TRC1904

Developing an Evidence-Based Framework for Bypass and Widening Projects and the Effects on Communities

Sarah Hernandez
Mervin Jebaraj
Muhammad Saifur Rahman

Department of Civil Engineering
University of Arkansas

Final Report

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By
Sarah Hernandez
Principal Investigator
College of Engineering, Department of Civil Engineering

Magdalena Asborno
Sanjeev Bhurtyal
Karla Diaz-Corro
Graduate Research Assistants

Leyla Coronel
Elizabeth Francis
Madeline Giebler
Lizbeth Juarez
Undergraduate Research Assistants

College of Engineering, Department of Civil Engineering

May 2021

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16. Abstract

This research examines the impacts of highway bypass, widening, and no-improvement projects on the economic and safety conditions of small towns in Arkansas. This research provides evidence-based comparisons of bypass, widening, and no-improvement projects in Arkansas that can be used to support the public outreach and community decision making processes. Through a case study approach, the impacts under varied project settings are assessed and measured. The study sites include five bypass locations, two widening projects, and two no-improvement locations. For regional economic impact estimation, the research project applied an IMPLAN model and compared it to the EconWorks Assess My Project Tool. Bypass study sites had a slightly higher median employment, labor income, value added, output, and tax revenue generated than widening sites. Comparing the EconWorks and IMPLAN estimates for direct jobs shows errors of up to 1,008%. Therefore, a "simplified methodology" that uses the IMPLAN results but does not require IMPLAN analysis or detailed data was developed to estimate impacts for future project sites in Arkansas.

To compliment the regional economic impact analyses, statistical and econometric approaches were implemented including time series regression and matched city comparisons. For bypass study sites, the statistical analyses support the conclusion that bypass projects cause a statistically significant increase in the per capita GDP for real estate and rentals, per capita GDP overall, and the number of establishments in the city. Weaker evidence was found to support the statistical significance of bypass projects causing increases in sales tax revenue, population density, home price, per capita GDP for retail, and the number of employees in the city. The perceived economic impacts generated from interviews with local residents tended to agree with the estimated impacts resulting from the economic impact analyses, but, in most cases, residents did not attribute the economic changes to the bypass or widening projects. For bypass study sites, the statistical analysis of crash rates shows that the crash rates pre-and post- bypass completion were not statistically different in the majority of sites. For widening projects, a significant effect on crash rates was found relative to statewide averages but not relative to their own historical patterns.

The research products generated from this project include the development of seven case studies in a format that can be submitted to the EconWorks Assess My Project Database and used for public hearing meetings for future projects.

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METRIC CONVERSIONS

SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
	NOTE: volumes greater than 1000 L shall be shown in m^3			
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
^oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^oC
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
^oC	Celsius	1.8C+32	Fahrenheit	^oF
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

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ABBREVIATIONS, ACRONYMS, AND SYMBOLS

AASHTO	Association of State Highway and Transportation Officials
ACS	American Community Survey
ADT	Average Daily Traffic
AEDI	Arkansas Economic Development Institute
AFFH	Agriculture, Forestry, Fishing and Hunting
ARDOT	Arkansas Department of Transportation
BEA	Bureau of Economic Analysis
BLS	Bureau of Labor Statistics
DFA	Department of Finance and Administration
DOT	Department of Transportation
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
GDP	Gross Domestic Product
GDPPC	Gross Domestic Product Per Capita
GIS	Geographical Information System
HERS-ST	Highway Economic Requirements System for States
IMPLAN	Impact Analysis for Planning
IRB	Internal Review Board
KDOT	Kansas Department of Transportation
KYTC	Kentucky Transportation Cabinet
MnDOT	Minnesota Department of Transportation
NCDOT	North Carolina Department of Transportation
OKDOT	Oklahoma Department of Transportation
REMI	Regional Economic Models
RIMS	Regional Input-Output Modeling System
RMEV	Rate per Million Entering Vehicle
RMVM	Rate per Million Vehicle Miles
RRL	Real Estate, Rental, and Leasing
SHRP2	Strategic Highway Research Program 2
SMITE	Spreadsheet Model for Induced Travel Demand
SPASM	Sketch Planning Analysis Spreadsheet Model
STEAM	Surface Transportation Efficiency Analysis Model
TIGER	Transportation Investment Generating Economic Recovery
TU	Transportation and Utilities
TxDOT	Texas Department of Transportation
VMT	Vehicle Miles Traveled
WisDOT	Wisconsin Department of Transportation

EXECUTIVE SUMMARY

A bypass route is a small segment of highway that moves traffic around the central business district of a city *[1]*. Community members often worry that the bypass will lead to negative economic impacts as through travelers who may have stopped at local businesses now bypass the town entirely. Thus, in some cases, communities and planners have opted to widen the existing main thoroughfare to accommodate higher traffic volumes. When consensus could not be reached, no improvements were made. This research examines the impacts of bypass, widening, and no-improvement projects on the economic and safety conditions of small towns in Arkansas. This research provides evidence-based comparisons of bypass, widening, and no-improvement projects in Arkansas that can be used to support the public outreach and community decision making processes. Through a case study approach, the impacts under varied project settings are assessed and measured. The study sites include five bypass locations, two widening projects, and two no-improvement locations (**Table 1**).

