Economic Impact of Bicycling in Texas

Final Report

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Executive Summary

Bicycling is an economic driver that can generate billions of dollars in retail spending and support millions of jobs nationwide each year (1). The economic impact of bicycling is a widely studied topic of interest to several state transportation agencies. More than ten states have conducted studies on the economic impact of bicycling in their state in the last five years, each finding considerable positive impacts in several key areas. These analyses help inform policymakers and stakeholders of the economic impacts investment in bicycle infrastructure and bicycling programs have on the state.

Additionally, bicycling is an affordable form of transportation and a recreational activity with virtually no environmental impacts, consuming much less non-renewable resources than any motorized form of transportation (2). Moreover, bicycling has been shown to have substantial direct health benefits by reducing mortality and cardiovascular risks in adults, as well as indirect benefits to overall public health by reducing the need for automobiles (2)(3).

The purpose of this report is to identify and estimate the different types of expenditures related to bicycling and to estimate their economic impacts within the State of Texas at both the statewide and local levels. Texas A&M Transportation Institute (TTI) researchers developed broad statewide estimates of the economic impacts of the bicycling industry in terms of employment, value-added, and total output. In addition, this report estimates the impact of transportation cost savings realized through cycling. TTI researchers also examine these impacts at the local-level via three case studies.

To fully estimate the economic impacts of bicycling in Texas, this analysis was divided into three sections:

Section 1. Identify potential economic impacts for evaluation

a. Conduct a literature review of both scholarly work and existing studies.
b. Identify economic impacts associated with bicycling.
c. Determine data availability and feasibility of analysis for each impact type.

Section 2. Estimate economic impacts of bicycling statewide

a. Collect available statewide data on bicycle tourism, bikeway construction, and bicycle manufacturing.
b. Develop methodology for estimating statewide benefits using available data.
c. Report findings for each impact type.

Section 3. Estimate economic impacts to local economies from case study projects

a. Select viable case studies which vary by type, purpose, geography, and size of community.
b. Adapt statewide assessment methodology to estimate impacts at the local level.
c. Report findings for each selected case study.

Background

In the first phase of the analysis, TTI researchers collected and reviewed literature and existing studies that examined the various types of economic impacts of bicycling. The literature notes the following economic impacts to be the most common amongst completed statewide studies and existing scholarly literature:

- Tourism & recreation- economic impacts resulting from in-state and out-of-state bicycle visitor spending

- Manufacturing, wholesale/distribution, and retail- economic impacts resulting from bicycle manufacturing and sales in Texas
- Capital construction spending on bikeway improvements- economic impacts resulting from the construction of bikeways in Texas
- Property values- economic impacts resulting from changes to property values of properties near bikeways
- Health- economic impacts realized from public health benefits of bicycling
- Mobility- economic impacts associated with travel time savings

In an examination of these impacts and their associated literature, TTI researchers determined potential data sources to be used in the analysis. The most common data source found in existing studies in other states were statewide surveys of the bicycling populations, which obtained bicycle user counts, spending and travel habits, frequency of use, and trip purpose. Given that a survey of Texas' bicycling populations was not conducted for this report and no statewide bicycle-focused survey data exists, researchers used supplemental sources as the primary source of data. Supplemental data was obtained from agencies such as the Texas Office of Economic Development and Tourism (EDT), Bureau of Economic Analysis (BEA), Bureau of Labor Statistics (BLS), U.S. Census Bureau, TxDOT, and others. The researchers clearly defined any assumptions made and any limitations of the results. See Section 1 for details.

Statewide Economic Analysis

Following the literature review, researchers developed a methodology to identify the impacts that bicycling has on the state economy. As seen in Table 1, the analysis estimates that bicycling supports over 36,000 jobs annually, both directly and indirectly, and generated nearly $1.1 billion in labor income from bicycle-related purchases, production, and construction of bikeways statewide. Moreover, researchers found that bicycling generated in excess of $352 million in monetized health benefits in 2017. These results were calculated through a series of economic impacts analyses using a variety of data sources as detailed in Section 2.

Table 1. Summary of Annual Statewide Economic Impacts Related to Bicycling

Type of Impact	Estimated Totals
Employment:	36,000 jobs supported[1]
Tax Revenue Generated[2]:	$153 Million in State and Local taxes.[1]
Labor Income Generated:	$1,225 million paid to workers
Congestion Savings:	$11 Million for every 1 percent shift from cars to bikes
Health Benefits:	$352 Million from reduced mortality risks

[1]Direct, indirect, and induced impacts from tourism, sales, manufacturing, and construction.
[2]Does not include taxes on production and imports for bikeway construction projects

Impacts from Bicycle-Related Expenditures

Bicycling contributes to the Texas economy in a number of ways ranging from the purchase of bicycle equipment to the investment of millions of dollars in constructing new bikeway infrastructure. Personal and public investments in bicycling have a reverberating effect on the state and local economies in the form of jobs and added value generated through a "multiplier" effect. Multipliers are factors used to calculate the dollar value of impacts for each dollar spent in a specific economic sector. To calculate the impact from these multiplier effects, the IMpacts for PLANning (IMPLAN) economic analysis model was used. IMPLAN is a form of input-output (IO) model which estimates the initial change in an economy resulting from spending/investment changes for a defined region.

The results of IMPLAN are presented as:

- **Employment** numbers represent total annual average jobs. This includes self-employed along with wage and salary employees. All full-time, part-time and seasonal jobs are included in these employment numbers and are calculated as full-time/ part-time averages over twelve months. Therefore, results are reported as individual job-years, not full-time equivalent (FTE) jobs. A job-year is one year of one job and part-time positions are included in the count as a single job.
- **Labor income** is the amount paid to workers within a region. Labor income includes both employee and proprietor income and is the source for induced impact calculations.
- **Value added** is the combination of labor income, property income, and indirect business taxes accrued in a region resulting from the economic activity analyzed. It demonstrates the difference between the value of production and the costs of purchasing services and goods to produce a good or product.
- **Output** represents the total value added, as well as any intermediate expenditures (i.e. purchase of intermediate goods). Intermediate expenditures are the purchase of non-durable goods and services. These are purchases that go into production of goods rather than those that are for final consumption. A general example of an intermediate expenditure could include wood in the manufacturing of furniture. The furniture manufacturer sells finished furniture, but there is an impact associated with that furniture manufacturer purchasing the wood from a lumber yard.

Each of these impacts are categorized and presented as either:

- **Direct-** a series of, or single production changes/ expenditures that resulting from the initial change in expenditures (to the retail industry, construction industry, etc.),
- **Indirect-** originating from the operations of the direct industry (suppliers of the retail industry, construction industry, etc.), or
- **Induced-** arising from the household spending of direct and indirect wages.

Direct, indirect, induced, and total impacts in each category are shown in **Table 2**. Total impacts include the sum of the direct, indirect, and induced impacts of each the examined category. Inputs for these analyses came from multiple data sources, including the Texas Office of Economic Development and Tourism (EDT), the U.S. Census Bureau, and TxDOT's Transportation Alternative (TA) program. Detailed methodology for calculations in each impact category can be found in Section 2.

A confidence level for each impact category is also included. This is a qualitative measure describing the accuracy of TTI's analysis based on the limitations and assumptions used in estimating each impact. For example, the impact of in-state bicycle tourism is 'medium' because while researchers know the total volumes of in-state tourism and average spending amounts in various economic sectors, the data does not identify what percentage of trips were made with bicycling as the primary purpose. In this case, researchers made conservative assumptions based on past analyses and available literature.

Table 2. Impacts of Bicycle-Related Expenditures in Texas (in 2018 dollars)

	Tourism	*Sales*	*Manufacturing*	*Construction*	*Total*
Direct Impacts					
Employment	24,631	1,275	195	213	26,314
Labor Income ($M)	$652.5	$39.2	$18.0	$10.9	$720.6
Total Value Added ($M)	$1,008.3	$63.6	$25.6	$13.2	$1,110.8
Output ($M)	$1,693.7	$94.3	$119.0	$24.3	$1,931.3
Indirect Impacts					
Employment	3,890	227	251	30	4,398
Labor Income ($M)	$216.5	$12.8	$18.5	$1.7	$249.6
Total Value Added ($M)	$349.1	$21.9	$29.8	$2.8	$403.6
Output ($M)	$631.7	$37.5	$57.8	$5.3	$732.3
Induced Impacts					
Employment	4,803	323	226	71	5,424
Labor Income ($M)	$224.8	$15.7	$11.0	$2.9	$254.4
Total Value Added ($M)	$390.7	$27.1	$19.0	$5.1	$441.9
Output ($M)	$680.4	$47.7	$33.4	$9.1	$770.6
Total Economic Impact					
Employment	33,324	1,825	673	314	36,135
Labor Income ($M)	$1,093.8	$67.7	$47.5	$15.5	$1,224.6
Total Value Added ($M)	$1,748.2	$112.6	$74.3	$21.2	$1,956.2
Output ($M)	$3,005.8	$179.6	$210.1	$40.6	$3,436.1
Confidence of Results	Medium	High	Low	Medium	

Source: IMPLAN

Cost Savings Benefits

TTI researchers also estimated the mobility and health impacts of bicycling within the state. **Table 2** does not feature these results because 1) these impacts were focused on cost savings instead of expenditures within economies and 2) these analyses did not utilize the IMPLAN model to generate estimates.

Mobility/Congestion Relief Savings - To analyze mobility benefits, TTI researchers estimated that there would be over $11 million in congestion cost savings if 1 percent of traffic on selected congested roadways across Texas switched from automobile to bicycle. Researchers used the Texas 100 Most Congested Roadways[1] dataset to select a representative sampling of congested roadways which could benefit from congestion reduction. The analysis excluded highways, freeways, and interstates because any mode shift along these roadways would have negligible impacts. Instead, the analysis focused on major and minor arterial and collector segments that were on or near bikeways. After candidate projects were selected, TTI researchers estimated the amount of traffic to be removed from the roadway if 1 percent of current volumes switched modes. Then recalculated vehicle congestion along those roadways with the new volumes and calculated benefits/savings using delay cost multipliers. Researchers created an

[1] More information about the Texas 100 Most Congested Roadways data and methodology can be found at https://mobility.tamu.edu/texas-most-congested-roadways/.

interactive visualization displaying the potential congestion relief benefits from these types of mode shifts that can be found by clicking here.[2]

Public Health Benefit Savings - Researchers also found that current estimated levels of ridership generate in excess of $352 million in annual monetized health benefits in 2017. These benefits are gained through regular exercise and active living provided by bicycling activities. To calculate these benefits, TTI researchers utilized the Health Economic Assessment Tool (HEAT). This tool uses duration, distance, and trip inputs as the base data to calculate annual monetized benefits from reduced mortality risks. These inputs are then adjusted by several parameters based on study area characteristics. HEAT then recalculates new bicycling volumes to apply health benefits based on those adjustments.

Property Values – The impact of bicycling on property values was not examined at the statewide level. Given the regional variation of property values throughout the state, this research excluded any analysis of the correlation between Texas bikeways and properties. Instead, researchers examined property values in relation to specific case study projects in Section 3.

Local Economic Analysis: Case Studies

For the final section, researchers examined the economic impacts of constructing specific bikeways and the benefits that result from using this infrastructure. These case studies were designed to not only highlight the direct impact these bikeways have on local economies, but to also identify other potential benefits, such as improving overall performance of a bicycling network, the aesthetic benefits to commercial and residential land uses, and how bikeways can impact individuals by offering alternative transportation options.

To accomplish this, TTI researchers collected data for three case studies and applied the methodology used in Section 2 to quantify benefits where possible. Case studies were selected to represent a range of bikeway types, geographies, and population densities. Case studies were limited to recently completed projects in which construction costs, bicycle user volumes, and year-to-year property values were known. The following case studies are included in this report:

- A-Train Rail Trail – Denton/ Lewisville – (shared use path)
- Lamar Street (Cycle Track) – Houston – (on-road protected bike lane)
- White Oak Trail Extension – Houston – (shared use path)

Economic Impacts of Bikeway Construction **-** For each of the case study bikeways, TTI researchers examined both quantitative and qualitative impacts. Impacts with available data included construction, property values, travel cost savings, and health impacts. For construction, researchers used capital cost data as an input into the IMPLAN model. These calculations followed the same methodology as the statewide project estimates shown above. See **Table 3** for estimated total impacts of the case study bikeways used in this report.

[2]https://tableau.tamu.edu/t/TTI/views/CongestionCostSavingsfromModeShifttoBicycling/Dashboard1?iframeSizedToWindow=true&:embed=y&:showAppBanner=false&:display_count=no&:showVizHome=no

Table 3. Total Impacts of Case Study Bikeway Construction

Impact	A-Train Rail Trail	Lamar Street Cycle Track	White Oak Trail Extension
Employment	97	3	34
Labor Income ($M)	$5.6	$0.2	$2.6
Total Value Added ($M)	$8.0	$0.3	$3.7

Source: IMPLAN

Property values - TTI researchers also examined the property values within a ¼ mile of these bikeways. Researchers found consistently positive trends in property values in each of the case study locations, but the relationships between bikeway construction and property values were not clearly distinguished. This was due to the bikeway location and characteristics of the surrounding areas. While bikeways providing additional transportation alternatives are often constructed in areas where the existing population may benefit, these locations may have existing amenities/ demand that could contribute to property value changes. Because existing data did not allow researchers to calculate what percentage of property value change could be attributable to new or enhanced access to a bikeway, researchers simply collected and presented the trends realized in property values and land use year-over-year. Five years' worth of data from county appraisal districts in each study area, including the Denton County Appraisal District (DCAD) and the Harris County Appraisal District (HCAD), were reviewed. Qualitative assessments for each bikeway were established.

Travel time cost savings - Researchers also investigated the travel time costs savings associated with existing bicycle volumes at case study locations. The results show that total transportation costs savings range from approximately $4,000 annually to nearly $50,000 annually. These figures were estimated by examining bicycle volumes and trip length at each case study location, then applying cost factors to determine savings. Bicycle volumes were collected from agencies that had established bicycle counting programs, which included the A-Train Rail Trail and the White Oak Extension. For the Lamar Street Cycle Track, researchers used existing Strava data to extrapolate volume estimates. This analysis assumed that riders were using the bikeway for utilitarian purposes as a passenger vehicle trip replacement and that bicyclists would have used an automobile if the bikeway was not available. Results for each case study are shown in **Table 4**

Table 4. Annual Estimated Travel Cost Savings from Mode Shift to Case Study Bikeways

Bikeway	Passenger Vehicle Trips Replaced	Passenger VMT	Passenger Vehicle Operating Cost Savings	Fuel Cost Savings	Environmental Benefits	Safety Benefits	Total Savings
A-Train Rail Trail	20,289	182,603	$26,234	$18,395	$1,392	$1,444	$47,466
Lamar Street Cycle Track	21,747	16,310	$2,343	$1,643	$124	$129	$4,240
White Oak Trail Extension	74,878	149,755	$25,515	$15,086	$1,142	$1,142	$38,928

Source: TTI analysis utilizing USDOT formulas

Public health benefits - Lastly, researchers looked at the health benefits associated with each case study. Using the same user counts and trip length data that was used to estimate travel cost savings, researchers calculated that the A-Train Rail Trail, the Lamar Street Cycle Track, and the White Oak Trail Extension project generated an estimated $1.04 million, $119,000, and $1.09 million, respectively, in monetized health benefits. These benefits come from the reduction in health risks through engaging in bicycling activities. Like the statewide calculations, the calculations for each study utilized the HEAT tool.

Table 5. Annual Estimated Health Benefits from Case Study Bikeways

Bikeway	Health Benefits ($M)
A-Train Rail Trail	$1.04
Lamar Street Cycle Track	$0.12
White Oak Trail Extension	$1.09

Source: HEAT Tool

Summary and Future Research Needs

The analysis conducted by TTI researchers highlights the considerable economic impact that bicycling has on the State of Texas. Bicycling draws in thousands of users both from within the state and from other states. Both local and visiting bicyclists spend money in local economies when participating in local events, visiting specific trails, or just riding recreationally along some of the thousands of miles of bikeways across the state. In addition, sales and production of bicycle equipment, as well as the construction of new bikeway infrastructure, create jobs and spending in local economies. Further, this report touches on potential mobility impacts that could be generated through mode-shift, as well as the associated health benefits that are gained through active living.

While highlighting the large impact bicycling has on the Texas economy, this analysis has also highlighted a lack of bicycle-related data available in the state. Data is critical to the accuracy and continued study of how bicycling affects both state and local economies. Typical estimations of the economic impacts of bicycling rely heavily on primary sourced information, such as surveys from bicyclists on their spending habits and travelling tendencies. At the time of writing this report, no such research had been conducted to estimate what proportion of Texas visitors are participating in bicycling events, their amount of spending in the various sectors of the economy, and characteristics of typical bicycling trips (e.g. length, purpose). These data can lead to a more robust economic analysis and better-informed policy decisions regarding bicycle investments and their returned economic impact on local economies.

Recommendations

To obtain the data necessary to conduct a more precise estimation, researchers recommend future research in the development and administration of data collection programs, as well as the recurring study of these impacts. The purpose of this research is to obtain necessary data to fully assess the economic impact of bicycling activities and to quantify impacts from government investment in bicycle infrastructure and programs. Researchers recommend the following:

Conduct statewide and regional surveys of bicyclists to determine spending and travel habits. Existing survey instruments, including statewide economic and tourism surveys and statewide or MPO travel surveys, should consider adding questions related to bicycling. Additionally, surveys could be administered at various bikeways and events across the state to better understand tourism and spending impacts to local economies. In addition, surveys should be used to determine what percentage of trips at various types of bikeways (e.g. bike lane, shared use path, off-road trail) are utilitarian, and what percentage are recreational. These data will help determine impacts to local economies and costs savings through mode switch.

Explore cost-effective means of bicycle counting programs, especially for rural communities. A limitation of this analysis was that rural case study projects often did not have any meaningful counting programs. This limited potential projects to examine, and subsequently, the size of communities being studied. Creating a model framework for conducting bicycle counts in smaller cities can better inform policy makers of the benefits of bicycle infrastructure investment, and allow for more robust impact analyses.

Reassess economic impacts of bicycling biennially to assess trends and ensure continuous data collection. Researchers recommend that these types of studies be conducted every two years so that policy makers and agencies can fully assess trends and needs in the industry. In addition, the regular reoccurrence of these studies helps ensure that data collection efforts are ongoing and consistent.

Improve documentation of bicycle-related construction costs. A lack of differentiation of bicycle-related infrastructure constructed as part of larger roadway improvements was a limiting factor in the selection of case studies and the depth of statewide analyses. Improved tracking of bicycle-related infrastructure investments in existing state databases can improve estimation of project-level and systemwide cost-benefit ratios.

Section 1 - Economic Impact of Bicycling Background

The purpose of this report is to quantify the economic benefits associated with bicycle activity for the state of Texas. The first part of this report is to determine the types of economic impacts associated with bicycling. This is accomplished through a review of existing literature, and the methodologies and data inputs used for the analysis.

Previous Economic Analyses of Bicycling in the U.S.

Numerous studies have been completed in recent years across the United States which examine the impact of bicycling, and bicycling related employment. Individuals purchasing bicycling equipment, attending bicycling events, and commuting to work by bicycle all result in some form of economic output. One of the largest impacts include bicycling as a form of outdoor recreation. The Outdoor Industry Association estimates that outdoor recreation generates 7.6 million direct jobs, $887 billion in consumer spending, and over $120 billion in combined federal, state, and local tax revenues (4). Of this, the agency found that the bicycling industry generates 848,000 jobs, $83 billion on ‘trip-related’ sales (bicycle tourism), and $97 billion in retail spending nationwide.[3]

Several states have also conducted economic impact analyses on bicycling. The most common types of analyses include the impacts of retail sales and manufacturing of bicycling equipment and sales associated with bicycle recreation and tourism. Expenditures in these categories generate direct impact in the form of retail sales and manufacturing employees, as well as indirect and induced impacts in the areas surrounding bikeways.

Table 6 identifies the location of study, year, the various economic impacts examined for the respective state, and notable data sources used in the analysis. This is not an exhaustive list of data sources for each study, but rather those which had the largest role in the analysis.

Table 6. Recent Statewide Economic Impact Analyses on Bicycling

Location of Study	Year	Primary Economic Impacts Estimated	Notable Data Sources
Arizona	2013	Retail and sales Manufacturing/ Wholesale Tourism	Bureau of Economic Analysis U.S. Census Bureau's County Business Patterns Redyn (web-based economic model) Online surveys
Colorado	2012	Manufacturing/ Wholesale Retail and sales Events Health	Surveys (existing) Health Economic Assessment Tool (HEAT) Infrastructure spending Property values
Illinois	2013	Retail and Sales	On-site surveys IMPLAN (economic impact analysis tool))

[3] The Outdoor Industry Association (OIA) is an outdoor recreation advocacy group which uses data from the Bureau of Economic Analysis, Bureau of Labor Statistics, and other sources to produce both nation-wide and state-specific economic impacts generated from outdoor recreation.

Location of Study	Year	Primary Economic Impacts Estimated	Notable Data Sources
Iowa	2012	Tourism and recreation Retail and sales Health	Online survey U.S. Census Bureau American Community Survey (ACS) Iowa Department of Transportation
Minnesota	2016	Retail and sales Manufacturing/ Wholesale Tourism and recreation Health	Bike store databases (Bikeshop.us[4], Yellowpages, etc.) In-person interviews Online surveys Economic Census Product Line GuideStar Database IMPLAN Trail counts HEAT
Montana	2013	Tourism and recreation	Online survey Adventure Cycling Association
New Jersey	2013	Infrastructure investment Retail and Service Tourism and recreation	Online Interviews Informal in-person interviews Federal spending in New Jersey NJDOT bid sheets/ state spending
North Carolina	2013	Infrastructure construction Ongoing use Direct use Health Mobility Property Values	U.S. Census Bureau U.S. Department of Commerce Tourism surveys (VisitNC, Econsult Corp.) Bureau of Transportation Statistics North Carolina Division of Tourism, Film, & Sports Development
Oregon	2012	Retail and sales Tourism and recreation	Online survey
Utah	2017	Real estate Infrastructure investments Retail and sales Environmental Health Reduced absenteeism	IMPLAN InfoUSA TNS Global survey (existing)
Vermont	2012	Retail and sales Tourism and recreation Manufacturing and wholesale Property values	VTrans capital program Municipal budgets Surveys (existing) National Household Travel Survey (NHTS) Victoria Transport Policy Institute (VTPI) National Association of Realtors

[4] www.bikeshop.us is not operational, as of December 2017.

Location of Study	Year	Primary Economic Impacts Estimated	Notable Data Sources
Washington	2015	Retail and sales Tourism and recreation	IMPLAN Bureau of Labor Statistics Surveys (existing) Public land records
Wisconsin	2012	Manufacturing and wholesale Retail and sales Tourism and recreation	Survey of Retailers Event Sponsors Wisconsin Department of Transportation's Economic Development Division National Household Travel Survey Bicycling Federation of Wisconsin A Profile of Visitors on the Bike Trails of Western Wisconsin Wisconsin Department of Transportation

Potential Economic Impacts to be Analyzed

This section of the report explores the potential economic impacts associated with bicycle use. These impacts are not limited to Texas, and have been examined by transportation agencies and advocacy groups both domestically and internationally. Research was conducted to determine the most common types of impacts that have been examined, along with the methodologies and the data used to conduct those analyses.

Researchers examined the following economic impacts related to bicycling activities:

- Tourism & recreation
- Manufacturing, wholesale/distribution, and retail (production)
- Capital construction spending
- Property values
- Health
- Mobility (utilitarian)

The analyses conducted in these areas are determined based on availability of data at varying geographic scales, uses, and infrastructure types. A detailed methodology of how TTI researchers approached each impact category is provided in Section 2.

Tourism & Recreation

The economic impact of tourism and recreation includes the effects of consumer spending resulting from bicycling events, such as races, fundraisers, etc., and special generators such as regional trails. As riders from out of the area come to use the bikeway, they will spend money at local restaurants, hotels, and other stores. This tourism generates additional sales tax revenues and increases overall economic output of a region. This type of impact is also one of the most difficult to estimate due to variation of bicycling cultures between geographies (i.e. bicycling preferences across states and regions) and lack of publicly available data on tastes, preferences, and volumes of cyclists.

Literature in this area has focused on user preferences in expenditures. A cross-country field study from 2010 of cyclists along the 3,500-mile TransAmerica (TransAm) Bicycle Trail resulted in three categories of bicycle tourists (5). *Shoestring cyclists* spend less than $30 a day and ride between 75 to over 100 miles a day, *economy cyclists* that spend around $50 a day and ride between 75 and 90 miles a day, and *comfort cyclists* that spend $75 to $100 per day and ride 50 to 75 miles per day. A recent Colorado study of bicycle tourists averaged $93.92 per day—suggesting a range of cost options for bicycle touring (6). Each level of cyclist had varying preferences in lodging, meals, etc. Bicycle tourists ride much longer distances than typical commuters do, and most of their daily expenses are focused on the local communities. A survey of 2,300 North American commuter bicyclists from 1997 showed that the average bicycle commuter was 39 years old, had an average household income of $45,000, and had an average annual commute distance of 3100 km (~1926 mi) (7). Demographics of bicycle tourists vary depending on location and time, and are determined through local study.

Site Specific

Typically, bicycle tourism and recreational economic impact analyses are done at a specific location, also referred to as 'single-source' impacts. These analyses will use a survey to record the number of visitors to these sites and a determination of how those individuals spend money in these locations. Examples of this type of study are the 2013 analysis of the Silver Comet Trail in Georgia, the 2014 analysis of the Northeast Texas Trail (NETT), and the 2012 economic impact of the Erie Canalway Trail in New York. These studies focus primarily on the number of users the trail attracts, where money is being spent along the trail, and what impact those expenditures have on the surrounding community. These site specific economic impacts analyses use a mix of survey and publicly available demographic data.

Statewide

Analyses conducted on a statewide level use tourism numbers that are generated from previously conducted surveys or an aggregation of single-source analyses. Typically, survey results are used to generate estimates of how many visitors the state received for bicycling, and to calculate estimates on per-day spending habits. Surveys typically include spending in the following areas:

- Dining/ groceries
- Lodging (Hotels, camping, etc.)
- In-state transportation (automobile rentals, transit, etc.)
- Bicycle equipment related expenditures
- Bicycle event fees (where applicable)

In the case of recurring bicycling events, the analysis would require the location of events, the number of attendees, and the amount of consumer spending at these events. Like special generator impacts, these analyses typically require survey data from attendees.

