and private negative impacts: environmental degradation such as loss of habitat, habitat fragmentation, disturbance of natural cycles and systems, air quality degradation and water quality degradation (Benfield, et al, 2001); economic costs associated with auto ownership and use, such as health, insufficient tax revenue at the local level to support infrastructure (water, sewer, roads) for low-density development and private costs of living in an auto-dependent structure (STPP, 2000); social impacts including reduced sense of community and quality of life as well as racial polarization and inequity issues (Bollier, 1998); public health impacts (while these impacts can be subsumed under the above three headings, the public health impact appears to be significant and warrants its own heading) such as increasing rates of obesity due to inactivity and rising asthma rates due to reduced air quality, psychological stress associated with driving on congested roads each day and the spread of disease due to disruption of ecosystems and climate change.
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.
To remedy the situation brought on by a half-century of sprawl development, smart growth advocates suggest a combination of regulatory and fiscal policies to shift development patterns toward a more efficient use of resources that will produce fewer negative effects. Regulatory policies include planning and zoning issues such as reduction of required parking, transit-oriented development, regional planning efforts, mixed land uses, infrastructure to support non-motorized travel, open space preservation and urban growth boundaries. Fiscal incentives include transferable development rights, location-efficient mortgages, regional tax sharing and a reduction in public subsidies to automobile use.

Just as the policies that encouraged sprawl development led to a consumer shift away from the city to a more inefficient form of low-density segregated land-use development, so too can smart growth policies induce a consumer shift toward a more efficient use of resources. This shift is occurring because local governments have realized that they can no longer afford to continue to develop as they have been, that low-density development is the most costly form for delivery of municipal service. Not only are people shifting their taste due to the more attractive purse strings, but people are being driven to change location because of increasing contempt for traffic congestion as well. Just as road expansion was the backbone of the sprawl era, transit is the backbone of the smart growth era through transit-oriented development which incorporates mixed land uses and a variety of housing types and affordability ranges within walking distance of transit hubs.

The 10 policies listed in column one produce a consumer shift resulting in six outcomes, listed in column three, that define the smart growth paradigm. Collectively, these outcomes allow growth to occur in a more equitable and sustainable manner where public and private resources needed to accommodate growth are minimized relative to sprawl development. The 10 smart growth objectives and the six outcomes are those generally agreed upon by smart growth advocates (SGA, 2001).
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.
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

<table>
<thead>
<tr>
<th>Category</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRANSPORTATION</td>
<td>benefits by facilitating non-motorized trip making and the attendant reduction in emissions, congestion, lost time, societal costs, public costs and personal costs.</td>
</tr>
<tr>
<td>ECONOMIC</td>
<td>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.</td>
</tr>
<tr>
<td>PUBLIC HEALTH</td>
<td>benefits through increased physical activity levels and reduced auto emissions.</td>
</tr>
<tr>
<td>OPEN SPACE</td>
<td>benefits through maintenance of wildlife habitat and heat island mitigation provided by tree canopy on the trail or greenway corridor.</td>
</tr>
<tr>
<td>EDUCATION</td>
<td>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.</td>
</tr>
<tr>
<td>SOCIAL CAPITAL</td>
<td>benefits through increased interaction among community members.</td>
</tr>
</tbody>
</table>

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**Trails & Greenways: Advancing the Smart Growth Agenda**

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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**

<table>
<thead>
<tr>
<th></th>
<th>1990</th>
<th>1995</th>
<th>1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network Miles</td>
<td>50</td>
<td>120</td>
<td>200</td>
</tr>
<tr>
<td>Funding (cumulative)</td>
<td>$1 million</td>
<td>$3 million</td>
<td>$6 million</td>
</tr>
<tr>
<td>Bridge crossings*</td>
<td>1,500</td>
<td>3,000</td>
<td>5,500</td>
</tr>
</tbody>
</table>

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 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.
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>
<thead>
<tr>
<th>Smart Growth Objective</th>
<th>Impact</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Mixed land uses</td>
<td>Direct</td>
<td>Trails and greenways, a form of open space, will inherently add to a mix of land uses.</td>
</tr>
<tr>
<td>2 Using existing community assets</td>
<td>Direct</td>
<td>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 &quot;used.&quot;</td>
</tr>
<tr>
<td>3 Ensuring a range of housing options</td>
<td>Indirect/Supportive</td>
<td>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.</td>
</tr>
<tr>
<td>4 Creating &quot;walkable,&quot; close-knit neighborhoods</td>
<td>Direct</td>
<td>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.</td>
</tr>
<tr>
<td>5 Promoting distinctive, attractive communities</td>
<td>Direct</td>
<td>Each trail and greenway is unique, reflecting the characteristics of the setting in which it is created and promoting its own history.</td>
</tr>
<tr>
<td>6 Preserving open space</td>
<td>Direct</td>
<td>Trails and greenways are open space.</td>
</tr>
<tr>
<td>7 Encouraging growth in existing communities</td>
<td>Direct</td>
<td>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.</td>
</tr>
<tr>
<td>8 Providing transportation choices</td>
<td>Direct</td>
<td>Many urban trails are used for trip making and thus provide a transportation choice to people living near them.</td>
</tr>
<tr>
<td>9 Making development decisions predictable, fair, cost-effective</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>10 Encouraging citizen/stakeholder participation in development decisions</td>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>
Table 7: Transportation Benefits of Trails and Greenways

