
THE POTENTIAL ECONOMIC IMPACTS OF THE PROPOSED CAROLINA THREAD TRAIL

FINAL REPORT MARCH 2007

Submitted to:

Catawba Lands Conservancy
105 West Morehead Street, Suite B
Charlotte, NC 28202

Submitted by:

Econsult Corporation
6th Floor
3600 Market Street
Philadelphia, PA 19104

and

Greenways Incorporated
5850 Fayetteville Road, Suite 211
Durham, NC 27713

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EXECUTIVE SUMMARY

The proposed Carolina Thread Trail (“the Trail”) will span approximately 500 miles across a 15-county region, including parts of both North and South Carolina. In addition to providing open space and enhanced recreational opportunities to residents and visitors, the Trail will be designed to “thread” communities together along routes designed by the communities themselves.

The Trail is expected to help the region continue to compete aggressively with other rapidly growing and quickly developing metro areas of the country by providing local amenities for area residents, visitors, and businesses. With full community support, and with appropriate implementation, the trail will provide a number of tangible and intangible economic benefits for the local communities throughout the region, improving overall quality of life and the region’s attractiveness in an increasingly competitive world.

All of the specific details of the Trail have not been worked out. This report is based upon a conceptual representation of where the Trail may be located. The ultimate locations will be determined over time and with heavy community input. Similarly, the ultimate length of the Trail is not yet known, and we thus use a conservative estimate of 500 miles in our analysis, although the final trail length may be significantly larger. Also, the development of the Trail will occur over a number of years – possibly fifteen to twenty or more – so the benefits (and the costs) will be spread out over a long period of time. Our estimates are based on a fully built-out and operational trail system, since the actual schedule is not known.

This report provides estimates of these economic benefits on the 15-county region that would be associated with the development of the Carolina Thread Trail. These benefits are both quantitative and qualitative in nature. They have been developed using (i) standard economic methodology, (ii) area-specific base data, and (iii) various other economic assumptions. These benefits extend across a wide array of disciplines (economic, recreational, environmental, e.g.), and would add to the region’s economy, to the local tax bases, and to the standard of living for current and future residents. Our estimates of these benefits are summarized here:

✓ ENHANCED PROPERTY VALUES AND LOCAL PROPERTY TAX REVENUES

There is significant research that supports the notion that the addition or expansion of greenspace positively affects the value of nearby property. Significant economic benefits are generated by the expenditures associated with public and private capital investments. These improvements are likely to increase surrounding residential property values by making adjacent neighborhoods more attractive, thus increasing the prices people are willing to pay for them, and increasing their wealth. These increases have a positive impact not only for residents but also on municipalities by way of additional property tax revenue. Using regional data as a base, this analysis finds the following for a fully built-out trail:

- An estimated 305,000 housing units will be directly affected by the proposed trail.
- The average projected benefit per house is estimated to be approximately \$3,580.
- Over 50% of all homes in the affected zone are projected to appreciate by the maximum benefit of \$4,500.
- The total dollar gain in property is forecast to be \$1.7 billion in the affected zone.
- This represents an approximate 4% increase in the value of the entire housing stock of the affected area.
- If this gain is accurately capitalized and assessed, this should yield an aggregate incremental increase in property tax revenues of approximately \$17 million per year.
- The Net Present Value of this revenue stream is approximately \$261 million (using a discount rate of 5% over 30 years, which would roughly correspond to the period associated with any bond issue to finance the proposed improvements).

✓ **INCREASED TOURISM**

The trail is expected to not only bring new visitors and tourists to the region and inject new dollars into the local economy, but also promote connectivity between tourist destinations for current visitors and local residents, translating into longer and more fulfilling stays. Based on 2005 tourism statistics and reasonable assumptions about the trail's potential impact, we estimate that the fully built-out trail could annually generate \$42-\$84 million in new tourism spending for the local economy and \$3 million to \$6 million in additional state and local tax revenues.

✓ **ECONOMIC BENEFITS FOR THE LOCAL ECONOMY GENERATED BY THE INVESTMENT TO CONSTRUCT THE TRAIL**

The construction investment of the proposed trail, as well as all other construction-related opportunities, will lead to increased economic activity, employment, and wages. Total benefits include all direct expenditures, as well as additional indirect and induced expenditures that result from them. Specifically, we estimate that:

- The proposed trail is expected to span approximately 500 miles with an average construction cost of \$200,000 per mile.

- Over the 15-year period, this investment is expected to generate over \$250 million in total direct, indirect, and induced economic activity.
- Of the total economic activity generated by the investment, over \$85 million represents the additional earnings of various workers.
- The construction of the trail is expected to support nearly 2800 new jobs (including jobs directly related to the construction itself).

✓ **ENHANCED BUSINESS COMMUNITY THROUGH BUSINESS EXPANSION AND ECONOMIC DEVELOPMENT**

Along with positive amenities already present in the area, the proposed trail will likely increase the attraction for business development. This enhanced business community will help to increase the region's competitiveness with other metro areas, as outdoor amenities become an increasingly attractive draw, particularly for the young professional set. Specifically, our findings show that:

- The proposed trail will likely increase the attraction for business development and expansion by offering year-round recreational opportunities for potential and existing business communities.
- The trail will create a strong draw for professionals choosing to reside in or relocate to the area.
- Information from industry professionals and site selection firms support the significance of greenspace and trails for business development and attraction.

✓ **AIR AND WATER QUALITY**

Water quality is a central issue to the region. There is national evidence that sufficiently sized and integrated green spaces can mitigate the negative effects of development and protect water quality. Green spaces also maintain and protect the quality and diversity of the natural environment and by extension the communities directly affected by them. Thus, the expanded trail becomes a strategic and attractive way to mitigate the negative environmental consequences of the region's explosive growth.

The trail will mitigate stormwater run-off and will encourage water table recharge. Reduced run-off associated with the greenway landscapes of the trail will help to mitigate storm water management and treatment concerns. Thus, there are significant cost avoidance benefits (reduced future expenditures as well as current and sustaining environmental enhancements).

- The associated tree cover within the greenway will contribute significantly to air quality management by potentially removing approximately 130 tons of particulate matter per year.
- The trail will help to reduce air pollution and lighten the healthcare burden in the community by offering an active community environment, while also lowering mortality and morbidity associated with heart and lung disease. Trail may also provide outlets for youth in particular to practice healthy lifestyles, and facilitating an even greater proportion of work and leisure trips that can be made without the use of a car.
- The trail will also help to reduce noise pollution and help to cool developed areas during warmer months.
- The trail will also contribute to retaining the natural beauty of the region while enhancing its overall appeal as well as improving privacy for local residents.
- The trail will serve as an anchor for a comprehensive system of green spaces designed to maintain and improve air and water quality in the region, a particularly pressing concern as development continues.

✓ **INCREASED RECREATION VALUE FOR RESIDENTS AND TOURISTS**

The full build-out of the proposed Carolina Thread Trail will generate significant increased recreational value for both residents and visitors. We can quantify that additional recreational value by estimating the aggregate amount users would be willing to pay for increased recreation opportunities. Our findings include the following:

- There are a total of 2.0 million annual trips estimated for the existing trail.
- A total of 6.0 million annual trips are estimated for the enhanced trail.
- This increase in visitors as a result of trail development is estimated to provide increased annual aggregate recreation value within a range of \$37 million to \$73 million.

To summarize, there are a number of important tangible and intangible benefits to the proposed trail expansion. The more aesthetic advantages have been described above, and while hard to quantify, are truly compelling reasons to be excited about the long term effects of the expanded trail on the region's quality of life.

Those aesthetic advantages are also the basis for some of the economic gains that the project is anticipated to produce. Consider, for example, the quantifiable gains from the \$100 million investment over a 15-year period to build out the trail:

- A \$1.7 billion aggregate increase in property values in the “affected zone”
- \$17 million more per year in property tax revenues
- \$37 million to \$73 million more per year in aggregate recreational value
- \$42 million to \$84 million more per year in tourism activity
- A one-time economic impact of \$250+ million, supporting over 2700 jobs and over \$85 million in worker earnings, from the construction project itself

While it is difficult to quantify a return on an investment in a public good like an enhanced trail system, we can roughly and conservatively estimate from the above impacts that each dollar invested in trail expansion during the 15-year build-out phase produces another \$10+ in positive economic impact during that time period, and that ongoing the annual economic benefit will exceed the amount of the initial investment in the form of more property tax revenues, increased recreational value, and added tourism activity. When one considers the many environmental, aesthetic, health, and quality of life advantages that that investment will also reap, those returns become all the more impressive, and further justify the investment required to complete the proposed trail expansion.

1.0 INTRODUCTION

The Carolina Thread Trail (“the Trail”) is proposed to span approximately 500 miles across a 15-county region that includes counties in both North and South Carolina.¹ Designed to serve as a “thread,” weaving communities together, the Trail is proposed with the following broad policy objectives:

- Think regionally, act locally
- Be broadly inclusive to maximize success
- Create a vision that is bold but achievable
- Invite communities to participate by offering them needed capital and support
- Attract new financial capital to the region
- Invest resources to build social capital and increase residents’ quality of life
- Have a bias towards action
- Conduct operations with absolute integrity and transparency
- Create a legacy for the region that is permanent and self-sustaining

The proposed trail is expected to help the 15-county region continue to compete aggressively with other rapidly growing, quickly developing metro areas of the United States by providing local amenities for area residents, visitors, and businesses. With full community support, the Trail will provide a collection of benefits for the local communities throughout the region, thereby improving overall quality of life.

Econsult Corporation, in conjunction with Greenways Incorporated, was engaged by the Catawba Lands Conservancy and The Trust for Public Land to identify and estimate the potential economic impacts of the proposed Carolina Thread Trail. This report provides estimates of the potential economic benefits that would be associated with the development of the Trail on the 15-county region. Some of these benefits are:

- Enhanced property values and local property tax revenues

¹ The 15 counties included in this region are Anson, Cabarras, Catawba, Cleveland, Gaston, Iredell, Lincoln, Mecklenberg, Rowan, Stanly, and Union counties in North Carolina and Cherokee, Chester, Lancaster, and York counties in South Carolina. Also, the trail is proposed to be 500 miles in length; however, the exact distance is yet to be determined and may, in fact, be more than 900 miles long. Throughout our analysis, we conservatively use the shorter length of 500 miles.

- Increased recreation value for residents and visitors
- Increased tourism
- Economic benefits generated by the investment to construct the trail
- Enhanced business community through business expansion and economic development
- Health and wellness benefits associated with an enhanced physical environment

We have addressed each of these benefits from a local perspective (i.e. relying on local data whenever possible). However, in some instances when local data was not available, we utilized comparable regional and national existing literature and conclusions. We also utilized the potential sources as identified in a study recently completed by UNC-Charlotte's Geography Department for the impact of an earlier, three-county trail concept, and present a comparable analysis for the larger 15-county region. To be sure to capture the local perspective of the residential and business community and to fully explore the economic potential of the trail on the local communities, we supplemented our use of outside data by working with local industry experts.

This report provides a complete picture of the benefits of the trail, identifying the aggregate impact that such a trail could potentially have on the region, spanning across much of North Carolina and into parts of South Carolina. Many local communities will seek to identify the benefits of the Trail that meet their specific needs. However, it is important to recognize the aggregate impact that this trail will have on the region as a whole, for the Carolina Thread Trail is designed to "thread" communities together, providing a collection of benefits for the entire region. Of course, it is important that each local community support the development of the Trail and actively participates in its formation; however, the focus should remain on the Trail as a regional amenity, one that can enhance local communities and the region alike.

In addition to using the more conservative 500-mile length for the Trail, the analysis also assumes the trail will be used for walking for pleasure, jogging, running, hiking, in-line skating and biking, and that the typical cross-section for the Carolina Thread Trail will be surfaced, rather than unsurfaced.

One of the many characteristics that make the Carolina Thread Trail initiative unique is its dynamic nature. As of now, there is a conceptual map designed for the Trail, however, the specific location and length of the Trail has not yet been determined and will eventually be designed by each individual community. Early meetings with county officials exemplify this collaboration and joint process of development. For our purposes, the benefits presented in this report are for the conceptual trail, and they provide a reasonable estimate for the fully designed, finalized trail.

It is important to note that many of the benefits presented here are not mutually exclusive and, in fact, affect each other. For instance, improved air and water quality may provide better overall conditions for recreation opportunities, thereby increasing the recreation benefits while also increasing property values.

This report is outlined as follows. Section 2.0 presents the potential economic benefits of the trail, specifically:

- Section 2.1 - the potential economic benefits of the trail on enhanced property values and increased property tax revenues based on proximity to the greenway/trail.
- Section 2.2 - the potential economic benefits of increased tourism for the region by attracting outside “new” visitors to the region.
- Section 2.3 - the potential economic impact that the physical construction will have on the region in terms of increased overall economic activity, increased employment, and increased earnings.
- Section 2.4 - the potential economic benefits of the trail on business expansion or relocation and economic development as the trail improves overall quality of life and enhances attractiveness to the region.
- Section 2.5 - the potential economic benefits of the trail on improved water and air quality, thereby enhancing the region’s overall environment.
- Section 2.6 - the potential economic value that increased recreation opportunities can bring to the region through examining consumers’ willingness to pay for the activity.
- Section 2.7 – the overall “return on investment” for the Trail, both during its initial development as well as ongoing.

Section 3.0 presents a summary and overall conclusions for the report.

2.0 POTENTIAL ECONOMIC BENEFITS OF THE CAROLINA THREAD TRAIL

The proposed Carolina Thread Trail will impact the community on a local and regional level in several ways. The trail will potentially improve or enhance:

- Property values and local property tax revenue
- Tourism
- Economic activity related to the construction of the trail
- Business expansion and economic development
- Health and wellness
- Recreation value

Together, these impacts produce a “return on investment” for the initial public and private outlay for the Trail expansion. The sections below outline all of these potential impacts in more detail.

2.1 Enhanced Property Values and Local Property Tax Revenues

This section of analysis estimates the projected impact of The Carolina Thread Trail on the values of nearby residential properties.

There is a substantial body of research literature supporting the result that the addition or expansion of greenspace positively affects the value of nearby property. Hammer, Coughlin and Horn IV (1974) found that proximity to a park added 33% to the value of proximate homes. Wachter (2005) estimated that cleaning and greening vacant lots in Philadelphia increased the values of adjacent homes by 30%. Phillips' (2001) research on the Oakland housing market found that results ranged from +2.2% to +20%. Econsult's own work in Philadelphia projected that the nominal benefits from remediating and greening the Philadelphia waterfront ranged from +15% to +36%, depending upon the scope and scale of the improvements.