Existing Studies & Methodology:

The following summarizes notable economic impact studies which focus on bicycle tourism and recreation, or have a significant component of the analysis examine the impact of tourism and recreation. A brief overview of the study, primary data sources, and type of analysis are noted.

<u>Northeast Texas Trail Economic Impact Assessment (2014)</u> – This site-specific study, conducted by the HWH Group, examines the economic impact of the 130-mile Northeast Texas Trail System (NETT), which spans seven counties and nineteen cities east of the Dallas-Ft. Worth area. The study focuses on the existing demographics of the area along the corridor to estimate the number of users the trail receives. The report makes assumptions on demand by using a multiplier based on populations in proximity to the trail. Spending per visitor is estimated, but it is not clear how these numbers are calculated. Moreover, the

benefits are not clearly defined. Costs are derived from construction and maintenance records. Following these calculations, a benefit-cost analysis is run, and a total impact is calculated.

An Economic Impact Analysis of the Coldwater Mountain Bike Trail (2012) – This site-specific study examined the potential economic impact of the Coldwater Mountain Bike Trail in Calhoun County, Alabama. The researchers utilized an online survey of the International Mountain Bike Association's (IMBA) southern regional division, which received 839 responses. The study used a range of 50,000 to 150,000 visitors per year as a baseline for the analysis. This figure came from average annual visitors per trail, and calculating a visitor per mile number. The study also investigated the market potential of the area within a 5- to 100-mile radius of the trail. It is not clear why that distance was selected, or where their findings came from. Survey results collected socioeconomic data, levels of bicycling activity, and overall interest in events. The survey also collected information on daily spending, which was compared to other trail surveys. The study also estimated bikers per mile, and then derived direct economic impact based on typical spending amounts per user. Multipliers were used to derive indirect and induced effects, as well as tax impacts.

Economic Impacts of Bicycling in Wisconsin – Part of this report includes an examination of the statewide impacts of bicycle tourism. However, the report notes that "quantifying the impact that bicycling has on tourism is impossible" (8). Instead, the document examines overall benefits of bicycle trails and tourism, while highlighting existing, area-specific studies. Furthermore, the report identifies tourism events, such as bicycle races, and examines existing studies on these events. The report focuses on production, estimating an annual impact of $556 million and 3,420 jobs. The report concludes with a recommendation that the state develop a study involving "the collection of new, comprehensive data on a statewide basis" to support "analysis of the economic impact of bicycle tourism."

Buffalo Valley River Trail (Pennsylvania) – Count and survey data were used to determine the number of visitors to the Buffalo Valley River Trail in Pennsylvania annually, multiplied by survey responses on spending, to estimate a direct economic impact of $281,000 a year (9). Data on trail users come from counts – manual count data by researchers can help verify automatic counts, should they be available, and can inform researchers on the distribution of modes, genders, and ages using the trail. Through analysis of this case, researchers developed a Rail-Trail Impact Assessment Method (RTIAM) with three overall steps: "(1) identifying trail demand through survey methods, manual counts, and automatic counts, (2) exploring the economic impacts as well as benefits to trail users, and (3) evaluating the need for possible trail expansion".

North Carolina Outer Banks – A study of the economic impact of bicycling tourism in North Carolina's Outer Banks region, the average bicycling tourist survey respondent spent $175 per person per day and stayed in the region an average of 8.3 days per trip (10). Using survey data as inputs into IMPLAN, researchers produced a mid-range estimate of $60 million and 1,400 jobs generated by bicycle tourists in the region's economy. Considering investments in bikeways in the Outer Banks area over ten years of approximately $6.7 million, the return on investment for the state is considerable, at "almost nine times greater than the one-time expenditure required to construct the facilities."

Minnesota - Assessing the Economic Impact and Health Effects of Bicycling in Minnesota – Researchers contacted participants and attendees of annual bicycling events and races across the state, and asked them similar questions to surveys intended for trail users, like average daily spending and size of travel party. Then, using additional details gathered from event organizers, such as length of the event and total event attendance, researchers were able to input average expenditures for participants into an input-output model to conclude that visitors to bicycle-related events in Minnesota during 2015 supported over $14 million in economic activity throughout the state.

Colorado - Economic and Health Benefits of Bicycling and Walking- The statewide analysis of the impacts from tourism and recreation was conducted, primarily, using the 2015 Longwoods International Colorado Tourism Report which identified:

- Number of marketable overnight leisure trip visits;
- Proportion of trips from in-state visitors;
- Proportion of visitors that reported bicycling on overnight leisure trip;
- Average length of overnight leisure trip stay;
- Average travel party size; and
- Average expenditures per person on a marketable overnight leisure trip.

The Colorado team also conducted two separate surveys, one to Colorado residents on travel behavior and spending and another to more than 1,000 Colorado bicycle retail and manufacturing businesses to generate direct employment and sales (in-state and out-of-state).

This report showed that bicycle events, races, and vacations contribute an estimated $434 million and that bicycle tourism by out-of-state visitors contribute $448 million to the Colorado economy.

Data Sources (including potential sources)

Data availability and acquisition for the economic impact of tourism and recreation are the most difficult aspects of analysis. Without an existing statewide survey of bicyclists, or conducting an original survey for the purposes of this report, researchers sought secondary data to conduct the analysis. **Table 7** identifies both primary and secondary sources explored by researchers.

Table 7. Tourism & Recreation Data Sources and Availability

Economic Impact	Data Need	Potential Sources	Availability
General Use (e.g. Utilitarian, Recreation)	Bikeway Inventory	Texas Parks & Wildlife Dept. (TPWD)	✓
		TxDOT Roadway-Highway Inventory Network (RHiNO)	✓
		OpenStreetMap	✓
	Number of Users	Office of the Governor, Economic Development & Tourism.	
		Strava (fitness tracking app)	✓
		Bureau of Transportation Statistics (BTS)	✓
		National Household Travel Survey (NHTS)	✓
		Outdoor Industry Association	
		Local trail counts	✓

Economic Impact	Data Need	Potential Sources	Availability
	Expenditures	Bureau of Economic Analysis - Personal Consumption Expenditures	✓
		Existing research - spending per mile	✓
Long-Distance Tourism	Number of Visitors/ Users (Out-of-State/ International)	Office of the Governor, Economic Development & Tourism.	
		Trail/ Local Counts	
		Strava (fitness tracking app)	
		Outdoor Industry Association	
	Expenditures	Bureau of Economic Analysis - Personal Consumption Expenditures	✓
Events	Location of the events	Bicycle Rides Texas	✓
	Number of attendees	Event Surveys	
	Consumer Spending	Event Surveys	

Limitations and Assumptions

As previously noted, data availability and acquisition are the challenging aspects of these analyses. As such, assumptions on the number and types of riders on Texas bikeways must be made. The literature found a range of daily spending, riding habits, and frequency among cyclists (5). In the case of analyzing these impacts in Texas, an examination of spending and usage as aggregated values from external studies is required. An example would be using per-day spending from studies such as Beierle, Moritz, and the various statewide reports which conducted spending surveys. This type of aggregation to produce Texas specific figures requires assumptions based on demographic and spatial characteristics.

Manufacturing, Wholesale/Distribution, and Retail (Production)

Cyclists spend money on a variety of equipment associated with the activity. This impact refers to the production of bicycle equipment in Texas. This would include the manufacturing of bicycle components, sale of assembled bicycles to retailers, and retail sale of bike equipment at stores within Texas.

Similar to quantifying the impacts of recreation and tourism, key data concerns for this economic impact include the levels of employment, wages, and revenues of bicycling manufacturing. However, these types of impacts are commonly estimated and straightforward in their calculation. Given the simplicity of this type of analysis compared to the other impacts, nearly every state with available data used some type of software to apply economic multipliers to generate these impacts. These studies were the primary focus of the literature review on this topic.

Existing Studies & Methodology

The following summarizes two economic impact studies which identify the retail and manufacturing impacts associated with bicycling in their respective states. These methodologies are indicative of the process used by other states conducting similar analyses.

Assessing the Economic Impact and Health Effects of Bicycling in Minnesota – The University of Minnesota, in their 2016 report, aimed to calculate the economic and health impacts of bicycling. The methodology included creating a list of bicycle-related businesses (retailers, wholesalers, manufacturers, advocacy groups, and service providers), interviewing industry leaders, surveying businesses, and gathering secondary sources. IMPLAN was used to apply multipliers to the collected data to generate economic outputs. The results showed that bicycling created $779.9 million in economic activity and supported 5,519 jobs in 2014.

Economic and Health Benefits of Bicycling in Iowa – Researchers from the University of North Iowa sought to estimate the economic impact of commute and recreational bicycling, bicycle retail, and the health benefits of bicycling in the state. Regarding bicycle retail, researchers sent a survey to each of the 38 bicycle retailers, 52 percent of which responded. Researchers also collected payroll information in the bicycle retail sector from the U.S. Bureau of Labor Statistics. The analysis shows that there are approximately 400 total full-time, full-time seasonal, part-time, and part-time seasonal jobs created by bicycling in the state.

Data Sources (including potential sources)

The data that is needed for a standard analysis in the economic impact for retail sales and manufacturing are the number of employees in the industry, the amount paid in wages per employee, and revenues. Like recreation and tourism, these data are typically collected through surveys of retail shops and production facilities throughout a study area. However, there are secondary data sources that were examined to derive needed data. See **Table 8.**

Table 8. Manufacturing, Wholesale/Distribution, and Retail Data Sources and Availability

Economic Impact	Data Need	Potential Sources	Availability
Retail Sales	List of Retailers	Statewide survey	
		ReferenceUSA	
	Employment	Statewide survey	
		Bureau of Economic Analysis	✓
		Texas Workforce Commission	
	Sales/ Expenditures	Bureau of Economic Analysis - Personal Consumption Expenditures	✓
		Statewide survey	
Manufacturing/ Production	Employment	Statewide survey	
		Bureau of Economic Analysis	✓
	Wages	Statewide survey	
		Bureau of Labor Statistics	✓
		Texas Workforce Commission	✓

Limitations and Assumptions

Similar to other impacts examined, the main limitation for these analyses is the availability of data. The IMPLAN software can generate outputs with limited data, but each of the required data is difficult to gather in their own regard. The software requires either employment, sales, or wages, which will then use multipliers to generate outputs. Without a statewide survey in this area, alternative date sources must be investigated.

Infrastructure Construction

This impact refers to the economic impact of constructing bikeways. This is a straightforward approach to looking at the impacts, and the analysis required the dollar amount that has expended on these types of bikeways. The direct/ indirect/ induced impacts could then be generated based on sector multipliers in IMPLAN.

Existing Studies & Methodology

New Jersey (The Economic Impacts of Active Transportation in New Jersey) – The New Jersey Department of Transportation commissioned a study which examines the economic impacts of active transportation in the state. The analysis contained a section on the impacts of capital expenditures in active living throughout the state. There was no record of the varying expenditures in this area, so researchers collected primary and secondary sources through NJDOT, MPOs, counties, and cities. Given that much of this infrastructure was funded using federal and state programs, on-system bikeway expenditures were available. However, infrastructure constructed as part of a larger transportation project required examination of bid-sheets and transportation plans. Their research found that there was approximately $63 million spent on over 250 projects throughout the state. These expenditures were calculated to have resulted in the creation of 648 jobs and approximately $44.47 million in wages across several sectors. This also generated a tax-impact of nearly $16 million. The study used the R/ECON™ I-O model, developed by Rutgers University.

Data Sources (including potential sources)

Primary data sources used in the analysis of this impact include government expenditures in bicycle-related construction. See **Table 9**.

Table 9. Construction Data Sources and Availability

Economic Impact	Data Need	Potential Sources	Availability
Construction	Expenditures	Federal Programs (TE/TAP, ARRA, etc.)	✓
		State Spending	✓
		County Spending	
		Local Spending	
	Location	TxDOT construction databases	
		Local transportation planning/ inventories	✓

Limitations and Assumptions

Limitations in the analysis of this impact include differentiating the project type and location. Bicycling infrastructure is generally included as a component of larger roadway projects. TxDOT roadway improvement projects that include bicycle infrastructure (i.e. bike lanes on new mobility project) are not visible through available data and may be categorized as an added capacity project. Moreover, separating the cost of bikeways from the total project cost would not yield accurate assumptions.

Property Values

These are the impacts that are seen on surrounding property values following the construction of bikeways. Typically, bikeways are seen by residents as an amenity that can increase accessibility (11). As such, a premium is placed on this type of infrastructure within proximity of residential developments.

Research shows that there are numerous factors that can contribute to home prices, including socioeconomic variables, existing transportation facilities (connections), and housing characteristics. Hedonic pricing models investigating bike and transit facilities near residential properties in Austin, TX showed higher overall property values (11). Additional studies in this field are shown in **Table 10**.

Existing Studies & Methodology

Studies, primarily, use some form of hedonic pricing model to analyze the impacts that on-street and off-street bikeways have on property values. The analysis compiles characteristics of both homes that are near bikeways, and those that are not. Examples of these types of studies, and their overall findings, are shown in **Table 10**.

Table 10. Comparison of findings from past hedonic studies. Adapted from Welch et al, 2015 (12)

Study	Location	Facility Type	Value per foot closer in proximity to trail access point (2014$)
Lindsey et al.	Indianapolis, IN	Shared use paths	$6.95
Krizek et al.	Twin Cities, MN	Shared use paths Bike lanes	Positive effect for non-roadside trails. No significant effect on busy streets.
Asabere & Huffman	San Antonio, TX	Shared use paths	$3,107.64[1]
Parent & Hofe	Miami, OH	Shared use paths	$4.19
Welch et. al	Portland, OR	Shared use local paths Shared use regional paths Bike lanes	$1.72 $0.35 $-3.91[2]
Li & Joh	Austin, TX	Bike infrastructure	Positive correlation between property values and bike infrastructure

[1]Increase in value for houses abutting a trail versus houses not immediately abutting a trail.
[2]The report noted that negative impact may have been attributed to the proximity of homes used in the study to undesirable features, such as noise/ air pollution and safety concerns.

Limitations and Assumptions

The type of analysis used for estimating the change in property values resulting from capital expenditures in bikeways is site specific and performed at specific locations. This is due to the number of, and uniqueness of, variables used in hedonic pricing models. For example, a home near a downtown would most likely benefit from a bikeway, such as a bike lane or shared use path, while a home in a rural area of the state may benefit more from an off-road trail or shared used path. These benefits would also change per the population in a given area, the climate of the region, and so on.

Health

The economic impact of bicycling regarding health refers to the benefits of an active lifestyle compared to a sedentary one. Higher usage of automobiles resulting from higher convenience adversely impacts public health through pollution and traffic hazards. Bicycling as an alternative mode of transportation is a potential solution to offset these negative impacts by allowing for a more active lifestyle. Public health and planning practitioners increasingly perform health impact assessments (HIA) to evaluate likely impacts from specific policy or infrastructure changes through a mathematical model that relies on estimates of likely impacts taken from previous research. The following section focuses on two prominent approaches to estimating health impacts of bicycling, the Health Economic Assessment Tool (HEAT) and value of saved lives (VSL) factoring approach. Additionally, data sources and methodologies used in these studies are noted.

Existing Studies & Methodology

Health Economic Assessment Tool (HEAT)

The World Health Organization (WHO) developed the Health Economic Assessment Tool (HEAT) to explore health economic impacts of bicycling and walking through this lens of reducing mortality (13). Users input local factors associated with a project, and the online tool provides an estimate of savings associated with deaths prevented because of an increase in bicycling. HEAT is widely used and considered an academically rigorous method to estimate cost savings from deaths prevented by bicycling, but does not estimate savings from the prevention of chronic disease (14). HEAT applies a risk of all-cause mortality to estimate the number and value of statistical lives saved due to bicycling (and walking). Originally derived from a large Danish cohort study, the tool has sometimes been criticized for its applicability to locations outside of Denmark. Nevertheless, with some adjustments to the model’s inputs, HEAT has been applied to cases in the U.S., including Portland, Oregon and the Minneapolis-St. Paul Twin Cities.

HEAT requires two main data inputs. The first is the annual number of bicycle trips or the number of people in the population who bicycle. In the Portland, Oregon application, the total number of bicycle trips made per year was estimated using bridge count data inputted into the metropolitan region’s travel demand model. In order to make use of HEAT in the Minneapolis-St. Paul region, researchers added questions on the number and duration of bicycle trips into the Minnesota State Survey. The second data input into the HEAT model is the average length of bicycle trips in the study area. The Portland and Minneapolis cases obtained these inputs from the same origin as the first input, the MPO’s traffic model and the state’s survey, respectively.

After the two main data inputs, number and length of bicycle trips, are compiled for input into the HEAT model, the model can be adjusted to the local case with several adjustment factors. First, the model relies on the target population’s all-cause mortality, or death rate. Depending on the study area, this adjustment factor can be obtained from any level of government health agency, from the Centers for Disease Control and Prevention (CDC) to state and local level health departments. Next, because HEAT calculates cost savings of deaths prevented, the model relies on an economic value called the value of a statistical life (VSL). VSL is commonly used in transportation planning reports, so departments of transportation (DOT) typically provide guidance on which value to use, updated periodically to adjust for inflation and income growth (15). USDOT and some state transportation departments also provide guidance on the appropriate discount rate to use in the HEAT and other transportation planning cost-benefit analyses.

After these adjustments have been made to the model, HEAT uses the inputs on number and length of bicycle trips to estimate the effect bicycling has on all-cause mortality and uses VSL to present a value of lives saved. The current (2014) model, however, only examines bicycling’s effect on mortality, not traffic injuries or morbidity (16). Therefore, researchers, transportation planners, and public health officials have begun exploring methods to quantify bicycling's health benefits in terms of the savings in health care costs associated with the reduction of chronic diseases. Accounting for such savings expands the benefits side of the cost-benefit ratio for bicycling's impact on health (1). With a growing interest in quantifying this type of health benefit, there is a more diverse set of methods than the reduction in mortality (HEAT) method explored above.

In comparing the reduction in mortality method to the reduction in health care costs method, Gotschi chose to derive per capita health care costs due to inactivity from three studies deemed to be transferable to his Portland case. Other studies have made use of more local data. In a study of the health economic impact of bicycling in Iowa, researchers first compiled data on the prevalence of chronic diseases associated with inactivity and obesity – diabetes, breast cancer, colorectal cancer, heart disease, and stroke – for their study area from the CDC's Behavioral Risk Factor Surveillance System (BRFSS) report, supplementing with data from local departments of health, when necessary. After prevalence for each disease was known, the direct health care costs associated with the diseases could be calculated with cost of care data sourced from the Wellmark Blue Cross Blue Shield cost estimator (17). This method results in an arguably more accurate estimation of health costs than Gotschi's method, based on admittedly "crude estimates of health care savings from physical activity in general."

<u>Assessing the Economic Impact and Health Effects of Bicycling in Minnesota</u>
This recent study provided a comprehensive evaluation of the economic impacts of bicycling in the state, including health impact estimates using the HEAT tool (18). Researchers found that bicycle commuting prevents between 12 and 61 deaths annually, translating to dollar savings of between $100 million and $500 million. Analysis of the Twin Cities Commuter Survey showed that "bicycle commuting three times per week is also linked to 46% lower odds of metabolic syndrome, 32% lower odds of obesity, and 28% lower odds of hypertension, all of which lower medical costs".

<u>Value of Saved Lives Factoring</u>
Another comparatively crude method is to assume that non-fatal bike collisions amount to a percentage of VSL. In an evaluation of Complete Streets improvements nationwide, Smart Growth America analysts assumed that a non-fatal collision is equal to 2.1 percent of USDOT's VSL, or approximately $193,000 (19). According to this analysis, each collision avoided has the potential for cost savings associated with emergency room visits, hospital bills, and rehabilitation and doctor appointments, in the amount of $193,000.

Not all bicycle improvements or increases in bicycling, though, can be said to represent a decrease in cyclist injuries. One health economic assessment of the London bicycle sharing scheme found that injuries to women cyclists were almost as costly as the gains made in overall health, with both presented in terms of disability-adjusted life years (DALYs) (20). Therefore, in addition to quantifying the health care cost savings associated with reduced disease incidence attributable to bicycling, researchers may be interested in exploring methods to quantify the costs associated with bicycle injury.

Elvik and Sundfør (2017) explored whether the costs of bicycle-related injuries have been underrepresented in cost-benefit analyses, especially because cases of bicycle collision injuries are underreported in official crash databases. Comparing disability weights from both the Eurocost system and the WHO's Global Burden of Disease tool, and a dedicated dataset about bicycle injuries in Norway and Sweden, the authors are able to quantify costs of bicycling injuries in terms of DALYs. Though the risk of injury may be a disadvantage to bicycling, Elvik and Sundfør also account for the "safety in numbers" phenomenon – assuming that cyclists actually become safer and have lower risk of injury as the number of cyclists on the road increases. Overall, they conclude that cyclist injuries tend to be slight and often represent health loss of just a fraction of a DALY. Furthermore, the costs associated with cyclist injuries are small when compared to the benefits of reduced all-cause mortality, as estimated with the WHO's HEAT tool.

Data Sources (including potential sources)

The previous examination of the HEAT tool and value of saved lives factoring include many factors derived from other places and previous studies that may or may not be applicable in Texas. **Table 11** lists options for national, statewide, and local data that could improve estimates in the state.

Table 11 Health Data Sources and Availability

Economic Impact	Data Need	Potential Sources	Availability
Health	Health Risks and Conditions	Texas Behavioral Risk Factor Surveillance System (BRFSS)	✓
	Bicycling and Walking Behavior	American Community Survey	✓
		National Survey of Bicyclist and Pedestrian Attitudes and Behavior (2002, 2012)	✓
		Statewide survey of bicyclist and pedestrian behavior for state and local analysis	
		Strava Metro	✓
Collision Risk	Transportation Crashes	TxDOT Crash Records Information System (CRIS)	✓
	Bicycling Traffic Volumes	Comprehensive statewide counts	
	Pedestrian Traffic Volumes	Comprehensive statewide counts	

Limitations and Assumptions

Some of the limitations and assumptions inherent in these health economic impact models have been explored here already. For example, the widely-used HEAT model does not estimate economic benefits of reduced traffic injuries, or chronic disease linked to an increase in bicycling, and many of its assumptions derived from a Danish cohort study may need adjustments from local sources. Also, many studies quantifying the health economic impact of bicycling assume that an increase in bicycling translates directly to an increase in physical activity, without being substituted from other forms of physical activity. It is also important to note that both methods – HEAT and cost savings – as employed by Gotschi (2011) apply a linear relationship between bicycling and monetary benefits. While there is substantial evidence for a linear relationship between physical activity and mortality, this model may not be appropriate in other cases – e.g., health care costs may be affected by a multitude of factors, including both health status and physical activity. Both the HEAT model and value of saved lives factoring approaches are likely to underestimate the health benefits of bicycling, if used without comprehensive local data.

In terms of the potential data sources, the national surveys may not provide statistical power for analysis at the statewide or more local levels. Depending on the geography of analysis, or desired sub-group (such as by gender or age), there may not be adequate responses to provide accurate estimates. This is why a statewide survey focused on this issue is listed as a source that is currently unavailable, in addition to statewide bicycle and pedestrian traffic volume data that would enable calculating localized collision risk.

Mobility

Measuring the economic impact of bicycling and pedestrian improvements on congestion and mobility is no small task. Until recently, simple and accurate measurement of auto congestion was difficult, time-consuming, and costly. Estimating an economic benefit associated with auto mobility is an even more recent ability. Ultimately, one cannot accurately measure economic benefits of bicycling on mobility until certain elements of bicycle mobility, such as speeds, volume, and mode share, can be established.

While automobile volumes have always been relatively simple to collect, speeds have been more difficult. Early efforts to measure mobility involved performing travel time runs, where several drivers would drive specific routes and time themselves, which proved to be extremely costly. As technology improved, some metropolitan areas used cameras to read license plates at multiple locations, which would then be matched in a labor-intensive process. Bluetooth readers came next and were quickly replaced by cell phone probe data to obtain automobile speeds (21).

Economic benefits of mobility improvements, then, are generally calculated as the change in delay (as a function of speed and volume) multiplied by the cost of congestion (22). This is the cost, per person, of lost time, productivity, and fuel of sitting in traffic. For auto travelers, this cost comes to about $17.81 per hour (23). Since automobiles are the dominant form of transportation, any reduction in the auto mode share (or the split between single occupant automobiles and any other mode) to another mode, in this case, bicycling, would add economic benefit.

Bicycling itself also likely results in similar mobility and economic benefits as autos do, but to a much lesser degree for several reasons. First, the cost of congestion for a cyclist would not include the cost of lost fuel, but it may be increased based on time (bicycling is inherently slower that driving). Second, the cost of congestion is contingent upon having congestion that slows down the traveler. There are very few places in the U.S., let alone Texas, which experience bicycle congestion. Third, the mode split of cyclists compared to other modes is incredibly small (24, 25).

Existing Studies & Methodology

There are few previous efforts to examine the congestion (and in turn, economic) benefits of bicycling outside of theoretical or hypothesized effect. This is largely due to the perceived unimportance of bicycling as a serious modal option up until recently and the related lack of data available to perform such studies. Additionally, technology able to accurately measure bicycle and pedestrian use is still in its nascent form.

<u>FLOW Project Research</u> - The FLOW Project, funded by the European Commission's Horizon 2020 program, assembled partners from multiple agencies, private firms, and academic research institutions to examine the ways in which bicycling and walking reduce congestion, could improve mobility and congestion in the future, and can be placed on equal research footing with automobiles (26).

In their research, they examined 20 case studies of cities in Europe and in the United States where bicycle and pedestrian strategies were implemented, there was sufficient data to assess their impact on congestion, and the impact was thought to be positive or at least neutral. Note this last quality automatically biases this study towards a favorable outcome, but offers this project insight due to the availability of data. Also, note that this study admits that in most cases, the strategy was implemented not to relieve congestion, and therefore little data was directly collected related to congestion. In those cases, *congestion impacts were gauged by qualitative information and assessment by local experts*.