Table 1. Summary of Study Sites

Project City and County	Begin Year[1]	End Year	Highway	Project Category	Cost (Million 2013$)	Length (mi)	Lanes	Cost per lane-mile (Million 2013$)
Grady, Lincoln	2005	2009	65	Bypass	22	3.9	4	$1.43
Hardy, Sharp	2003	2005	412	Bypass	24	1.5	4	$3.97
Flippin, Marion	2004	2008	412	Bypass	17	3.2	4	$1.36
Sheridan, Grant	2008	2014	167	Bypass	46	8.6	4	$1.33
Vilonia, Faulkner	2007	2012	64	Bypass	53	10.1	4	$1.31
Gould, Lincoln/Desha	2006	2011	65	Widening	35	8.6	2	$2.03
Siloam Springs, Benton	2010	2012	412	Widening	14	1.6	2	$4.23
Green Forest, Carroll	2012	N/A	62	None	N/A	N/A	N/A	N/A
Dover, Pope	2011	N/A	7	None	N/A	N/A	N/A	N/A
1. For no-improvement sites, the year refers to the year the Environmental Assessment report was published.								

Three approaches were applied for economic impact estimation in this project. These include: (1) a regional economic impact estimation using IMPLAN and the FHWA's EconWorks Assess My Project tool (referred to as 'EconWorks' in the remainder of this report), (2) statistical comparisons, and (3) econometric analysis. For regional economic impact estimation, the research project applied an IMPLAN model and compared it to EconWorks, two commonly used economic impact assessment tools typically applied for sketch-planning. IMPLAN is a regional impact model that enables the evaluation of the economic impact of specific activities such as construction or operation of public works projects. EconWorks provides estimates impacts including jobs, wages, and economic output based on project type, region, urban/class level, economic distress, and length of the project.

From the IMPLAN analysis, bypass study sites had a slightly higher median employment, labor income, value added, output, and tax revenue generated than widening sites. Estimates from EconWorks derive from a database of 132 projects, and there are a limited number of cases on which to base economic impact estimations for Arkansas. Comparing the EconWorks and

IMPLAN estimates for direct jobs shows errors up to 1,008%. Therefore, a “simplified methodology” that uses the IMPLAN results but does not require IMPLAN analysis or detailed data was developed to estimate impacts for future project sites in Arkansas. The results show increased accuracy in estimation using the “simplified model” (Average Absolute Percent Error, AAPE of 54%) compared to EconWorks (AAPE of 161%) when all projects are compared.

For bypass study sites, the statistical analyses support the conclusion that bypass projects cause a statistically significant increase in the per capita GDP for real estate and rentals, per capita GDP overall, and the number of establishments in the city. Weaker evidence was found to support the statistical significance of bypass projects causing increases in sales tax revenue, population density, home price, per capita GDP for retail, and the number of employees in the city. Overall, there were no statistically significant decreases in the sociodemographic variables analyzed in the study that could be attributed to the construction of a highway bypass. In all bypass study sites, there was a decrease in ADT along the main route through town, and this could be statistically attributed to the construction of the bypass. For widening study sites, considering there were only two sites, less definitive conclusions could be drawn. Like the bypass sites, by examining the time series regression, it was found that there were statistically significant increases in sales tax revenue and per capita GDP for all categories. However, these increases were not found to be statistically significant for both study sites when compared to control cities. This means that without investigating additional widening study sites, no definitive conclusions can be drawn.

Perceived economic impacts generated from phone interviews with local residents tended to agree with the estimated impacts resulting from the economic impact analyses, but, in most cases, residents did not attribute the economic changes to the bypass or widening projects. Safety impacts of the study sites were assessed by analyzing crash rates. For bypass study sites, crash rates pre-and post- bypass completion were not statistically different in the majority of sites. For widening sites, crash rates decreased relative to statewide averages after project completion but not relative to their own historical patterns.

The research products generated from this project include the development of seven case studies in a format that can be submitted to EconWorks and used for public meetings for future projects. An Implementation Report is provided along with this Final Report to document the steps needed to develop a case study and to use the simplified methodology to estimate the impact of a planned project. Future work should continue to expand the set of study sites to those with more diverse economic settings, especially for widening projects.

CHAPTER 1: PROJECT OVERVIEW

1.1 STRUCTURE OF THE REPORT

Following the Project Overview in Chapter 1, this report is organized as follows:

- Chapter 2 reviews the state-of-the-practice methods for economic impact analyses applied to highway infrastructure projects,
- Chapter 3 summarizes the economic impacts of highway improvements and public perceptions of project impacts for the Arkansas case studies,
- Chapter 4 describes the development of simplified methodology for impact evaluation,
- Chapter 5 presents the research product, i.e., public outreach documents and case narratives for EconWorks, and
- Chapter 6 summarizes key findings, addresses limitations, and suggests avenues for future work.

1.2 BACKGROUND

A bypass route is a small segment of highway that moves traffic around the central business district of a city (**Figure 1**) *[1]*. Bypasses are perceived as a means to enhance the mobility of the city's main thoroughfare. By directing through traffic to the bypass, the main street can become safer, less congested, and quieter. This can lead to improved quality of life in the downtown area by allowing for ease of traffic movements and pedestrian activity. In many small towns the bypassed road is the main business route for the town with retail, service, and other commercial establishments, while the bypass is a higher speed thoroughfare to route through-traffic around the main business district (**Figure 2**). However, community members often worry that the bypass will lead to negative economic impacts as through travelers who may have stopped at local businesses now bypass the town entirely. Thus, in some cases, communities and planners have opted to widen the existing main thoroughfare to accommodate higher traffic volumes. In some cases, consensus could not be reached between the public, local officials, and ArDOT. As a result, no improvements were made.

This research examines the impacts of bypass, widening, and no-improvement projects on the economic and safety conditions of small towns in Arkansas. This research provides evidence-based comparisons of bypass, widening, and no-improvement projects in Arkansas that can be used to support the public outreach and community decision making processes. Moreover, economic impact analysis continues to be an important component of an overall project impact analysis for new transportation investment projects. In fact, TIGER grant applications may in the future require economic impact analyses and post-mortem analysis *[2]*. Economic impact analyses are also strongly endorsed by the American Association of State Highway and Transportation Officials (AASHTO)*[2]*. Such analyses provide insight into how transportation investments affect the local, regional, and national economy.