Clearly, significant economic benefits are generated by the expenditures associated with public and private capital investments. In addition, these improvements are likely to increase surrounding residential property values by making adjacent neighborhoods more attractive. These increases will have a positive impact not only for residents but also on the local municipalities by way of additional property tax revenue. For the purposes of this study, we applied the results from Campbell and Munroe (2004),² which specifically focused on the potential economic impact of the Catawba Regional Trail.

The capitalization of an amenity into nearby property values is typically measured as a function of distance to the amenity. This is done to reflect the fact that the effect dissipates with distance. This implies that the value of the greenway is greatest to those dwellings located immediately adjacent to the greenway, and declines as distance from the greenway increases. This can be thought of as the *percent* change in house values given a *percent* change in proximity to the amenity, or trail in this case.

We estimated this figure for three major counties that are located within the greenway's impact area (Mecklenburg, Gaston and York), and find that the rate of decay per 1% change in proximity ranges from a high of -5.07% for York county to a low of -3.12% for Mecklenburg county.

In more detail, we apply these findings to:

1. Compute an average impact of greenspace.
2. Identify the location of the entire proposed Carolina Thread Trail (beyond just the three counties), and identify all those areas that it passes through—and hence will likely impact.
3. Obtain counts of housing units and their median value, by census block group, for each county the greenway passes through, from the 2000 U.S. Census.

² Campbell, Harrison S. and Munroe, Darla K. (2004). "The Economic Impact of the Catawba Regional Trail."

4. Update the 2000 house values to 2006 by applying the OFHEO³ house price indices for North and South Carolina.
5. Apply the averaged results of Campbell and Munroe to the updated house values in those impacted block groups to obtain the forecasted impact of the greenway.

This analysis estimates the projected impact of The Carolina Thread Trail on the values of nearby residential properties. In summary, we find that:

- An estimated 305,000 housing units will be directly affected by the proposed trail (they are in the “affected zone”).
- The average projected benefit per house is estimated to be approximately \$3,580.
- Over 50% of all homes in the affected zone are projected to appreciate by the maximum benefit of \$4,500.
- The total dollar gain in property values is forecast to be \$1.7 billion in the “affected zone”.
- This represents an approximate 4% increase in the value of the entire housing stock.
- If this gain is accurately capitalized and assessed, this should yield an aggregate incremental increase in property tax revenues of approximately \$17 million per year.
- The Net Present Value of this revenue stream is approximately \$261 million (using a discount rate of 5% over 30 years, which would roughly correspond to the period associated with any bond issue to finance the proposed improvements).

For more detail on our methodology and on these results, please see Appendix A: Enhanced Property Values.

³ The Office of Federal Housing Enterprise Oversight is an agency of HUD that regulates Fannie Mae and Freddie Mac; the two largest secondary mortgage market institutions in the country. Using their data, OFHEO estimates house price indices showing quarterly house price appreciation, by state and MSA, for the entire country. Their indices are considered a professional and objective standard for the industry.

2.2 Increased Tourism

Another important benefit of the proposed trail is the increase in tourism it would generate for the region. The trail is expected to not only bring new visitors and tourists to the region and inject new dollars into the local economy, but also promote connectivity between tourist destinations for both visitors and local residents as well. The former would likely result in longer stays by outside visitors, and the latter should enhance residents' quality of life.

Campbell Monroe estimated that a 150-mile trail would attract 62,000 users per year, of which 21,000, or approximately 33%, would come from outside of "the region." Since their "region" consists of only three counties (Gaston, Mecklenburg, and York), a portion of their "visitors" could be residents of our larger 15-county region. While this methodology is reasonable, we believe it significantly understates the potential impact of the fully built-out trail on increasing both the number of tourists and the dollars spent per tourist.

We identified two approaches to estimating the potential tourism impact of the proposed trail. First, we use county tourism impact data to estimate the impact of a certain percentage increase in tourism generated by the expanded trail. Second, we use the variant of the Campbell and Monroe (2004) methodology and apply it to our estimates of increased number of trail trips generated by the proposed trail (see recreation value impact above).

The North Carolina Division of Tourism Film and Sports Development obtains annual estimates of tourism impacts, by county, from the Travel Industry Association of America (TIA). For 2005, TIA estimated that tourism generated (directly and indirectly) over \$4.2 billion in spending supporting nearly 50,000 jobs. They also generated over \$200 million in state taxes and over \$100 million in local taxes.

This allows us to estimate the impact of different percentage increase in tourism, as it suggests each 1% increase could generate over \$40 million in economic spending and 500 jobs, as well as \$3 million in state and local taxes.

Visitors to North Carolina engage in a variety of activities, and TIA reported the following participation in activity classifications that could include trail use:

Tourism/Sightseeing	19%
National/State Park	6%
Nature/Culture	3%

If we conservatively assume that the percentage of total tourists that are users of the Trail is 1%, and that their spending is similar to the average visitor, we can attribute 1% of the \$4.2 billion in annual tourist spending, or \$42 million, to users of the Trail. It is very possible that the Trail, when fully built-out, would double or triple the number of Trail-using tourists. This would suggest the new trails system could generate \$42 million to \$84 million in new economic activity and upwards of \$3 to \$6 million per year in incremental state and local tax revenues.

2.3 Construction Investment Impacts

The construction investment on the proposed trail expansion will produce a significant increase in economic activity, employment, and wages. The increased employment impacts are estimated on a regional basis using an input-output model that encompasses the 15-county region in North and South Carolina. These employment impacts are part of the total impact estimate that includes all *direct, indirect, and induced impacts*⁴ of the expenditures for the construction of the proposed trail on a regional basis. In addition to the estimate of total regional employment, we also estimate significant increases in regional wages and salaries attributable to all related employment. Total benefits include all direct spending impacts as well as those that are indirect and induced through suppliers for directly affected industries and employee wages and benefits.

The proposed trail is expected to span approximately 500 miles⁵ with an average investment of approximately \$200,000/mile⁶. Including development costs, the construction investment over a 15-year period (the proposed period of construction) is estimated at approximately \$115 million. This investment will generate significant economic benefits for the local communities and the region. Over the 15-year period for the 15-county region, this investment is expected to generate over \$250 million in total economic activity, nearly 2800, and over \$85 million in earnings (as shown in Table 2.1).

⁴ In quantifying a project's total economic impact, we first account for its **direct impacts**; that is, the spending and job creation immediately associated with the project. An additional, ripple effect of these direct expenditures occurs as firms that supply goods and services for this project ramp up production to accommodate this new demand. Suppliers of these supplies also ramp up their efforts, and so on as this increased and interconnected activity spreads throughout the region. These are known as **indirect impacts**. Finally, since all of this increased economic activity results in workers being paid wages, there is some increase in consumer spending within the region that would not have otherwise taken place save the existence of this project; this is known as the **induced impact**.

The total impact of this project - of any project - on a local economy, then, is the sum of its direct, indirect, and induced expenditures. See Appendix B for more information on the specific input-output model employed by Econsult Corporation.

⁵ The Carolina Thread Trail is proposed to be 500 miles in length; however, the exact distance is yet to be determined.

⁶ This estimated average cost per trail mile encompasses a wide range of development costs. Certain areas would see significantly smaller costs. While others, where high quality trail development would be appropriate, could cost upwards of twice that cost/mile. We believe the \$200,000 / mile is a reasonable average to utilize.

Table 2.1: One-Time Economic Impacts from the Development of the Proposed Carolina Thread Trail Over a Fifteen-Year Construction Period

	Catawba Region
Direct Expenditures (\$MM)	\$ 115.0
Indirect & Induced Expenditures (\$MM)	\$ 142.2
Total Output (\$MM)	\$ 257.2
Multiplier	2.2
Total Employment	2,766
Total Earnings (\$MM)	\$ 86.6
Average Wage	\$ 31,316

Source: Catawba Lands Conservancy and Econsult Corporation

2.4 Business Expansion / Economic Development

This category of benefits evaluates the “basket of goods” offered by the area and assesses the enhanced attraction that the proposed trail will potentially provide for further improving the Charlotte-Mecklenburg business. Along with positive amenities already present in the area, such as moderate temperatures and minimal rainfall, the proposed trail will likely increase the attraction for business development by offering year-round recreational opportunities for potential and existing business communities. Along with providing opportunities for business leaders and developers, the trail is also expected to attract young professionals to the area who are known to value these types of amenities (as observed not only in North Carolina, but throughout the county). This enhanced attractiveness of the region to the business community will help to increase the region’s competitiveness with other metro areas.

In addressing the questions of what businesses consider when deciding whether to move or relocate to a new area, we gathered information from industry professionals and site selection firms. We reviewed articles and conducted interviews to determine whether trails and/or greenways were included in firms’ site selection criteria. This research clearly supports the notion that increased trails and greenspace are thought to enhance a region’s attractiveness for new and relocating businesses for several reasons.

A collection of testimonials on greening as a strategy for attracting businesses and employers is provided here to demonstrate the breadth and depth of support for this point of view (see Figure 2.1).

Figure 2.1 – Business Testimonials on Trails and Greenways

“Greenway Project Worthy of Support” –The Charlotte Business Journal⁷

“The greenway could also serve as a catalyst for development. Indeed, Pappas Properties’ plan to redevelop Midtown Square includes creek restoration. Pappas’ plans embrace the waterway, proposing cafes along its banks...Greenway backers see opportunities for restaurants, retail and housing at three or four points along the way.” (The Charlotte Business Journal, 2001)

Tommy Norman, President, NORCOM Development - NORCOM Properties is a Charlotte-based development firm.⁸

“Greenways and Open Space in Charlotte/Mecklenburg have been a part of the Master Plan of the Park System for this region for over twenty-five years. The implementation

⁷ July 23, 2001

⁸ Phone interview on November 15, 2006 with email received on November 17, 2006.

through a majority of those years has been focused on those areas of less congestion and bordering natural streambeds. In 1999, there was a commitment by the County and then the voters to proceed with a Land Banking Bond package to acquire major parts of a contiguous fifteen mile corridor through the Center City and much of the developed southern reaches of the County, all bordering one of our two major floodways, Little Sugar Creek. As the property has been acquired, assembled, removed and replanted as open space, some major portions bordering it have started redeveloping into major commercial nodes with two in particular, the Metropolitan mixed-use development of retail, residential and office of around \$250,000,000 and an approximate 50,000 square foot “green” office building overlooking the Greenway in an area that used to be occupied by fast foods and an automotive repair facility.

There clearly is a substantial jump in property values as a result of the implementation of this greenway program through the urban core of Charlotte, so much so that almost every elected official has claimed some degree of credit for its development.” (Norman, 2006)

Bill Gartland, Vice President, Crosland - Crosland is one of the Southeast’s leading diversified real estate companies and has been building in the Charlotte area since the 1930’s.⁹

“We feel that greenway trails are a great amenity for residential & mixed use developments as walking trails & open space are critical elements for making great places. It is difficult to quantify the impact of incorporating greenways on property values as they are only one component of the amenity package which include parks, pools etc. in our communities. However, homes that front on significant greenway space are easier to sell & do often generate premiums of 5% of more than comparable homes internal to the neighborhood.” (Bill Gartland, Vice President, Crosland, 2006)

Maggie Collister, The Littlejohn Group¹⁰

“Almost every high end development of note that I have seen is pushing some form of nature trails or natural preserve, which is a huge change from the old way of doing things...I think it is hard to quantify the economics of greenways/nature preserves, except that people seem to want them. We may be coming to a point where people expect them in communities, especially over a certain price point.” (Maggie Collister, The Littlejohn Group, 2006)

“Tourism authority considers greenway at Rocky River Gold Club” – Independent Tribune.¹¹

⁹ E-mail received on November 20, 2006.

¹⁰ Maggie Collister coordinates market research and maintains an extensive competitive market database for The Littlejohn Group, a Charlotte-based real estate analysis firm with wide-ranging experience throughout the Southeast.

¹¹ April 28, 2006: <http://www.independenttribune.com>.

"Cox said he feels a pathway connecting the golf club with the hotel would be a certain draw for tourists, adding that a walkway encompassing the entire Concord Mills and Lowe's Motor Speedway area would be ideal for the area." (Independent Tribune, 2006. In reference to Cabarrus Regional Partnership CEO, John Cox)

Ivan Jecklin, Weinstein Properties VP¹²

"We market the greenway as great amenity for our residents. If we are looking at two equal properties and one had a greenway and the other did not, we would definitely go for the one with the greenway!" (Jecklin, 2006)

*"The pulse of nature in the heart of the city."*¹³

"An integral part of Metropolitan will be the Little Sugar Creek Greenway, an exciting reclamation project. Here, flowing water will become the centerpiece of a beautiful linear park. The park will provide a fascinating venue for special events, festivals and the more simple pleasures of a long walk on a sunny day. People from area neighborhoods and businesses will be drawn to it. So far, the county has invested \$26.5 million in land acquisitions. When complete, the Greenway will be 15 miles long, stretching from the South Carolina line to just north of Uptown Charlotte. The result will be the region's most spectacular park, giving Metropolitan true landmark status." (Pappas Properties, 2006)

"Developers plan \$71M mixed-use project" – The Charlotte Business Journal (November 8, 2006)

"A local development team has planned a \$71 million, mixed-use project in Cherry, promising apartments, town homes and commercial space...The project would be near some of Charlotte's more enterprising developments, including the Little Sugar Creek greenway..." (The Charlotte Business Journal, 2006)

"West-side tract is targeted for 474-unit development: Freedom Greene project to include par-three golf, tie in with new greenway" –The Charlotte Business Journal (January 20, 2006)

"A Canadian developer is planning a 474-unit residential project incorporating a par-three golf course on Freedom Drive, playing off the site's proximity to the Mecklenburg County greenway...The project name, Freedom Greene, plays off the fact that it's near the planned greenway system..." (The Charlotte Business Journal, 2006)

¹² Weinstein owns nine communities in the Charlotte area, including the Bexley Greenway complex. Phone interview on November 15, 2006

¹³ From Pappas Properties website for the Metropolitan Project: <http://www.metmidtown.com/greenway.htm>.