Of the 20 case studies, only one was from the United States (New York City) and involved the addition of bicycling infrastructure, such as cycle tracks and bike lanes. All the others were in European cities using strategies ranging from building dedicated bicycle highways to bicycling promotion campaigns.

In most of these cases, impacts were either estimated using macroscopic modeling software or used measures from other non-related sources (like transit travel times) to estimate bicycling's impact. In these cases, researchers often noted that several other factors occurred at the same time, muddling the impact that bicycling actually had. Often in both these estimated methods, researchers also used surveys and expert local judgement to confirm or validate the estimates.

In other cases, simple and highly localized bike and auto counts were used to create a before/after view of mode share. These counts were generally collected and aggregated at an annual scale and in locations where bicycle counts already existed. However, in most instances, bicycle counts were only collected after the treatment, if at all.

The New York City case used a combination of bicycle and auto counts in addition to data from the city's bikeshare program, CitiBike (27). Bikeshare data offer unique insight into a segment of the bicycling population and provide actual travel times that can be used as a factor for other trips. Additionally, the Copenhagen case incorporated the direct measurement of speed for both bicycles and autos, in addition to regular counts of both modes (28).

Washington, D.C. Bikeshare and Bicycle Infrastructure - A 2015 study in the Washington, D.C., area examined the congestion impacts of the Capital Bikeshare program on surrounding roadways (29). Researchers used statistical methods to determine if roadways near bikeshare stations experienced more or less traffic congestion, primarily on minor arterial and collector roadways.

The study used vehicle speed probe data from the University of Maryland's CATT Lab and the Regional Integrated Transportation Information System (RITIS). This data provides both spatial and temporal speed data that can be used to calculate an unweighted delay value for autos. The core of this research examined the roadways on and near bikeshare stations to see if delay changed for autos, thereby reducing congestion.

The results of the study found that while speeds increase and delay decreased on roadways that contained a station, congestion increased a similar amount on adjacent roadways. Researchers noted that the apparent increase in congestion is likely due to drivers avoiding roads with cyclists. Researchers, though, also noted that the number of cyclists on these roadways did increase, indicating a mode shift (though the magnitude of the shift remains unknown).

Data Sources (including potential sources)

In the above cases, accuracy and reliability lie on a spectrum of what data are used and how they are collected. On the low end, those instances where researchers used professional judgement, anecdotes, and modeled information offer little confidence or accuracy. However, these methods can be applied nearly everywhere. On the high end, those instances where researchers used direct and continuous data collection of both cyclist and motorist volumes and speeds offer the greatest levels of accuracy and reliability. However, these types of data are difficult to obtain for larger areas and do not exist in Texas. **Table 12** lists the types of data and their availability that would be necessary to accurately calculate the economic impact of bicycle mobility in Texas.

Table 12. Mobility Data Sources and Availability

Economic Impact	Data Need	Potential Sources	Availability
Mobility	Volumes	Statewide Bicycle Counting Programs	
		Individual City Counting Programs	~
		Statewide Automobile Counting Program/HPMS*	✓
		Statewide Bicycle Facility Inventory	
	Speed	Bicycle and Pedestrian Speed Data	
		Automobile Speed Data*	✓
		Bikeshare System Travel Times	~
	Mode Splits*	U.S. Census Bureau Journey to Work Data	✓
		National Household Travel Survey Data	✓

**These data sources are only relevant in estimating the economic impact of congestion reduction from a shift from driving to bicycling.*

Bicycle data availability is extremely limited, especially at the statewide level. Note from the above table that most sources do not exist or are severely limited to local sources. Even in local communities where a counting program exists, count locations are few, limiting the broader applicability of estimations for an entire metropolitan area.

The most promising sources of data likely lie in the use of vehicle probe speed data. Linking vehicle probe data sources to volumes and roadway classifications provided by the Federal Highway Administration's Highway Performance Monitoring System (HPMS) could provide enough information to also connect mode shift information from driving to bicycling while simultaneously providing congestion (and economic) benefit.

Bikeshare information could also provide quality spot information for urban areas with a robust program, like San Antonio. Bikeshare data, paired with mode split information, could provide some sort of estimated economic benefit for an urban area. If that up-scaling of data proves troublesome, the bikeshare system data could still be used to provide mobility benefits for the bikeshare system itself.

What is still largely unknown, however, would be to understand shifts in bicycling volumes over time and across large geographies. This would either require a statewide counting program, especially heavy in metropolitan areas, or similar probe data as used in auto calculations. While both data types are possible or have limited availability (Strava), their reach is still not widespread to a usable point. Additionally, for this data to be usable, a comprehensive statewide inventory of bikeways and infrastructure would be needed, which does not exist.

Limitations and Assumptions

For this research, it may not be reasonably possible to accurately and reliably measure *past mobility and economic performance* using methods and available bicycling data. However, researchers may be able to offer insight into *future performance* using vehicle probe speed data paired with the HPMS vehicle volume and roadway classification data. Using these sources, researchers could reveal the potential economic benefit should a certain number of drivers shift to bicycling—increasing the bicycling mode split. This offers state and regional planners and policy makers to set reasonable targets for future bicycling improvements. As more bicycling counts become available through a statewide data collection program, specific benefits could be used alongside these targets for further justification.

Bikeshare data would most likely be used (if available) to estimate the mobility impacts of the bikeshare system itself, rather than be used to scale up any broader benefits. This could be useful in comparing other regional mobility projects with the impact of a bikeshare system on a community. However, there are many caveats and assumptions that would be required of the bikeshare system to provide any value.

In the few cases where bicycling and congestion have been studied together, studies have shown neutral or slightly positive results; this does not mean that bicycling infrastructure is a bad investment. Many of these studies did reveal a significant increase in bicyclist, pedestrian, and driver safety, which ultimately reduces incidents and congestion (though at an unknown amount). Any increase in bicycling, even with neutral congestion impacts could indicate the mode is absorbing latent demand. This could ultimately eliminate, reduce, or slow the need for additional auto improvements in the roadway.

Ultimately, what gets counted counts. As bicycling count programs at the metropolitan and state level continue to progress, more data will become available to accurately and reliably reveal the mode's impact on the greater transportation system and economy.

For these and other reasons, measuring the mobility-based economic benefits of bicycling is incredibly difficult. At a bare minimum, researchers would need to know the number of cyclists on a corridor or more specifically, the mode shift from auto to bicycling. In the few cases where this has specifically been measured, more precise measurement was taken at a relatively small scale.

Section 1 Summary

This section determined the potential economic impacts associated with bicycling. Researchers accomplished this through a thorough review of existing literature and available case studies. The results of this investigation revealed the most commonly quantified economic impacts include:

- Recreation and tourism
- Manufacturing, wholesale/distribution, and retail (production)
- Infrastructure construction
- Property values
- Health
- Mobility

As part of this process, researchers identified data and methodologies that are typically used to calculate these impacts. Furthermore, researchers determined the availability of data for Texas at varying geographic scales for each impact. For example, researchers sought to identify data sources for user counts at the statewide, regional, metropolitan, and rural levels. This revealed variation in the scale at which data is available for each identified.

Given the results of this examination, the next step for researchers was to determine what of the listed economic impacts were feasible for analysis based on available data sources, and at what geographic level. Researchers also determined to what extent geographical differentiation of impacts, as well as any forecasting of impacts, was possible. This was done through collection of available data through the sources listed in this document.

Section 2 – Statewide Impacts Analysis

The research team collected data from Task 1 of this report to identify the total economic impacts of bicycling in Texas in several topic areas. Given limited availability of data for this report, results are shown at the smallest geographic unit and most current year possible. This allowed researchers to conduct quantitative and/ or qualitative analyses in each of the given topic areas where applicable. These topic areas include:

- Tourism & recreation
- Manufacturing, wholesale/distribution, and retail
- Capital construction spending
- Health
- Mobility

Given that property values are subject to numerous location-specific quantifiable and qualitative variables, they are not included in this statewide analysis. How property values are affected on an individual project scale are considered in Section 3 of this report.

The purpose of Section 2 is to not only highlight the economic importance of bicycling across the state, but to also identify what impacts investment in bicycle infrastructure has on state and local economies. According to the available literature, impacts are generated from simply purchasing bicycle equipment to investing millions in new bikeway infrastructure. All facets of bicycling have a reverberating effect on the state and local economies in the form of jobs and added value through a "multiplier" effect. Multipliers are factors used to calculate the dollar value of impacts for each dollar spent in a specific economic sector. For example, cyclists purchasing equipment at local sporting goods stores not only generate direct employment in a region, but also contribute to indirect impacts from business to business transactions and induced impacts resulting from employees of the sporting goods stores spending earnings at other businesses in the region. Another example would be the construction of new bikeways. As local governments invest money into bikeways, workers must be hired. This construction generates employment, while also having indirect effects of the purchase of construction materials, and the induced effect of increased local spending.

To calculate these multiplier effects, the IMpacts for PLANning (IMPLAN) economic analysis model was used where possible. IMPLAN is a form of input-output (IO) model which measures the initial change in a local economy. IMPLAN uses regional social accounting matrices (SAM) to track the flow of goods and services in an economy. The social accounting matrix is a "double entry bookkeeping system capable of tracing monetary flows between industries through debits and credits (30)." A SAM provides non-market financial flow information that expands the traditional Input-Output model.

The results of IMPLAN are presented as direct, indirect, and induced impacts in terms of employment, labor income, value added, and output. Direct impacts are a series of, or single production changes/ expenditures that result in an activity (31). Indirect impacts result from local industries (those providing the direct impacts) buying goods and services from other businesses in the study area. These are dollars that are continually spent downstream until they leak from the economy. Induced impacts are the response of an economy from the initial change. This typically consists of the employees spending earned income within the local economy on various goods and services and circulating money throughout the local economy.

The following bullets provide details on types of impacts, how they are measured, and how they are calculated:

- **Employment** numbers represent total annual average jobs. This includes self-employed along with wage and salary employees. All full-time, part-time and seasonal jobs are included in these employment numbers and are calculated as full-time/ part-time averages over twelve months (32). Therefore, results are reported as individual job-years, not full-time equivalent (FTE) jobs. A job-year is one year of one job and part-time positions are included in the count as a single job.
- **Labor income** is the amount paid to workers within a region. Labor income includes both employee and proprietor income, and is the source for induced impact calculations.
- **Value added** is the combination of labor income, property income, and indirect business taxes accrued in a region resulting from the economic activity analyzed. It demonstrates the difference between the value of production and the costs of purchasing services and goods to produce a final product.
- **Output** represents the total value added, as well as any intermediate expenditures (i.e. purchase of intermediate goods). Intermediate expenditures are the purchase of non-durable goods and services. These are purchases that go into production of goods rather than those that are for final consumption. A general example of an intermediate expenditure could include wood in the manufacturing of furniture. The industry sells finished furniture, but there is an impact associated with that industry purchasing the wood from a lumber yard.

The economic impacts were calculated for four topic areas: 1) visitor spending patterns, 2) retail/ wholesale trade, 3) manufacturing, and 4) costs of construction. Available data in these categories provided a straightforward means of calculation at the state and county levels. Researchers aggregated county impacts into geographic subdivisions for a more accurate analysis.

Researchers also use a qualitative scale of confidence in the results (either low, medium, or high) for quantified impacts. This is based on the amount of assumptions and limitations to the analysis, as well as the age of the data available. A brief explanation of confidence is provided within each results section.

The following sections provide the methodologies and results of the impact analyses in each of the five impact categories.

Tourism & Recreation

Researchers used a mixture of publicly available data to estimate the economic impact that bicycle recreation and tourism has on Texas. Primary data sources for these analyses were reports conducted for the Economic Development and Tourism Division (EDT) of the Governor's Office, bicycling event websites and news publications, U.S. Census Bureau commuting statistics, and existing case study information collected in Task 1 to develop both the methodology and parameters for data assumptions.

Bicycle recreation is bicycling for a non-utilitarian purpose. This can include bicycling as a means of exercise, a group of friends making a trip around the city, or just riding for a couple hours on a weekend morning. A subset of bicycle recreation is bicycle tourism. For this report, bicycle tourism is defined as individuals travelling to another location to participate in a bicycling activity. Individuals can travel intrastate and/or interstate. These activities usually involve the purchase of accommodations, entry fees, food and dining, and transportation. Expenditures in these areas create economic impacts.

As such, the primary data for determining the impact in this topic area is visitor spending. The individuals being attracted to an area to participate in a bicycling event or to just ride leisurely, and spending money at local restaurants, hotels, etc. These expenditures result in direct, indirect, and induced impacts to the local economy.

In 2016, the EDT estimated that there were 664,000 direct jobs created in the state from all tourist expenditures (33). This analysis aims to estimate what portion of those jobs and other impacts are from bicycle-related activities and events.

There is also a qualitative side to this topic area. Outside of visitor spending, researchers also looked at the qualities of Texas bicycling that attract visitors, as well as the numerous bicycling events that take place. Therefore, the qualitative measures are examined first, followed by the quantitative analysis on the resulting visitor spending from bicycling in Texas.

Existing Texas Networks

Texas has no shortage of bikeways that are commonly used for both on-road and off-road bicycling activities. These bikeways not only serve to promote recreational bicycling within the state, but also to attract bicycle tourists from other states to use these bikeways.

There are state, local, and privately-owned bikeways in the state. The Texas Parks and Wildlife Department (TPWD) manages nearly 1,000 miles of paved and non-paved shared-use paths. See **Table 13**.

Table 13. Summary of TPWD Bicycling Trails

Region (major cities in region)	**Trail Miles**
West Texas (El Paso, Big Bend, San Angelo)	280.5+
Hill Country (Austin, San Antonio)	214.8
Panhandle Plains (Lubbock, San Angelo, Abilene)	186.5
Prairies and Lakes (Dallas, Waco, College Station)	175.8
Gulf Coast (Houston, Corpus Christi)	76
Piney Woods (Tyler)	23.3
South Texas Plains (Laredo, Brownsville)	22
Total	**978.9+**

Source: (34)

In addition to the bikeways on state-maintained rights-of-way, there are thousands of miles of dedicated bikeways throughout the major metropolitan and small-urban areas of Texas. For example, the North Central Texas Council of Governments (NCTCOG), in their 2040 long range transportation plan, noted that there are over 7,000 miles of combined dedicated bikeways and roadways with shoulders capable of handling bicycle traffic in their planned "Veloweb" regional bikeway system. See **Table 14**. This includes segments of popular regional shared-use paths that extend out from the metropolitan region into rural areas of the state, such as the Northeast Texas Trail (NETT). The NETT extends 130 miles from Farmersville to New Boston (10 miles west of Texarkana) with current ridership ranging from 500 to 7,000 bicyclists annually (35).

Table 14. NCTCOG Existing & Future Bikeway Network Miles (February 2016)

Facility Type	Miles
Regional Veloweb Paths	
Regional Veloweb, Existing	442
Regional Veloweb, Funded	146
Regional Veloweb, Planned	1,288
Total Veloweb Paths	**1,876**
Community Shared-Use Paths	
Community Shared-Use Paths, Existing	333
Community Shared-Use Paths, Funded	42
Community Shared-Use Paths, Planned	1,999
Total Community Paths	**2,374**
Total Regional Veloweb and Community Paths	**4,250**
On-Street Bikeways	
On-Street Bikeways, Existing	200
On-Street, Funded	71
On-Street, Planned	2,161
Total On-Street Bikeways (Urbanized Area)	**2,432**
On-Street Wide Shoulders, Existing (rural areas between communities)	248
On-Street Wide Shoulders, Planned (rural areas between communities)	100
Total On-StreetWide Shoulders (Rural Area)	**348**
Total On-Street Bikeways	**2,780**
Total All Facilities	**7,030**

Source: NCTCOG Mobility 2040 The Metropolitan Transportation Plan for North Central Texas

Additionally, Austin’s Metropolitan Planning Organization (MPO), the Capital Area Metropolitan Planning Organization (CAMPO), and the Houston Galveston Area Council (HGAC) have over 3,200 and 1,200 existing miles of bikeways, respectively. CAMPO proposes an additional 3,109 miles regionally. HGAC’s plan shows a need for nearly 1,000 regional bikeway miles at a cost of over $400 million to connect the region. See **Table 15** and **Table 16**.

Table 15. Existing and Planned Bicycle Facilities in CAMPO Area

County	Existing Miles	Planned & Proposed Miles	Total miles
Bastrop	126	117	243
Burnet	10	165	175
Caldwell	8	6	14
Hays	484	335	819
Travis	1,490	1,417	2,907
Williamson	1,073	868	1,941
Total	3,225	3,109	6,334

Source: CAMPO 2045 Regional Active Transportation Plan

Table 16. Existing Facilities within the Houston-Galveston TMA

Facility Type	Miles
Bicycle Lane	149
Shared Use Path/Trail	688
Signed Shared Roadway	127
Signed Shoulder Bike Route	251
Total	1,215

Source: HGAC 2040 Regional Pedestrian and Bicycle Plan

There are hundreds, if not thousands of miles of dedicated bikeways and bike-able roadways spread across the state. Given that not all cities have a multimodal transportation plans like CAMPO, NCTCOG, and HGAC, it would be difficult to accurately determine a full inventory, or to accurately determine the number of riders using those bikeways. As such, the mileage presented in this report does not capture the full extent of the bicycling network within the state.

Bicycle Events

In addition to the thousands of miles of bikeways throughout the state, researchers found that there were around 200 annual bicycle events that take place in Texas. Data on these events were gathered from numerous public sources, such as event websites, news articles, and bicycle advocacy groups. Events with available participation information indicate that there were over 150,000 total participants for between 150-200 bicycling events.[5] Additionally, there were another 51 events found where no attendance data was available. See **Table 17** for the five highest attended bicycling events in Texas according to available data.

[5] Cycling events vary from year to year. Most events found are held on an annual basis. Events found for this report were held/ scheduled from January 2017 to September 2018.

Table 17. Highest Attended Bicycling Events

Event	Location	Date	Recurrence	Fee	Attendance
Red Balloon Run and Ride	Plano, TX	21-Apr-18	Annual	$35/$40 day of event	15,000
BP MS 150 Houston Tour	Houston, TX	April 28-29, 2018	Annual	$400 fundraising minimum	13,000
Hotter'N Hell Hundred	Wichita Falls, TX	August 24-27, 2017	Annual	$35 early/$40 regular/$45 day of event	13,000
Tour de Houston	Houston, TX	19-Mar-17	Annual	$30 early/$35-$40 regular/$45 day of event	5,000
Red Star Bicycles Trinity Levee Race	Dallas, TX	14-Oct-17	Annual	Free	4,000

Source: Bicycle Rides Texas, Event Websites

These data highlight the considerable number of cyclists participating in events throughout the state. However, event sponsors did not delineate between in-state and out-of-state participants. Moreover, EDT research does not categorize visitor totals by either those engaging in bicycling or bicycling as the primary reason for their visit. Simply put, it is not possible with the current data to determine which visitors have participated in a bicycling event from out-of-state. This is critical because of the impacts that come from in-state tourism versus out-of-state tourism. In-state tourism, from a statewide economic impact perspective, is simply money that would have been spent in one part of the state being spent in another part. Out-of-state tourism, however, is money that would have otherwise been spent elsewhere, but is being spent in state as a direct result of an event. This added economic activity from bicycling events is an important distinction that merits additional data collection.

Methodology

For the quantitative portion of this analysis, researchers calculated the impacts of tourism by estimating the effect of visitors engaging in bicycling activities in Texas. The study year for this analysis is 2016 as this is the latest year of available and complete data.

While ridership estimates for these regional bikeways are not widely available, a qualitative analysis can be conducted. For bicycle tourism, researchers estimate the total economic impact in terms of value added through visitor spending. This is calculated by first, estimating the following variables:

- Total annual statewide visitors (in-state and out-of-state)
- Percent of visitors participating in bicycling/ primary trip purpose
- Average daily expenditures
- Length of stay (number of days)

These variables are used as inputs into the IMPLAN modeling software.

The analysis follows closely the methodology used in Colorado, which identified bicycle tourism as an economic driver for the state (36). That study, which was conducted in 2015, used a survey conducted by Longwoods International, which tracks tourism, and tourism-related metrics. For TTI's analysis, the primary data source is the Office of Economic Development and Tourism's (EDT) 2016 Texas State Profile (37). Much of the data required for TTI's analysis is found in this report, including tourism totals, average daily spending, and average length of stay.

Study Regions – The data collected for TTI's study were divided into seven geographic regions of Texas. These regions were used to further delineate the results to make more accurate estimates about visitor spending and total tourism numbers. See **Figure 1**.

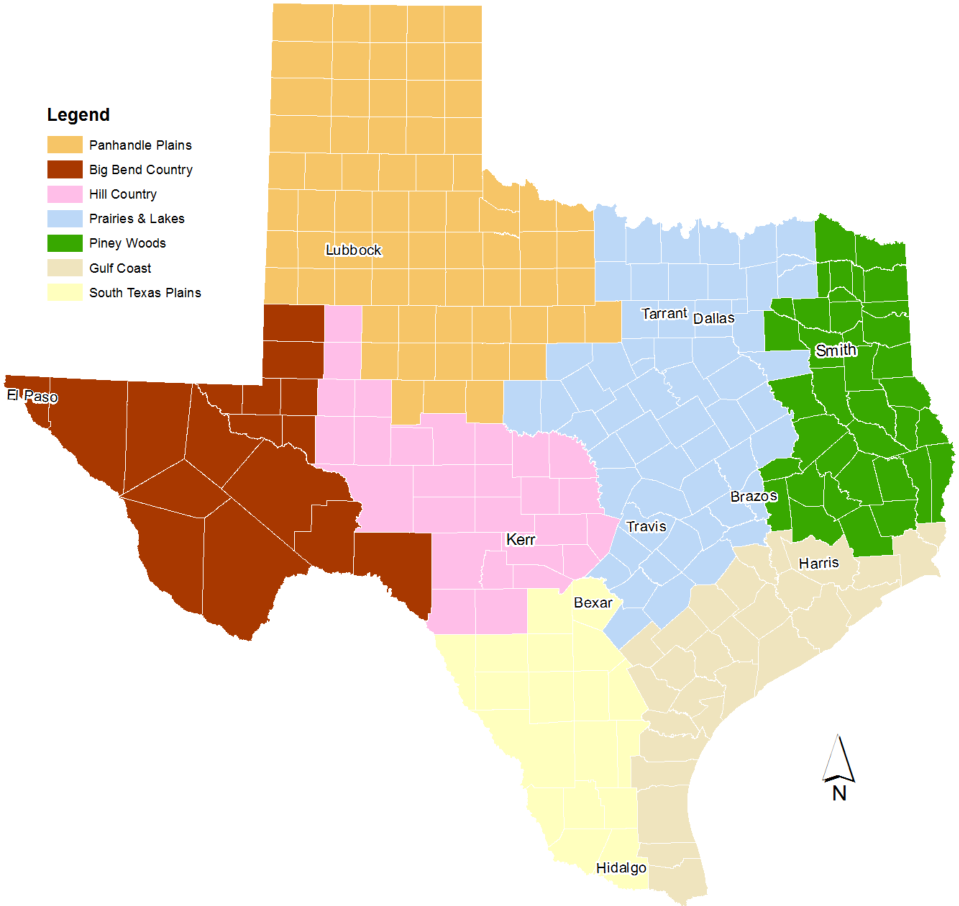


Figure 1. Tourism Study Regions

The following variables were used in the analysis:

Total visitors – There was a reported 549.48 million person-days[6] comprised of a total 266.15 million person-stays[7] in 2016 (37). See **Table 18**. It was also reported that out of the total person-days, there were 407.7 million leisure person-days in 2016. For this analysis, it is more prudent to use the total amount of person days to fully capture the per person daily expenditure totals.

Table 18. Texas Total & Leisure Person Days

	Texas Total	Panhandle Plains	Big Bend Country	Hill Country	Prairies & Lakes	Piney Woods	Gulf Coast	South Texas Plains
Total Person Days (2016) (millions)	549.48	43.61	18.73	61.86	163.76	25.27	142.29	93.96
Leisure Person Days (2016) (millions)	407.70	32.01	10.04	44.81	114.48	19.62	110.67	76.08

Source: (37)

Number of tourists who bicycled – Using available Texas Specific Data, and data from states which conducted a comparable economic impact of bicycling study, researchers estimated the approximate proportion of total person-days spent bicycling. Given that data is extremely limited in this area, assumptions on a reasonable percentage were made. Texas research indicated that fishing, golfing, and hiking made up 2.8 percent, 2.0 percent, and 1.6 percent of visitor activities, respectively. While biking was not specifically recorded in the existing Texas research, it was assumed by TTI researchers that bicycling it is estimated to be around 2 percent. This results in an estimated 11 million person-days across the entire state spent bicycling in Texas. Due to the size of the state, this is considerably higher than values found in existing studies. See **Table 19**.

Table 19. Existing Case Study Bicycle Visitor Findings

	TX	CO	MN	NC
Year	2016	2015	2015	2011/2012
Visitors				
Total Visitors	266,150,000*	11,970,000	-	23,000,000
Total bicycling tourists	-	1,735,650	50,212	470,000
Percent of total tourism involving bicycling	-	6.5%	-	2.0%
Avg. length of trip (days)	1.96	5.1	-	-
Avg. spent bicycling (days)	-	1.5	1.4	-

* Represent total person-stays
Source: (36, 37, 38, 39)

Average daily expenditures – Researchers estimated the average daily spending using the EDT's 2016 Texas State Profile which listed average daily spending for Texas, and for each of the major regions.

[6] Person-days refers to a single day for a single traveler.
[7] Person-stays refers to trip for a single traveler. A single trip could include one or more person-days.

These daily spending numbers represent an average for all visitors, not just those participating in outdoor recreation activities, such as bicycling. Researchers compared average daily per capita spending totals utilized in existing bicycling economic impact studies and determined that there were no significant differences between the totals. See **Table 21**. The spending totals can be seen in **Table 20**.