(A) Hardy, AR before the completion of the Highway 412 bypass in 2000

(B) Hardy, AR after the completion of the Highway 412 bypass in 2011

Figure 1. Example of Bypass Construction in Hardy, Arkansas

(a) View along the Main Street in Hardy, AR

(b) View along the Bypass in Hardy, AR

Figure 2. Views along the Main Street and Bypass Routes in Hardy, Arkansas

There are numerous studies concerned with measuring the qualitative and quantitative impacts of highway bypass projects. The majority of these studies focus on the economic impacts of bypassing small and medium-sized communities, i.e., communities of between 1,000 and 50,000 people, since the state DOT has primary responsibility for these areas *[3]*. In an extensive review of bypass impacts studies on small and medium-sized communities, Seggerman and Williams (2014) highlight key impact areas: congestion, freight movement, safety, economic development, sprawl/population growth, and property values (**Table 2**). While reasonably definitive conclusions related to the impact of bypasses on congestion and freight movement can be cited, mixed effects have been cited relating to economic development, sprawl, and property values. Typically, the mixed effects are the result of different local and regional economic conditions, population characteristics, and other project settings. In a meta-analysis of 100 highway economic impact studies, the Economic Research Development Group (2015) found that mixed economic impacts can be tied back to the following key factors related to each project:

1. **Economic context of the study area:** economically distressed areas did not benefit economically (e.g., direct jobs) from highway projects. An economically distressed

area is defined as having a ratio of more than 1.2 of city or county level unemployment to the national unemployment.

2. **Project location**, e.g., rural or urban: More direct jobs are created in rural settings.
3. **Local factors**: land-use policies and poor complimentary infrastructure can reduce the positive economic impacts of a project.
4. **Coordination**: projects supported by other coordinated economic development programs tended to have greater positive economic impacts.

In this project, through a case study approach, the impacts under varied project settings are assessed and measured. Nine study sites were selected by the ARDOT research project subcommittee for evaluation in this project. Five of the sites are bypass locations including Highway 65 in Grady, Highway 63 in Hardy, Highway 167 in Sheridan, Highway 64 in Vilonia, and Highway 62 in Flippin. Two sites are widening projects including Highway 65 in Gould and Highway 412 in Siloam Springs. Two additional sites with no-improvement but with preliminary planning documents and public meetings indicating the need for a bypass or widening project were selected in the cities of Dover and Green Forest. Study sites vary in economic context, project location, and local factors and provide variability in project scale.

Table 2. Summary of Impact Studies by Issue (recreated from Seggerman and Williams, 2014)

Issue	Concerns	Research Findings
Congestion	Bypass will reduce traffic congestion on the main route through town.	Peak hour traffic through the Central Business District (CBD) was reduced*[4].*
Freight movement	Bypass will improve speed and reliability of truck movements.	Trucks tend to choose the bypass leading to increased travel time reliability*[5].*
Safety	Bypasses can offer safety benefits by reducing traffic on the CBD main thoroughfare and providing a bypass route designed for safer passing and other road safety features.	Mixed impacts with some areas reporting fewer vehicle and pedestrian accidents*[6].*
Economic development, business activity, and business relocation	Bypass provides an opportunity for economic development and increased tax base. There will be a decline in sales and loss of business activity along the CBD main thoroughfare, especially for gas and fast-food businesses. Businesses will relocate from the CBD to the bypass route and reduce the local tax base.	Economic impacts on small and medium sized communities are mixed[7-10] Perceptions of bypass impacts vary by industry, but total sales often increase*[11].* Travel-related businesses and big-box retail tend to relocate near bypass. Service-related businesses stayed in CBD*[8].*
Sprawl and population loss	Bypasses induce sprawl out of the CBD which adversely affects community character.	Mixed outcomes have been measured in regards to sprawl and population loss. The likelihood of sprawl depends on the region's growth rate among other factors*[12, 13]*.
Property values	Property values and occupancy rates will decline along the CBD main throughfare.	Research shows no clear trends. Overall tax base increased in all case studies, but reasons for the increase differed*[14]*.

The methods to quantify and compare economic, social, and safety impacts in prior studies can be summarized into five main approaches listed in order of increasing complexity (Srinivasan and Kockelman, 2001):

1. **Anecdotal evidence**: interview and focus groups with community members and local planners. This took the form of semi-structured interviews solicited by mail. Responses were used to gauge public perceptions of economic and safety impacts.
2. **Before-and-after comparisons**: comparison of economic conditions (including population, employment, and tax records) one year before the bypass or widening completion and five years after. This approach was used to assess impacts of a project on crash rates for safety analysis and to compare economic conditions before and after a project completion.
3. **Matched-pairs comparisons**: comparison of economic conditions in a control-area and the study area. Four control areas, or matched cities, were selected for each study site. The control cities share similar population, highway conditions, traffic counts, and economic characteristics as the study area before the bypass or widening construction. This approach was used to assess the economic impacts of a project.
4. **Econometric analyses**: examples include multivariate regression analysis to isolate the marginal influence of a bypass or widening project from other factors that possibly impact local economies. Studies using econometric analysis often pull data from a large number of study areas to make generalizations about influences of project or local characteristics on economic impacts.
5. **Economic impact models:** models and tools that estimate the impact to economic sectors based on project expenditures. Notable examples of such tools include a publicly available tool called the EconWorks and a proprietary software packaged called IMPLAN.