"University City traffic is unwanted sign of growth"–The Charlotte Business Journal (June 28, 2002)

"The greenway plan for Mecklenburg County identifies 28 miles of potential greenway space in University City. Only 3.6 miles have paths. Other than the greenway, there are no bike paths. It's those numbers -- and the challenges they present -- that led the University City Area Council, an adjunct of the Charlotte Chamber, to propose a business investment district that could provide funding for priorities such as sidewalks, signage and greenways." (The Charlotte Business Journal, 2002)

"Renewal of creek is a welcome addition" –The Charlotte Business Journal (December 22, 2000)

"The proposal to create a greenway along Little Sugar Creek would be a welcome addition to the city, forming a pedestrian-friendly link between uptown, midtown, Freedom Park and Park Road Park...Such amenities will become increasingly important for the center city as residential density increases...Charlotte isn't known as a city of parks, either; studies show we have fewer such amenities than most cities our size. Nor is the city known for being pedestrian-friendly; a greenway along the creek, sheltered from the dangers and noise of busy streets, will provide much-needed relief." (The Charlotte Business Journal, 2000)

"Crescent readies launch" – The Charlotte Business Journal (February 4, 2005)

"The 1,000-acre tract is part of 6,000 acres owned by the Close family, which is being developed with a long-term master plan. The centerpiece of the sprawling site -- which will include a mix of uses -- is the 2,000-acre Anne Springs Close Greenway, which features 32 miles of trails and offers a variety of ecologically oriented programs." (The Charlotte Business Journal, 2005)

"Burnett also mentions amenities, most notably the greenway, which will serve as an oasis as the region becomes increasingly developed." (The Charlotte Business Journal, 2005. In reference to Crescent Senior Vice President, Mike Burnett)

"Fort Mill targeted for \$200M mix of homes, business"–The Charlotte Business Journal (September 12, 2003)

"A Charlotte company is planning an ambitious, \$200 million mixed-use development near Fort Mill that will combine retail with light industrial and residential uses and link two area greenways." (The Charlotte Business Journal, 2003)

"Open-space movement comes to town" – The Charlotte Business Journal (January 12, 2001)

"Core urban areas and inner-ring suburbs are creating parks and greenways to attract businesses, residents and investment. On the fast-growing suburban fringe, residents are

setting aside vital landscapes to preserve the character of their communities...Citizens in both rural and urban areas are recognizing the importance of protecting farmland. And communities in outlying areas threatened by second-home development are setting aside scenic lands that support tourism and preserve the open-space resources that characterize a rural community.” (The Charlotte Business Journal, 2001)

“Going over the line: Mixed-use project will change the face of Union County retail” – The Charlotte Business Journal (July 18, 2003)

“...Blakeney's extensive green space, parks and greenway system is another plus. "Retailers look at the overall scale, and a power center by itself is not as impressive as one surrounded by parks." Ryan Preston, Crosland Retail's director of leasing.” (The Charlotte Business Journal, 2003)

“BellSouth exec earns management award” – The Charlotte Business Journal (October 22, 2004)

“...Are you optimistic Charlotte can attract smart folks in their 20s and 30s vs. losing them to Atlanta and other big cities?”

“There are some things we need to continue to do to make [Charlotte] a great place. The park and greenway system is very important because that's really what the younger crowd is looking for. It's not just the bars. It's the quality of life.” (The Charlotte Business Journal, 2004. From an interview with the head of BellSouth Corp.'s North Carolina operations, Krista Tillman)

In summary, we find that:

- The proposed trail will likely increase the attractiveness of the region for business development/expansion location by offering year-round recreational opportunities for potential and existing business communities.
- The trail could potentially create a strong draw for professionals choosing to reside or relocate to the area.
- Information from industry professionals and site selection firms support the significance of greenspace and trails for business development and attraction.

2.5 Air and Water Quality

The mixed blessing of robust development in a region is the increasing burden that development places on the region's environment and livability. At its worst, unchecked development can translate into diminished air and water quality, increased pollution and congestion, and other negative impacts on existing residents' quality of life. It is important, then, for growing regions to effectively manage their growth in a way as to balance expansion with environmental concerns, accommodating new residents while continuing to provide an amenity-rich lifestyle for existing residents. This section considers the extent to which the Carolina Thread Trail moves the region towards such a balance.

Water: Regional Availability and Quality

Water is projected to become a resource in need of careful management in most parts of the US.¹⁴ Overall, this shortage is in part due to the result of depleted water tables and general availability and in part due to increased decontamination loads on water treatment facilities. Both of these effects are largely predicated on human alteration of the landscape and have the potential to impact the Catawba region.

The study that projects no issues with water quality for the Catawba region¹⁵ in the future does not model scenarios in which contaminant concentrations increase with additional development. However, to remain competitive and to continue to enhance the region, development is encouraged.

Overall, the quality of the water in the Catawba Region has moved from relatively good condition with spikes in poor condition toward a more steady fair condition, indicating a general degradation in quality. Using Mecklenburg County as an example, groundwater and soil contamination has more than doubled since 1995, from 600 contaminated sites in 1995 to 1,269 sites in 2005.¹⁶ The trends are similar through the region. Further, in 2004 only 33% of the surface water was safe for prolonged human contact. From the perspective of increasing contamination loads and usability, water quality is a serious problem in the Catawba region that will only intensify with future economic development unless real protective measures are implemented.

¹⁴ "EPA Chief Sounds Alarm on Water for U.S., World", M. Kilian, Chicago Tribune, 28 March 2002.

¹⁵ An August 2006 study of the proposed Concord Kannapolis interbasin transfer.

¹⁶ "State of the Water", Mecklenburg County State of the Environment Report, 2006.

Identifying Major Sources of Water Contamination

Identifying the major contamination sources for the watersheds is critical. Most contaminants point towards human activities. Data allow us to suggest that the major water quality issues facing Mecklenburg County are surface run-off control and discharges from water treatment facilities or effluent pipes. Knowing this allows us to recognize the value of run-off control measures and allows us to place emphasis on green space measures that enhance run-off control. We anticipate that greenways are a cornerstone of a storm water run-off control system that simultaneously yields benefits that include water quality.

Each county has an impact on the water quality of others. Without cooperation and coordination of efforts, any county-specific effort will likely be limited in its effectiveness. The trail system provides a point of focus among the relevant parties and a common economic instrument to help align the environmental incentives for cooperation and enhancement of the regional communities. This, thereby, provides a mechanism to encourage water table recharge and mitigate area run-off. Thus, there are significant cost avoidance benefits as well as environmental enhancements.

Air Quality

Smog, "black carbon" particulate, acid rain, green house gases, and ozone holes all have well documented negative effects on human health and the environment.¹⁷ The particulate component of air pollution is by common practice the proxy for measuring human health effects.¹⁸ As these particles can accumulate other airborne chemicals and are a burden on health, it is a reliable methodology to measure exposure to many irritants and carcinogens. However, it is critical to recognize that in order to fully address the air pollution problem that arises from development, a suite of measures that regulate non-particulate emissions is an essential component of any air quality program.

Mitigating Air Pollution

Greenways and the associated tree cover are the single most important aspect of airborne particulate control outside of source reduction. David Nowak of the U.S. Forest Service argues that trees improve air quality through temperature reduction, particulate trapping, potentially reduce ozone, and reduce energy requirements for adjacent buildings.¹⁹ Trees are also 3 times as

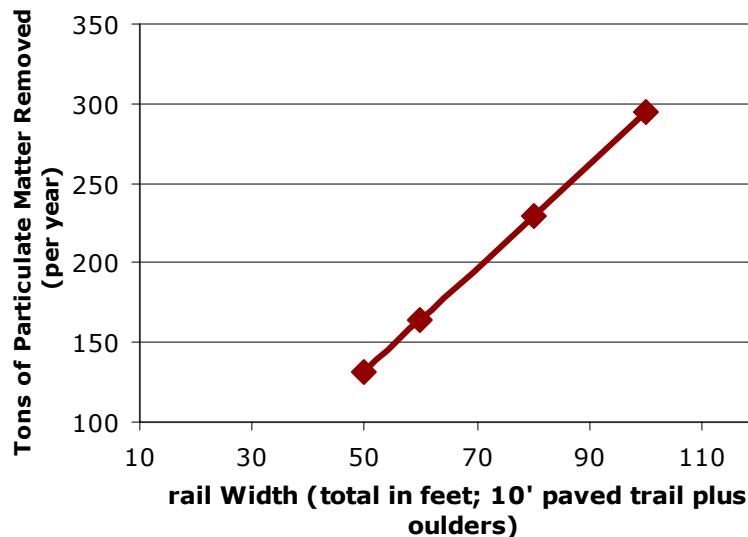
¹⁷ United States Environmental Protection Agency, fact sheet, <http://www.epa.gov/air/concerns.html>.

¹⁸ "Air Quality and Cardiovascular Disease", R. Brook, et. al. AHA Scientific Statement, *Circulation*, 2004, 109; 2655-1671.

¹⁹ "The Effects of Urban Trees on Air Quality", U.S. Forest Service, Syracuse, NY, www.fs.fed.us/ne/syracuse/TREE%20Air%20Qual.pdf.

effective at removing air borne pollutants as grass or prairie cover.²⁰ The "rule-of-thumb" appears to be that for every 5% increase in surface area planted by trees, we see an increase in air cleaning by 1%. Overall, we have calculated that the proposed paved trail extracts roughly 130 tons of particulate from the air each year (Figure 1).²¹ For comparison, this represents 2% of the total particulate matter released in Mecklenburg County in 2004.²²

Figure 2.2: Air Quality Impact of Trails Tree Cover



Source: Data obtained in D.J. Nowak and D.E. Crane

Combining demographic data with exposure data suggests that controlling air pollution has a preventative effect and will likely reduce the burden on health services disproportionately in those sectors least able to shoulder the financial burden of those services.²⁴

²⁰ Hewitt, N, Stewart, H, Donovan, R and MacKenzie, R, undated. Trees and Sustainable Urban Air Quality, Research summary from Lancaster University at <http://www.es.lancs.ac.uk/people/cnh/docs/UrbanTrees.htm>.

²¹ See Appendix C for more details. This assumes the trail to be 500 miles long, 10 feet wide with flanking 20-foot areas of tree cover. As we expand the average width of the trail network, the total air cleaning capacity of the trail rises linearly. The values shown in Figure 1 represent the total value for tree cover surrounding the projected trails and project the relationship between square footage and mitigation impact of the completed trail. They do not describe "before" and "after" for any particular part of the trail.

²² "Mecklenburg County Air", Mecklenburg County State of the Environment Report, 2006.

²³ "The Urban Forest Effects (UFORE) Model", D. J. Nowak and D. E. Crane. In: Integrated Tools for Natural Resources Inventories in the 21st Century, M. Hansen and T. Burk, eds., USDA Forest Service Technical Report NC-212, St. Paul, MN. p.714-720, 2000.

Thus, air quality improvements simultaneously increase the overall quality of life for all community members while potentially reducing the financial burdens on institutions and at-risk sectors of the community.

Tree Cover: Linking Air and Water Quality

Tree cover will control not only air pollution but also soil erosion and thereby sediment run-off. Coder and colleagues at the University of Georgia have shown that a 5% increase in coverage yields a 2% decrease in run-off, consistent with the goal of controlling storm water flows.²⁵ This same study indicated that 350 square feet of forest reduces noise by 7db, enough to silence human speech. Other positive attributes of tree cover that bear enumerating include: increased privacy, decreased heat island effect, reduced wind gusting, shade, increased wildlife habitat and microclimate control.²⁶

Projected Growth: North Carolina Population Trends

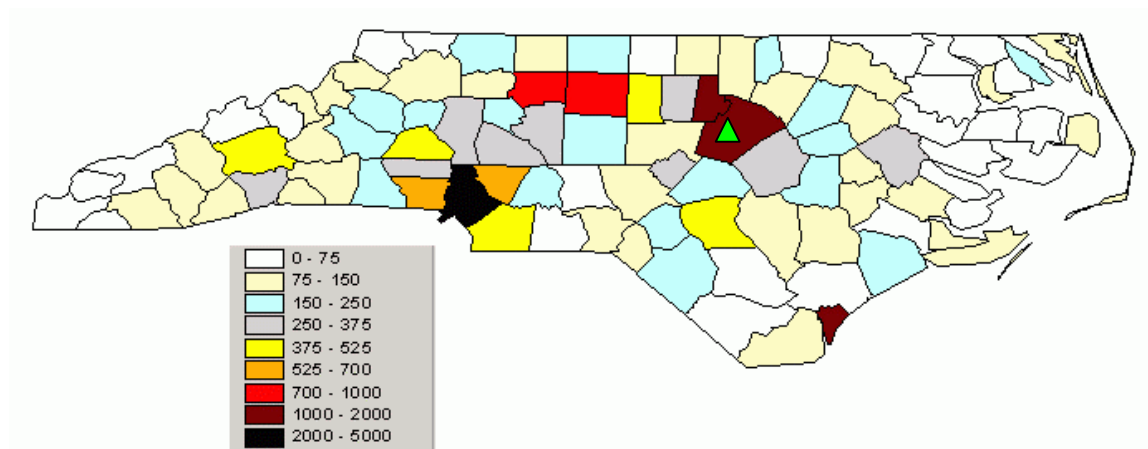
The U.S. Census Bureau and the North Carolina State Demographics database post the following forecasts on population density by county for North Carolina.²⁷ Note that by 2020, the Census Bureau predicts Mecklenburg County will be the only in the state to have in excess of 2000 persons per square mile (as noted by the green triangle in Figure 2).

²⁴ "The Importance of Population Susceptibility for Air Pollution Risk Assessment: A Case Study of Power Plants Near Washington, DC", J. Levy, S. L. Greco and J. D. Spengler, Environmental Health Perspectives, Volume 10, Number 12, December 2002. See Appendix A.2 for more details.

²⁵ Coder, KD, 1996, Identified Benefits of Community Trees and Forests, University of Georgia Cooperative Extension Service - Forest Resources Publication FOR96-39.

²⁶ See Appendix C for more details.

²⁷ Source: <http://demog.state.nc.us/>; accessed November 5 2006.

Figure 2.3: Population Density: Persons per Square Mile 2020

Source: U.S. Census 2000

Population pressure and its attendant burdens (air pollution, water supply use, public service use, etc.) will require Mecklenburg County (and the Catawba region) to become the leader in maintaining environmental quality for the entire state. This county (and region) will serve as the model for simultaneous urbanization and environmental concern.

In summary, we find that:

- The greenway trail will mitigate stormwater run-off and will encourage water table recharge.
- Reduced run-off associated with the greenway landscapes of the trail will help to mitigate storm water management and treatment concerns.
- The associated tree cover within the greenway will contribute significantly to air quality management by potentially removing approximately 130 tons of particulate matter per year.
- The trail will help to reduce air pollution and lighten the healthcare burden in the community by offering an active community environment, while also lowering mortality and morbidity associated with heart and lung disease.
- The trail will provide outlets for youth in particular to practice healthy lifestyles.
- The trail will facilitate an even greater proportion of work and leisure trips that can be made without the use of a car.