Table 20. Texas Spending Per Person Per day (2016) ($)

	Texas Total	Panhandle Plains	Big Bend Country	Hill Country	Prairies & Lakes	Piney Woods	Gulf Coast	South Texas Plains
Avg. Per Person Per Day Spending	125.80	105.10	137.50	123.80	131.10	88.20	114.20	133.20
Transportation	41.50	41.10	64.60	37.90	46.90	30.00	37.40	39.60
Food	30.90	26.30	26.50	32.90	30.60	21.80	28.30	32.20
Lodging	47.40	33.80	41.90	50.10	51.30	37.60	46.90	45.00
Shopping	16.30	14.90	12.80	16.80	15.70	14.50	12.60	18.50
Entertainment	9.90	5.90	7.50	9.20	9.70	4.50	9.30	13.70
Miscellaneous	4.20	3.20	4.10	3.50	3.40	2.00	3.30	5.10

Source: (37)

Table 21. Average Daily Spending Comparisons

	Avg. Per Person Per Day Spending (nominal year $)	Avg. Per Person Per Day Spending ($2016)
Texas (2016)	125.80	125.80
Arizona (2012)	260.01	273.09
Colorado (2015)	93.92	94.86
Minnesota (2015)	120.20	121.40
Montana (2013)	75.75	78.19
North Carolina (2012)	60.00	63.02
Utah (2014)	181.81	183.85
Average (Not including Texas)	131.95	135.74

Source: (37)(36)

Assumptions and Limitations

When analyzing the economic impacts of bicycle tourism, major limitations stem from a lack of bicycle-specific tourism information. Many existing studies took a poll of bicycle tourists at events or at specific bikeway locations in the State. For this analysis, researchers relied on literature, existing case studies, and professional opinions for many of the assumptions. Researchers in this study took care in comparing assumptions to other existing studies to ensure that variables, such as per day expenditures, were not out of line with the norm.

A major factor in this section was the number of cyclists engaging in bicycling activities, and spending money as part of this activity. Compared to studies conducted in other states, Texas stands as an outlier in the number of tourists per year. For example, Colorado reported nearly 11 million total tourists and determined 6.5 percent of those individuals were engaging in bicycling activities. Given that Texas reported over 266 million person stays (trips), at an average over 1.96 days per trip, results in almost 550 million person-days, the total number of visitors potentially bicycling is estimated to be magnitudes higher than Colorado.

Results

The results estimate total direct, indirect, and induced bicycle tourism recreation impacts in terms of employment, labor income, value added, and total output impacts. The results are grouped in terms of both domestic (intrastate) and out-of-state (interstate) bicycle tourism.

Researchers place a medium-level confidence in these results. These results are generated from survey data of visitor spending and travel habits, but these habits are not specific to bicycling. Researchers needed to make assumptions based on the literature to tailor the results to bicycling. A survey administered directly to cyclists using bikeways in the state would provide better data, and raise confidence in future analyses.

Domestic (Intrastate) – The EDT's 2016 Texas State Profile reported that 62.4 percent of 2016 tourism were in-state tourism (37). This means that Texans were travelling to another part of the state for business and/ or leisure. These results are intended to capture the residents of Texas which travel and spend time bicycling. For TTI's analysis, the estimated total person-days spent bicycling were multiplied by this percentage to determine in-state recreation and tourism impacts. See **Table 22**.

Table 22. In-State Travel Impacts of Bicycling (2016)

Location	Impact Type	Employment	Labor Income ($)	Total Value Added ($)	Output ($)
Big Bend	Direct Effect	453.9	10,715,405	14,516,911	26,293,517
	Indirect Effect	59.2	2,501,249	4,259,248	8,802,538
	Induced Effect	65.1	2,395,178	4,471,009	8,219,594
	Total Effect	578.3	15,611,832	23,247,167	43,315,648
Gulf Coast	Direct Effect	3,282.5	92,310,682	140,914,458	233,299,254
	Indirect Effect	502.0	33,193,480	52,352,298	89,335,107
	Induced Effect	579.3	29,024,797	49,571,216	83,488,517
	Total Effect	4,363.8	154,528,959	242,837,971	406,122,879
Hill Country	Direct Effect	1,742.0	39,633,615	60,438,885	109,483,422
	Indirect Effect	235.7	10,548,140	16,382,623	32,622,111
	Induced Effect	189.0	7,064,204	12,962,078	23,600,394
	Total Effect	2,166.7	57,245,958	89,783,587	165,705,927
Panhandle	Direct Effect	1,026.0	24,164,173	35,751,361	63,904,537
	Indirect Effect	141.1	6,299,563	10,435,335	22,017,969
	Induced Effect	167.7	6,460,830	11,604,613	21,858,788
	Total Effect	1,334.8	36,924,567	57,791,309	107,781,295
Piney Woods	Direct Effect	523.2	11,477,718	17,853,299	32,559,710
	Indirect Effect	68.3	3,092,491	4,798,292	9,583,779
	Induced Effect	67.4	2,641,173	4,786,561	8,674,513
	Total Effect	658.8	17,211,383	27,438,152	50,818,001
Prairies & Lakes	Direct Effect	6,798.9	185,102,550	298,657,502	487,546,759
	Indirect Effect	1,181.0	69,153,787	115,029,360	200,989,237
	Induced Effect	1,598.9	80,771,281	140,172,474	241,310,511
	Total Effect	9,578.7	335,027,618	553,859,336	929,846,507
South Texas Plains	Direct Effect	2,488.5	66,135,668	100,528,550	168,640,596
	Indirect Effect	401.9	19,308,454	30,792,562	58,375,400
	Induced Effect	529.4	22,120,538	37,864,421	67,691,415
	Total Effect	3,419.9	107,564,660	169,185,533	294,707,410
Total	Direct Effect	16,315.0	429,539,812	668,660,966	1,121,727,795
	Indirect Effect	2,589.3	144,097,164	234,049,718	421,726,141
	Induced Effect	3,196.8	150,478,002	261,432,372	454,843,732
	Total Effect	22,101.1	724,114,978	1,164,143,055	1,998,297,667

Source: IMPLAN, (37)

Out-of-State (Interstate) – Out-of-state tourism represented 37.6 percent of total Texas tourism in 2016. The results shown are intended to capture visitor spending impacts of individuals coming from out-of-state and participating in bicycling activities. The same methodology and assumptions used for intrastate estimates were used for interstate travel. See **Table 23**.

Table 23. Out-of-State Travel Impacts of Bicycling (2016)

Location	Impact Type	Employment	Labor Income ($)	Total Value Added ($)	Output ($)
Big Bend	Direct Effect	329.6	7,867,155	11,874,800	21,233,032
	Indirect Effect	47.7	1,965,563	3,305,410	6,823,084
	Induced Effect	48.5	1,783,272	3,328,313	6,119,567
	Total Effect	425.8	11,615,990	18,508,523	34,175,683
Gulf Coast	Direct Effect	1,977.9	55,623,162	84,910,096	140,577,924
	Indirect Effect	302.5	20,001,221	31,545,653	53,830,191
	Induced Effect	349.0	17,489,319	29,869,867	50,307,237
	Total Effect	2,629.5	93,113,702	146,325,616	244,715,351
Hill Country	Direct Effect	1,049.7	23,881,794	36,418,303	65,970,780
	Indirect Effect	142.0	6,355,930	9,871,581	19,656,913
	Induced Effect	113.9	4,256,636	7,810,483	14,220,750
	Total Effect	1,305.6	34,494,360	54,100,367	99,848,443
Panhandle	Direct Effect	618.2	14,560,463	21,542,485	38,506,578
	Indirect Effect	85.0	3,795,891	6,287,958	13,267,237
	Induced Effect	101.1	3,893,064	6,992,523	13,171,320
	Total Effect	804.3	22,249,417	34,822,966	64,945,136
Piney Woods	Direct Effect	315.2	6,916,062	10,757,758	19,619,313
	Indirect Effect	41.2	1,863,424	2,891,279	5,774,841
	Induced Effect	40.6	1,591,476	2,884,210	5,226,951
	Total Effect	397.0	10,370,962	16,533,246	30,621,105
Prairies & Lakes	Direct Effect	2,525.7	74,245,358	113,566,400	184,436,453
	Indirect Effect	439.9	26,776,391	42,643,631	75,475,449
	Induced Effect	634.1	32,023,623	55,581,681	95,673,914
	Total Effect	3,599.7	133,045,373	211,791,712	355,585,817
South Texas Plains	Direct Effect	1,499.5	39,850,979	60,574,895	101,616,768
	Indirect Effect	242.2	11,634,581	18,554,492	35,174,920
	Induced Effect	319.0	13,329,042	22,815,740	40,788,416
	Total Effect	2,060.7	64,814,602	101,945,127	177,580,104
Total	Direct Effect	8,315.9	222,944,972	339,644,736	571,960,848
	Indirect Effect	1,300.5	72,393,002	115,100,004	210,002,637
	Induced Effect	1,606.2	74,366,433	129,282,817	225,508,155
	Total Effect	11,222.5	369,704,406	584,027,558	1,007,471,640

Source: IMPLAN, (37)

The results in **Table 22** and **Table 23** show that there is a considerable impact from bicycle tourism in the state. The analysis shows 16,315 direct jobs supported by domestic bicycle tourism and 8,316 direct jobs supported by out-of-state bicycle tourism in 2016. Since the analysis is assuming that there are an estimated 11 million tourism days spent bicycling in the state every year, there is a large impact. However, it is important to note that these impacts are spread out over large geographic regions of the state. Given the rural nature of bicycling as an outdoor recreation activity, these jobs and impacts are most likely well-dispersed throughout the state.

Production/ Manufacturing

Researchers conducted an analysis of both spending on bicycle-related expenditures (retail sales), and the production of bicycles and bicycle parts and accessories (wholesale) within the state. The primary source of data for estimating these impacts was the 2012 Census Product Line reports. These reports were conducted as part of the 2012 Economic Census, which is an expansion on economic data that has been collected by the U.S. Census Bureau's decennial census. This report is conducted every five years, and collects data from nearly 4 million small, medium, and large businesses across the country. These data are delineated at the national and state levels.

Methodology

For bicycling and manufacturing, three main industry sectors were considered in TTI's analysis: retail sales, wholesale trade, and manufacturing. These served as the primary data in absence of any recent survey of Texas-specific bicycle retailers and/ or producers. The latest Economic Census, for year 2017, had not been released at the time of this analysis. The Economic Census examines economic activities in the various North American Industry Classification System (NAICS) categories. These categories are a grouping of similar economic activities.

Table 24 shows the retail sales and wholesale trade amounts for bicycle parts and accessories.

Table 24. Bicycle-Related Product Line Sales in Texas (2012)

2012 NAICS code	Products and services code	Number of establishments	Sales ($1,000)
45111 - Sporting goods stores	20539 - Bicycles, parts & accessories	257	159,966
4521 – Department Stores	20539 – Bicycle parts & accessories	31	2,882
42 - Wholesale trade	12712 - Bicycles and bicycle parts and accessories, including tires and tubes	38	125,613

Source: U.S. Census Bureau, 2012 Economic Census

Table 25 lists the annual payroll from motorcycling, bicycle, and parts manufacturing. Due to the NAICS grouping in this sector, the manufacturing of both motorcycles and bicycles are included in the estimates. These fall under the broad NAICS classification "Other transportation equipment manufacturing." As such, it is not possible to delineate the data further without more detailed information.

Table 25. Bicycle-Related Manufacturing in Texas (2015)

2015 NAICS code	Number of establishments	Paid Employees	Annual Payroll ($1,000)
336991 - Motorcycle, bicycle, and parts manufacturing	21	195	9,461

Source: U.S. Census Bureau, 2012 Economic Census

Assumptions and Limitations

The major limitations of TTI's analysis are that the economic censuses are only conducted every five years, and that product line data is not available at geographies smaller than the state level. A major assumption made for the analysis is the degree at which manufacturing includes bicycles. It is likely that the magnitude of motorcycle manufacturing outweighs the impact of bicycle manufacturing in Texas as few bicycle manufacturers are located in the state. As such, the results shown for this analysis are most likely overstating the effects of bicycle manufacturing due to the data not being delineated between motorcycles and bicycles.

Results

The analysis conducted using IMPLAN software showed that sales of bicycles and bicycling parts and accessories supported approximately 1,800 jobs statewide and added near $180 million in total output in 2012. See **Table 26**. Manufacturing of motorcycles, bicycles, and parts supported approximately 670 jobs statewide and added just over $210 million in total output in 2012. See **Table 27**.

Table 26. Bicycle-Related Product Line Sales in Texas (2012) (in 2018 dollars)

Impact Type	Employment	Labor Income ($)	Total Value Added ($)	Output ($)
Direct Effect	1,275.0	39,191,605	63,624,441	94,368,309
Indirect Effect	226.8	12,838,461	21,865,222	37,518,605
Induced Effect	323.2	15,681,958	27,076,074	47,711,146
Total Effect	1,825.0	67,712,024	112,565,737	179,598,059

Source: IMPLAN

Table 27. Motorcycle & Bicycle Manufacturing in Texas (2012) (in 2018 dollars)

Impact Type	Employment	Labor Income ($)	Total Value Added ($)	Output ($)
Direct Effect	195.0	18,012,120	25,582,308	118,978,127
Indirect Effect	251.2	18,548,273	29,761,124	57,788,605
Induced Effect	226.4	10,973,742	18,955,973	33,386,665
Total Effect	672.6	47,534,134	74,299,406	210,153,397

Source: IMPLAN

Researchers have a high confidence for results of product line sales, and a low confidence for manufacturing. Product line sales are directly related to bicycles and come directly from the U.S. Census Bureau Economic Census. Manufacturing also comes from the Economic Census, but also included manufacturing of motorcycle parts. Therefore, impacts are most likely overstated.

Construction

Economic impact estimates of infrastructure construction are seemingly the most straightforward impacts included in this analysis, but are one of the most difficult to quantify. There are a number of reasons that this is true. First, given that bikeways are constructed primarily at the local level, there is not always aggregated information on the construction costs of these bikeways. For example, a shared use path for a new neighborhood development is most likely paid for by the developers of the property or home owner's association. The construction costs specific to that neighborhood bikeway may not be made public record since no local dollars are being spent on that bikeway. Second, local dollars spent on bicycle improvements could come from a number of different public entities. Trails and other off-road shared use paths could be a part of a parks and recreation department's improvement program, bike lanes and cycle tracks may come through the public works department, while on-system bikeways may be programmed through the MPO and/or TxDOT. This results in projects being planned and programmed by multiple government agencies and placed in multiple planning documents. Collecting these records for every city in the state was not feasible as part of this research project.

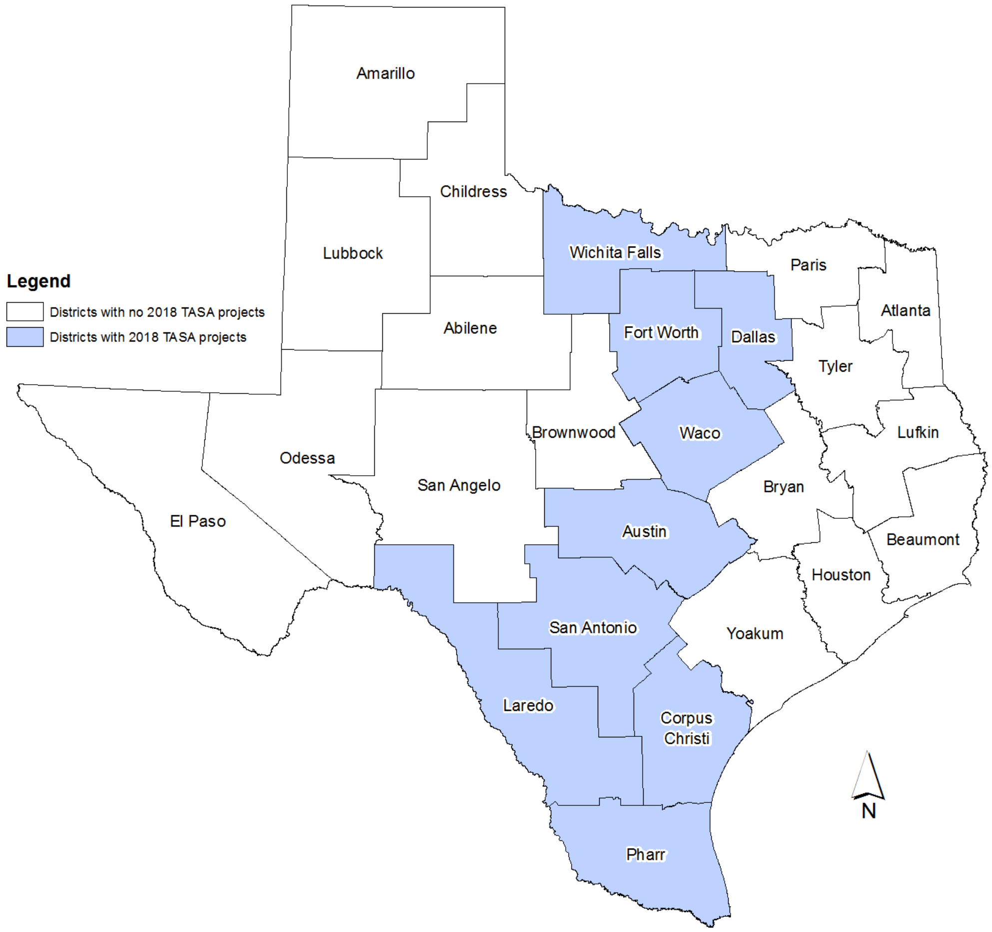
Given these concerns, researchers identified a specific set of federal funds that are dedicated (in Texas) for the construction of bicycle and pedestrian infrastructure. The Transportation Alternatives (TA) Program is a federal funding program under the Moving Ahead for Progress in the 21^{st} Century (MAP-21) Act and reauthorized under the Fixing America's Surface Transportation (FAST) Act which apportions funds to each state and large MPOs (over 200,000 population area) for a variety of non-traditional transportation activities; a majority of the funding is used for bicycle and pedestrian infrastructure improvements.

Methodology

To estimate the impacts from various construction projects throughout the state, data was collected on TA funded shared use paths, Safe Routes to School,[8] and bicycle-specific projects. For this analysis, researchers did not look at all funds distributed, but rather, only those obligated to a new bicycle construction project. These projects were first grouped by estimated let date to determine the impact year. For this analysis, researchers estimated impacts for projects with estimated construction in 2018. Second, researchers separated projects by county, and sorted those projects by TxDOT District. See Figure 2 for counties with a TA funded bicycle infrastructure project scheduled to let in fiscal year 2018.

Researchers created study regions within the IMPLAN model for each TxDOT district with a selected project. Using these regional models, researchers used transportation construction cost multipliers to estimate what impacts these projects are expected to have on the regional economies.

Figure 2. TxDOT Districts with 2018 TASA Projects



[8] Safe Routes To School was a national grant program that supported infrastructure improvements that promoted removing barriers to walking and biking around schools.

Assumptions and Limitations

As previously mentioned, the lack of local data on the dollars spent for all bikeways means that the impacts are underestimated. While a cost per mile is possible to develop, it is not possible to develop a total inventory of every district without a statewide data collection effort. Any shared use path or on-street bike lane has a value and impact, but they are not always reported in the same way. For example, the cost to incorporate a bike lane into a roadway widening project is not separated from the total project cost. As such, there is no way to determine the impact the bike lane specifically has relative to the construction project as a whole. Therefore, using government data sources, such as TA projects, is the most effective way of highlighting the impacts of bicycle related infrastructure construction.

This analysis also does not consider any privately-owned bikeways that exist today. These bikeways are most likely constructed by private owners which would not report construction cost. Therefore, these impacts are not able to be accounted for.

Results

The TA program in Texas supported over $26 million in spending for planned bicycle improvements in 2018. Using the IMPLAN model, researchers were able to identify the total economic impacts of this construction by TxDOT district. See **Table 28**.

Table 28 Impact of TA-Funded Bicycling Infrastructure Construction (2018)

TxDOT District	Impact Type	Employment	Labor Income ($)	Total Value Added ($)	Output ($)
Austin	Direct Effect	10.7	641,038	803,764	1,930,415
	Indirect Effect	2.4	155,953	266,299	432,179
	Induced Effect	3.2	132,857	255,382	443,231
	Total Effect	16.3	929,847	1,325,446	2,805,825
Corpus Christi	Direct Effect	4.5	314,794	399,406	871,381
	Indirect Effect	1.4	87,278	151,866	303,380
	Induced Effect	2.1	83,980	145,967	263,614
	Total Effect	8.0	486,053	697,238	1,438,375
Dallas	Direct Effect	14.2	1,066,363	1,293,571	2,115,509
	Indirect Effect	1.4	99,979	159,967	270,374
	Induced Effect	5.5	267,939	471,695	789,290
	Total Effect	21.2	1,434,281	1,925,233	3,175,173
Fort Worth	Direct Effect	31.1	1,882,934	2,288,775	4,076,594
	Indirect Effect	3.9	253,537	413,259	717,269
	Induced Effect	12.2	564,811	964,471	1,664,876
	Total Effect	47.1	2,701,282	3,666,506	6,458,739
Laredo	Direct Effect	8.3	284,382	341,941	818,144
	Indirect Effect	1.2	58,382	99,787	200,505
	Induced Effect	1.8	58,721	105,076	195,737
	Total Effect	11.3	401,486	546,803	1,214,386
Pharr	Direct Effect	55.5	2,018,015	2,422,639	5,600,000
	Indirect Effect	8.3	381,838	637,742	1,322,257
	Induced Effect	15.6	539,855	925,529	1,761,372
	Total Effect	79.4	2,939,707	3,985,911	8,683,628
San Antonio	Direct Effect	43.8	2,575,954	3,128,238	5,648,706
	Indirect Effect	6.4	400,422	658,207	1,155,363
	Induced Effect	19.0	852,860	1,446,678	2,520,022
	Total Effect	69.2	3,829,235	5,233,123	9,324,090
Waco	Direct Effect	6.1	372,296	449,331	799,999
	Indirect Effect	0.5	26,139	48,171	87,629
	Induced Effect	1.6	64,756	113,224	207,270
	Total Effect	8.2	463,190	610,726	1,094,897
Wichita Falls	Direct Effect	38.8	1,734,160	2,120,445	4,347,557
	Indirect Effect	4.3	217,267	381,788	801,853
	Induced Effect	10.2	383,212	677,815	1,283,123
	Total Effect	53.3	2,334,639	3,180,048	6,432,533
Total	Direct Effect	213.0	10,889,935	13,248,110	24,277,889
	Indirect Effect	29.8	1,680,794	2,817,082	5,290,809
	Induced Effect	71.2	2,948,990	5,105,838	9,128,534
	Total Effect	314.0	15,519,719	21,171,033	40,627,647

Source: IMPLAN, TASA Funding Sheets.

Researchers have medium confidence in these results. The impacts shown understate the impacts by looking at a single funding source, but the multipliers are widely used in economic modeling. It can be said that the multiplier effect for transportation construction projects is considerable, and the millions of dollars spent every year throughout the state on infrastructure projects has a large, and positive impact on local economies.

Mobility

Based on the narrow set of available research (discussed in Section 1), the impact of bicycling on congestion is limited at best and likely has limited impact at a regional scale. This is largely due to bicycling's overall lack of mass adoption as a regular modal option, sensitivity to weather, and limited range for commuting options. However, there are noted instances where bicycling has been shown to have a congestion reduction benefit in specific cases—specifically on major and minor arterials that experience congestion on a regular basis (*40*).

The Analysis Concept

While measuring the existing congestion benefit of bicycling at a statewide scale remains incredibly difficult, researchers believe a better approach would be to estimate the congestion benefits of bicycling as it increases as a percentage of mode share on specific and relevant corridors. Stated differently, this analysis would measure the decrease in congestion caused by drivers switching to bicycling and calculate a congestion savings estimate. Since bicycling would have a congestion impact on congested arterials if drivers switched to bicycling, estimating the economic impact of an increase in the bicycle mode share due to an implemented bicycle project would provide realistic and measurable benefit on those corridors.

The resulting calculations would provide an estimate of congestion cost reduction seen by varying percentages of mode shift from driving to bicycling on congested arterial corridors. The state, cities, and MPOs could measure the before and after change in mode share on these corridors using vehicle and bicycle count data to estimate specific congestion cost impacts. Note that this would require a baseline of vehicle and cycle counts on the corridors in question to accurately estimate mode shift.

Understanding this information will allow the state, cities, and MPOs to set realistic and attainable goals, monitor progress, and experiment with varying bicycling strategies[9] to maximize mode shift and spend scarce bicycle resources in the most effective manner possible.

Methodology

Researchers used the following steps to estimate the potential congestion benefits that bicycling could provide on congested arterials and collector roadways.

Step 1: Identify Candidate Segments

To calculate these mobility benefits, researchers first built a database of applicable roadway segments to be analyzed. Researchers used the Texas 100 Most Congested Roadways[10] dataset to select a representative sampling of roadways. This dataset provided numerous benefits in that the over 1,800 segments represent those that experience the most congestion in the state, the segments have already been conflated to both TxDOT's roadway inventory (RHiNO) dataset and INRIX's probe speed dataset (thus

[9] A list of bicycling strategies identified to have some congestion impact can be found at https://policy.tti.tamu.edu/congestion/how-to-fix-congestion/.
[10] More information about the Texas 100 Most Congested Roadways data and methodology can be found at https://mobility.tamu.edu/texas-most-congested-roadways/.

making it easier to run an analysis of this type), and the dataset is analyzed annually enabling a stable source for future bicycle analysis.

To select roadway segments for the analysis, researchers first narrowed the Texas 100 Most Congested Roadways dataset to display only major and minor arterials and collectors based on TxDOT's roadways classification. Highways, freeways, and interstates were specifically excluded from the analysis because bicycling activities would not have a measurable and positive congestion impact on these facilities. The trip distance these facilities cater towards generally precludes most bicycling trips, and bicycle projects explicitly attempting to curtail congestion on these facilities should be discouraged.[11] Researchers also excluded local streets because these do not regularly experience congestion. Because there were so few collectors already in the dataset, researchers included all collectors.

Researchers then applied congestion thresholds of 4,000 average daily traffic per lane (ADT/Lane) for minor arterials and 5,500 ADT/Lane for major arterials to narrow the list further to represent only roadway segments that experience some form of congestion. This operates from the assumption that one will see no congestion improvement on a roadway segment if there is no congestion on the roadway to begin with.

Researchers then specifically looked for and classified roadway segments that were on or near an existing bikeway. Doing so would maximize the ability for the state to, in the future, select corridors of interest to perform more detailed analyses of the impacts of bicycling. Finally, researchers made selections from as many urban areas as possible to provide representation of various urban area sizes and types across the state.