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Value</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use levels</td>
<td>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.)</td>
<td>TR News, 1995. EBRPD, 1998</td>
</tr>
<tr>
<td>Use frequency</td>
<td>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.</td>
<td>TR News, 1995.</td>
</tr>
<tr>
<td>User shed</td>
<td>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.</td>
<td>Shafizadeh and Niemeier, 1996.</td>
</tr>
<tr>
<td>Bike commuter tendency to seek trails</td>
<td>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.</td>
<td>Aultman-Hall, 1997.</td>
</tr>
<tr>
<td>Trips diverted from motor vehicles</td>
<td>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.</td>
<td>City of Seattle, Wash.</td>
</tr>
<tr>
<td>Time lag of impact</td>
<td>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.</td>
<td>PSRC, 2000.</td>
</tr>
<tr>
<td>Air quality impact</td>
<td>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.</td>
<td>City of Seattle, Wash.</td>
</tr>
<tr>
<td>Value of trip diverted from motor vehicle to bicycle</td>
<td>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.</td>
<td>Litman, 1999.</td>
</tr>
</tbody>
</table>
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**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Value</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trail impact on exercise rates</td>
<td>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.</td>
<td>Brownson, et al. 2000.</td>
</tr>
<tr>
<td>Barriers to use</td>
<td>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.</td>
<td>Troped, 2001.</td>
</tr>
<tr>
<td>Impact of proximity on use rates</td>
<td>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.</td>
<td>Lindsey et al. 2001.</td>
</tr>
<tr>
<td>Use rates by socio-economic use stratification</td>
<td>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.</td>
<td>Brownson, et al. 2001. 2000.Troped, 2001.</td>
</tr>
<tr>
<td>Cost of poor air quality</td>
<td>Total costs associated with motor vehicle emissions range from $28b to $531b for health and $2.5b to $4.6b for crops</td>
<td>USEPA, 2001</td>
</tr>
<tr>
<td>Cost of obesity</td>
<td>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.</td>
<td>Pratt et al. 2000.</td>
</tr>
</tbody>
</table>
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**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Value</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business activity</td>
<td>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 $11.02 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.</td>
<td>Moore, 1992</td>
</tr>
<tr>
<td>Cost-benefit</td>
<td>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.</td>
<td>MDNR, 1994</td>
</tr>
<tr>
<td>Job creation</td>
<td>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.</td>
<td>Strauss, 1996</td>
</tr>
<tr>
<td>Real estate values</td>
<td>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.</td>
<td>Moore, 1992 NPS, 1995 Brown County, 1998 SED, 1987</td>
</tr>
</tbody>
</table>
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 Investment

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.

Regional Trail System Income Distribution

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

Regional Trail System Racial Distribution
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

<table>
<thead>
<tr>
<th></th>
<th>Capital Crescent Trail</th>
<th>Washington &amp; Old Dominion Trail</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Trip Makers</strong></td>
<td>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.</td>
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</tr>
<tr>
<td></td>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
</tr>
<tr>
<td><strong>Access Points</strong></td>
<td>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.</td>
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</tr>
<tr>
<td></td>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
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</tbody>
</table>
## 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.

### Transportation

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<thead>
<tr>
<th>Capital Crescent Trail</th>
<th>Washington &amp; Old Dominion Trail</th>
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<tr>
<td><strong>Signs</strong>&lt;br&gt;Sigs of all kinds are useful to trail users.&lt;br&gt;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.</td>
<td></td>
</tr>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td></td>
</tr>
<tr>
<td><strong>Destination Infrastructure</strong>&lt;br&gt;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.</td>
<td></td>
</tr>
<tr>
<td><img src="image2.png" alt="Image" /></td>
<td></td>
</tr>
<tr>
<td><strong>Transit Connection</strong>&lt;br&gt;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.</td>
<td></td>
</tr>
<tr>
<td><img src="image3.png" alt="Image" /></td>
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</tbody>
</table>
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

**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

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<tr>
<th>Capital Crescent Trail</th>
<th>Washington &amp; Old Dominion Trail</th>
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</table>

**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...

**Wildlife/Flowers**
...to wildflowers, these corridors hold an abundance of wildlife.

**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.

**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

**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.

### 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

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<tr>
<th>Capital Crescent Trail</th>
<th>Washington &amp; Old Dominion Trail</th>
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### 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**

<table>
<thead>
<tr>
<th>History</th>
<th>Capital Crescent Trail</th>
<th>Washington &amp; Old Dominion Trail</th>
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<tbody>
<tr>
<td>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.</td>
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</table>

**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.
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.
References

General References


See: http://www.nga.org/cda/files/001129TRANSREPORT.pdf


References by Topic

AIR QUALITY

City of Seattle, Wash. Bike Spot Program (CM-1140(17)) and Burke-Gilman Trail Expansion Air Quality Analysis.


ECONOMIC


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


ENVIRONMENT


HEALTH


See: http://www.detroitfreepress.com
See: http://www.bikefed.org/PDF/Cyhealth.pdf
See: www.idealibrary.com http://www.idealibrary.com
See: http://www.smartgrowth.org

INDUCED TRAVEL
See: http://www.bts.gov/jts/v3n1/fulton.pdf
See: http://www.cts.cv.ic.ac.uk/staff/wp2-noland.pdf

OPEN SPACE
See: http://www.planning.org
See: http://www.enn.com

SMART GROWTH


SOCIAL CAPITAL AND SOCIAL EQUITY


TRANSPORTATION


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 5.

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.