- The greenway trail will also help to reduce noise pollution and help to cool developed areas during warmer months.
- The greenway trail will also contribute to retaining the natural beauty of the region while enhancing its overall appeal as well as improving privacy for local residents.
- The greenway trail will serve as an anchor for a comprehensive system of green spaces designed to maintain and improve air and water quality in the region as development continues, thereby providing future mitigation cost avoidance benefits to the region.

For more detail on our environmental work in this section, please see Appendix C: Improved Water and Air Quality.

2.6 Increased Aggregate Recreation Value

The full build-out of the proposed Carolina Thread Trail will generate significant recreation value to residents and visitors. We estimate the potential recreation value based on the Unit Day Value (UDV) methodology used by the Federal government. This methodology implies that users value recreation and relies on surveys to estimate consumers' willingness to pay for recreation uses such as trails. Each year, the U.S. Army Corps of Engineers²⁸, publishes estimates of dollar values assigned for various (types and quality levels of) recreation activities based on consumer willingness-to-pay. The activities are categorized into general and specialized recreation activities. The general category, which we use in this analysis, includes both active and passive recreation activities.²⁹

For example:

Active:

- Walking/hiking/jogging
- Rollerblading/Skateboarding
- Biking
- Fishing
- Boating

Passive:

- Sitting
- Picnicking

Our objective here is to estimate the aggregate incremental recreation value associated with the expanded and improved trail system.³⁰

To estimate the aggregate incremental annual benefit of the recreation opportunities and activities the new system of trail would bring to the community, the unit day dollar value (UDV) is applied to the estimated number of additional trail trips.

$$\begin{aligned} \text{Unit Day Value (UDV)} &= \$ / \text{trail trip} \\ \text{Increased Trail Trips} * \text{UDV} &= \text{Aggregate Incremental Annual Benefit} \end{aligned}$$

²⁸ CECW-CP USACE Economics Guidance Memorandum, 06-03, Unit Day Values for Recreation, FY2006.

²⁹ The report notes that the "specialized recreation" values are very site and region specific, so the national values are less reliable. The values are obviously higher but also represent recreation activities that are undertaken with far less frequency. We omit this category and note that this makes our estimates more conservative.

³⁰ Note that this approach only values the use of the trail itself, not the value (likely positive) that residents place on the existence of the trail, whether or not they use it.

We estimate the aggregate incremental annual benefit based on the assumptions noted earlier in this report.

This aggregate value is estimated in two steps:

Step 1: User Visits

To get additional annual trips, we estimate both pre- and post-greening user numbers. This not only provides explicit point estimates of the pre and post benefits, but it also provides a number that, when combined with other benefits, can be compared to the cost of the greening, so that the Net Present Value of the overall project can be parameterized.

For example, if there are currently X trips on the existing trails, and the new system of trails is expected to draw an additional Y trips (by both locals and tourists), then the additional dollar benefit of the new overall trail system would be $\$UDV \times (X+Y)$; but the $Y \times UDV$ represents the increment.

For this analysis, we first estimate the number of annual trail trips for both “pre- and post-greening”. The term ‘pre-greening’ refers to conditions before a greenway system is in place. The term ‘post-greening’ refers to conditions after a greenway system is in place. Essentially, we assume that an enhanced, higher-quality trail will increase both the number of users and the number of trips per user.

Current trail usage by North Carolinians is estimated to be approximately 6.85 trips per person per year for the activities noted in earlier assumptions (walking for pleasure, jogging, running, hiking, in-line skating, and biking) on surfaced trails.³¹ According to the U.S. Census, the adult population estimate of the 15-county project study area for 2005 is 1.7 million.³² At a rate of 6.85 trips/person, the Greater Charlotte Area would yield over 11 million trips per year in a post-greening trail scenario. However, it may be that those people most likely to use trails already do so in certain areas where trails exist. To be conservative, we assume the annual average trips would be 50% of this figure, or approximately 3.5 trips per person over the age of 18. Therefore, the calculation for the post-greening number of annual trail users is as follows:

³¹ North Carolina Department of Environment and Natural Resources. 1998. *The North Carolina Comprehensive Trail and Greenway Survey*. Division of Parks and Recreation, Raleigh, NC. Table 3. This study represents a thorough scientific survey that is highly regarded by NCDNR as being representative of trail use in NC. North Carolina's State Trails Coordinator is confident in the findings of the survey and confirmed that 6.85 is a reasonable estimate for use in this study. From Table 3 of this study, the annual mean trips per person on surfaced trails are broken down as follows: Walking for Pleasure - 3.71, Jogging/Running - 1.52, Hiking - 0.69, Biking - 0.86, In-Line Skating - 0.07. This adds up to an average of 6.85 trips annually, per person.

³² Source: Population Division, U.S. Census Bureau. Annual Estimates of the Population by Selected Age Groups and Sex for Counties: April 1, 2000 to July 1, 2005.

$$\begin{aligned} &\text{Post-Greening Estimate:} \\ &(3.5 \text{ trail trips/adult}) * (1.7 \text{ million}) \\ &= 5.95 \text{ million trail trips or approximately 6 million trips/year} \end{aligned}$$

From this, we create a range of increased value based on a high and low estimate of trail trips. We assume the low estimate to be approximately 4 million trips and the high to be approximately 8 million trips.

Existing trails make up approximately 5% of the total mileage of the conceptual Carolina Thread Trail when fully built out. However, much of the existing trails are located in or near Mecklenburg County, so we assume greater use per mile. To be conservative, we assume that existing trail users represent 50% of the estimate 1.7 million potential users of the proposed trail, and that they currently use the existing trail less often than they would a higher-quality trail. (We assume 2.5 trips per adult on the current, partially improved trails). Therefore, the calculation for the 'pre-greening' number of annual trail users is as follows:

$$\begin{aligned} &\text{Pre-Greening Estimate:} \\ &50\% \text{ users} = 0.85 \text{ million} \\ &0.85 \text{ million} * 2.5 \text{ trips/user} = 2.125 \text{ million trips or approximately 2.0 million} \end{aligned}$$

Step 2:

Based on certain information culled from the recent *Regional Growth and Open Space Survey*³³, residents of the region have expressed strong preferences for recreational opportunities such as those offered by trails and greenways. We assume that the existing, limited trail system has an "average" valuation by residents and users (50 points on a 0-100 point scale). We further assume that the new, proposed trail system would be much higher quality representing 90 points on the scale. Based on the UDV figures shown in Table 1, we estimate the value for the existing and proposed trail system (a high and a low value based on the trail user estimate) as shown in Table 2.

³³ Preliminary Results. UNC-Charlotte Urban Institute, September 22, 2006.

Table 2.2: Unit Day Values for Recreation, Fiscal Year 2006
Conversion of Points to Dollar Values

Point Value	General Recreation Values*	General Fishing and Hunting Values*	Specialized Fishing and Hunting Values**	Specialized Recreation Values Other Than Fishing and Hunting**
0	\$3.19	\$4.59	\$22.33	\$12.96
10	\$3.79	\$5.18	\$22.93	\$13.76
20	\$4.19	\$5.58	\$23.33	\$14.75
30	\$4.79	\$6.18	\$23.93	\$15.95
40	\$5.98	\$6.78	\$24.52	\$16.95
50	\$6.78	\$7.38	\$26.92	\$19.14
60	\$7.38	\$8.17	\$29.31	\$21.14
70	\$7.78	\$8.57	\$31.10	\$25.52
80	\$8.57	\$9.17	\$33.50	\$29.71
90	\$9.17	\$9.37	\$35.89	\$33.90
100	\$9.57	\$9.57	\$37.88	\$37.88

Source: Greenways Inc., Econsult Corporation, and USACE

*Points from Table 1: Guidelines for Assigning Points for General Recreation in source report.

**Points from Table 2: Guidelines for Assigning Points for Special Recreation in source report.

Table 2.3: Pre- and Post-Greening Recreation Value Estimates (\$ Millions)

Trail System	Estimated Trail Trips	Recreation Value (UDV)	Estimate Recreation Value (UDV) for Proposed Trail Trips	Annual Increase in Value Over Existing
Existing (pre-greening)	2	\$6.78	\$14	-
Proposed (post-greening) - Low	4	\$9.17	\$37	\$23
Proposed (post-greening) - High	8	\$9.17	\$73	\$59

Source: Greenways Inc., Econsult Corporation, and USACE

These estimates imply that the proposed trail will increase the recreation value in the region over the existing scenario by approximately \$37 million to \$73 million. The benefits of greening, even with conservative assumptions, are estimated to be significant and positive for the region. In summary, we find that:

- There are a total of 2.0 million trips estimated for the existing trail.

- A total of 6.0 million trips are estimated for the proposed trail.
- This increase in visitors is estimated to provide increased aggregate recreation value within a range of \$37 million to \$73 million.

2.7 Return on Investment

The question of estimating a “return on investment” for a public good like a trail system is complicated by at least a couple of considerations. First, one must ask, “return to whom” – in other words, are we looking to see how much of a government’s public expenditures are recouped in the form of larger tax revenues, or are we concerned with a broader return to the general public? Second, many of the types of benefits accrued from public investments are hard to quantify monetarily but are undoubtedly positive, significant, and important to a government and to its citizens.

We first note, then, that a number of the anticipated benefits of the proposed expansion of the Carolina Thread Trail are intangible and hard to quantify, like enhanced quality of life or purer air and water for residents and tourists. These are not insubstantial gains, and combined with the returns we estimate below, make the case for trail expansion all the more compelling.

Let us now consider the timing and amounts of quantifiable positive impacts that result from the expansion of the Trail, which comes at a development cost of \$115 million in public and private dollars over a 15-year period (see Table 2.4).

During that fifteen-year period, those construction and related expenditures produce a total economic impact of \$257 million in direct, indirect, and induced expenditures, supporting over 2700 jobs and over \$86 million in earnings. They also generate additional property tax revenues as a result of increased property values near the Trail, as well as additional recreational value enjoyed by residents and tourists and additional tourism activity that can be attributed to the Trail.

Table 2.4: Return on Investment in Expansion of Trail

<u>category</u>	<u>total development cost</u>	<u>total benefit during development period</u>	<u>annual benefit after development period</u>
DEVELOPMENT COSTS	\$115M in public and private investment		
DEVELOPMENT IMPACTS		\$257 million in direct, indirect, and induced expenditures, supporting 2700 jobs and \$86 million in earnings	
additional property tax revenues as a result of increase in property values		ramping up to \$17 million per year	\$17 million per year
additional recreational value enjoyed by residents and tourists		ramping up to \$37 million to \$73 million per year	\$37 million to \$73 million per year
additional tourism activity attributed to the Trail		ramping up to \$42 million to \$84 million per year	\$42 million to \$84 million per year

Source: Econsult Corporation

Just looking at the initial 15-year build-out period, and assuming a straight-line ramping up³⁴ of positive impacts from property tax revenues, recreational value, and tourism activity, we see that each \$1 spent on the expansion of the Trail produced an additional \$10+ in economic impact during the 15-year build-out phase (see Table 2.5).³⁵

³⁴ I.e. that, starting at \$0, these positive impacts increase uniformly from Years 1 to 15 until they reach the amounts we project annually for after Year 15, when the Trail is fully built out.

³⁵ For estimates for which we have ranges of positive benefits, we use the midpoint of those ranges in our calculations.

Table 2.5: Total Return on Each \$1 Spent on Trail Expansion During Development Period

development cost of trail expansion from Years 1-15 (\$M)			(\$115)
one-time economic impact from development (\$M)		\$257	
annual net new property tax revenues (\$M)	\$17		
Year 1-15 net new property tax revenues (\$M) *		\$128	
annual net new recreational value (\$M)	\$55		
Year 1-15 net new recreational value (\$M) *		\$413	
annual net new tourism activity (\$M)	\$63		
Year 1-15 net new tourism activity (\$M) *		\$473	
total positive economic impact in Years 1-15 (\$M)			\$1,270
each \$1 spent on Trail expansion produces an additional			\$ 10.04

Source: Econsult Corporation

*assuming 15-year, straight-line ramp up

Ongoing, those dollars invested in Years 1-15 on expansion of the Trail provide an annual return in excess of the total upfront development investment, in the form of net new property tax revenues, recreational value, and tourism activity, as shown in Table 2.6 below:

Table 2.6: Ongoing Annual Return on Investment in Trail Expansion After Full Build-Out

development cost of trail expansion from Years 1-15 (\$M)		(\$115)
annual net new property tax revenues (\$M)	\$17	
annual net new recreational value (\$M)	\$55	
annual net new tourism activity (\$M)	\$63	
total annual positive economic impact (\$M)		\$135
annual return on initial trail expansion (after full build-out)		117%

Source: Econsult Corporation

It bears repeating that these impressive returns, both during the build-out phase and after, are made all the more impressive by the fact that they do not take into consideration the many intangible benefits that will be enjoyed by residents and tourists as a result of the Trail. While it is true that some measure of these benefits, like enhanced water and air purity or a more vibrant business community or an overall higher quality of life, are embedded in items that we do already quantify, most notably the rise in property values, much of those intangibles are over and above the economic impacts, further making the case that the expansion of the Trail will produce significant positive benefits that justify the initial investment.

3.0 SUMMARY AND CONCLUSIONS

The proposed Carolina Thread Trail is expected to generate significant economic benefits for the 15-county region, including parts of North and South Carolina. Benefits include:

✓ **Enhanced property values and local property tax revenues**

- An estimated 305,000 housing units will be directly affected by the Trail.
- The average projected benefit per house is estimated to be approximately \$3,500.
- Over 50% of all homes in the affected zone are projected to appreciate by the maximum benefit of \$4,500.
- The total dollar gain in house values is forecasted to be \$1.7 billion.³⁶ This represents an approximate 4% increase in the value of the entire housing stock in the affected area.
- If this gain is accurately capitalized and assessed, it would eventually yield an aggregate incremental increase in property tax revenues of approximately \$17 million per year, or \$261 million over thirty years (using a discount rate of 5%).

✓ **Increased tourism**

- The fully built-out trail could annually generate \$42 million to \$84 million in new tourism spending for the local economy and \$3 million to \$6 million in additional state and local tax revenues.

✓ **Increased economic activity, jobs, and earnings for the local economy generated by the construction investment**

- The proposed trail is expected to span approximately 500 miles with an average construction cost of \$200,000 per mile.