Note that this filtering process only produced 85 qualified segments and excluded many smaller urban areas in the state. Researchers decided to remove the filter restricting roads only on or adjacent to bikeways to include additional roadways. This included another 115 roadway segments from a much more diverse geographical distribution. This list was reviewed and finalized by TxDOT staff (who requested the addition of three additional segments) before researchers moved forward with the analysis.

Step 2: Remove Vehicles as a Percentage Shift in Mode

With this finalized list, researchers used the 2017 Texas Most Congested Roadways speed, volume, and delay information as the basis of analysis. To calculate estimated congestion benefit, researchers first removed motorized vehicles from the selected corridors in increments of 1 percent during the day, which would most affect the peak travel periods (6:00 am to 9:00 am and 4:00 pm to 7:00 pm) up to 5 percent and also 10 percent.[12] Congestion may exist on the selected roadways at other times during the day, so this represents a conservative approach to congestion mitigation for all roadway segments. Removing motorized vehicles from the roadway assumes motorists shift mode to bicycling thereby no longer affecting roadway delay.

Step 3: Recalculate Vehicle Congestion

Once researchers have systematically removed the motorized vehicles from the roadway segments, traffic density for the roadway was recalculated. Researchers then applied this new density value to specific speed equations that recalculate speeds based on traffic density levels for arterial and collector streets using SAS statistical software (these equations also exist for freeways, but were not used as there are no

11 Researchers do note that rural highway segments may accommodate cycling activity; however, the level of congestion and cycling activity would never reach thresholds needed to observe congestion relief.

12 Since bike share among other modes is generally extremely low (<2 percent in most cases), researchers capped the analysis at 10 percent in order to provide a reasonable set of targets to be attained. Should bicycling remove more than 10 percent of vehicle trips, additional analyses could be performed to calculate the benefit.

freeways being analyzed). Researchers used these new adjusted speeds to calculate updated delay estimates.

Step 4: Calculate Congestion Benefit and Savings

Researchers finally used these new delay estimates to compare against the delay estimates from the base case. This produced a series of delay savings values (expressed as a percent) that each level of mode shift (1-5% and 10%) would produce. Researchers then calculated delay savings (expressed in annual hours) and congestion cost savings (expressed in annual dollars) for each of these mode-shift levels using the following equation:

$$Delay\ Savings\ (Annual\ Hours) \times \$19.81 = Congestion\ Benefit\ (Annual\ Dollars)$$

Congestion cost savings uses $19.81 per annual hour of delay. This value is derived from dividing the total congestion cost for all 1,800 Texas 100 Most Congested Roadways segments by the total person hours of delay in the list. This congestion cost includes personal value of time and fuel as well as commercial value of time and fuel. Note that this value is higher than a commuter-only cost of congestion of $17.81 per annual hour of delay. Since auto commuters are being removed from the traffic stream, which contains commercial vehicles, the commercial cost needs to be included in the hourly rate.

Assumptions and Limitations

The primary assumption in this analysis is that any motor vehicles removed from a chosen roadway segment will transition to shift to bicycling. The nature and use of the analysis makes this an appropriate use in estimating hypothetical congestion benefits.

However, the primary limitation and secondary assumption is that induced demand is not created through the sudden relief in capacity supply constraints. As automobiles are removed from the roadway, freeing up capacity, other vehicles would likely fill the created void. While congestion during the peak may remain, the duration and intensity would likely decrease (making the congested period shorter). Researchers broadly accounted for this in the analysis by examining congestion throughout the entire day. However, there are some circumstances where roadway congestion lasted far outside the peak period or was so intense that the effects of additional cyclists became negligible. This partly explains why in some circumstances, congestion benefits did not increase as the percentage of users increased.

Another key assumption is that the increase in bicycling on the congested roadway does not interact significantly with automobile traffic. This could be accomplished through other assumptions that separated bikeways exist on the street or that cyclists take an alternate route.

Results

The analysis produced delay reduction values (expressed as a percentage) for each of the six mode-shift-to-bicycling percentage values (1-5% and 10%). These values represent the annual delay savings (in hours) forecasted to be realized from a mode shift from driving to bicycling on the analyzed roadways. Tables in Appendix A display the results of this analysis for all percentage mode shifts.

Since the existing bicycle mode share remains extremely low, the results of the analysis of shifting 1% of drivers to bicycling may prove far more useful in terms of estimating benefit and setting baseline targets for benefits. Figure 3 illustrates the congestion savings as well as the annual congestion savings expressed in dollars for the Austin area for the top 15 segments. Note that while the percent delay savings may be less for some corridors, the dollar amount may be greater. Researchers created an interactive visualization based on Figure 3 that can be found by clicking here[13] which provides significantly more information.

Percentage of delay benefit ranged from 0 percent (no benefit) to 20 percent (highly suspect). Average benefit for a 1 percent mode shift to bicycling for all corridors in the analysis provided a 2.0 percent delay reduction, increasing approximately 0.35 percent per single percentage point increase in mode shift. This would translate to over $11 million in congestion savings for the state if the 200 segments included in the analysis achieved a 1 percent shift in mode to bicycling.

Figure 3. Top 15 Austin Corridors Benefiting from a 1% Increase in Bicycling.

Austin/Round Rock

Select a City: Austin/Round Rock

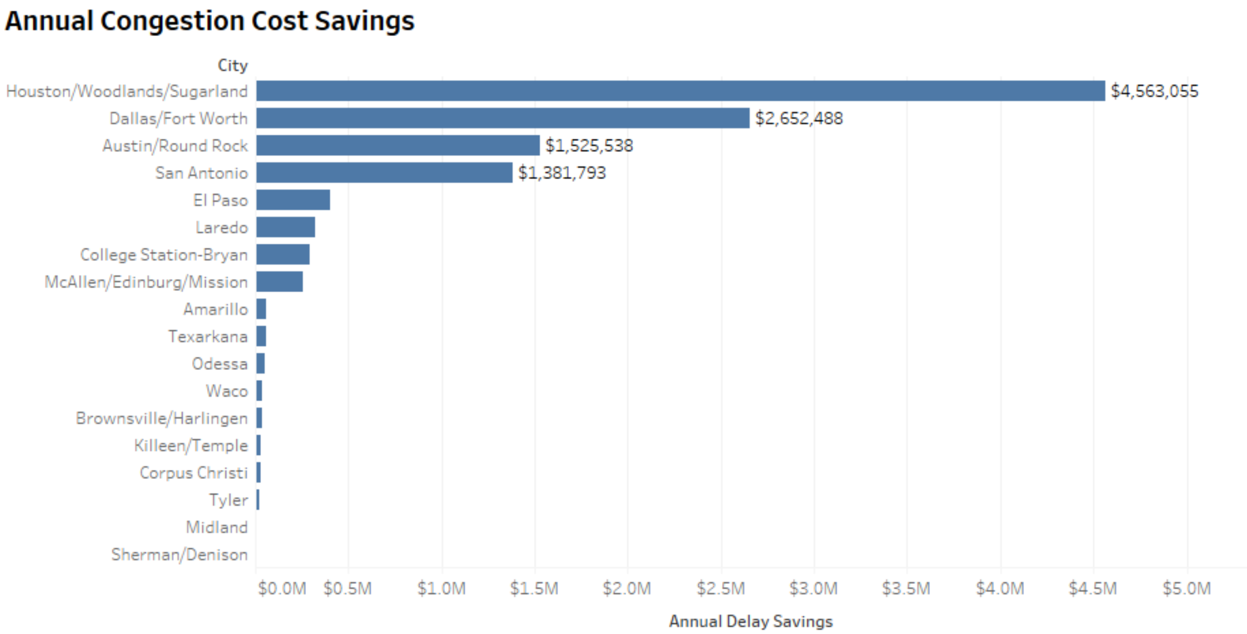
% Mode Shift to Bicycling: 1%

Road Name	Segment Length	Daily Traffic Volume	Delay before Treatment	Delay Savings	Anl Delay Savings
N Lamar Blvd	3.8	29,954	355,000	7.2%	$506,274
	2.8	27,836	189,225	6.0%	$226,052
RM 2222	3.4	26,314	254,676	2.3%	$115,858
	3.6	29,297	86,272	0.9%	$15,347
S 1st St	2.9	25,707	267,343	2.2%	$117,235
Riverside Dr	5.7	25,098	189,581	1.6%	$59,393
Burnet Rd	4.9	25,887	337,742	0.8%	$55,231
Brodie Ln	4.2	23,121	100,631	2.5%	$50,651
W William Cannon Dr	4.5	29,404	95,028	2.2%	$41,457
FM 969	3.9	26,577	148,157	1.3%	$37,056
W Parmer Ln / FM 734	7.5	52,555	354,352	0.5%	$36,869
Manchaca Rd	3.3	22,048	120,939	1.5%	$36,139
Southwest Pkwy	6.8	29,326	39,034	4.6%	$35,634
Spicewood Spring / Anderson	4.4	22,915	157,476	0.7%	$22,890
Wells Branch Pkwy	3.3	23,164	70,339	1.5%	$20,581

While these individual annual savings in the cost of congestion may be relatively small, when they are added together over a metropolitan area, reveal a significant savings from bicycling each year. Figure 4 illustrates how much each metropolitan area assessed in this analysis could benefit in congestion cost savings from achieving a 1% mode switch from driving to bicycling on the sampling of arterial and collector roadway segments. Note that the larger metropolitan areas had more segments in the analysis; actual total benefits may change based on the breadth of any region-wide push to promote bicycling and shift drivers to bicycling. In general, the largest metropolitan areas could experience over $1,000,000 in annual congestion savings from moving 1% of the drivers on congested arterials and collectors to bicycling.

[13] https://tableau.tamu.edu/t/TTI/views/CongestionCostSavingsfromModeShifttoBicycling/Dashboard1?iframeSizedToWindow=true&:embed=y&:showAppBanner=false&:display_count=no&:showVizHome=no

Figure 4. Total Annual Congestion Cost Savings for All Assessed Segments at 1% Mode Shift to Bicycling.



Health

In addition to serving as a primary transportation mode for many, bicycling provides a form of exercise that can be integrated into daily life. Regular bicycle commuters may need little additional exercise to meet the U.S. Surgeon General's recommendation of "at least 150 minutes of moderate-intensity activity each week (adults) or at least one hour of activity each day (children)"(41). This recommendation follows years of studies showing a strong link between physical activity levels and reductions in all-cause mortality (including the risk of crashes from bicycling).

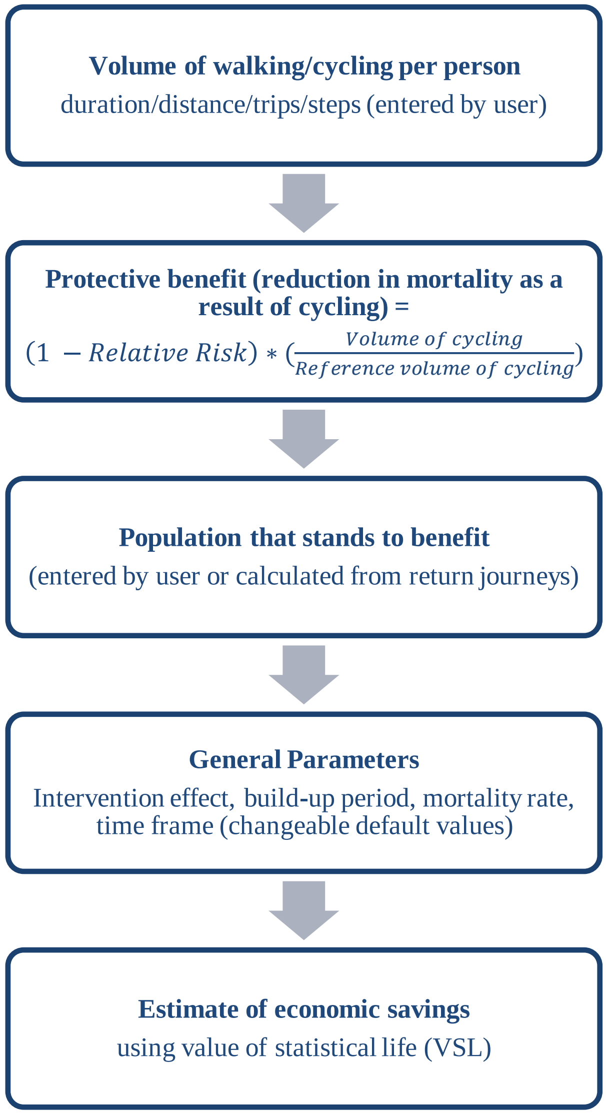
This study builds on the review of approaches for calculating the health benefits of bicycling in the Task 5.1 memo. The review found the Health Economic Assessment Tool (HEAT), developed by WHO/Europe is most widely used in the United States for health impact assessments and economic benefits studies related to bicycling and walking. Rather than relying on studies from exemplars, the HEAT tool builds on a systematic review of reductions in relative risk from mortality by all causes, including seven of the most rigorous studies out of a total of 8,901 different articles. Using results of this meta-analysis of studies, the HEAT tool uses a linear relationship of 0.9 relative risk dose-response curve with a confidence interval between 0.87 and 0.94, meaning that for every unit of increased bicycling, relative risk increases at nine-tenths of the unit value (42).

Similar to any other economic benefit calculation, the benefits of bicycling to health can be estimated in financial terms, subject to several inputs and assumptions. Given values for how many people would bicycle for a certain time on most days, HEAT estimates the 'economic value of the health benefits that occur as a result of the reduction in mortality due to their physical activity'. The HEAT tool is designed to be able to estimate benefits for bicycling (or walking) for either a static time and geography, or to show changes based on policy or construction. In this case, researchers estimate the static benefits of bicycling in the state of Texas for one year, 2017. This section describes the inputs chosen for this assessment, before describing the results of the statewide analysis. This assessment uses HEAT version 2.3, the 2014 update.

Despite its rigor, the HEAT tool must be used carefully to avoid misinterpreting results. Authors of the user guide recommend several cautions. The tool is useful for population-level assessments, and cannot be used for individuals. Since it relies on health benefits from consistent activity, it is not useful for evaluating special events—inputs should reflect long-term average conditions. It is only for adult populations, applied to populations between age 20 and 64 for bicycling. It should not be used on populations with high average physical activity levels, which is more of a concern for local-area assessments, but not a particular concern with the state of Texas as a whole. Finally, HEAT calculations represent order of magnitude estimates of an expected effect, rather than precise estimates.

Figure 5 shows the generalized process that HEAT uses to estimate health benefits.

Figure 5. General Process of the Health Economic Assessment Tool (HEAT)



Source: (42)

HEAT Inputs

The HEAT tool includes a total of sixteen possible questions, though some are skipped depending on certain choices. This assessment focused on a single point in time, the year of 2017. Most of the input data come from the 2017 National Household Travel Survey (NHTS) and 2016 American Community Survey Data (ACS).

The *volume of bicycling per person* was estimated using several factors. The average miles per bicycle trip (2.19) was derived from the total person miles bicycling (8,956,440,000 in the 2009 NHTS) divided by the total number of bicycle trips (4,081,820,000 in the 2009 NHTS). Texas cyclists were assumed to be able to bike 365 days per year.

The *protective benefit* is calculated as a function of the relative risk of bicycling (0.9) and the change in volume of bicycling. Since this assessment only uses one time point, this factor is canceled out.

The *population that stands to benefit* is the number of cyclists in Texas. Most Texans ride a bike at least once a year, but American Community Survey data from 2016 shows that only 0.3% commute to work via bicycle most often. Researchers adapted a national formula from NCHRP Report 552 (43) to estimate the total number of adult Texans bicycling on a regular basis, including trips for all purposes (shopping, recreation, etc.). Using their 'moderate' factor, researchers multiplied the share of bicycle commuters (0.3%) by 1.2, then added 0.4. This rate of bicycling multiplied by the Texas population of 27,862,596 results in an estimate of 100,306 who bicycle on a regular basis. HEAT estimates that this level of bicycling is likely to lead to an 11% reduction in the risk of mortality for the 100k people regularly bicycling in the state, which the HEAT tool uses to estimate reductions in mortality from increased bicycling.

Researchers used the default mortality rate of 414.49 per 100,000. The Centers for Disease Control publishes mortality rates for the total population, and for age cohorts, but does not include one factor for ages 20-64. However, this default is similar to the mortality rate for the CDC mid-range of ages (20-64).

The value of a statistical life is important for the estimate of economic savings, translating a life to be worth an economic value. Researchers used the U.S. Department of Transportation value of $9.6 million provided in the *Revised Departmental Guidance on Valuation of a Statistical Life in Economic Analysis* (44).

Since researchers only computed one year's worth of value (2017), discount rates for future benefits are not applicable but are available for future assessments in HEAT.

HEAT Results

Given these inputs, the HEAT tool estimates that the Texans who regularly bike, do so for an average of 799 miles in a year. This results in a protective benefit of an 11% reduction in relative risk for cyclists who ride regularly in Texas. Based on assumptions that not all regular bicyclists ride enough to achieve this level of health benefit, the HEAT tool reduces the 100,306 total bicyclists to 83,588, which is used for further calculations. This calculation estimates that current levels of bicycling saves 346 lives through health benefits alone, and even after all risks included, saves 37 Texans annually. Given these preliminary calculations, the annual monetized health benefit of this level of bicycling, computed for 2017, is $352,643,000 in Texas.

Section 2 Summary

The analysis found that bicycling in Texas contributed to over 36,000 jobs and over $1 billion in total economic output. These impacts come from tourism, construction, retail/ sales and manufacturing, mobility, and health benefits directly from or related to bicycling.

The thousands of miles of bikeways attract not only Texas residents, but also those travelling from out-of-state to use the bikeways. In addition, tens of thousands of cyclists participate in the hundreds of bicycling events annually that take place in Texas. The spending habits of these bicycle tourists create thousands of jobs and add value to the economy.

Researchers also examined the impacts of retail sales and production of bicycles and bicycle parts and accessories. While retail sales look exclusively at bicycle and bicycle parts and accessory sales, production does not. The most recent data (2012) shows that retail sales produced 1,825 jobs and nearly $180 million in total output. Production supports 673 jobs and over $210 million in total output, which includes motorcycle, mopeds, and bicycles, so production results overstate the benefits.

Construction of federally funded bicycle-related projects expected to be let in 2018 are estimated to have considerable impacts in several TxDOT districts in terms of jobs and total output. These numbers also do not take into account any privately constructed bikeways or bikeways being constructed through any state or local funds outside of the federal TA program. This lack of total construction cost data is detrimental to fully identifying the impacts of bikeway construction. A case study approach in Section 3 will allow for all funding sources (e.g. local budget, special districts, etc.) to be used in the analysis.

Researchers found that bicycling creates over $11 million in annual congestion cost savings statewide if only 1 percent of existing automobile traffic switched to bicycling as the mode of transportation. These savings would come from the congestion reduction on arterials and collectors, and this reduction equates to system-wide travel cost savings.

Lastly, researchers created an estimate that biking creates a monetary health benefit of over $352 million. These values used 2017 cyclist estimates, and results are shown in 2017 dollars. These benefits were calculated using the HEAT tool which estimates the economic value of the health benefits gained from active living, which includes bicycling for both utilitarian and recreational purposes.

Section 3 – Local Economic Analysis: Case Studies

For the final part of this analysis, researchers examined the economic impacts of specific bikeways and their associated activities. These case studies are designed to not only highlight the direct impact these bikeways have on local economies, but to also identify other potential benefits to the economy. This includes, but is not limited to, improving overall performance of a bicycling network, the aesthetic benefits to commercial and residential land uses, and how these bikeways can impact individuals by offering alternative transportation options. These benefits vary by case study and are discussed qualitatively where applicable. These qualitative benefits, examined in conjunction with measurable metrics such as construction impacts and travel cost savings, offer an estimated impact of each bikeway to the local economy.

To estimate these impacts, researchers collected data on case studies and applied the methodology used in Section 2 to quantify benefits where possible. Case studies were selected to represent a range of bikeway types and geographies. The case studies included in this report are the following:

- A-Train Rail Trail – Denton/ Lewisville
- Lamar Street Cycle Track – Houston
- White Oak Trail Extension – Houston

Case studies are organized to present an overview of each project, including location, funding/ financing used in project delivery, primary purpose of the bikeway (e.g. extension/ connection to an existing network, higher use of right-of-way/ floodplain, etc.), and any additional benefits of the project where information was available. Researchers also collected any available user count data to determine ridership. Strava-based user count estimates were used where no bicycle user counts had been conducted. Researchers then quantified impacts where user count data was available. The methodologies for impact estimates and user counts are explained in the next section.

Methodology

This analysis uses all available bicycle user count data to identify and estimate the impacts where possible. These impacts to be measured include the following:

Construction – The methodology to estimate construction impacts of individual bikeway projects is the same as measuring several projects within a region or the state. Using the IMPLAN model, researchers use construction costs, project timing, and regional multipliers to estimate the total impact. As in Section 2, these results represent a temporary impact in terms of direct, indirect, induced, and total economic impact to the study region (county/ counties in which the project is located). For more detailed explanation of the results provided through IMPLAN, refer to Section 2.

Property Values – Property value impacts resulting from the construction of a bikeway are difficult to measure without a dedicated study with a time period both pre- and post-construction. However, that does not necessarily mean that they do not exist, or that bikeway impacts are negligible relative to other variables. Researchers collected property value information from the various County Appraisal Districts (CADs) from counties in which case studies were located. Researchers evaluated property value[14] changes over time by land use

[14] Assessed (taxable) value of the property was used. This removed tax-exempt properties, such as government buildings, from the evaluation.

within ¼ mile of the project.[15] Researchers focused on a 5-year time frame, which included evaluation of property value changes over the 5-years beginning two years before project construction, during the project construction year(s), and extending until two years following construction where possible. Recent projects used the most current data available. Assumptions on the bikeways contribution to property growth is evaluated on a case-by-case basis.

Travel Time Savings – Researchers used cost savings multipliers recommended by the USDOT for use in benefit-costs analysis applications, such as BUILD (formerly TIGER) discretionary grants, to estimate savings in several areas. These include passenger vehicle operating cost savings, fuel cost savings, environmental benefits, and safety benefits. Inputs for travel time savings analyses are the number of bicycle trips and trip length. Using these inputs and assuming that individuals are making a bicycle trip along the selected bikeway that would otherwise be made in an automobile, researchers estimate a dollar amount savings in each of these areas. These are rough estimates given that trip purpose (utilitarian or leisure) for users are not known. As such, these results are most likely overstating the benefits. Bicycle trip counts for these benefits were either collected from regional agencies' counting programs or extrapolated from user-generated data within Strava.

Health – Researchers used the HEAT Tool, which was also used to measure statewide health impacts in Section 2, for case study projects. These results show the health benefits gained by cyclists using bikeways in terms of reduced mortality risks and medical costs gained from active living.

Assumptions and Limitations

Not all economic impacts identified in this report are able to be effectively estimated at the local level due to a lack of targeted research data. Data on the spending habits and origin/destination of bikeway users (i.e. in-state, out-of-state, etc.) is limited in the state. As such, it was necessary for researchers to make assumptions about spending habits to calculate the economic benefits as a direct result of bikeway construction and use, which presents a limitation to this analysis. In the case of a shared use path, for example, riders may be using the bikeway recreationally because it is near where they live. If this is the case, and that rider did not make a trip to access the bikeway, then any expenditures made would have likely still occurred if that bikeway did not exist. However, if an individual travelled from one region of the state to another to ride a shared use path or bikeway, any expenditures made in this region would have not occurred otherwise, which represent a direct economic impact to the economy.

To determine these habits, economic impact studies rely on survey data to extrapolate annual figures. Some examples of this are the economic impact studies of the Silver Comet Trail in Georgia in 2013 and the Katy Trail in Missouri (45)(46). These reports highlight the impact that visitors, and their spending habits, have on the local and state economies. The methodology included the use of a survey to collect data from users. Given this lack of available data in Texas, this report keeps any estimated impacts from visitor spending at the regional[16] and statewide levels to avoid overstating impacts over spending at the local level.

Regarding ridership estimates, one case study site, the Lamar Street Cycle Track in downtown Houston, does not have permanent counters. Since the research team could not obtain full bicycle count data,

[15] Land uses were derived from the Texas Comptroller Property Tax Classification Guide codes provided in the data.
[16] Regions in Section 2 were created to mirror the regions used in the Texas EDT's 2016 Visitor profile.

researchers extrapolate counts from users of the Strava platform for the twelve months between July 1, 2016 to June 30, 2017 based on factors computed for comparable facilities (1).

On-street bikeways, specifically bike lanes, have construction costs that are included as part of a larger mobility or maintenance project. This makes it difficult to fully sperate the construction impact of the bikeway components from the rest of the project (47). Existing research focuses on the cost-effectiveness of bike lanes, and how bike lanes can connect pieces of a large network, as opposed to the economic impact of a single bikeway (48).

These case studies examine property values and land use composition changes (where data allows) to show possible impacts from trail construction and use. While much of the literature agrees that there is a positive correlation between bikeway investments and property values, results are shown with caveats that many of these bikeways have other potential variables that could boost values, such as light-rail lines, parks, and private investments. One example of impact analyses looked at reported values of properties near the trail and applied an average growth rate using local data (45). Another examined median home prices within varying distances from the trails to determine added values (49). Both studies included in their reports that these estimates are subject to numerous variables which influence property values. It is specifically stated in the Northwest Arkansas report that their model "does not claim an impact or purport to demonstrate a causal relationship between the two variables due to data limitations and unmeasured variables (multi-family units and apartments, rental prices, endogeneity of trail placement, and the co-location of other desirable amenities near trails) (49)."

Similar assumptions must be made for Texas bikeways. This section presents property data and makes observations on potential relationships. Bikeways chosen for this section were recent construction projects, typically no less than three years old. Furthermore, bikeways that provided mode-shift opportunities (i.e. not solely for recreational use), and those with readily available data, were preferred by researchers. However, these selection criteria typically result in projects within an already developed urban setting. As such, numerous variables that influence surrounding property values must be considered. Any stated relationship between the value of the bikeway and any resulting value change for properties must be taken with consideration.

Transportation cost savings that come from using bikeways for utilitarian purposes are more applicable for on-street bikeways as the primary purpose of these is mobility, but can also be applied to off-street bikeways as well. These case studies estimate the travel costs savings as if the users are using the bikeway as a passenger vehicle trip replacement. Without any additional information, such as total trip length of the user or trip purpose, it is not appropriate to separate users by travel purposes.