The work described in this report applies all above listed approaches to a set of study sites in Arkansas to understand and quantify economic and safety impacts of past projects. Economic impacts are and will continue to be an important component of impact analysis for transportation investments. With federal grants such as the TIGER grant program starting to require post-mortem analysis of impacts, it will be necessary for planners to have a means to accurately estimate project impacts*[15]* . AASHTO also "strongly endorses" the importance of estimating project impacts post construction in order for agencies to better understand how transportation investments impact local, regional, and state economies *[15]*.

Of all possible economic impact modelling tools, EconWorks and IMPLAN were chosen because they represent commonly used economic impact assessment tools that can be applied at the sketch-planning level for project-specific analysis. Sketch-planning refers to a very early planning stage when only general conceptualizations of a project's scope and design are available. EconWorks contains a collection of web-based tools and downloadable spreadsheets aimed at the early project planning stages and was developed as part of the FHWA Strategic Highway Research Program 2 (SHRP2). One of the key purposes of the tool is to provide data-driven evidence for public debate over anticipated project impacts. EconWorks comprises a library of case studies, differentiated by project attributes such as project type, project setting, population characteristics, etc. The case studies provide details on project impacts from already-built projects, which serve as the basis for estimates of new project impacts. Users can enter proposed project details into the online EconWorks tool to estimate potential ranges of direct, indirect, and total impacts. The tool is based on 132 case studies of highway capacity projects including bypass and widening projects across different project settings (rural, urban, or mixed; economic distress level, etc.). Of the 132 case studies, 28 are in the southeast region where Arkansas is referenced with two of those case studies representing bypasses and four representing widening projects.

IMPLAN is a regional impact model that enables the evaluation of the economic impact of specific activities such as construction or operation of public works projects, as well as retail, wholesale, manufacturing, and service sales within an economy. IMPLAN uses a 536-sector input-output model to measure the effects of three types of impacts: direct, indirect, and induced. Direct impacts consist of employment and purchases of goods and services in the region resulting from the activity being evaluated, in this case, construction and services related to it. Indirect impacts (inter-industry) consist of goods and services purchased by the firms which supply inputs consumed in the direct activity. Induced impacts consist of increased household purchases of goods and services in the region by employees of direct and indirect employers.

ARDOT can better meet grant program requirements and recommendations by using tools such as EconWorks or IMPLAN to estimate project impacts. Since IMPLAN is a proprietary software, its use presents a sometimes-significant added cost and required level of expertise when compared to a free tool such as EconWorks; although, IMPLAN may give more reliable and detailed results. Thus, a goal of this project is to evaluate the accuracy of EconWorks' economic impact assessments for the Arkansas study sites by comparing it to more detailed impacts estimated from IMPLAN and other economic analysis methods (i.e., statistical evaluation and econometric methods) and then to create a reliable economic impact model scaled to types of projects seen in Arkansas.

To develop and apply the economic impact analysis methods described above (i.e., anecdotal case studies, matched-pairs comparisons, econometric models, and economic impact models including EconWorks and IMPLAN), the research work includes the collection of local, regional, and national data. In general, the data used for the various analyses include:

1. Unemployment rate
2. Population size and density
3. Employment and employment density by employment sector
4. Per capita income
5. Property values
6. New building construction permits
7. Property and sales tax collected

Relevant data was gathered mostly from publicly available databases such as the US Census, including the American Community Survey (ACS), US Bureau of Labor Statistics, the Arkansas Economic Development Commission, ARDOT, county property tax records, and local chamber of commerce records. Property values were also collected from Data Scout, a private data aggregator used by county tax collectors in the state of Arkansas. Additionally, to supplement quantitative findings and to provide perspectives from community members, interviews and surveys were conducted to gather anecdotal evidence in regard to community development impacts.

1.3 PROJECT OBJECTIVES

The goal of this study was to develop an evidence-based framework to assess the potential economic and safety impacts of bypass and widening projects in Arkansas. The research served to address four objectives:

Objective 1: Detailed Review of Previous Findings

The research team investigated methods employed by other states to measure the economic, social, and safety impacts of bypass and widening projects. This was done through a literature review of academic journals as well as state and federal research and project reports.

Objective 2: Compile Characteristics of Projects and Project Settings

The research team compiled characteristics of projects and project settings for the study sites from project planning documents and included data on project costs, length, construction time periods, traffic volumes, etc. Furthermore, data on various economic variables such as number of jobs, number of establishments, and per capita gross domestic product were also compiled from publicly available sources such as the US Economic Census, Arkansas Department of Finance and Administration, Bureau of Labor Statistics, and County Assessors' Office.

Objective 3: Evaluation of Impacts on Study Sites

The research team evaluated the economic and safety impacts of study sites using matched-pairs comparisons, statistical analyses, econometric analyses, and regional economic impact assessment methods. The assessment of community perceptions of economic and safety impacts was carried out through semi-structured phone interviews with local community members. A simplified methodology (regression analysis using public data sources) was developed to estimate the impacts of highway improvement in terms of number of jobs attributed to the project based on project length (miles) and annual average daily traffic.

Objective 4: Evidence-Based Decision Guidance Documents for Public Outreach

As a research product, evidence-based decision guidance documents were prepared for future public outreach. These documents summarize the economic and safety impacts of each of the study sites. The Decision Guidance documents can be used to support community outreach events and will help shed light on potential impacts of new projects in Arkansas cities. Each case study was prepared according to the EconWorks study requirements and can be submitted to EconWorks for consideration in the case study reference collection.

CHAPTER 2: STATE-OF-THE-PRACTICE METHODS FOR ECONOMIC IMPACT ANALYSIS

This chapter reviews the state-of-the-practice methods and tools used for economic impact assessment of highway infrastructure projects. A description of publicly available and propriety tools is provided.