³⁶ This is a conservative figure, as it assumes the lower end of trail length of 500 miles; if the trail ends up being much longer, more houses would be in close proximity to it, thus leading to a larger aggregate gain in house values.

- Over the 15-year period, this investment is expected to generate over \$250 million in total economic activity.
- Of the total economic activity generated by the investment, over \$85 million represents the additional earnings of various workers.
- The construction of the trail is expected to support over 2700 new jobs (including jobs directly related to the construction itself).

✓ **Enhanced business community through business expansion and economic development**

- The proposed trail will likely increase the attraction for business development and expansion by offering year-round recreational opportunities for potential and existing business communities.
- The trail will create a strong draw for young professionals choosing to reside in or relocate to the area.
- Information from industry professionals and site selection firms support the significance of greenspace and trails for business development and attraction.

✓ **Improved water and air quality**

The trail will mitigate stormwater run-off and will encourage water table recharge. Reduced run-off associated with the greenway landscapes of the trail will help to mitigate storm water management and treatment concerns.

- The associated tree cover within the greenway will contribute significantly to air quality management by potentially removing approximately 130 tons of particulate matter per year.
- The trail will help to reduce air pollution and lighten the healthcare burden in the community by offering an active community environment, while also lowering mortality and morbidity associated with heart and lung disease. Trail may also provide outlets for youth in particular to practice healthy lifestyles, and facilitating an even greater proportion of work and leisure trips that can be made without the use of a car.
- The trail will also help to reduce noise pollution and help to cool developed areas during warmer months.

- The trail will also contribute to retaining the natural beauty of the region while enhancing its overall appeal as well as improving privacy for local residents.
- The trail will serve as an anchor for a comprehensive system of green spaces designed to maintain and improve air and water quality in the region, a particularly pressing concern as development continues.

✓ **Increased aggregate recreation value**

- There are a total of 2.0 million annual trips estimated for the existing trail.
- A total of 6.0 million annual trips are estimated for the proposed new trail.
- This increase in visitors as a result of trail development is estimated to provide increased annual aggregate recreation value within a range of \$37 million to \$73 million.

To summarize, there are a number of important tangible and intangible benefits to the proposed trail expansion. The more aesthetic advantages have been described above, and while hard to quantify, are truly compelling reasons to be excited about the long term effects of the expanded trail on the region's quality of life.

Those aesthetic advantages are also the basis for some of the economic gains that the project is anticipated to produce. Consider, for example, the quantifiable gains from the \$100 million investment over a 15-year period to build out the trail:

- 1.7 billion property value increase in affected zone
- \$17 million more per year in property tax revenues
- \$37 million to \$73 million more per year in aggregate recreational value
- \$42 million to \$84 million more per year in tourism activity
- A one-time economic impact of \$250+ million, supporting over 2700 jobs and over \$85 million in worker earnings, from the construction project itself

While it is difficult to quantify a return on an investment in a public good like an enhanced trail system, we can roughly and conservatively estimate from the above impacts that each dollar invested in trail expansion during the 15-year build-out phase produces another \$10+ in positive economic impact during that time period, and that ongoing the annual economic benefit will exceed the amount of the initial investment in the form of more property tax revenues, increased

recreational value, and added tourism activity. When one considers the many environmental, aesthetic, health, and quality of life advantages that that investment will also reap, those returns become all the more impressive, and further justify the investment required to complete the proposed trail expansion.

APPENDIX A: ENHANCED PROPERTY VALUES

Averaging Campbell and Munroe's (2004) Results

Table A.1 reports and summarizes the results from Table 10 in the author's report³⁷. The α parameter was obtained by solving for that value of α which would yield the (higher) house price computed by the authors when distance to the greenspace equaled zero.

Table A.1: Summary of Campbell and Munroe's (2004) Distance Decay Parameters

County	α	β
Mecklenburg	8.32	-.0312
Gaston	8.19	-.0376
York	8.72	-.0507
Average	8.41	-.04

Source: Econsult Corporation

Using the average of the distance decay parameters suggests a greening gradient with the following specification:

$$\ln(P) = 8.41 - .04 \times \ln(d) \quad (2)$$

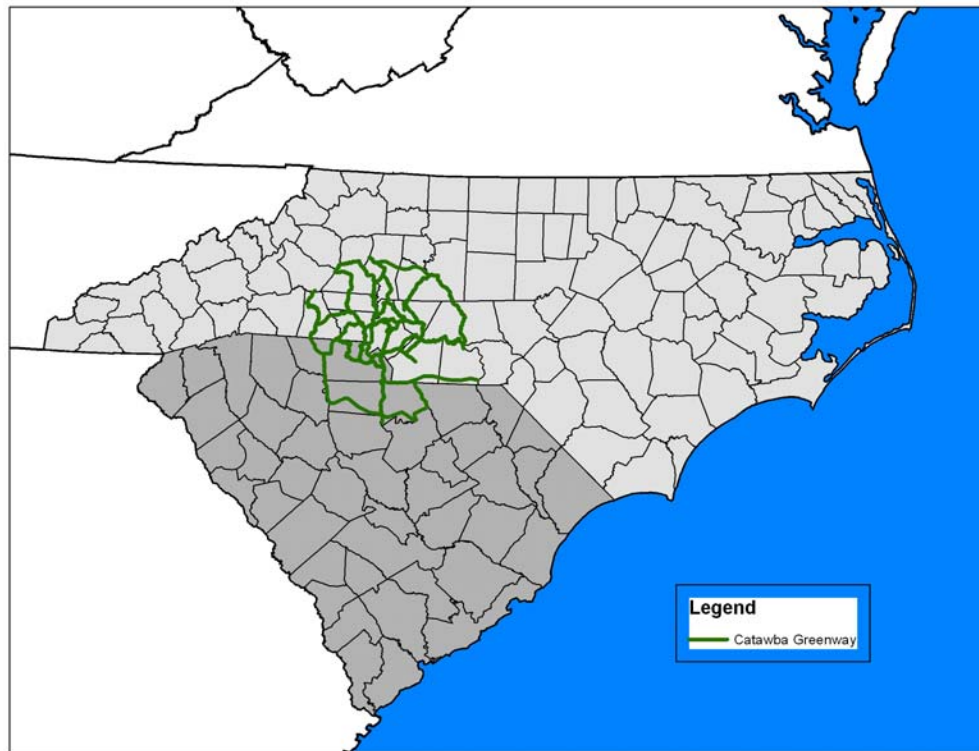
This equation implies that the benefits of the greenway are approximately \$4,500³⁸ for those dwellings closest to the greenway, and decline by 4% with every 1% increase in distance that a house is located from the greenway.

Identifying the Catawba Trail's Impact Zone

An ArcView shapefile containing the layout of the Catawba trail network was obtained from Greenways, Inc. This file was read into the GIS software, and overlaid with maps of the Census block group boundaries of NC and SC. The location of the trail network in the states is identified in Map A1, with the trailway represented by the green lines:

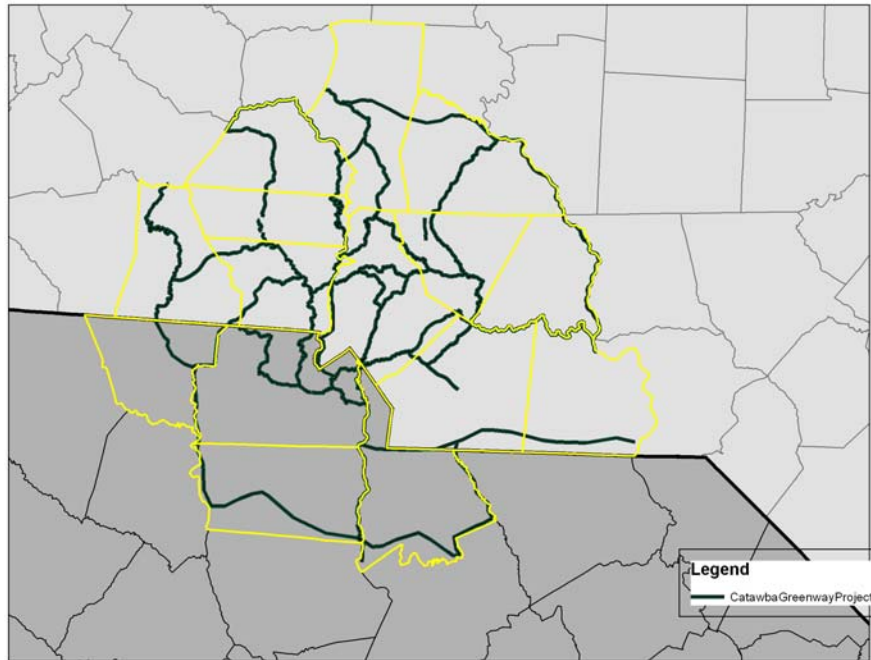
³⁷ Only the parameters for the impact on single-family homes are reported.

³⁸ Computed by exponentializing 8.41: $\exp(8.41) = \$4,500$.

Map A.1: The Carolina Thread Trail

Source: Econsult Corporation

Counties in SC and NC through which the trail passes were then identified by performing a spatial intersection in ArcView. Map A.2 displays the affected counties, highlighted with yellow boundaries.

Map A.2: Counties in the Carolina Thread Trail's Impact Zone

Source: Econsult Corporation

Counties through which the trail network runs include:

North Carolina:

- Iredell
- Rowan
- Catawba
- Cleveland
- Lincoln
- Mecklenburg
- Cabarras
- Stanly
- Gaston
- Anson
- Union

South Carolina:

- Cherokee
- York
- Lancaster
- Chester

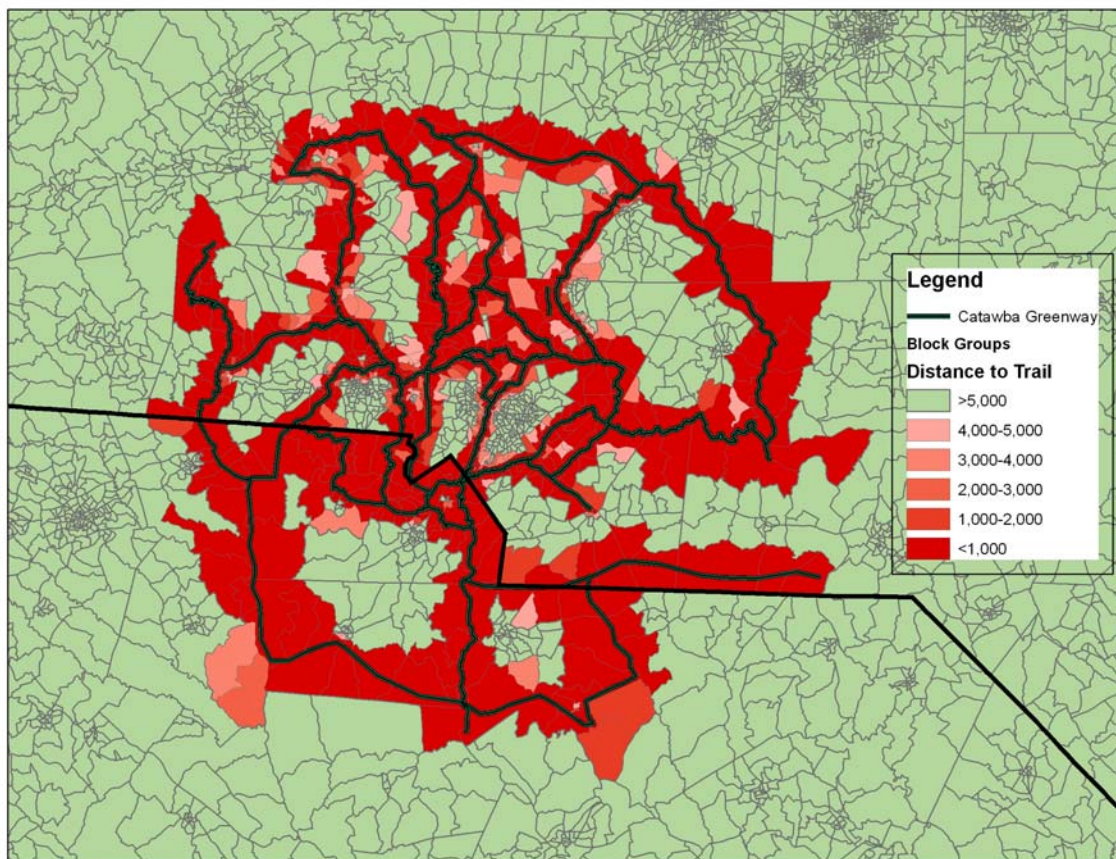
According to ArcView's distance tool, the total mileage of the proposed trail network is 500 miles, and the total landmass of the subject counties it passes through is 13,800 square miles.³⁹

³⁹ We assume, for the purposes of this report, that the trail will be 500 miles in length. Adjustments to the calculations for all benefits have been made, as noted earlier.

Identifying the Impacted Housing Stock of the Thread Trail Network

Campbell and Munroe's (2004) estimated that the capitalization of the greenspace amenity was largely limited to properties within 5,000 feet of the trail. To identify this housing stock, we overlaid the planned trail onto a map of Census Block Groups in both North and South Carolina. With the assistance of GIS software, we then computed the distance of each block group to the trail.⁴⁰ Map A.3 shows those block groups that lie within 5,000 feet of the trail, highlighted in red:

Map A.3: Impacted Areas



Source: Econsult Corporation

Block groups with a distance of less than 5,000 feet to the trail were then subsetting out of the statewide-files. According to this data, the trail's impact zone has the following characteristics:

⁴⁰ Because block groups are polygon features, the distance was computed as the linear distance from each block group's center (centroid) to the trail.

- There are 491 block groups (out of a total of 8,127) in both states, covering an area of 1,160 square miles.
- As of the year 2000, the impact zone contained a total population of 737k persons, earning a median household income of \$38,879.
- There are a total of 305,000 houses in the impact zone, with the average block group containing 621 houses.
- The median house value (as of 2000) \$91,100, while the average house value is \$100,600⁴¹.
- The aggregate value of the housing stock in 2000 is estimated to be \$30.6 billion.