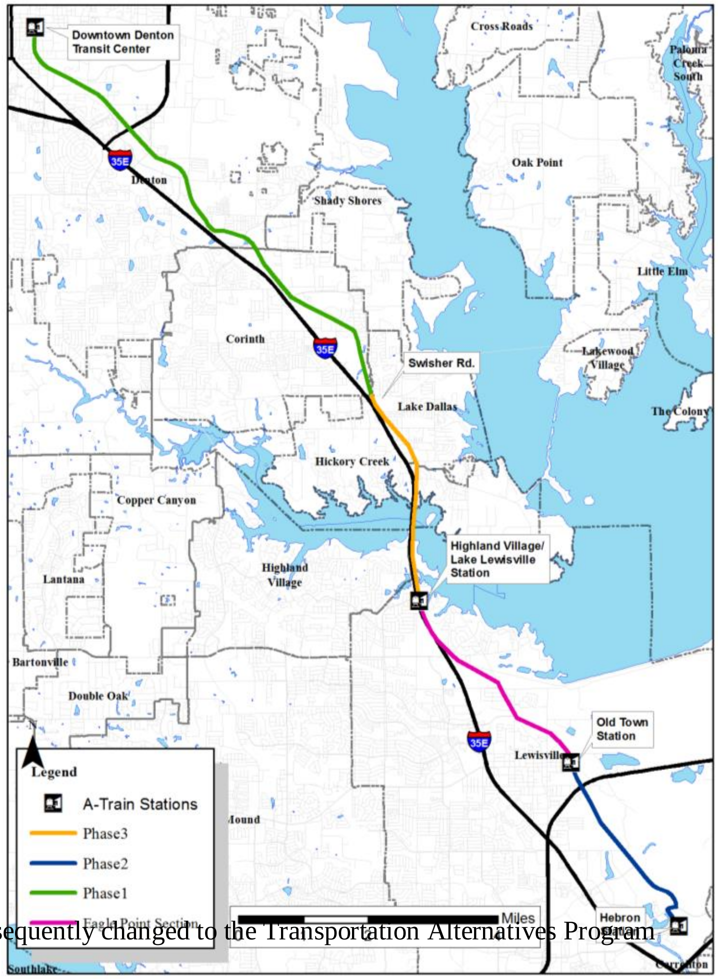
The health impact estimates incorporate the same assumptions used in the statewide HEAT model used in Section 2, including statewide averages of bicycle travel behavior from the American Community Survey and National Household Travel Survey, used in lieu of a locally validated intercept survey for each bikeway. Bikeway usage is based on existing count data on the A-Train Rail Trail and White Oak Trail Extension, with estimates generated using crowdsourced data for the Lamar Street Cycle Track. Since these estimates are associated with individual projects, researchers also assume 50 percent of the journeys are return trips, to conservatively estimate the number of trips at a given counting site are out-and-back journeys. These calculations also assume an average adult population ranging from 20-64 years in age. Researchers used the length of the bikeway to represent an average length of trip. A local survey would be needed to show how many people ride only part of the bikeway, the entire bikeway and no more, or those that incorporate the bikeway as part of a longer trip.

The HEAT tool was updated during the course of this study, and the latest version was unstable at the beginning of the study. Both the statewide and case study assessments use HEAT version 2.3 for consistency, but re-assessment with a later version may produce different results. To assess reliability of estimates, researchers also compared HEAT results with the tool developed as part of National Cooperative Highway Research Program Report 552, Guidelines for Analysis of Investments in Bicycle Facilities. Though the HEAT tool is regarded as the international standard for estimating health impacts of bicycling, the tool includes algorithms estimated using more European studies than US studies. Since most HEAT estimates were within the high and low estimates using the Report 552 method, the health estimates can be considered reliable between methods.

A-Train Rail Trail

The A-Train Rail Trail is a shared use path located in southeast Denton County comprised of two separate shared use paths, the Denton Branch Rail Trail and the Lewisville Hike & Bike Trail. The original bikeway was constructed after the City of Denton purchased abandoned Union Pacific right-of-way in 1993 (50). This led to the construction of the original Denton Branch Rail Trail in 1998. This original 8-mile shared use path was funded using grant dollars from the Intermodal Surface Transportation Efficiency Act (ISTEA) and the Transportation Enhancements (TE)[17] program. These dollars funded the creation of an approximately 8-mile limestone gravel path that connected downtown Denton to Lake Dallas.

Figure 6. Location of A-Train Rail Trail



In 2011, the A-Train transit project was completed. This light-rail line utilized the abandoned Union Pacific railway line as a part of a 21-mile regional rail system. The original trail was removed from where the abandoned rail line ran, and a new rail line was built in its place. The rail trail was located in the right-of-way and parallel to the new rail line, and was upgraded to a paved shared use path. This first phase of construction resulted in the 8-mile Denton Branch Rail Trail. The cost of this project was estimated at $4.5 million.

The "Lewisville Hike & Bike Trail" was constructed as part of Phase II of the project. This 4-mile shared-use path runs from downtown Lewisville to Hebron Rd. This phase was originally designed to extend from the Highland Village/ Lake Lewisville Station to Hebron Parkway, but funding considerations caused it to be shortened in length from Hebron Parkway to downtown Lewisville. This phase was set to let in June 2018. The cost of the completed Phase II

[17] The Transportation Enhancements (TE) was subsequently changed to the Transportation Alternatives Program (TAP) in 2012 with the passage of MAP-21.

section was $6 million. Phase III, which extended the Eagle Point trail across Lake Lewisville, opened in Summer 2018 at an estimated cost of $3 million. The Eagle Point section, the final phase, will connect Downtown Lewisville to the Highland Village/ Lake Lewisville Station and is estimated to cost around $2.6 million. Figure 1 identifies the A-Train Rail Trail construction phases and the Eagle Point section.

This bikeway acts as part of the Veloweb, which is North Texas' regional bike network (mentioned in Section 2 of this report). The segments of this bikeway, and their connection across Lake Lewisville, play an integral role in connecting the economic center and residential areas of two of the most prominent cities in Denton County, Denton and Lewisville. In combination with the completed A-Train light rail line, these bikeways will have a significant economic impact providing multi-modal connections.

Ridership

The North Central Texas Council of Governments (NCTCOG) has an established bicycle and pedestrian count program for the region. As part of this counting program, permanent counters are focused on shared-use paths which have been identified as having significant value as active transportation corridors and connecting major destinations and transit stations (51). Per the latest count report, there are thirty permanent counter locations within the jurisdictional boundaries of NCTCOG. These counters record daily counts of both pedestrian and bicycling activities.

The NCTCOG counting program has two permanent counter locations for the Denton Branch Rail Trail and has recorded 2015 and 2017 annual bicycle counts. **Table 29** provides the total annual bicycle volumes for these two permanent count station.

Table 29. Denton Branch Rail Trail Annual Bicycle Volumes (2015 & 2017)

Year	MedPark Station	Morse Street
2015	23,594	20,674
2017	24,127	32,276

Source: NCTCOG

In estimating the economic impacts, researchers looked at all three completed phases of the project. However, when looking at travel cost savings, researchers limited scope to only segments with available count data. As all three phases were not connected at the time of this study, it was not clear on whether cyclists in the section with counts would ride parts of the trail without count data.

Construction

The extent of the current trail, which runs from downtown Denton to just south of Downtown Lewisville (18.1 miles) was constructed in three phases. The first phase was completed in Denton after the original right-of-way was purchased in 1998. In 2011, the original rail trail was replaced with a new light-rail line. In order to keep the rail trail, a new shared-use path was built parallel to the new light rail line in the acquired right-of-way. This case study focuses on the work and construction that has taken place since the completion of the DCTA A-Train transit line, which includes Phase I, II, and III.

These phases, including the Eagle Point Section, were estimated to cost $16.1 million. Construction cost estimates were received from communication with the Denton County Transportation Authority (DCTA). **Table 30** outlines the estimated impacts.

Table 30. A-Train Rail Trail Estimated Construction Impacts (in 2018 Dollars)

Impact Type	Employment	Labor Income ($)	Total Value Added ($)	Output ($)
Direct Effect	61.5	3,760,725	4,731,495	11,216,844
Indirect Effect	15.9	1,074,899	1,693,474	3,013,519
Induced Effect	19.2	791,284	1,564,535	2,675,870
Total Effect	96.6	5,626,908	7,989,504	16,906,232

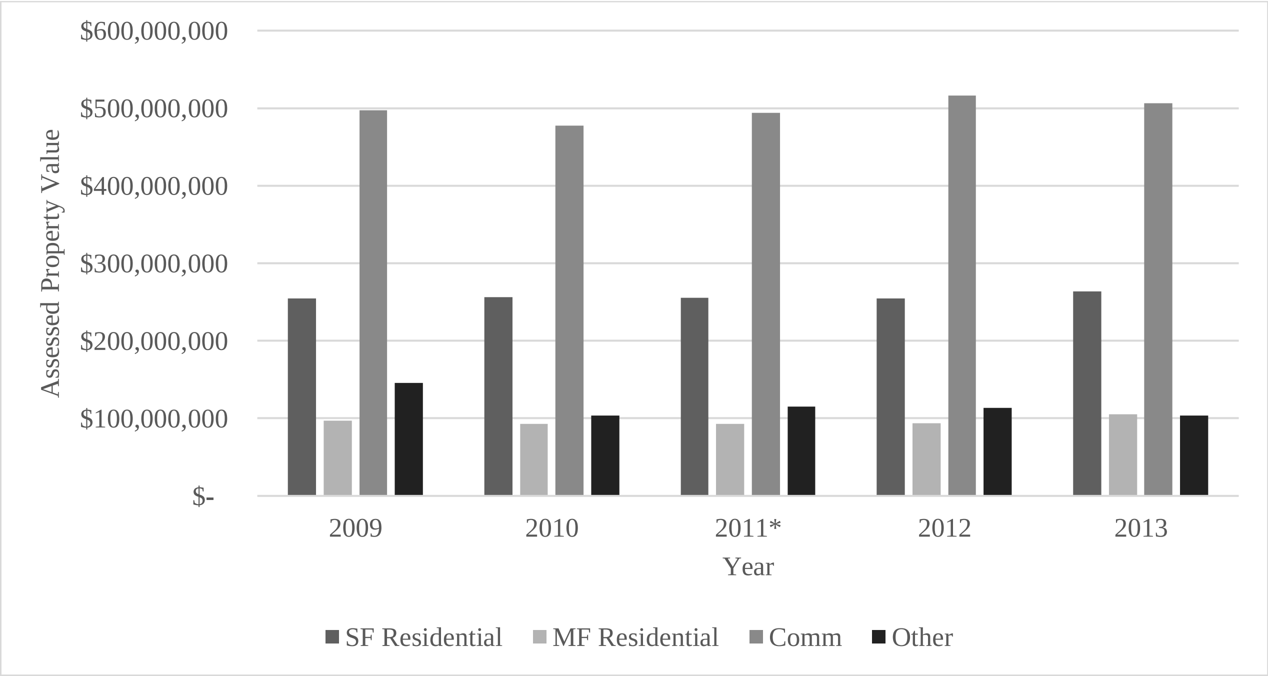
Source: IMPLAN

Property Values

For the A-Train Rail Trail, researchers examined property value changes at each phase of the construction. Land uses within a quarter-mile are mixed between single-family residential, multi-family residential, commercial, and industrial uses. The values of all properties within a quarter-mile of the full trail, in 2017, exceeded $2.1 billion. The two largest contributors to property values were Commercial and Single-Family (SF) Residential.

Regarding Phase I of the project, there was little change in the value of property within a quarter-mile in the years preceding and following construction. See Figure 7. Researchers speculate that the other variables, including the proximity of the trail to downtowns, lake-front properties, a major interstate, and a light-rail line, have a more substantial impact on the properties in this area. While it is not unreasonable to assume that this shared-use path has an impact on property values in this area, it most likely has a relatively small impact when compared to other amenities.

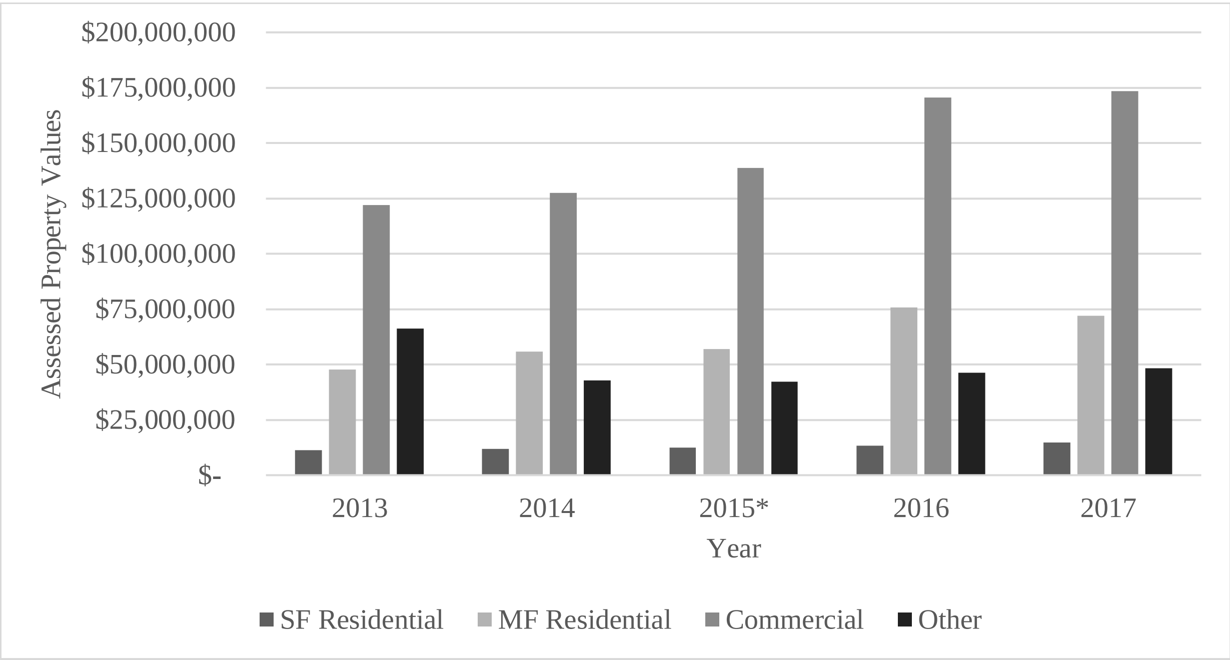
Figure 7. Property Values Within a Quarter-Mile of Phase 1 Construction of the A-Train Rail Trail (2009-2013)



* Denotes project completion year
Source: Denton County Appraisal District

In 2015, the second phase of the trail (Lewisville Hike and Bike Trail) was finished. Figure 7 shows the pre- and post-construction assessed property values within a quarter-mile of the trail. The data shows that there was a considerable increase in commercial property (over $30 million) in the year following construction. It is likely that the construction of the shared use path had a positive impact on the commercial land uses in the area. However, like Phase I, there are a multitude of other variables that need to be considered before a definitive statement on the impacts of this shared use path can be made.

Figure 8. Property Values Within a Quarter-Mile of Phase II Construction of the A-Train Rail Trail (2013-2017)



* Denotes project completion year
Source: Denton County Appraisal District

Travel Cost Savings

The counters established by NCTCOG provide researchers with bicycle user volumes on an annual basis. To estimate travel cost saving benefits, researchers took an average of the two 2017 counts. Using cost factors for several variables (vehicle operations, emissions, etc.) from USDOT sources, researchers were able to derive cost savings for Phase I of the A-Train Rail Trail (Denton Branch Rail Trail). See **Table 31**.

Table 31. Annual Estimated Travel Cost Savings from Use of the Denton Branch Rail Trail

Passenger Vehicle Trips Replaced	Passenger Vehicle VMT	Passenger Vehicle Operating Cost Savings	Fuel Cost Savings	Environmental Benefits	Safety Benefits	Total Transportation Savings
20,289	182,603	$26,234	$18,395	$1,392	$1,444	$47,466

Source: TTI analysis utilizing USDOT formulas

Health Impacts

Bicycle volume counts (trips) taken on the Denton Branch Rail Trail average 24,127 per year, or approximately 77 per day. The HEAT calculation estimates 58 riders of this bikeway would bicycle enough to regularly meet or exceed average rates, resulting in a health benefit through increased physical activity. Based on visitors riding all 12 miles of the completed Phases 1 and 2 segments, the tool estimates reduced mortality due to changes in bicycling behavior from the DCTA Rail Trail result in an annual health benefit worth $1,039,000. For comparison, this value is near the mid-range of the health benefits from physical activity calculated with a comparison method provided in NCHRP 552 (Low Estimate $63,427, High Estimate $1,438,755).

Lamar Street Cycle Track

The Lamar Street Cycle Track is a ten-foot wide, on-street, two-way protected bikeway located within downtown Houston. This bikeway runs three-quarters of a mile from Bagby Street to La Branch Street along the one-way (westbound) Lamar Street. The original bikeway, which finished construction in 2015, connected Sam Houston Park and Discovery Green. See Figure 4. In 2017, an extension to the original bikeway connecting the northwest portion of the bikeway to the Buffalo Bayou Park trail system via Sam Houston park was completed (52). The article cited also notes that the bikeway is anticipated to extend to east downtown (EaDo). Future extensions may connect eastward to the Columbia Tap Trail.

Figure 9. Location of the Lamar Street Cycle

The purpose of this bikeway is to provide safer connections between the Buffalo Bayou and Columbia Tap Trail shared use paths for cyclists traveling on existing streets in downtown Houston. Before construction, there were concerns of cyclists feeling unsafe travelling on streets in downtown (52). To create safer connections, the bikeway was constructed as a two-way cycle track (protected bicycle lane) with two, five-foot travel lanes, separated from automobiles by a two-foot buffer and physical separators. In addition, signals were added to direct cyclists travelling east on the one-way street (against the flow of automobile traffic).

To provide space for the bikeway, the City of Houston repurposed a motor vehicle lane of traffic along Lamar Street in downtown Houston. The Houston Chronicle reported before the bikeway construction that the daily volume of traffic and road hazards to cyclists on Lamar had been lower than other streets (53). This allowed for the repurposing of the traffic lane while having minimal expected impacts to vehicular congestion in the area (54)

Ridership

The Houston-Galveston Area Council (HGAC) has established four permanent pedestrian and bicycle counters within their planning area. These counters are located along popular off-street shared use paths and collect daily user data year-round. In addition, HGAC has placed temporary counters to collect user data at over 250 additional locations since 2012. Temporary counters have been placed for a single month up to 3-months until being removed. Permanent and temporary counters count pedestrian and/or bicycle activities.

HGAC has not used temporary counters to record bicycle counts along the Lamar Street Cycle Track. As such, researchers used the Strava-generated counts to provide an estimate of users along the bikeway. Researchers averaged the Strava traffic volumes for each block from Sam Houston Park to Discovery Green, resulting in 2,292 Strava trips between July 1, 2016 to June 30, 2017. Researchers multiplied the Strava trips by the expansion factor computed in TxDOT Research Project 0-6927, which evaluated bicycle and pedestrian count equipment and estimating methodologies (55), resulting in a conservative estimate of 30,228 total bicyclists (83 average daily bicyclists) during the one-year collection period. This estimate is considered conservative based on analysis of Strava usage patterns at different bikeway locations across the state which suggests a higher percentage of bicyclists using the Strava app on shared-use paths, principally for recreation and health, as compared to bicyclists using the Strava app on on-road bikeways. Downtown bicyclists, including commuters & bike share users, are less likely to record trips using Strava, and may be undercounted. As of this writing, TTI and TxDOT are currently refining a process to estimate on-road bicycle traffic volumes (56).

Construction

The Lamar Street bikeway features 5-foot wide lanes with conspicuous green paint and a two-foot buffer from traffic with Zebra® Cycle Lane Separators. In addition, the City of Houston placed thermoplastic road marking paint and signage to indicate that the lane was intended for cyclists. Bike signals were placed at signalized intersections to direct cyclists. Articles written around the time that the bikeway was added indicate that the construction would take place over one month as part of a resurfacing project (57).

Cost estimates for the construction of the cycle track were provided from the City of Houston. The data showed that the initial phase of the project cost approximately $240,000. This included resurfacing and signage material and installation costs. The data did not, however, include any costs associated with the addition of bike signals at intersections. City of Houston records indicate that the majority of the project costs related to the labor and materials for roadway resurfacing.

To account for the second completed phase of the project, which connected the track to the Buffalo Bayou Trail on the northwest side of downtown, researchers took a mileage-based proportional amount of the costs and applied it to the segment. The total construction cost of the Lamar St Cycle Track equaled approximately $320,000.

The impacts of the construction for both phases are shown in **Table 32**.

Table 32. Lamar Street Cycle Track Estimated Construction Impacts (in 2018 Dollars)

Impact Type	Employment	Labor Income ($)	Total Value Added ($)	Output ($)
Direct Effect	1.6	128,035	160,597	330,054
Indirect Effect	0.5	50,461	79,708	131,979
Induced Effect	0.6	33,847	56,685	91,620
Total Effect	2.7	212,343	296,990	553,653

Source: IMPLAN

The economic impact of construction is notably smaller than the off-street shared-use paths presented in other case studies. This is due to the lower cost and time required to construct an on-street bikeway as compared to a shared use path. However, cycle tracks, which include physical barriers between automobile traffic, have potentially high benefits in terms of accessibility and safety for bicyclists relative to the cost of implementation.

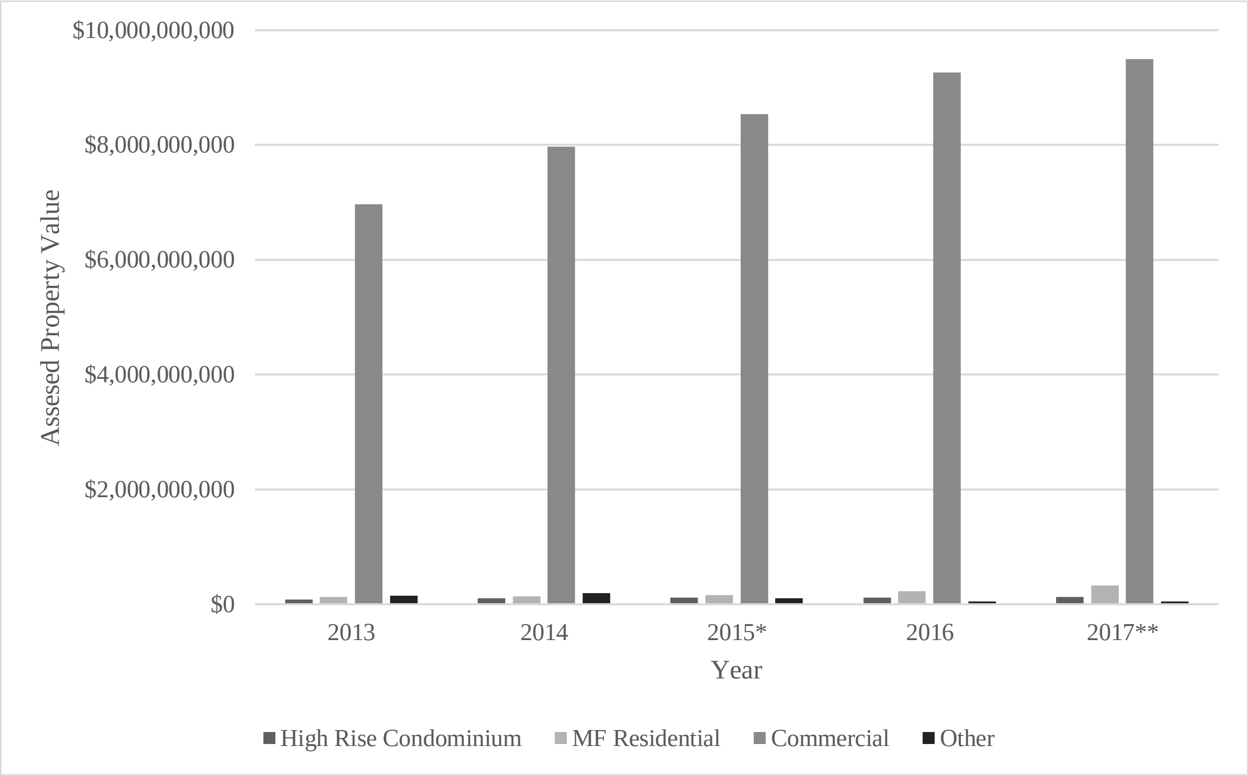
Property Values

Considerable research has been conducted regarding how bikeways affect property values for residential areas, but fewer research studies have examined how bikeways affect property values and retail sales for dense commercial areas such as downtowns. The literature regarding this topic commonly shows a positive impact on property values and retails sales. However, these effects are typically provided with several caveats in the data. As explained in the assumptions and limitations section above, existing studies commonly show bikeways positively impact property values and retail sales, but cannot claim any correlation between the two.

Given the commercial land uses of the properties in proximity to the Lamar Street Cycle Track, retail sales could likely experience a positive impact due to an increase in bicycle user access. Some studies have shown localized increases in retail sales associated with bikeway infrastructure construction and have indicated that shop owners attribute these retail sales increases to additional bicycle user access as the primary reason.

The property data acquired from the Harris County Appraisal District (HCAD) shows the primary land use for this area is commercial. As of 2017. There are high rise condominiums within a quarter-mile of the bikeway which experienced total assessed property value increases of 40 percent from 2013 to 2017. Commercial property values increased as well, growing 27 percent during that same time. See Figure 10.

Figure 10. Property Values Within a Quarter-Mile of the Lamar Street Cycle Track (2013 - 2017)



* Denotes Initial Construction

** Denotes project completion year
Source: Harris County Appraisal District

The data collected from the HCAD show that property values increased steadily from 2013 to 2017. It is not certain what positive impacts the cycle track had on assessed property values in the surrounding area. In addition, it is not certain if there was an impact to retail sales of the commercial buildings with available data. Sales are sometimes investigated when bikeways are near commercial development to highlight impacts of higher exposure (58). Further research on sales and survey of business owners would help determine if there is any positive correlation between the cycle track and local property values.