2.1 REGIONAL IMPACT ASSESSMENT TOOLS

Several software tools perform regional economic impact assessment for highway capacity projects (**Table 3** and **Table 4**). Regional level models estimate the effect of a project investment for the entire region in which the project has an impact. This region can be defined as broadly as a state or as specifically as a city. Most tools take the form of cost-benefit analyses and focus on the direct user impacts of individual projects in terms of travel costs (travel time savings and vehicle operating costs) and other quantifiable outcomes (air pollution and crash occurrence). Sketch-planning tools such as MicroBENCOST, SPASM, and EconWorks are appropriate for screening level analysis and, thus, only require basic project costs and a general understanding of project benefits. Regional economic models like IMPLAN are more appropriate for the prioritization process and project development stage and require more defined inputs.

Economic impact models have been applied widely in the transportation sector for a number of project types and several models have resulted in the development of software tools for end users. A main limitation of many economic models is that a single transportation project, of the scale of the bypass studies examined in this research work, may not register impacts at a regional (or city) scale and thus may not be suitable. Secondly, there are some concerns that the input-output tables underlying some models may not accurately capture transportation sector impacts, especially indirect or induced impacts *[16]*. Lastly, models contained in IMPLAN were developed by private consultants and thus require usage fees for their associated software tools that can be substantial depending on the scale of the analysis desired.

EconWorks includes a model of economic impacts and a user tool for applying the model. EconWorks contains a web-based tool with downloadable spreadsheets aimed at the early project planning stages. One of the key purposes of the tool is to provide data-driven evidence for public debate over anticipated project impacts. Of these many tools, this project selected the EconWorks and IMPLAN tools, mainly due to their widespread use. Each of these tools is briefly discussed below with more detailed discussion provided in Chapter 3.

Table 3. Summary of Publicly Available Impact Assessment Tools

Tools	Overview
Sketch Planning Analysis Spreadsheet Model (SPASM); Surface Transportation Efficiency Analysis Model (STEAM)	Benefit-cost tool for screening level analysis. Worksheet based tool requiring public agency costs, characteristics of facilities and trips, and travel demand. Best for corridor level projects. STEAM is a planning-level extension of the SPASM model designed for cross-modal demand management policy analysis.
Spreadsheet Model for Induced Travel Demand (SMITE)	Sketch-planning tool implemented as a spreadsheet application. Estimates the effect of induced demand.

Table 3. Summary of Publicly Available Impact Assessment Tools (Cont.)

Tools	Overview
Highway Economic Requirements System for states (HERS-ST)	Evaluates competing projects using benefit-cost ratios. Tool developed by the FHWA.
Regional Input-Output Modeling System (RIMS-II)	An input-output model developed by the US Dept. of Commerce. Estimates total economic impact (not by industry sector) using multiplier tables generated by the Bureau of Economic Analysis (BEA). Does not include fiscal (tax) impacts or temporal ripple effects.
EconWorks	EconWorks is a collection of web-based tools designed to help planners incorporate economic analysis into early project decision making. It is shared and maintained by consultants hired by the FHWA.

Table 4. Summary of Proprietary Impact Assessment Tools

Tools	Overview
MicroBENCOST	Sketch planning tool for basic benefits and costs of highway projects. Best for projects with isolated impacts.
Impact Analysis for Planning (IMPLAN)	An input-output modeling system (rather than a set of multipliers) that can be modified to reflect trade flow assumptions and new industries. Estimates impacts by industry including direct, indirect, and induced impacts. Capable of multi-region modeling and estimating fiscal impacts. Can be estimated at the zip code level.
Regional Economic Models, Inc. (REMI)	REMI is a hybrid input-output and econometric modeling package. Three methodologies are at the core of most REMI implementations, including input-output models, computable general equilibrium models (CGE), and econometric models. REM models are the most comprehensive and may be used for analysis of large-scale transportation investments. Provides dynamic forecasts of impacts.

EconWorks includes a library of case studies, differentiated by project attributes such as project type, project setting, population characteristics, etc. The case studies provide details on project impacts from already-built projects, which serve as the basis for estimates of new project impacts. Users can enter proposed project details into the online EconWorks tool to estimate potential ranges of direct, indirect, and total impacts. The EconWorks tool is a product of the SHRP2 Economic Analysis Tool projects, namely Transportation Project Impact Case Studies (C03) and Tools for Assessing the Wider Economic Benefits of Transportation (C11). C03 provides planners with a web tool to evaluate the range of possible economic development impacts that can occur under different project settings. C11 expanded on C03 by including "wider" economic impacts that integrate travel time reliability, intermodal connectivity, and accessibility to labor and markets into the impact analysis. Together, both tools can guide project screening while providing planners with data-driven evidence to present for public outreach. The tool is based on 132 case studies of highway capacity projects including bypass and widening projects across different project settings (rural, urban, or mixed; economic distress level, etc.).

Although the EconWorks tool is a valuable resource for planners at the early project development stages, ARDOT has identified several shortcomings following several implementation projects. The most notable limitation of the case study database is that only a small number of case studies are in the library. Of the case studies included, there is limited geographic distribution of specific project types and a lack of diversity in the levels of success that projects in the database have had in terms of economic impacts. This means that there may not be a wide enough range of case studies to support analysis of new project. Thus, there is a need for greater variety of the case studies to assure EconWorks users that they are getting reasonably comparative projects. The work carried out in this project develops Arkansas case studies suitable for inclusion into the database. This will greatly expand the usability of the EconWorks tool for Arkansas planners.