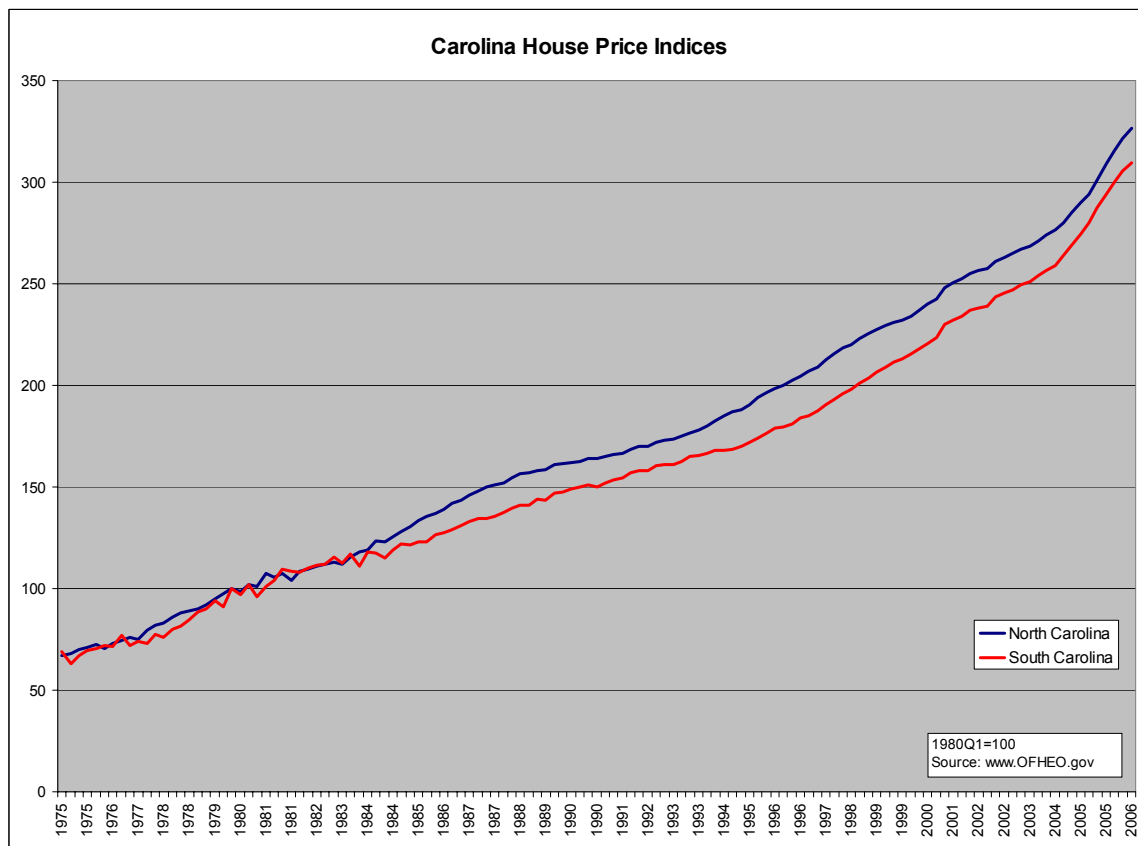
Since these estimated housing values are as-of 2000, it was necessary to next update them to their current year 2006 values.

Updating the Value of the Impacted Housing Stock of the Thread Trail Network

The median house values reported by the US Census are from 2000 decennial Census. Before forecasting the projected price capitalization of the trailway, it is first necessary to update the values to 2006. This was done by downloading⁴² and then applying the 2006Q3 OFHEO house price indices (HPIs) for North and South Carolina to the 2000Q2 house values in each block group. The OFHEO HPIs are econometric estimates of the inter-temporal pattern of general house price appreciation in these markets.

⁴¹ The fact that the average house value exceeds the median house indicates that the sample is positively skewed.

⁴² Source: <http://www.ofheo.gov/download.asp>.

Figure A.1: OFEHO House Price Indices for North and South Carolina

Source: OFEHO

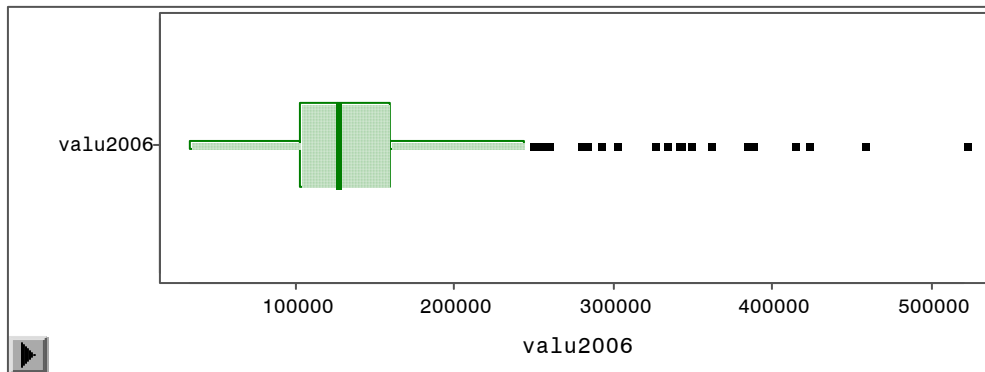
Similar to other market indices like the Dow Jones or S&P 500, the HPIs are scaled to reflect the percent appreciation over time. The indices currently have terminal values of 326 and 310 for North and South Carolina, respectively. Since both indices have values of 100 in 1980Q1, then taking the percent differences in these numbers imply that the average, statewide levels of appreciation are 226% and 210%, respectively; or, an approximate tripling in value⁴³ during this 27-year time period.

The values of the index in 2006Q2 are 237.1 and 217.83, for North and South Carolina, respectively. The percent change between these numbers and the 2006Q3 terminal values of the index imply average statewide appreciation rates of 38% and 42%. These appreciation rates were then applied to 2000 Census values of median house price, by block group, to obtain the updated 2006Q3 prices.

⁴³ Although there is certainly some geographic variation in house price appreciation throughout the state, the distribution of this variation is likely to be distributed around the mean appreciation rate represented by the state-level index.

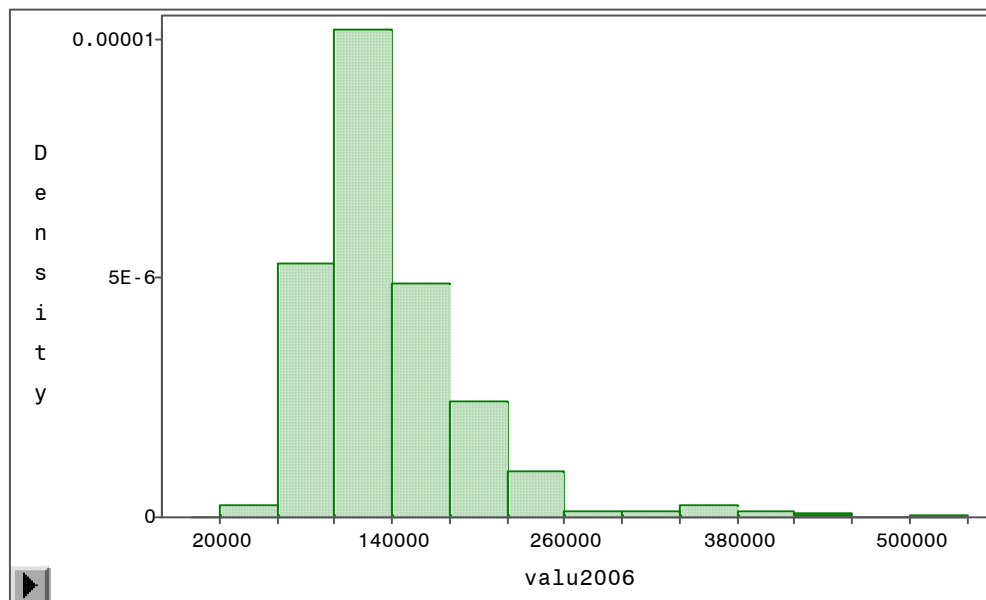
The following plot shows the distribution of the updated (median) house values, across block groups in the trail's impact zone:

Figure A.2: Boxplot of 2006 House Values in the Impact Zone



Source: Econsult Corporation

Figure A.3: Distribution of 2006 House Values in the Impact Zone



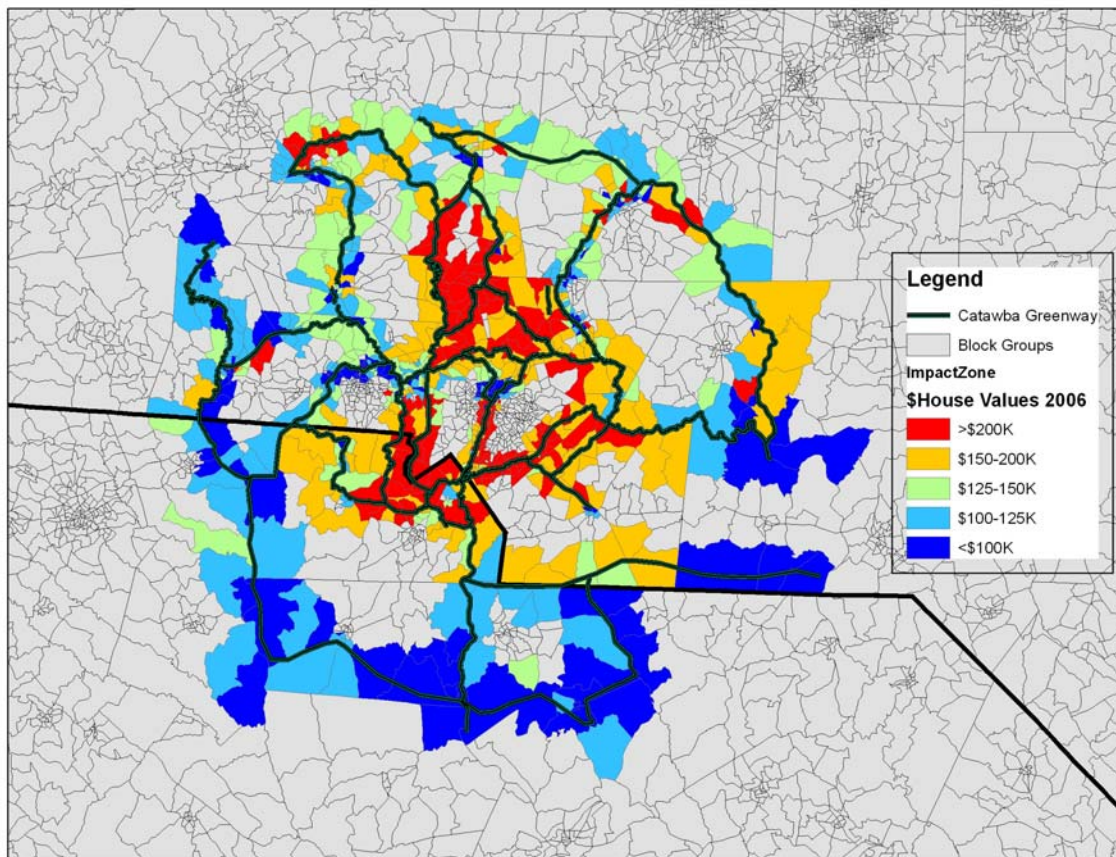
Source: Econsult Corporation

According to the data, the distribution of 2006 house values has the following characteristics:

- The median value is \$126,000, and the average is \$139,000.
- The standard deviation is \$60,000.
- 75% of all homes are valued greater than \$102,000, while 25% of all homes are valued greater than \$159,000.
- The minimum value is \$33,000, while the maximum is \$521,000.
- The aggregate value of the entire housing stock in the impact zone is \$45.7 billion.

The following map illustrates the spatial variation on current house values, based upon the quintiles of the above distribution. Warmer colors denote relatively higher-priced areas, while cooler colors denote relatively lower-priced areas:

Map A.4: 2006 Median House Values in the Trail Impact Zone



Source: Econsult Corporation

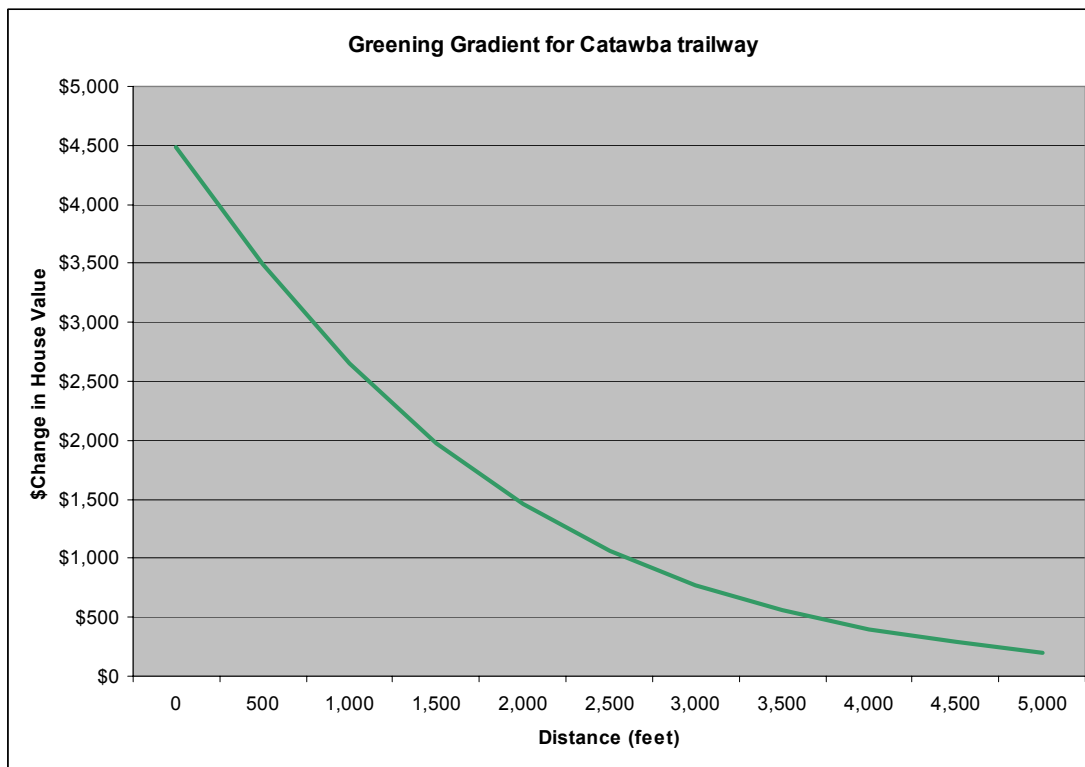
The map indicates a common pattern in house values exhibited by many US cities: house prices in the inner city area of Charlotte are relatively low, but become quite high as you move to the suburbs, only to go back down again in the rural, exurban areas outside of the city. Such a pattern likely reflects the trade-off between location (proximity to the city) and house size and quality. Suburban locales typically accrue the gains of an optimal trade-off, since they offer the proximity to the city that rural locales don't, while simultaneously offering the larger and more modern homes that urban locales do not.