Travel Cost Savings

Using Strava generated ridership estimates, researchers were able to produce a series of travel cost savings for the Lamar Street Cycle Track. Given that the cycle track is a bikeway principally providing connectivity between two trail systems, the real travel savings may be understated. The numbers are based on a combination of length and ridership. If riders are using the Buffalo Bayou Trail or the Columbia Tap trail to connect to and/or from downtown Houston, these benefits could be larger. Further research on the trip purpose and origin/destination of riders on this bikeway is needed.

Table 33. Annual Estimated Travel Cost Savings from Use of the Lamar Street Cycle Track

Passenger Vehicle Trips Replaced	Passenger Vehicle VMT	Passenger Vehicle Operating Cost Savings	Fuel Cost Savings	Environmental Benefits	Safety Benefits	Total Transportation Savings
21,747	16,310	$2,343	$1,643	$124	$129	$4,240

Source: TTI analysis utilizing USDOT formulas

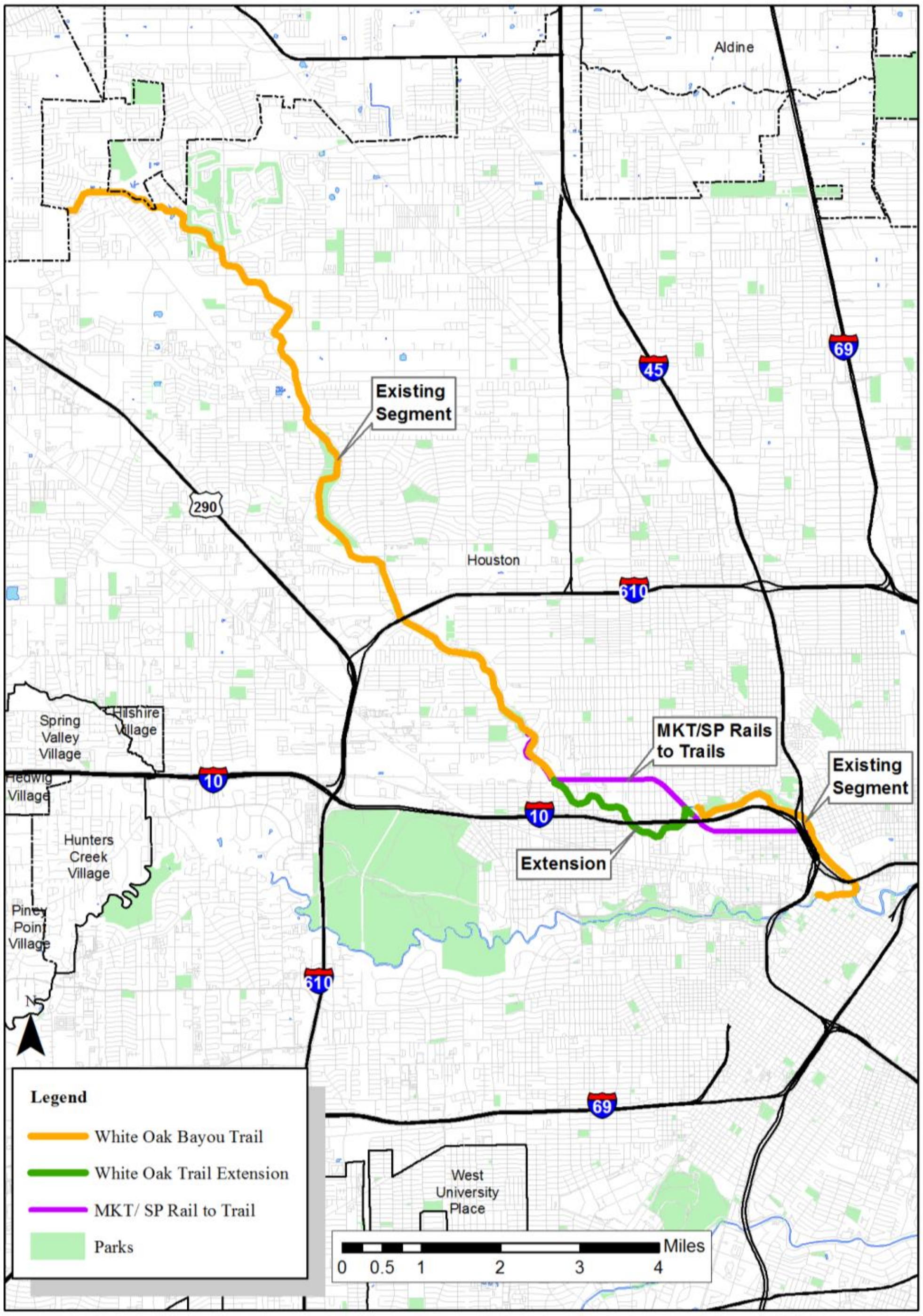
Health Impacts

Though no direct counts are available for this site, researchers estimated total annual bicyclist traffic by scaling Strava Metro counts recorded from July 2016 to June 2017, resulting in an estimate of 83 daily riders on the Lamar Street Cycle Track. Using the previously discussed methodology and assumptions and an average trip length at the approximate length of the Lamar Street Cycle Track (3/4 mile), the HEAT tool estimates 62 of the 83 daily riders derive health benefits by regularly meeting or exceeding average bicycling rates. The current annual health benefit of the Lamar Street Cycle Track is estimated at $119,000, less than the mid-point of the NCHRP 552 method (low estimate $13,223, high estimate $271,707).

White Oak Trail Extension

The White Oak Trail Extension is a two-mile extension of the White Oak Trail shared use path within the White Oak Bayou Greenway. This shared use path is located on the bank of the White Oak Bayou traveling northwest from downtown Houston. The White Oak Bayou Greenway is part of a planned greenway network aimed at redeveloping approximately 3,000 underutilized acres of land along Houston bayous. The goal of the project is to connect 150 miles of shared use paths across the city (59).

Figure 11. Location of the White Oak Trail Extension



The White Oak Bayou Greenway is approximately 15 miles long and connects several residential neighborhoods with parks and downtown from northwest Houston. The White Oak Trail Extension played a key role in connecting two large parts of the White Oak Bayou Greenway. Before completion of the recent extension project, the two existing White Oak Bayou trail segments were not connected. Instead, riders were redirected along the MKT/ SP Rail Trail (Heights Trail).

Ridership

Available counts for the White Oak Trail Extension are limited. While the White Oak Trail shared use path has two permanent counters, neither are located on the extension. However, two HGAC temporary counters, recorded pedestrian/ bicycle activity near the end points of the newly constructed section in Spring and Fall 2016. See **Table 34**.

Table 34. User Counts for White Oak Trail during March 4-14, 2016 and September 1-12, 2016

Temporary Count Location		Avg. Daily Users	Total Users
White Oak Trail at W. T.C. Jester Boulevard Underpass*			
	Spring 2016	555	6,108
	Fall 2016	459	5,510
White Oak Trail at Stude Community Center*			
	Spring 2016	452	4,968
	Fall 2016	435	5,223
Average Annual Bicyclists Estimated**			104,080

*Includes both bicycle and pedestrian users.

**Calculated by TTI researchers

Source: HGAC

Given that the bikeway was not completed until late 2017, any counts provided for the new segment are estimates based on average numbers from completed portions of the connecting bikeways on either end of the extension. These temporary counts counted both pedestrian and bicycle activity along the bikeway and did not differentiate between the two. However, these counts provided researchers with a reasonable baseline to estimate ridership for this shared-use path. Researchers used an average of the daily users between seasons to create a single daily estimate. This average was multiplied by 365 to create an annual count. Researchers then compared these derived annual user volumes to the permanent counter yearly counts that have been conducted on other segments of the White Oak Trail. These permanent count locations reported an annual total and differentiated between pedestrians and cyclists. The results showed that around 60 percent of users were bicyclists. This was applied to the total estimate, to show an estimated 104,080 cyclists annually (285 cyclists per day) along the trail. This is comparable to the counts recorded at the permanent counters at other locations along the trail (60)(61).

Construction

The project was paid for using tax increment reinvestment zone dollars administered by the Memorial-Heights Redevelopment Authority. Tax-increment reinvestment zones are designed to divert the incremental property value increases resulting from an investment. These funds are used to finance the initial investment, and additional projects within the district. According to budget documents from the Memorial-Heights Redevelopment Authority, the project cost approximately $4 million. The project started in 2015 and was completed in 2017. Researchers estimated economic impacts using these construction dollars as an input. See **Table 35**.

Table 35. White Oak Trail Extension Estimated Construction Impacts (in 2018 Dollars)

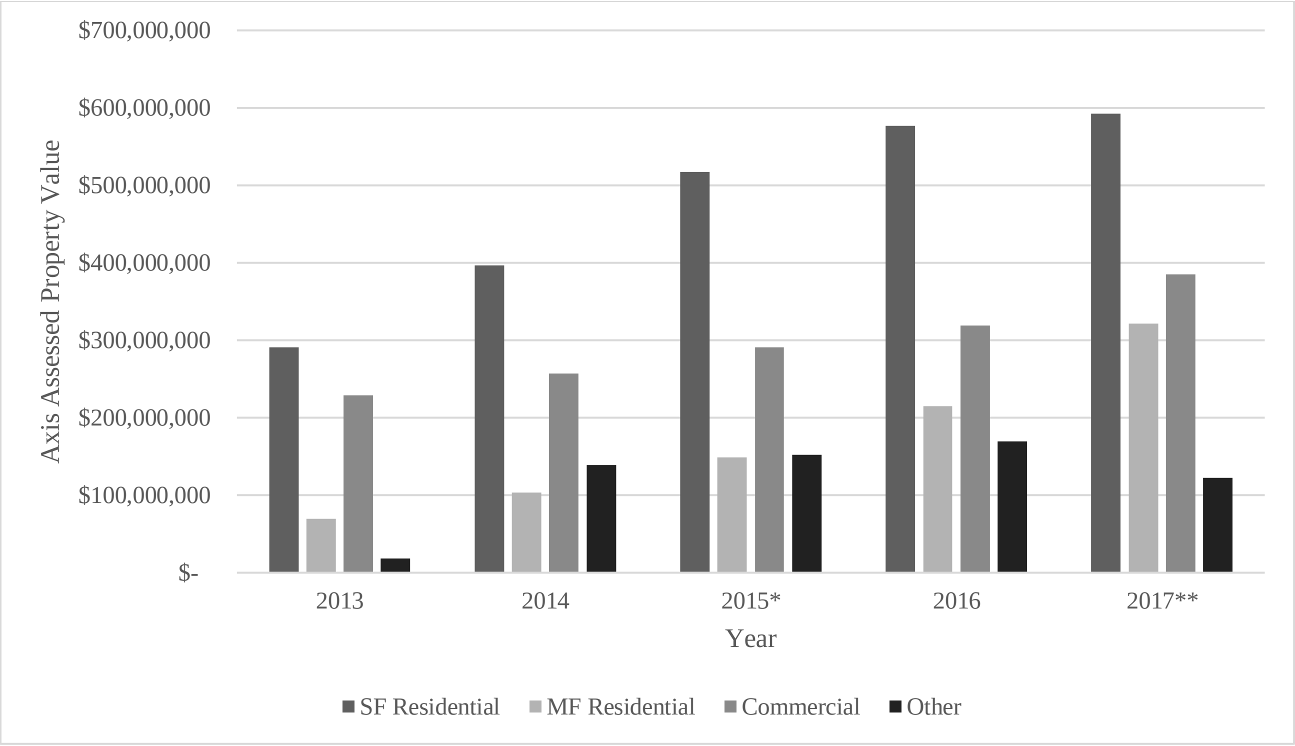
Impact Type	Employment	Labor Income ($)	Total Value Added ($)	Output ($)
Direct Effect	19.8	1,581,437	1,983,629	4,076,685
Indirect Effect	6.1	623,270	984,519	1,630,154
Induced Effect	7.6	418,064	700,145	1,131,656
Total Effect	33.5	2,622,770	3,668,293	6,838,494

Source: IMPLAN

Property Values

Property values in this area of Northwest Houston had been seeing a significant increase in the several years leading up to project completion. This area has seen consistent growth before the bikeway extension was completed. Data acquired from the Harris County Appraisal District (HCAD) reveal that single-family and multi-family residential parcels average $400,000 and $17 million respectively. It is not clear, as with other case studies, what percentage of this value is contributed by the proximity to a bikeway. There are several variables not accounted for due to lack of available data, such as value gained from proximity to existing amenities (e.g. downtown, parks, and highways, etc.). However, researchers conclude that the addition of the bikeway contributes positive trend in property values. See Figure 12. Furthermore, the bikeway increases accessibility for residents within the area, which has been shown in the literature to have positive impacts to property values.

Figure 12. Property Values Within a Quarter-Mile of the White Oak Extension Bikeway (2013-2017)



* Denotes project start year

** Denotes project completion year

Travel Cost Savings

The temporary and permanent counts provided by HGAC allowed researchers to calculate the travel cost savings for this shared use path. See **Table 36**. Like other case studies in this report, these impacts must assume that cyclists are using the bikeway for utilitarian purposes. Without an accurate mode shift percentage for the given shared use path, the results in **Table 36** are most likely overstating total impacts.

Table 36. Annual Estimated Travel Cost Savings from Use of the White Oak Trail Extension

Passenger Vehicle Trips Replaced	Passenger Vehicle VMT	Passenger Vehicle Operating Cost Savings	Fuel Cost Savings	Environmental Benefits	Safety Benefits	Total Transportation Savings
74,878	149,755	$21,515	$15,086	$1,142	$1,184	$38,928

Source: TTI analysis utilizing USDOT formulas

Health Impacts

This White Oak Trail shared use path's heavy use contributes to its health benefits with 285 riders per day (annual estimate of 104,080 bicycle users divided by 365 days). Given the same assumptions as the other cases and an average trip length spanning the 2-mile extension, the HEAT tool estimates 214 of the riders yield a health benefit from the bikeway by riding as much or more than average. The tool estimates health benefits from reduced mortality due to bicycling behavior to be $1,099,000 per year, significantly higher than estimates using the NCHRP method (low estimate $19,626, high estimate $403,276). Despite this discrepancy, the health benefit could be conservative, because this link connected previously separate sections of a path now connecting 15 miles—which likely supports an average trip length exceeding the estimate of 2 miles.

Case Study Summary

The case studies identified in this report represent a variety of project types, locations, and purposes. To identify the economic impacts and benefits of these bikeways, researchers collected a variety of data through primary and secondary sources. Communications with local agencies, appraisal data from county appraisal districts, and user counts extrapolated from Strava are some examples of the data used in this section. See **Table 37** for the summarized results.

Table 37. Case Study Impact Summary

	A-Train Rail Trail	Lamar Street Cycle Track	White Oak Trail Extension
Employment	97	3	34
Labor Income ($thousands)	$5,626.9	$212.3	$2,622.8
Total Value Added ($thousands)	$7,989.5	$297.0	$3,668.3
Total Transportation Cost Savings ($thousands)	$47.5	$4.2	$38.9
Health Benefits ($thousands)	$1,039	$119	$1,099

This analysis selected bikeways with varying purposes in varying locations. The Lamar Street Cycle Track, for example, serves a more utilitarian purpose by connecting cyclists between networks in a safe way through a highly dense downtown area. The A-Train Rail Trail and the White Oak Bayou Trail shared use paths have the potential to offer a mix of purposes with a variety of densities and property values.

Each example bikeway also shows a unique use of available land that was repurposed into a shared use path or bikeway having a positive economic impacts on the local area. This includes repurposing of railroad right-of-way, an underused travel lane within an urban setting, and floodplain. These areas, most of which had a high demand prior to bikeway construction, have been enhanced to provide more accessibility and safer travel for cyclists in the area. The benefits of these bikeways have been shown in terms of dollars added through construction and property value increases, and dollars saved through travel costs savings and healthy living where possible. Any other qualitative benefits were included where information was available.

The results show that property values, among all case studies, continued to see increases after bikeways were constructed. As stated in Section 1, the literature shows a positive correlation between bikeways and property values. The data collected and analyzed for this analysis indicated that the property values within a quarter-mile proximity of case study locations showed a positive trend. While the exact amount could not be determined, researchers can assert that these bikeways, which are an amenity to residential and commercial properties, most likely contributed to this positive trend in value. In addition, there were also gains to the local economy through this construction. The labor and materials costs generated employment opportunities and indirect and induced impacts to the local economy. These impacts were highest for the off-street projects and lower for on-street projects due to length of construction and necessary materials/ labor needs. Lastly, benefits from potential mode shifts included both reduction in travel costs, but also reduced potential health care costs through active living. These savings can be seen as additional indirect and induced impacts to the economy.

There were several assumptions and limitations of these analyses due to lack of available data and research on the habits and prevalence of bicyclists among some of the popular bikeways in the state. A common issue among these case studies, as with other research, is the lack of accurate data and measuring techniques. As such, many of the benefits of bikeways vary from location to location due to unknown or immeasurable reasons. Construction of highway facilities can be measured through volume, speed, accessibility, and safety; bicycling must take into account several more variables due to the importance of recreation in the activity. As such, participation in bicycling activities and any associated benefits are subject to demographics, weather conditions, crime and safety, bikeway types, amenities, and many other aspects that affect the overall impacts of a bikeway.

The data limitations for this analysis, however, are well known among government agencies, researchers, and bicycle professionals. During this section, researchers spoke with local officials and all demonstrated a considerable amount of interest in the analysis and the need for better bicycle and pedestrian data collection throughout the state.

This section was designed to identify the positive or negative economic impacts of the selected case studies in this research. The research shows considerable impacts in several areas, but these impacts are caveated with assumptions and limitations to the analysis. To fully identify the benefits of these bikeways, additional research must be conducted on both regional as well as statewide levels, to determine habits of Texas bicyclists at individual locations and within local bikeway networks. It will be important to determine percentage share of trip purposes and any bicycle-related spending that occurs as a direct result of the bikeway being available for use. Data in these areas could significantly increase the accuracy and scope of these analyses.

Summary and Future Research Needs

The analysis conducted by TTI researchers highlights the considerable economic impact that bicycling has on the State of Texas. Bicycling draws in thousands of users both from within the state and from other states. Both local and visiting bicyclists spend money in local economies when participating in local events, visiting specific trails, or just riding recreationally along some of the thousands of miles of bikeways across the state. In addition, sales and production of bicycle equipment, as well as the construction of new bikeway infrastructure, create jobs and spending in local economies. Further, this report touches on potential mobility impacts that could be generated through mode-shift, as well as the associated health benefits that are gained through active living.

While highlighting the large impact bicycling has on the Texas economy, this analysis has also highlighted a lack of bicycle-related data available in the State. Data is critical to the accuracy and continued study of how bicycling affects both state and local economies. Typical estimations of the economic impacts of bicycling rely heavily on primary sourced information, such as surveys from bicyclists on their spending habits and travelling tendencies. At the time of writing this report, no such research had been conducted to estimate what proportion of Texas visitors are participating in bicycling events, their amount of spending in the various sectors of the economy, and characteristics of typical bicycling trips (e.g. length, purpose). These data can lead to a more robust economic analysis and better-informed policy decisions regarding bicycle investments and their returned economic impact on local economies.

Recommendations

To obtain the data necessary to conduct a more precise estimation, researchers recommend future research in the development and administration of data collection programs, as well as the recurring study of these impacts. The purpose of this research is to obtain necessary data to fully assess the economic impact of bicycling activities and to quantify impacts from government investment in bicycle infrastructure and programs. Researchers recommend the following:

Conduct statewide and regional surveys of bicyclists to determine spending and travel habits. Existing survey instruments, including statewide economic and tourism surveys and statewide or MPO travel surveys, should consider adding questions related to bicycling. Additionally, surveys could be administered at various bikeways and events across the state to better understand tourism and spending impacts to local economies. In addition, surveys should be used to determine what percentage of trips at various types of bikeways (e.g. bike lane, shared use path, off-road trail) are utilitarian, and what percentage are recreational. These data will help determine impacts to local economies and costs savings through mode switch.

Explore cost-effective means of bicycle counting programs, especially for rural communities. A limitation of this analysis was that rural case study projects often did not have any meaningful counting programs. This limited potential projects to examine, and subsequently, the size of communities being studied. Creating a model framework for conducting bicycle counts in smaller cities can better inform policy makers of the benefits of bicycle infrastructure investment, and allow for more robust impact analyses.

Reassess economic impacts of bicycling biennially to assess trends and ensure continuous data collection. Researchers recommend that these types of studies be conducted every two years so that policy makers and agencies can fully assess trends and needs in the industry. In addition, the regular reoccurrence of these studies helps ensure that data collection efforts are ongoing and consistent.

Improve documentation of bicycle-related construction costs. A lack of differentiation of bicycle-related infrastructure constructed as part of larger roadway improvements was a limiting factor in the selection of case studies and the depth of statewide analyses. Improved tracking of bicycle-related infrastructure investments in existing state databases can improve estimation of project-level and systemwide cost-benefit ratios.

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Appendix A: Mobility Analysis Results Tables

Table 38. Austin Delay Reduction by Percent Mode Shift to Bicycling.

Delay Reduction (%) by Percent Mode Shift to Bicycling

City	Road Name	To	From	1%	2%	3%	4%	5%	10%
Austin/ Round Rock	N Lamar Blvd	W Cesar Chavez St / SL 343	W 45th St	7.2%	7.3%	7.4%	7.5%	7.7%	8.1%
		W 45th St	US 183	6.0%	6.1%	6.2%	6.4%	6.5%	6.8%
	FM 1325	McNeil Merriltown Road	SH 45	6.1%	6.1%	6.1%	6.1%	6.1%	6.1%
	Southwest Pkwy	S MoPac Expy / SL 1	SH 71	4.6%	4.6%	4.6%	4.6%	4.6%	4.6%
	RM 2222	IH 35	MoPac Expy / SL1	2.3%	2.7%	3.2%	3.6%	4.1%	6.2%
		MoPac Expy / SL1	N Capital of Texas Hwy/ SL 360	0.9%	1.8%	2.6%	3.5%	4.3%	7.9%
	Brodie Ln	Aspen Creek Pkwy	US 290 / SH 71	2.5%	2.8%	3.0%	3.2%	3.5%	4.6%
	S 1st St	Ben White Blvd / US 290 / SH 71	Cesar Chavez St / SL 343	2.2%	2.5%	2.8%	3.1%	3.3%	4.5%
	W William Cannon Dr	IH 35	S MoPac Expy / SL 1	2.2%	2.5%	2.8%	3.0%	3.3%	4.7%
	Duval Rd / Burnet Rd / FM 1325	US 183 (Burnet Rd)	US 183 (Seton Center)	1.7%	3.4%	5.1%	6.8%	8.5%	16.0%
	Riverside Dr	E Ben White Blvd / SH 71	Lamar Blvd / SL 343	1.6%	1.9%	2.2%	2.4%	2.7%	3.8%
	Manchaca Rd	W William Cannon Dr	S Lamar Blvd / SL 343	1.5%	1.8%	2.1%	2.4%	2.7%	3.7%
	Wells Branch Pkwy	S Heatherwilde Blvd	MoPac Expy / SL1	1.5%	2.3%	3.2%	4.0%	4.9%	9.0%
	FM 969	FM 973	Ed Bluestein Blvd / US 183	1.3%	1.9%	2.6%	3.2%	3.9%	7.1%
	E Parmer Ln / FM 734	Manor Expy / US 290	IH 35	1.0%	1.6%	2.2%	2.8%	3.4%	6.3%
	W Whitestone Blvd / RM 1431	Toll Rd 183A / SH 183A	Nameless Rd / FM 2243	0.9%	1.6%	2.2%	2.9%	3.3%	5.7%
	Burnet Rd	W 38th St	US 183	0.8%	1.3%	1.7%	2.2%	2.7%	4.7%
	Hunter Rd / FM 2439	IH 35 (Hopkins St)	McCarty Ln	0.8%	1.6%	2.4%	3.2%	4.0%	7.8%
	Spicewood Spring / Anderson	N Lamar Blvd / SL 275	N Capital of Texas Hwy / SL 360	0.7%	1.0%	1.2%	1.5%	1.8%	2.9%
	W Slaughter Ln	IH 35	Brodie Ln	0.7%	1.3%	2.0%	2.7%	3.3%	6.6%
	W Parmer Ln / FM 734	IH 35	SH 45	0.5%	1.0%	1.7%	2.3%	2.9%	6.0%
	Dessau Rd / FM 685	E Parmer Ln / FM 734	SH 130 / SH 45	0.5%	1.0%	1.5%	2.0%	2.5%	3.3%
	Cesar Chaves St / SL 343	IH 35	S MoPac Expy / SL 1	0.5%	1.0%	1.5%	2.0%	2.4%	4.8%
	Airport Blvd /SL 111	Bluestein Blvd / US 183	IH 35 / US 290	0.5%	0.9%	1.4%	2.0%	2.5%	5.1%
	Barton Springs Rd	S Congress Ave	S MoPac Expy / SL 1	0.4%	0.7%	1.1%	1.4%	1.8%	2.7%
	Williams Dr	IIH 35	FM 3405	0.3%	0.6%	1.0%	1.3%	1.6%	2.6%
	S Lamar Blvd / SL 343	US 290 / SH 71	W Cesar Chavez St	0.3%	0.6%	1.0%	1.3%	1.6%	3.9%
	Bee Cave Rd / RM 2244	S MoPac Expy / SL 1	S Capital of Texas Hwy / SL 360	0.3%	0.5%	0.8%	1.1%	1.3%	2.7%

Table 39: Dallas/Fort Worth Delay Reduction by Percent Mode Shift to Bicycling.