IMPLAN is a regional impact model with an associated software tool that enables the evaluation of the economic impact of specific activities such as construction or operation of public works projects, as well as retail, wholesale, manufacturing, and service sales within an economy. IMPLAN uses a 536-sector input-output model to measure the effects of three types of impacts: direct, indirect, and induced. The basic data sources for the current edition of the IMPLAN database and the models used in this study are the Input-Output Accounts of the US, developed by the U.S. Department of Commerce, Bureau of Economic Analysis (BEA), and county income and employment data published by BEA and the Bureau of Labor Statistics (BLS). The model reflects 2017 industrial structure and technology and 2017 prices. Trade flows and the results of this analysis were adjusted to reflect prices of the respective years.

The main limitations of IMPLAN are the cost and expertise required for use and the spatial scale. In most cases, a state DOT would hire a consulting company specializing in economic impact analysis to apply an IMPLAN model for project analysis. In terms of spatial scale, the model can evaluate county and state level impacts. Since the bypass and widening projects typically only span a single city, county and state level model outputs can dilute the understanding of economic impacts on a small town.

The tools discussed in this section differ from general statistical or econometric approaches described in Chapter 1, in the next section (2.2) and later in Chapter 3 in one main way. Tools, as described in this section, include databases, multiplier tables, or other pre-defined reference data that are used to determine the impact of a study site. Statistical approaches and econometric analyses and models, on the other hand, do not reference previously defined databases. Instead, statistical and econometric approaches are used to evaluate project effects by estimating trends over time or across select study sites.

2.2 STATE-OF-THE-PRACTICE METHODS FOR PROJECT IMPACT ANALYSIS

This research study included a literature review of state DOT impact studies, academic research articles, and SHRP2 EconWorks research reports. Ten state research reports, from the years 1992 through 2018, were reviewed. The reports represent a diverse geographic perspective covering the states of California, Iowa, Kentucky, Minnesota, North Carolina, Oklahoma, Texas, and Wisconsin. EconWorks research reports contained comprehensive information on data, data source, analysis, and interpretation of the findings. The reports include a guide to conduct interviews and surveys for social and safety impacts analysis. The reports also have guidelines on construction of narrative to be submitted to EconWorks at the end of the project. The reports and research papers provide an understanding of the types of data collected and methodologies implemented for the economic, social, and safety analyses to be conducted in this study. In this section, a comparative overview of the literature is provided with a detailed summary available in **Appendix A**: Review of Literature.

The common impact assessment methods used by state DOTs include surveys/interviews and matched-pair analysis. For a 'matched-pair' analysis, a city with socio-demographic and transportation characteristics similar to the study location is selected and, through statistical modeling, serves as a comparison to understand the impacts of a transportation project separate from general economic and travel changes over the same time period. Examples of statistical methods include random effects models which are regression type approaches that consider time series and cross-sectional data. Of the various economic impact models used, IMPLAN was the most common.

In particular, a report from the North Carolina Department of Transportation (NCDOT) titled, 'Analysis and Validation of Historical Transportation Investments' *[17]*, describes a project similar to the current work in terms of scope and in the desire to integrate with EconWorks. The NCDOT study used IMPLAN, an economic input-output model, to measure the effects of the project in terms of job creation/growth. In addition, they relied on surveys and interviews to provide evidence of impacts on the community. While tools like IMPLAN aid in understanding the impacts of construction on local communities, a 'matched-pair' analysis allows quantification of impacts on business revenue, relocations, crashes, etc. Less commonly used assessment methods included advanced econometric tools like hedonic regression, random effects models, and cluster analysis.

In addition to state DOT reports, academic literature was also reviewed. Of the methods described in the academic literature, commonly used approaches include (1) *statistical approaches* that compare pre- and post-construction periods to identify statistically significant shifts in economic impact variable trends and (2) *econometric analyses* such as matched-pair analyses. More specifically, the following methods were commonly employed for impact analysis in the academic studies and echoed in the state DOT reports:

1. **Statistical Approaches:** Comparison of macroeconomic, population, employment, downtown vacancy rates, and sectoral growth rates before and after construction projects using *trend analysis* and *statistical comparisons* of pre and post construction periods. These methods determine whether the growth difference for the variable of interest at a study location changes over time with the inflection point indexed to the completion of the project.
2. **Econometric Analyses:** Use of regression analysis following Thomson, et al. (2001) and (2011), to understand the importance of project construction. The traditional least square regression techniques are used as well as recently developed methods which are more robust to statistical errors. The theoretical model used in the literature estimates the difference in

economic growth rates before and after project completion based on population, distance from downtown, and other control variables. This approach is referred to as *time series analysis.* Another form of regression typically employed in the academic literature is to estimate the difference in the growth of economic sector wages based on differences between the control and matched city populations, proximity to downtown areas, existing primary sector activity, economic readiness indicators (such as having industrial parks or economic development organizations), and investment type and scale. This approach is referred to as *matched-pair analysis*.

The state DOT literature also highlights the data necessary to execute the economic impact analysis methodologies. In all reports, use of demographic data was limited to population size, employment, and per capita income. Highway usage data was typically represented with Annual Average Daily Traffic (AADT) and in some cases included truck counts and Vehicle Miles Travelled (VMT). Considering that truck counts and VMT are more sparsely collected than AADT, these variables were not often cited in state economic impact assessment reports. Safety measures are typically reported using crash occurrence or crash rates (crash occurrence relative to AADT). For economic settings, unemployment rate relative to national unemployment rates were commonly used to define the level of economic distress. Retail activity was typically estimated using sales data with some studies separating general retail from gas stations and restaurant sales. It is noted that sales data, as opposed to sales tax revenue, is difficult to obtain and is a major limitation in most studies. When available, many studies used parcel data that depicted the parcel type (industrial, commercial, residential). Unique, unclassified, data used in prior state studies includes underground tank storage information as a proxy for gas station locations, location features such as distances to city attractions, and local optional sales tax initiatives.