Projecting the Impact of the Trailway on House Values

The estimated price gradient that was derived from Campbell and Munroe's (2004) original work is given by:

$$\ln(P) = 8.41 - .04 \times \ln(d) \quad (2)$$

This equation implies that the benefits of the greenway are approximately \$4,500 for those dwellings closest to the greenway, and decline by 4% with every 1% increase in distance that a house is located from the greenway. Exponentializing (2) converts the gradient from logs to dollars. The following figure plots this equation as a function of distance:

Figure A.4: Greening Gradient for The Carolina Thread Trail

Source: Econsult Corporation

As the plot indicates, the benefit of the greenway will be capitalized at a value of \$4,500⁴⁴ for those homes immediately adjacent to it, and this benefit will fall at a rate of approximately 86 cents per foot, until going converging to a negligible value close to zero at a maximum distance of 5,000 feet.

This gradient is then applied to the housing stock of the impact zone by using the distance of each block group in the gradient equation given by (2). The results are as follows:

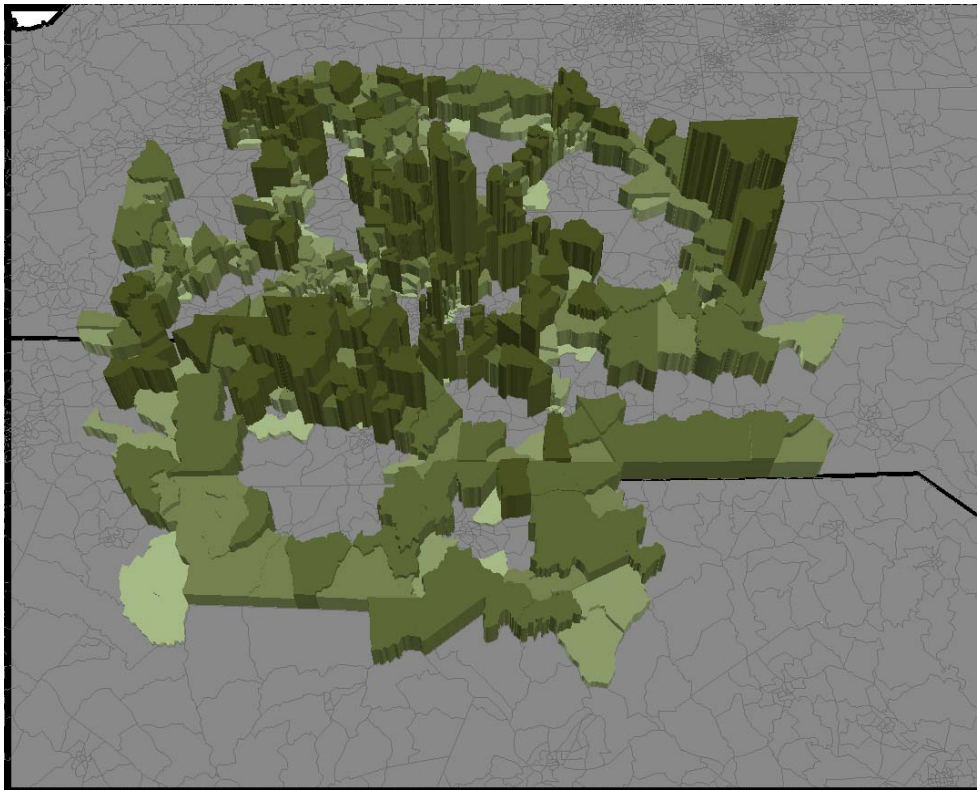
- The average projected benefit per house is \$3,580.
- Over 50% of all homes in the impact zone are projected to receive the maximum benefit of \$4,500.
- The total dollar gain in house values is forecast to be \$1.7 billion in the “affected area”.
- This represents an approximate 4% increase in the value of the entire housing stock in the affected area over 2006 baseline levels.

⁴⁴ Note: all dollar figures are in 2006 dollars.

- If this gain is accurately capitalized and assessed, this should yield an incremental increase in property tax revenues of \$17 million.
- The Net Present Value of this revenue stream is \$340 million.⁴⁵
- By contract Campbell and Munroe (2004) found an aggregate gain in residential property values of \$24 million, and an incremental gain in annual property tax revenues of \$370,000.
 - The large difference between these two sets of number can be explained by the fact that this analysis includes updated house values, and covers a significantly larger geographic scope (15 counties v. 3 counties).

To characterize the spatial variation in the increase in property values, the total dollar benefit accruing to each block group was first calculated by multiplying the number of housing units in each block by the projected dollar benefit to each home. The resulting number represents the aggregate dollar gain to the housing stock in each block group, as a result of constructing the trailway. These numbers were then exported to ArcView and applied to each block group. The following map extrudes each block group by the value of the aggregate benefit, relative to other block groups. Darker shades of green denote greater dollar benefits:

⁴⁵ This calculation assumes that the revenue stream is received in perpetuity, net of inflation, with a 5% opportunity cost of capital.

Map A.5: Projected Dollar Benefits of the Greenway, by Block Group

Source: Econsult Corporation

As would be expected, those areas that disproportionately benefit from the presence of the trails are those that are near multiple trail nodes, and also have a large housing stock. In this case, this appears to be the suburbs both to the north and south of Charlotte.

APPENDIX B: ECONOMIC AND FISCAL IMPACT MODEL METHODOLOGY

B.1 Economic Impact Analysis

The economic impact estimates presented in this report were derived from the regional Input-Output (I-O) model developed and maintained by the U. S. Department of Commerce, Bureau of Economic Analysis (BEA). This model, the Regional Input-Output Modeling System (RIMS II), is widely used to estimate the economic impacts of regional projects or programs. The results generated from the RIMS II model are widely recognized as plausible, and defensible, in cases where the input data to the model are accurate and based on reasonable assumptions. This section describes the basic concepts that underlie RIMS II.

An I-O model provides a compact means of summarizing interindustry relationships within regions. The model itself is essentially an accounting framework, expressed as a matrix or array. For each industry in the region, the model shows the distribution of inputs purchased and outputs sold to all other regional industries. The RIMS II model is based on the BEA National I-O model, which shows the input and output structure for nearly 500 industries, and the BEA regional economic accounts, which are used to adjust the information in the national model to reflect a given regions' industrial structure and interindustry trading patterns.

The data that drive the I-O model are the planned expenditures associated with the project or program being studied. In the jargon of I-O models, those expenses make up the "direct expenditures", that form one part of the programs' total economic impact on the region. Assuming that the planned project is a new store, the direct expenditures are the sum of all spending needed to construct, equip and operate that facility.

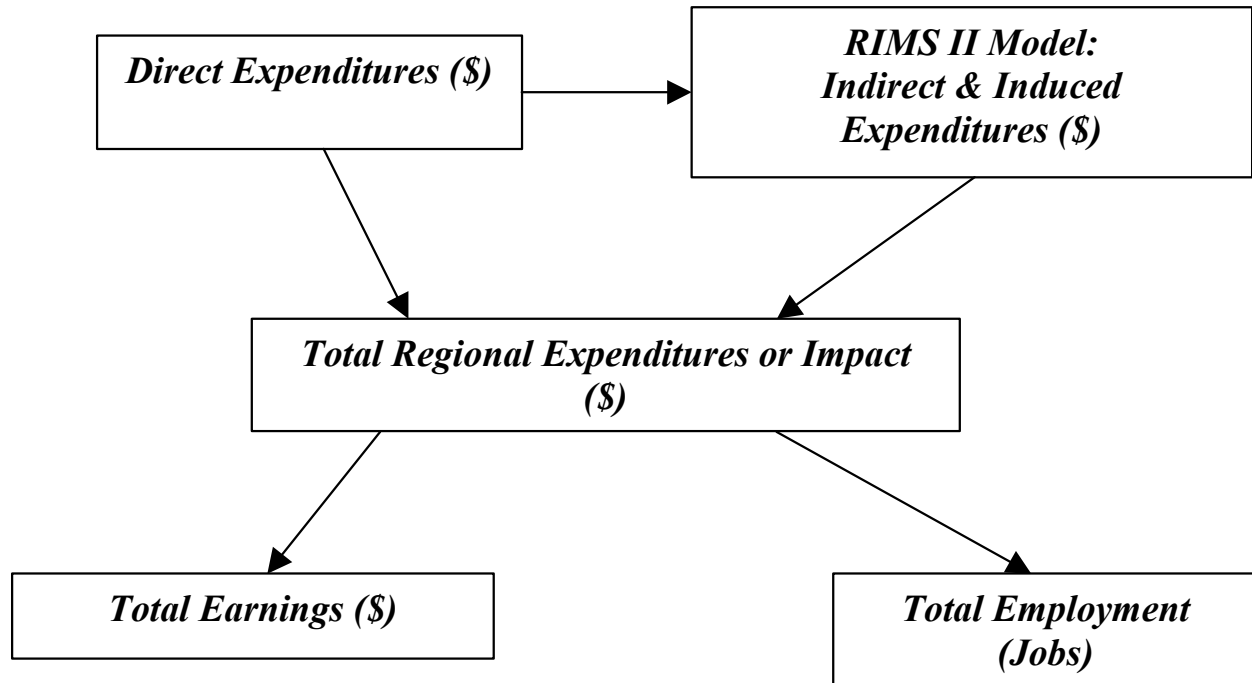
Some of that spending will be to purchase goods and services from other businesses in the region, causing those firms to increase production. In turn, the firms supplying the new store will need to increase purchases from their suppliers, to meet their new orders. The sum of all of this interindustry spending are the "indirect expenditures" associated with the new store.

All of the economic activity resulting from the new store, whether direct or indirect, will require workers who must be paid. Some of their earnings will be spent at businesses within the region on various goods and services, creating another round of economic activity like that described above. These expenditures equal the "induced expenditures" associated with the new store.

The sum of the direct, indirect and induced expenses represent the total economic impact of the new store on the region. In addition to measuring that impact in dollars as output or expenditures, the RIMS II model produces estimates of the proportion of that spending paid to regional households as wages and salaries. Finally, the RIMS II model generates estimates, by industry, of the number of full- and part-time jobs related to the new store. Both the earnings and employment estimates are useful alternative measures of the regional economic impact of the new project.

The following schematic depicts the flow of data, from inputs to outputs, through the model:

Figure B.1: Input-Output Model Flow Chart



The overall “success” of the economic impact analysis depends in large part on the initial design of the analysis. For example, if the project involves both construction and operation phases, it is important to separate the total expenditures between the two, and run the RIMS II model for each set of expenditures. The phases occur at different points in time, and have different impacts on the regional economy. Hence, the accuracy of the results depends on recognizing those differences, and treating them appropriately.

B.2 Fiscal Impact Analysis

The RIMS II model provides estimates of the economic impact of a new project or program on the regional economy. It does not, however, estimate the fiscal impact of the increased economic activity on state and local governments. Econsult has constructed a model that takes the output from the RIMS II model and generates detailed estimates of the increases in state and local tax collections that arise from the new project. Those revenues are in fact a part of the total economic impact of a new project that are often ignored in conventional economic impact analyses.

The RIMS II model provides estimates of direct, indirect, and induced expenditures, earnings, and employment within the defined region. The Econsult fiscal model combines the RIMS II output with U. S. Census Bureau County Business Patterns data to produce estimates of the distribution of additional employment and earnings by county. In addition, the 2000 Census "Journey to Work" data on commuting flows are utilized to estimate income earned by residents of each county within the region, regardless of where they work. The fiscal model can then estimate the increase in earned income taxes by county and for the state as a whole resulting from the new project. For complex cases, like Philadelphia, the model can differentiate between residents and nonresidents and apply the proper wage tax rate. Pennsylvania state business and sales taxes, as well as business taxes in Philadelphia, are estimated based on the most recent data on average sales tax base per employee by major industry, as contained in publications from the Pennsylvania Department of Revenue.

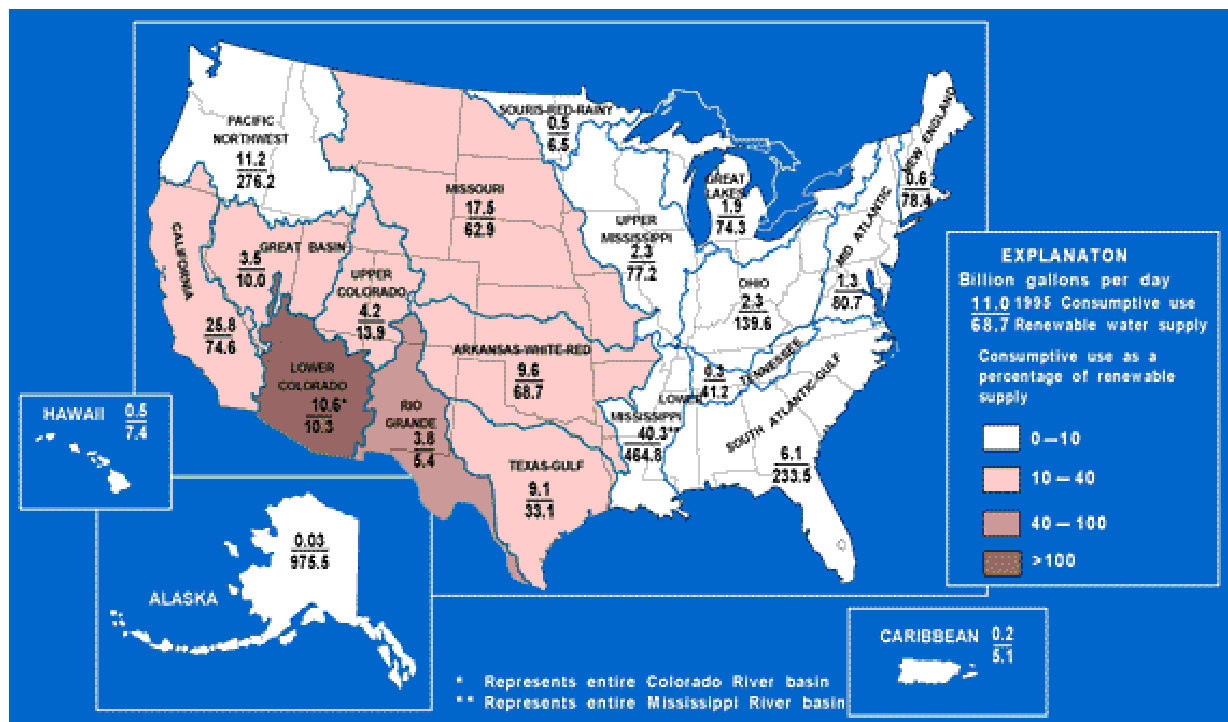
The Econsult fiscal model is flexible, and has been extended to estimate New Jersey and Delaware taxes arising from some new project, as well as Pennsylvania state and local taxes. Those extensions are done on a case-by-case basis, depending upon the analysis being performed.