Delay Reduction (%) by Percent Mode Shift to Bicycling

City	Road Name	To	From	1%	2%	3%	4%	5%	10%
Dallas/ Fort Worth	W Parker Rd	Coit Road / FM 544	Oak Hollow Dr	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%
	Greenville Ave	Northwest Hwy / SL 12 N	Belt Line Road / Main St	5.9%	5.9%	5.9%	5.9%	5.9%	5.9%
	Spring Valley Rd	S Coit Rd	Marsh Ln	5.4%	5.5%	5.5%	5.5%	5.5%	5.5%
	Preston Rd / SH 289	Mockingbird	IH 635	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%
	Lemmon Ave	N Haskell Road	W Northwest Hwy / SL 12 N	5.3%	5.3%	5.3%	5.3%	5.3%	5.3%
	Irving Blvd / SH 356	Walton Walker Blvd / SL 12 W	Airport Fwy / SH 183	5.3%	5.3%	5.3%	5.3%	5.3%	5.4%
	Bryant Irvin Rd	Dirks Rd	SH 183	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%
	Berry St	Riverside Dr / BU 287P	University Dr	4.7%	4.7%	4.7%	4.7%	4.7%	4.7%
	FM 2499	SH 121 / SH 26	Cross Timbers Rd / FM 1171	4.6%	4.9%	5.1%	5.2%	5.3%	5.9%
	Josey Ln	Lyndon B Johnson / IH 635	President George Bush Turnpike Toll Rd	4.1%	4.3%	4.4%	4.6%	4.8%	4.8%
	Singleton Blvd	N Beckley Ave	S Walton Walker Blvd / SL 12 W	4.1%	4.2%	4.4%	4.5%	4.5%	4.5%
	Belt Line Rd	N Glenbrook Dr	US 75	3.5%	3.9%	4.3%	4.6%	5.0%	6.7%
	McCart Ave	Cayman Dr	IH 20	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%
	Cooper St / FM 157	BU 287P	IH 20	1.5%	1.9%	2.4%	2.8%	3.3%	5.4%
		IH 20	W Division St / SH 180	1.2%	1.5%	1.7%	2.0%	2.2%	3.5%
	N Beach St	Airport Fwy / SH 121	Northeast Loop 820 / IH 820	2.6%	2.8%	3.0%	3.2%	3.3%	4.3%
	Midway Rd	Lyndon B Johnson / IH 635	W Parker Rd	2.2%	2.6%	3.0%	3.4%	3.7%	5.5%
	Ovilla Rd / FM 664	US 287	IH 35E / US 77 (Plaza Dr)	2.2%	2.9%	3.6%	4.3%	5.0%	8.1%
	Oaklawn Ave	Irving Blvd	Mockingbird	1.9%	2.2%	2.6%	2.9%	3.2%	4.7%
	Arapaho Rd	US 75	Surveyor Blvd	1.9%	2.1%	2.1%	2.1%	2.1%	2.1%
	Crowley Plover Rd / FM 1187	IH 35W	BF 1187C	1.8%	2.1%	2.3%	2.6%	2.8%	3.2%
	S Hulen St	W Risinger Rd	IH 20	1.7%	2.0%	2.3%	2.6%	2.8%	4.2%
	Collins St	Southeast Pkwy	Pioneer Pkwy / SH 303	0.6%	1.1%	1.6%	2.1%	2.6%	4.9%
		Pioneer Pkwy / SH 303	Tom Landry Fwy / IH 30	0.4%	0.8%	1.2%	1.6%	2.0%	3.8%
	Boat Club Rd / FM 1220	Jacksboro Hwy / SH 199	Bailey Boswell Rd	1.0%	1.7%	2.4%	3.1%	3.8%	7.1%
	Western Center Blvd	Denton Hwy / US 377	S Blue Mound Rd / FM 156	0.9%	1.1%	1.3%	1.5%	1.7%	2.7%
	Rufe Snow Dr	Sue Dr	Hightower Rd	0.9%	1.3%	1.8%	2.2%	2.6%	4.7%
	Inwood Rd	Stemmons Fwy / IH 35E/ US 77	Northwest Hwy / SL 12 N	0.7%	1.4%	2.1%	2.8%	3.5%	6.8%
	Collins St / FM 157	Tom Landry Fwy / IH 30	Airport Fwy / SH 183	0.7%	1.3%	2.0%	2.6%	3.3%	6.5%
	N Tarrant Parkway	Denton Hwy / US 377	US 81 / US 287	0.6%	1.1%	1.6%	2.2%	2.7%	5.3%
	S Buckner Blvd / SL 12 E	C F Hawn Fwy / US 175	E R L Thornton Fwy / IH 30 / US 67	0.5%	1.0%	1.5%	1.9%	2.4%	4.8%
	Matlock Rd	W Sublett Rd	S Cooper St / FM 157	0.5%	1.0%	1.4%	1.9%	2.4%	4.7%
	Coit Rd	Forest Lane	Frankford Rd	0.5%	0.9%	1.4%	1.9%	2.3%	4.8%
	Mockingbird Ln	N Buckner Blvd / SL 12 E	US 75	0.4%	0.9%	1.3%	1.7%	2.2%	3.8%
	FM 544	SH 78	Dublin Rd	0.4%	0.9%	1.3%	1.7%	2.1%	4.1%
	W Risinger Rd	IH 35W	Crowley Rd / FM 731	0.3%	0.6%	0.9%	1.1%	1.4%	2.3%

Table 40: Houston Delay Reduction by Percent Mode Shift to Bicycling.

Delay Reduction (%) by Percent Mode Shift to Bicycling

City	Road Name	To	From	1%	2%	3%	4%	5%	10%
Houston/ Woodlands/ Sugarland	Wilcrest Dr	Southwest Fwy / US 59	Westpark Tollway	13.6%	13.6%	13.6%	13.6%	13.6%	13.6%
	Fairbanks N Houston	Northwest Fwy / US 290	Sam Houston Tollway NW	8.2%	8.2%	8.2%	8.2%	8.2%	8.2%
	Westpark Dr	Kirby Dr	Synott Rd	7.5%	7.5%	7.5%	7.5%	7.5%	7.6%
	Victory Dr	W Little York Road (Shepherd Dr)	W Little York Road (Alabonson Rd)	7.4%	7.4%	7.4%	7.4%	7.4%	7.4%
	W Little York Rd	Alabonson Rd	Northwest Fwy/ US 290	7.1%	7.1%	7.1%	7.1%	7.1%	7.1%
	Hillcroft Ave	S Main St /UA 90	Southwest Fwy/ IH 69/ US 59	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%
	Blalock Rd	Katy Fwy / IH 10 / US90	Northwest Fwy/ US 290	6.2%	6.2%	6.2%	6.2%	6.2%	6.2%
	Galveston Rd / SH3	El Dorado Blvd	Sam Houston Tollway SE	6.2%	6.2%	6.2%	6.2%	6.2%	6.2%
	W Bellfort St	S Post Oak Rd	Sam Houston Tollway SW	5.9%	5.9%	5.9%	5.9%	5.9%	5.9%
	S Fry Road	Westheimer Pkwy	Katy Fwy / IH 10 / US 90	5.5%	5.6%	5.8%	6.0%	6.1%	6.9%
	Briar Forest Dr	Sam Houston Tollway SW	SH 6	5.2%	5.3%	5.3%	5.3%	5.3%	5.3%
	Alvin Bypass / SH 35	S Gordon St / BS 35C	N Gordon St / BS 35C	4.9%	4.9%	4.9%	4.9%	5.0%	5.0%
	Beechnut St	Sam Houston Tollway SW	Winkleman Dr	4.5%	4.6%	4.7%	4.7%	4.8%	5.1%
	JFK Blvd	N Sam Houston Pkwy E / SL 8	Will Clayton Parkway	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%
	Gessner	Southwest Fwy / IH 69 / US 59	Katy Fwy / IH 10/ US90	4.0%	4.1%	4.3%	4.5%	4.6%	5.4%
	N Mason Rd	Katy Fwy / IH 10/ US90	Clay Rd	3.3%	3.5%	3.7%	3.8%	4.0%	4.8%
	S Braeswood Blvd	West Loop S/ IH 610	Bissonnet St	3.3%	3.5%	3.8%	4.0%	4.2%	5.1%
	Wirt Rd / Chimney Rock Rd	Southwest Fwy / IH 69 / US 59	Kempwood Dr	3.2%	3.4%	3.7%	3.9%	4.1%	5.3%
	Murphy Rd / FM 1092	SH 6	Southwest Fwy/ US 59	3.0%	3.2%	3.4%	3.6%	3.8%	4.7%
	Briar Forest Dr / San Felipe St	West Loop S/ IH 610	Sam Houston Tollway W	2.6%	2.9%	3.1%	3.3%	3.5%	4.4%
	Memorial Dr	Sam Houston Tollway NW	SH 6	2.6%	2.8%	3.0%	3.2%	3.4%	3.8%
	Kuykendahl Rd	FM 2920	Lake Woodlands Dr	2.3%	2.7%	3.1%	3.5%	3.9%	5.2%
	Richmond Ave	West Loop S/ IH 610	Sam Houston Tollway W	2.2%	2.6%	3.0%	3.4%	3.8%	5.3%
	Main St / Marina Bay Dr	SH 146	Gulf Fwy/ IH 45	2.1%	2.4%	2.6%	2.9%	3.2%	4.4%
	SH Nasa Pkwy	Space Center Blvd	Gulf Fwy / IH 45	2.0%	3.3%	4.7%	6.1%	7.5%	14.5%
	Aldine Westfield Rd	Farrell Rd	Spring Stuebner Rd	1.9%	2.2%	2.4%	2.7%	2.9%	4.1%
	Kingwood Dr	Mills Branch Dr	Sorters Rd	1.9%	2.3%	2.6%	3.0%	3.3%	5.0%
	Clay Rd	Northwest Fwy/ US 290	Sam Houston Tollway W	1.8%	2.1%	2.5%	2.8%	3.1%	4.7%
	Almeda Rd / FM 521	Sam Houston Tollway SW	S Loop W Fwy / IH610	1.3%	1.8%	2.3%	2.8%	3.2%	4.7%
	Stuebner Airline Rd	Cypress Creek Pkwy / FM 1960	Spring Cypress Rd	1.3%	1.6%	1.9%	2.2%	2.5%	4.0%
	Spears Rd / Antoine Dr	Sam Houston Tollway NW	North Fwy / IH 45	1.3%	1.7%	2.1%	2.5%	2.9%	5.1%
	Northpark Dr	Mills Branch Dr	Sorters Rd	1.2%	1.7%	2.1%	2.6%	3.0%	5.3%
	N Main St	Texas Ave	W Cedar Bayou Lynchburg	1.1%	1.3%	1.3%	1.3%	1.3%	1.3%
	Genoa Red Bluff Rd	Red Bluff Road	Sam Houston Tollway SE	1.1%	2.2%	3.4%	4.5%	5.6%	10.9%
	Spencer Rd / FM 529	Northwest Fwy / US 290	SH 6	1.1%	1.8%	2.6%	3.3%	4.1%	7.7%
	FM 1488	FM 2978	FS 149	1.1%	2.2%	3.2%	4.3%	5.3%	10.4%
	Will Clayton Pkwy	Atascocita Rd	John F. Kennedy Boulevard	1.1%	2.1%	3.2%	4.2%	5.2%	9.6%
	Grogans Mill Rd	North Fwy / IH 45	Research Forest	1.0%	1.4%	1.9%	2.3%	2.8%	5.0%
	Waller-Tomball Rd / FM 2920	SH 249	Cypress Rosehill Rd	0.9%	1.8%	2.7%	3.5%	4.4%	8.6%

Table 41. Houston Delay Reduction by Percent Mode Shift to Bicycling. (Continued)

City	Road Name	To	From	1%	2%	3%	4%	5%	10%
	FM 518	Parkwood Dr / FM 528	S Main St /SH 35	0.5%	1.0%	1.5%	2.0%	2.4%	4.8%
		S Main St /SH 35	South Fwy / SH 288	0.4%	0.7%	1.1%	1.4%	1.8%	3.5%
	Research Forest	North Fwy / IH 45	Branch Crossing Drive	0.9%	1.3%	1.8%	2.2%	2.7%	4.9%
	Barker Cypress	Katy Fwy / IH 10 / US 90	Clay Rd	0.8%	1.5%	2.2%	2.8%	3.5%	6.8%
	Edgebrook Dr / Fairmont Pkwy	East Sam Houston Pkwy S / SL 8	Almeda Genoa Rd	0.8%	1.6%	2.3%	3.0%	3.8%	7.4%
	Dairy Ashford	Aleif Clodine Road	N Eldridge Pkwy	0.8%	1.3%	1.7%	2.2%	2.6%	4.7%
	Gosling Road	Flintridge Dr	College Park Dr / SH 242	0.7%	1.4%	2.1%	2.8%	3.5%	7.2%
	Montrose Blvd	Main St	N Main St	0.7%	1.0%	1.4%	1.8%	2.1%	3.9%
	N Fry Rd	Katy Fwy / IH 10 / US90	FM 529	0.6%	1.3%	1.9%	2.5%	3.1%	6.1%
	Woodlands Parkway	North Fwy / IH 45	FM 2978	0.6%	1.2%	1.7%	2.3%	2.9%	5.6%
	S Post Oak Rd	FM 2234	S Loop W Fwy / IH610	0.5%	1.0%	1.4%	1.9%	2.4%	4.9%
	Woodway Dr	Memorial Drive	S Voss Road	0.5%	0.9%	1.4%	1.9%	2.3%	4.6%
	Westheimer Rd / FM 1093	Sam Houston Tollway W	SH 6	0.4%	0.9%	1.3%	1.7%	2.2%	4.3%
	Garth Rd	Decker Dr	East Fwy / IH 10	0.4%	0.7%	1.0%	1.4%	1.7%	3.3%
	Main St	Old Spanish Trail / UA 90	Southwest Fwy / US 59 (Blodgett St)	0.3%	0.6%	0.9%	1.2%	1.5%	1.9%
	Voss Rd / Hillcroft Ave	Southwest Fwy/ IH 69/ US 59	Katy Fwy/ IH 10/US 90	0.3%	0.6%	0.9%	1.2%	1.5%	2.9%

Table 42. West Texas Delay Reduction by Percent Mode Shift to Bicycling

Delay Reduction (%) by Percent Mode Shift to Bicycling

City	Road Name	To	From	1%	2%	3%	4%	5%	10%
Amarillo	Buchanan St / US 60 / US 287	IH 40 / US 287	Amarillo Blvd / IH 40 B / US 60	4.9%	5.0%	5.2%	5.3%	5.4%	6.0%
El Paso	Horizon Blvd / FM 1281	Ascencion St	Darrington Rd	3.6%	3.8%	3.9%	4.1%	4.2%	4.8%
		Darrington Rd	Gateway Blvd / IH 10	1.3%	2.6%	3.9%	5.2%	6.4%	12.4%
	Zaragoza Rd	Gateway Blvd / IH 10	Waterfill	3.5%	4.5%	5.4%	6.3%	7.2%	11.5%
	Montwood Dr	Lee Trevino Dr	Viscount Blvd	1.6%	2.0%	2.4%	2.8%	3.2%	5.1%
		FM 659	Lee Trevino Dr	1.2%	1.6%	2.0%	2.4%	2.8%	4.9%
	N Yarbrough Dr	Gateway Blvd / IH 10	Montana Ave / US 180 / US 62	2.4%	2.7%	3.1%	3.4%	3.7%	5.3%
	Montana Ave / US 180 / US 62	Global Reach Dr	Gateway Blvd / IH 10	1.4%	2.1%	2.8%	3.4%	4.1%	7.3%
	Sunland Park Dr	N Mesa St / SH 20	Montoya Drain	1.2%	1.6%	1.9%	2.2%	2.6%	4.2%
	George Dieter Dr	N Zaragosa Rd / FM 659	Montwood Dr	0.9%	1.7%	2.5%	3.4%	4.2%	8.2%
	Resler Dr	CanAm Hwy / IH 10/ US 180	Redd Rd	0.7%	1.4%	2.1%	2.8%	3.5%	6.9%
	N Mesa St / SH 20	Texas Ave	Executive Center Blvd	0.4%	0.7%	1.1%	1.4%	1.8%	3.3%
Midland	SH 191	SH 349 / FM 1788	Faudree Rd /SS 588	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	SL 250 (N)	N County Rd 1150	N Big Sprint St / BS 349C	3.3%	5.7%	8.1%	10.4%	12.4%	20.4%
Odessa	8th St	BI 20 E	N Dixie Blvd	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%
	SH 191	Faudree Rd /SS 588	Preston Smith Rd	3.8%	3.9%	4.1%	4.2%	4.4%	5.1%

Table 43: San Antonio Delay Reduction by Percent Mode Shift to Bicycling.

Delay Reduction (%) by Percent Mode Shift to Bicycling

City	Road Name	To	From	1%	2%	3%	4%	5%	10%
San Antonio	Exkhert Rd / FM 1517	Babcock Rd	Bandera Rd / SH 16	11.6%	11.6%	11.6%	11.6%	11.6%	11.6%
	Wetmore Rd	Connally Loop N / IH 410	Thousand Oaks Dr	8.2%	8.2%	8.2%	8.2%	8.2%	8.2%
	Connally Loop SE / IH 410	Lucian Adams Fwy / IH 37 / US 281	Rigsby Ave / US 87	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%
	Huebner Rd	Bandera Rd / SH 16	Charles West Anderson Loop / SL 1604 N	6.1%	6.4%	6.7%	7.0%	7.3%	8.6%
	Fredericksburg Rd / SL 345	Connally Loop NW / IH 410	McDermott Fwy / IH 10 / US 87 (Northwest Pkwy)	4.6%	4.6%	4.6%	4.6%	4.6%	4.6%
	Broadway St	Austin Hwy	IH 35	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%
	Military Dr / SL 13	IH 37	S PanAm Expy / IH 35 / IH 10	2.9%	3.0%	3.0%	3.1%	3.2%	3.6%
	Wurzbach	Connally Loop W /IH 410 / SH16	Blanco Rd / FM 2696	2.5%	2.9%	3.2%	3.6%	3.9%	5.6%
	Walzem Rd / FM 1976	Sequin Rd / FM 78	Austin Hwy / SL 368	2.5%	2.8%	3.2%	3.5%	4.0%	6.2%
	Bitters Rd	Starcrest Drive	Charles West Anderson Loop / SL 1604 N	1.5%	2.3%	3.1%	3.8%	4.8%	10.1%
	Old Seguin Rd / SH 46	IH 10 (Seguin Rd)	IH 35	1.5%	2.0%	2.5%	3.0%	3.5%	5.8%
	Rittman _ N Foster Rd	IH 10 / US 90	N PanAm Expy / IH 35 / IH 410	1.3%	1.9%	2.4%	2.9%	3.4%	5.9%
	De Zavala Rd	FM 1535	Babcock Road	1.0%	1.5%	1.9%	2.3%	2.7%	4.8%
	Wurzbach Pkwy / Starcrest Dr	N PanAm Expy / IH 35	Bitters Rd	1.0%	1.9%	2.8%	3.4%	3.8%	5.5%
	Seguin Rd / FM 78	Connally Loop E / IH 410	Charles West Anderson Loop / SL 1604 E	0.7%	1.5%	2.2%	2.9%	3.6%	7.0%
	Tezel Rd	Culebra Rd / FM 471	Bandera Rd / SH 16	0.7%	1.1%	1.1%	1.1%	1.1%	1.1%
	Blanco Rd / FM 2696	Connally Loop N / IH 410	Charles West Anderson Loop / SL 1604 N	0.6%	1.1%	1.7%	2.3%	2.8%	5.5%
	FM 471	Bandera Rd / SH 16	Charles West Anderson Loop / SL 1604 NW	0.5%	1.1%	1.7%	2.2%	2.7%	5.4%
	Potranco Rd / FM 1957	Raymond E. Stotzer Jr Fwy / SH 151	Talley Rd	0.4%	0.7%	1.0%	1.4%	1.7%	3.4%
	Bandera Rd / SH 16	Connally Loop NW / IH 410	FM 1560	0.4%	0.7%	1.1%	1.4%	1.7%	3.4%
	Stone Oak Parkway	Charles West Anderson Loop / SL 1604 N	US 281	0.3%	0.7%	1.0%	1.4%	1.7%	3.4%
	Culebra Rd / FM 3487	Connally Loop W / IH 410	FM 471	0.3%	0.6%	0.9%	1.2%	1.5%	1.9%

Table 44: Central Texas Delay Reduction by Percent Mode Shift to Bicycling.

Delay Reduction (%) by Percent Mode Shift to Bicycling

City	Road Name	To	From	1%	2%	3%	4%	5%	10%
College Station-Bryan	Harvey Mitchell Pkwy / FM2818	George Bush Dr /FM 2347	SH 21	3.1%	3.6%	4.1%	4.5%	5.0%	7.2%
	George Bush Dr / FM 2347	S TX Ave/ BS6R	Harvey Mitchell Pkwy / S FM 2818	2.8%	3.0%	3.2%	3.3%	3.5%	4.4%
	Villa Maria Rd _ Briarcrest Dr	Boonville Rd/ FM 158	N Harvey Mitchell Pkwy / FM2818	2.7%	2.9%	3.1%	3.2%	3.4%	4.2%
	S TX Ave / BS6R	Earl Rudder / SH 6 (Deacon Dr)	E Villa Maria	1.1%	1.6%	2.2%	2.6%	3.1%	5.3%
	Wellborn Rd / FM 2154	William D. Fitch Pkwy / SH 40	University Dr / FM 60	0.9%	1.2%	1.4%	1.7%	2.0%	3.3%
	University Dr / FM 60	Earl Rudder / SH 6	SH 47	0.8%	1.1%	1.5%	1.8%	2.1%	3.5%
Corpus Christi	Everhart Rd	Yorktown Blvd	S Alameda St	1.6%	1.8%	1.9%	2.1%	2.3%	2.8%
	Agnes St / SH 44	Padre Island Dr / SH 358	FM 3386	1.3%	2.1%	2.8%	3.3%	3.7%	5.1%
	S Staples St	Yorktown Blvd	S Padre Island Dr / SH 358	0.4%	0.7%	1.1%	1.5%	1.8%	3.6%
Killeen/Temple	Stan Schlueter Loop	E Central TX Expy / US 190	S Clear Creek Rd / SH 201	2.3%	2.7%	3.1%	3.5%	3.9%	5.8%
Sherman-Denison	Texas 306 Loop / SH 306	S Bryant Blvd / US 277/ US 87	Sherwood Way/ BU 67	2.6%	2.6%	2.6%	2.6%	2.6%	2.6%
Texarkana	Richmond Rd / FM 559	Summerhill Rd / SH 93	IH 30 / US 59	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%
Tyler	S Beckham Ave / TX 155	E Southeast Loop 323	E Front St / SH 31	0.5%	0.8%	1.1%	1.2%	1.2%	1.2%
Waco	Hewitt Dr/ FM 1695	Sun Valley Blvd / FM 2063	Woodway Dr / US 84	3.7%	3.8%	4.0%	4.1%	4.2%	4.9%

Table 45: Texas Border Area Delay Reduction by Percent Mode Shift to Bicycling.

Delay Reduction (%) by Percent Mode Shift to Bicycling

City	Road Name	To	From	1%	2%	3%	4%	5%	10%
Brownsville/ Harlingen	N ED Carey Dr / SL 499	IH 69E / US 83 / US 77	Grimes Ave	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%
	E Ruben M Torres Sr Blvd / FM 802	Padre Island Hwy / E 14th St / SH 48	Old Port Isabel Rd	0.6%	1.3%	1.9%	2.6%	3.2%	6.3%
		Old Port Isabel Rd	IH 69E / US 83 / US 77	0.4%	0.8%	1.2%	1.6%	2.0%	3.9%
El Paso	Horizon Blvd / FM 1281	Ascencion St	Darrington Rd	3.6%	3.8%	3.9%	4.1%	4.2%	4.8%
		Darrington Rd	Gateway Blvd / IH 10	1.3%	2.6%	3.9%	5.2%	6.4%	12.4%
	Zaragoza Rd	Gateway Blvd / IH 10	Waterfill	3.5%	4.5%	5.4%	6.3%	7.2%	11.5%
	Montwood Dr	Lee Trevino Dr	Viscount Blvd	1.6%	2.0%	2.4%	2.8%	3.2%	5.1%
		FM 659	Lee Trevino Dr	1.2%	1.6%	2.0%	2.4%	2.8%	4.9%
	N Yarbrough Dr	Gateway Blvd / IH 10	Montana Ave / US 180 / US 62	2.4%	2.7%	3.1%	3.4%	3.7%	5.3%
	Montana Ave / US 180 / US 62	Global Reach Dr	Gateway Blvd / IH 10	1.4%	2.1%	2.8%	3.4%	4.1%	7.3%
	Sunland Park Dr	N Mesa St / SH 20	Montoya Drain	1.2%	1.6%	1.9%	2.2%	2.6%	4.2%
	George Dieter Dr	N Zaragosa Rd / FM 659	Montwood Dr	0.9%	1.7%	2.5%	3.4%	4.2%	8.2%
	Resler Dr	CanAm Hwy / IH 10/ US 180	Redd Rd	0.7%	1.4%	2.1%	2.8%	3.5%	6.9%
	N Mesa St / SH 20	Texas Ave	Executive Center Blvd	0.4%	0.7%	1.1%	1.4%	1.8%	3.3%
Laredo	Mines Rd / FM1472	IH 35 / US 83	Bob Bullock Loop / SL 20	6.4%	6.4%	6.4%	6.4%	6.5%	6.5%
	SH 359	Willcox Rd	Bob Bullock Loop / SL 20	5.5%	5.5%	5.5%	5.5%	5.5%	5.5%
	Saunders St / US 59	E Del Mar Blvd	IH 35 / US 83	1.5%	1.8%	2.2%	2.6%	3.0%	4.7%
McAllen/ Edinburg/ Mission	10th St	IH 2 / US 83	Dove Ave	2.6%	2.8%	3.0%	3.1%	3.3%	3.7%
	23rd Rd St / SS 115	US - Mexico border	IH 2 / US 83	2.2%	2.5%	2.7%	3.0%	3.2%	3.5%
	Jackson Rd	Military Hwy / US 281	IH 2 / US 83	1.9%	2.3%	2.7%	3.1%	3.5%	5.4%
	Nolana St	N Alamo Rd / FM 907	Ware Rd / FM 2220	1.1%	1.7%	2.3%	2.9%	3.4%	6.3%
	Conway Ave / SH 107	Buddy Owens Blvd / FM 1924	IH 2 / US 83	0.9%	1.2%	1.6%	1.9%	2.2%	3.8%
	Ware Rd /FM 2220	IH 2 / US 83	Buddy Owens Blvd	0.9%	1.3%	1.3%	1.3%	1.4%	1.6%
	Trenton Rd	IH 69C / US 281	N 23rd St / FM 1926	0.4%	0.9%	1.3%	1.8%	2.2%	4.3%
	McColl Rd	IH 2 / US 83	Trenton Rd	0.3%	0.6%	0.8%	0.8%	0.8%	0.8%

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