CHAPTER 3: IMPACTS EVALUATION

This chapter provides an overview of the methods used to understand the economic and safety impacts of highway bypass and widening projects in Arkansas. The methods comprise: (i) the identification and description of study site locations including the data requirements for case study analysis and criteria for including Arkansas case studies in EconWorks databases (*Section 3.1*), (ii) economic impact assessment using IMPLAN, statistical approaches, and econometric analyses (*Section 3.2*), (iii) evaluation of public perceptions of impacts using survey methods (*Section 3.3*), and (iv) evaluation of safety impacts using historical crash data (*Section 3.4*) (**Figure 3**).

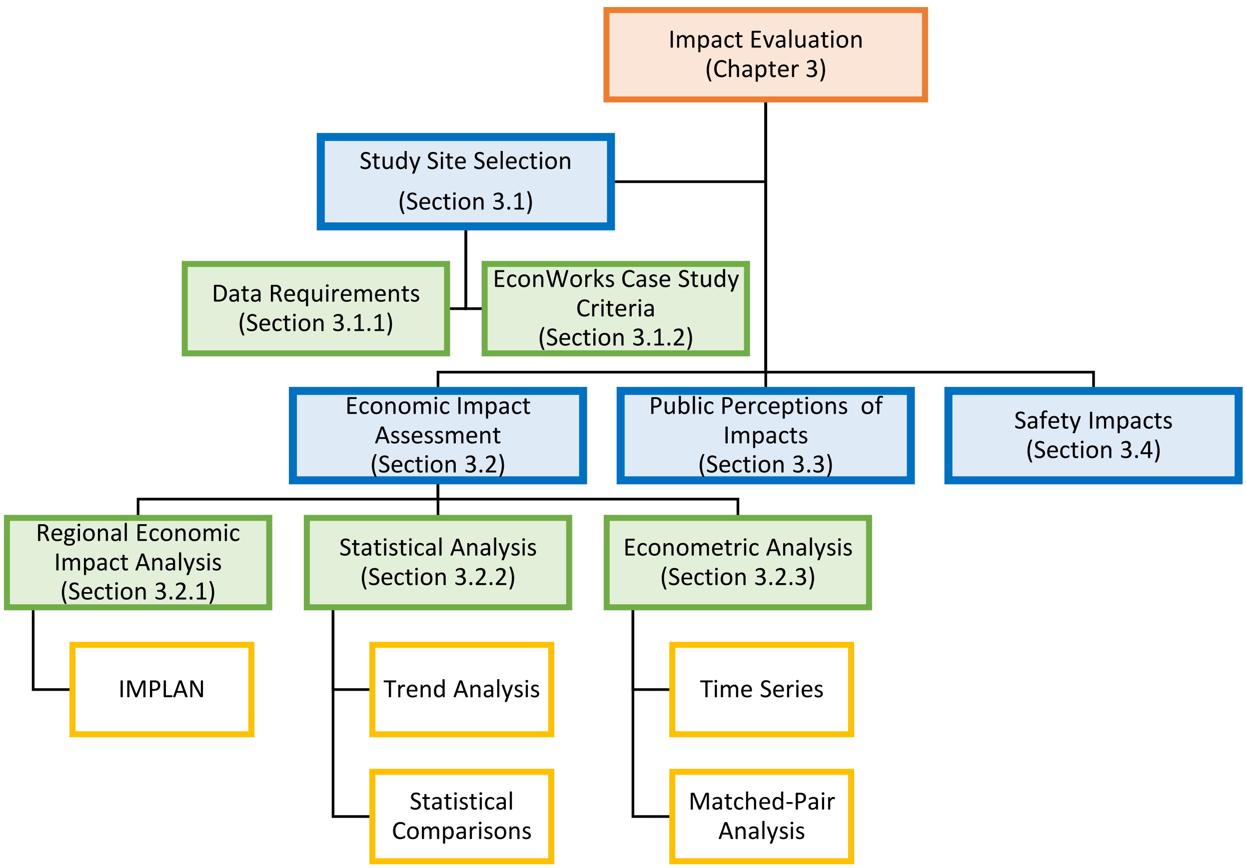


Figure 3. Overview of Impact Analysis Methods

3.1 STUDY SITE SELECTION

Study site locations were recommended by the ArDOT TRC1904 Subcommittee assembled for this project. The final set of study sites were provided by the Subcommittee based on data and project document availability. The study sites include five bypass locations, including Highway 65 in Grady, Highway 63 in Hardy, Highway 167 in Sheridan, Highway 64 in Vilonia, and Highway 62 in Flippin; two widening projects including Highway 65 in Gould and Highway 412 in Siloam Springs; and two no-improvement locations in Dover and Green Forest (**Table 5** and **Figure 4**).

Sites vary in economic context, project location, and local factors and provide variability in project scale.

Table 5. Summary of Study Sites

Project City and County	Begin Year[1]	End Year	Highway	Project Category	Cost (Million 2013$)	Length (mi)	Lanes	Cost per lane-mile (Million 2013$)
Grady, Lincoln	2005	2009	65	Bypass	22	3.9	4	$1.43
Hardy, Sharp	2003	2005	412	Bypass	24	1.5	4	$3.97
Flippin, Marion	2004	2008	412	Bypass	17	3.2	4	$1.36
Sheridan, Grant	2008	2014	167	Bypass	46	8.6	4	$1.33
Vilonia, Faulkner	2007	2012	64	Bypass	53	10.1	4	$1.31
Gould, Lincoln/Desha	2006	2011	65	Widening	35	8.6	2	$2.03
Siloam Springs, Benton	2010	2012	412	Widening	14	1.6	2	$4.23
Green Forest, Carroll	2012	N/A	62	None	N/A	N/A	N/A	N/A
Dover, Pope	2011	N/A	7	None	N/A	N/A	N/A	N/A
1. For no-improvement sites, the year refers to the year the Environmental Assessment report was published.								