APPENDIX C: IMPROVED WATER AND AIR QUALITY

Water: Regional Availability and Quality

Data from the United States Geological Survey indicate that North Carolina has an overall strong position relative to potential water shortages. Figure C.1 shows that consumptive use in North Carolina was less than 10% of renewable supply in 1995 (most recent data).

Figure C.1: Consumptive Use and Renewable Water Supply (by Water-Resources Region)



Source: United States Geological Survey⁴⁶

Drilling down to the County level for 2000, however, provides us with a more accurate picture of the situation faced by the Catawba region watersheds. Year 2000 data available from the EPA for the 25 counties drawing upon the watersheds relevant for this study show an average daily draw of 55.78 gallons from the public supply per person. This is consistent with the plumbing industry

⁴⁶ United States Geological Survey, accessed on November 10 2006; <http://water.usgs.gov/watuse/misc/consuse-renewable.html>.

averages for household use. However, when the entire region's population, activities and sourcing are included (industrial activity, private supply, direct draws from surface water, etc.), the load increases to 2,839 gallons per person per day.

The impact of growth on the regional water supply is difficult to model or predict. Considerations include changes in rainfall due to lost water table and surface water recharge, increased draw from reservoirs, and shunting of supply. With regard to the latter, some data have been released and gives us a framework for predicting long-term burden. An August 2006 study of the proposed Concord Kannapolis interbasin transfer increases the draw from the Catawba basin from roughly .5% of total basin volume to 2%, with .8% of the drawn pulled to through the interbasin transfer. A resulting 8% reduction in total reserve leaves 86.4% of the basin water unused. Projections of growth modeled in the study past 2030 suggest there will be relatively low amounts of distress on the total water supply within the Catawba region. Further, the analysis suggests that no significant impact on water quality will occur from drawn down and subsequent concentration of contaminants.⁴⁷

Identifying Major Sources of Water Contamination

Within the Mecklenburg County watersheds, the contamination events reported to the EPA were in three major categories: fecal coliform contamination, turbidity, and sediment. Translating, these are animal and/or human waste contamination, non-dissolving suspended particles (organic compounds and other chemicals) and larger depositing particles (erosion products) respectively. Further, "unknown" sources of contamination also occur with relative frequency, and are not identified in the dataset (Table C.1).

⁴⁷ "August 31 2006 Supplement to the Concord Kannapolis IBT Environmental Impact Statement", North Carolina Division of Environment and Natural Resources, Division of Water Resources, August 2006; accessed via <http://www.ncwater.org/>.

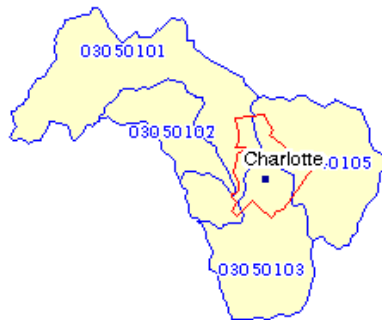
Table C.1: Type and Frequency of Waterway Contamination

Year 2005		Percent of Reported	
Causes of Impairment Reported	Lower Catawba	Upper Catawba	Rocky
FECAL COLIFORM	35	22.73	4.76
MACROINVERTEBRATE	15	2.27	na
UNKNOWN	12.5	45.45	42.86
TURBIDITY	11.25	13.64	4.76
DISSOLVED OXYGEN	10	na	na
SEDIMENT	7.5	9.09	47.62
PHOSPHORUS	6.25	na	na
COPPER	2.5	na	na
HABITAT DEGRADATION	na	6.82	na
Total Number of Causes of Impairment Reported: 80	80	44	21

Source: Econsult Corporation

The cause of the three well-defined impairments is most often surface run-off pulling non-point source contaminants into the waterways.

In general, approaching the analysis of water quality issues on a county and sub-county basis provides a method by which the impact of storm water control on water quality can be evaluated. At the same time that each community faces specific challenges in terms of the contamination and demands placed upon it, it is also linked to the counties around it. For example, the EPA data indicates that Mecklenburg County contacts multiple watersheds⁴⁸:

Figure C.2: Mecklenburg County Watersheds

Source: EPA

⁴⁸ http://cfpub.epa.gov/surf/county.cfm?fips_code=37119; accessed November 5 2006.

These areas overlay the following counties:

Lower Catawba Watershed (Extends primarily below the border into South Carolina):	Upper Catawba Watershed (Extends below Gastonia and into South Carolina):	Rocky Watershed:
<ul style="list-style-type: none"> * Mecklenburg * Union * Chester (SC) * Fairfield (SC) * Kershaw (SC) * Lancaster (SC) * York (SC) 	<ul style="list-style-type: none"> * Alexander * Avery * Buncombe * Burke * Caldwell * Catawba * Cleveland * Gaston * Iredell * Lincoln * McDowell (SC) * Mecklenburg * Mitchell * Watauga * Wilkes * Yancey * York (SC) 	<ul style="list-style-type: none"> * Anson * Cabarrus * Iredell * Mecklenburg * Rowan * Stanly * Union * Chesterfield (SC)

The 3 major watersheds involve over 25 counties in two states.

Air Quality

Particulate carbon is generated by combustion: power plants, industrial burning, automobiles, lawn mowers, fire places and the like all release various amounts of fine particulate carbon into the atmosphere. As these particles are breathed, they irritate the passageways and deliver any chemicals attached to them to the tissues of the lungs. Particulate matter is typically randomly

shaped and approximately spherical and therefore is identified by diameter and measured in micrometers. "PM10" is the abbreviation for "particulate matter diameter 10 microns or less". PM10 and more recently PM2.5 are current standard diameter thresholds for health effect measures. PM2.5 is a more recent measure, and reflects a growing recognition of the role ultra fine particles play in carcinogenesis.

Numerous epidemiological have shown a strong link between PM exposure and occurrence of acute respiratory infections, lung cancer and chronic respiratory and cardiovascular diseases.⁴⁹ The biological mechanisms behind these associations are not fully understood, but the results of research show that PM induces several types of adverse cellular effects, including cytotoxicity (cell-killing), mutagenicity (cancer-causing), DNA damage and stimulation of proinflammatory cytokine production. The latter is an immune response that plays a role in allergies, asthma, arthritis and other autoimmune diseases.

Air Filtration Calculations

Averaging published data on average particulate removal per year per square meter, we determined a national average of 12.1 kg per meter squared of tree cover per year of particulate matter removed.

Using 500 miles of trails, we calculated total area of tree cover by taking the width of the trail, subtracting the trail width (10 feet), and using the remaining value multiplied by the total trail length to obtain a total area. Total area was converted to meters. This value was then multiplied by the particulate removal value above to obtain a number of kg of particulate removed per year by the tree cover provided by the trail system. This was then converted to U.S. tons. We used trail widths of 50 feet, 60 feet, 80 feet and 100 feet to generate the curve in Graph 1 in Section 2.5.

Healthcare Impacts on Specific Groups

The effects of air pollution on the health of the elderly have been well documented. Analysis of longitudinal data in the Chicago metropolitan area for exposure to a 10-ug/m³ increase in ambient PM10 showed a doubling of risk of hospital admission for those with pre-existing heart and lung-related illnesses exposed to PM10. In contrast, age, race and sex did not correlate with increased admission rate on these days. The suggestion is that populations with cardiovascular disorders are acutely and disproportionately affected by air pollution.⁵⁰

⁴⁹ "Fine Particulate Matter National Ambient Air Quality Standards:" P. R. S. Johnson and J. J. Graham, Environmental Health Perspective, Vol. 113, No. 9, September 2005.

⁵⁰ "Are There Sensitive Subgroups for the Effects of Airborne Particles?", A. Zanobetti, J. Schwartz, and D. Gold, Environmental Health Perspectives, Volume 108, Number 9, September 2000.

The benefits of air quality control also appear to accrue asymmetrically by socioeconomic class. Researchers at the Harvard School of Public Health found a dose-dependent response to net reductions in air pollution, focusing on 2.5 um-particulate matter (PM2.5), NOx, SO2, mercury and carbon dioxide emissions. Using EPA data of existing emissions and regulatory target levels, they modeled the effect of meeting regulatory demands in outputs from power plants (dispersed point source emissions) using CALPUFF. In examining demographic modifiers of outcome, educational attainment and socio-economic status correlate most strongly with susceptibility to air born pollutant effects.

When analyzed, the results show that the majority of averted premature infant deaths also occur in the lower economic strata. Similarly, a disproportionate number of averted pediatric asthma cases are accrued in African-Americans.

Tree Cover: Linking Air and Water Quality

Summarizing work done by Hewitt and colleagues, trees with large leaf surface areas and minimal reactive volatile organic compounds (VOCs) release are the best choices. Scots pines, larch, maple, ash, common alder and birch are among those trees surveyed that most reduce pollution without increasing ozone-forming contamination of the air. Trees that tend toward the opposite end (high VOC-emitting) of the profile include willow, poplar and most species of oak.¹⁰

Image C.1: Run-off Control: Green Space Options



Source: Grass Swales, Residential Neighborhood (EPA - "Installation of Grass Swales")

Bioswales, detention and retention ponds are now standard responses to handling storm water run-off. The goal is to filter and treat the water as it moves into the water table or before it moves downstream and into the waterways. Together, they constitute on-site water treatment facilities in addition to providing green space with their attendant amenities. The reduction in water treatment costs for storm water flows combined with the green space amenity they provide likely makes them cost-effective in most if not all instances when compared to the costs of up-sizing infrastructure to treat run-off in conjunction with municipal wastewater streams.

Bioswales and detention ponds temporarily hold the storm water, slowing its progress to waterways and ultimately mitigating the TSS and volume load over time during storm events. Retention ponds are designed to retain water during the storm event and are typically partially-full year round. We do not here discuss the merits of each approach or the challenges of sizing associated with each method. Since all three function in essentially similar ways, we have chosen to emphasize bioswales and detention ponds and treat retention ponds as a specialized type of detention pond. Sizing is critical, and studies have shown that chronic under-sizing and neglected maintenance result in failure to perform adequately.⁵¹

With regard to detoxification, studies indicate that detention ponds and swales may reduce total suspended solids (TSS) by 50-90%, Phosphorous between 30-90% and heavy metals by 40-80%.⁵² When swales and detention areas are planted with native species, plants typically thrive and do not require replanting.

Looking at actual implementation, there are several varieties of built systems, including lower cost grass swales (pictured above). Generally, bioswales are designed to handle certain anticipated loads, are planted with flood and drought tolerant species, and are often built upon sand beds, etc., to facilitate water drainage and filtering. In the simplest instance, proper grading combined with drought tolerant grass suffices to create a detention and water table recharge area for run-off.

More elaborate systems designed to handle higher loads are also commonplace. Roadside (Image C.2) and trailside or commercial (Image C.3) swales are often more extensive and are sized to handle loads resulting from road and parking lot (Image C.4) run-off.

⁵¹ "Retention deficit: Evaluating retention pond effectiveness at controlling suburban stormwater runoff, James City County, Virginia", Hancock, G. S.; Popkin, M. B., American Geophysical Union, Fall Meeting 2005.

⁵² "Stormwater Technology Factsheet: Wet Detention Ponds", EPA 832-F-99-048, September 1999.

Image C.2: Roadside Swale



Source: Rivianna Stormwater Management Partnership, <http://www.rivanna-stormwater.org/>

Image C.3: Commercial Swale



Source: Garbally office complex, Vancouver, BC

Image C.4: Parking Lot Run-off

Source: Cleveland, Ohio, parking lot bioswale

Detention ponds are more extensive in scope and cost when compared to bioswales, but also provide greater run-off handling capacity as well as opportunities for more extensive amenities and wildlife habitat (Image C.5). Dry versions are also common, and approximate in appearance the grass swale (Image C.6). Dry detention ponds are typically bare bones, but nothing inherently prevents them from having tree cover.

Image C.5: Wildlife Habitat



Source: *University of North Carolina at Wilmington Pond Project*,
www.uncwil.edu/people/Cahoon/PondProject.html

Image C.6: Grass Swale



Source: *Maryland Department of the Environment, Dry pond*

Sizing the Response: Site-Specific Requirements and Strategies

Standards for matching green space and run-off mitigation with paved or build area vary by jurisdiction. Civil engineering firms employed by developers typically will work to meet the municipal and state requirements, but community planning and overarching design falls to the municipality. Some states have evolved standard methods to approach site mitigation within the framework of community planning. In particular, Georgia has published a manual that details a method of site-specific analysis. We have outlined the approach below.

For a given site, 80% (EPA standard) reduction of Total Suspended Solids (TSS) is required.

$$WQv = Sv * Rv * A / 12$$

where:

WQv = total volume of rainfall handled; required to be handled by control facilities

Sv = storm volume, in inches per event, for a designated percentile of total storm events (i.e. a value of 1.5 inches would mean 1.5 inches of rain is the volume associated with the 90th percentile of all storms occurring in the region determined by averaging the values in inches for a given number of locations)

Rv = $0.05 + 0.009(I)$ where I is the percentage of impervious cover (building footprints, sidewalks, asphalt, etc.)

A = site area in acres

[Expression of WQv as "cubic feet" = $WQv * 43,560$]

This figure is the basis for determining the size of the facility or structure that can handle the chosen load.

Example:

A 1-acre site contains a building and parking lot that covers 25% of the lot. Assume the 90% rainfall figure is 1.5 inches for the site.

$WQv = 1.5 * (0.05 + 0.009 (25)) * 1 / 12 = 0.0343$ acre-feet or $.0343 * 43,560 = 1497.38$ cubic feet or 11,200 gallons.

This is the volume that must be diverted from the run-off flow to achieve 80% reduction in TSS (total suspended solids) for total pollutant flow off site. An 11,200 gallon retention pond might be 50 feet by 50 feet by 5 feet deep, occupying 2500 SF of the site area.

The specific goal can be achieved using a combination of techniques that are compatible with the development plan, not necessarily a large pond. However, it does point to an inherent tension between land improvements (buildings, parking lots, etc.) and retained open space or "green" improvements (bioswales, retention ponds, etc.). Determining what portion of the load created by future development can be borne by the greenway will be an important factor in supporting future growth.