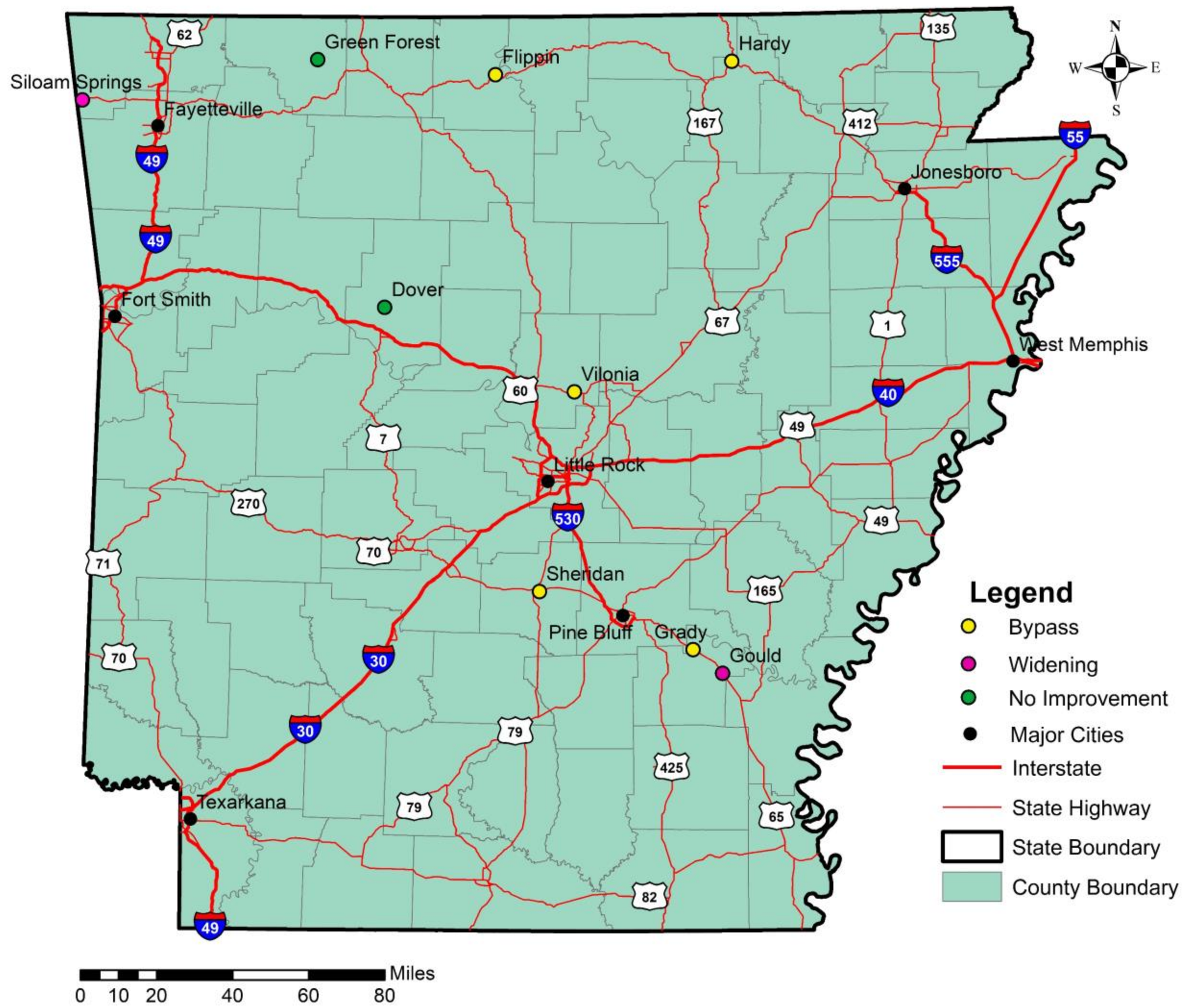


Figure 4. Location of Project Cities

3.1.1 Study Site Descriptions

Among the bypass projects, in terms of construction duration, Sheridan took longest (seven years) whereas Hardy took least (three years) time for completion (**Figure 5**). In terms of length, Vilonia bypass is the longest (10.1 miles) whereas Hardy bypass is the shortest (1.5 miles) bypass project (**Figure 6**). Construction cost of Vilonia bypass was highest ($52.7 million) and Flippin was least ($17.4 million). Among the widening projects, in terms of construction duration, Gould took longest (six years) whereas Siloam Springs took the least amount of time (5 years) years for completion (**Figure 5**). Gould is the longest widening project with the length of 8.6 miles (**Figure 6**). Construction cost of Gould was higher ($35 million) compared to Siloam Springs ($13.5 million). Note that the sites in Green Forest and Dover are not included in the above-mentioned figures because they did not receive a treatment (bypass nor widening). Comparing projects by cost per lane mile, Siloam Springs had the highest cost of $4.38M and Vilonia had the lowest cost of $1.31M per lane mile (**Figure 7**). On average, the bypass projects cost $1.87 per lane mile while the widening projects cost $3.02 per lane mile.

By city population, Siloam Springs is approximately 38 times as large of a population as the smallest city included in the study sites, Grady (**Figure 8**). Of the bypass sites, the average population was 2,008 while the range was between 475 and 4,478. Of the widening sites, the average population was 8,030 while the range was between 1,187 and 14,872.   Four of the nine study sites experienced population decreases since completion of the project or environmental assessment. The average rate of population decrease of those four cities was 16.4%. The average rate of population increase of the remaining five cities was 16.1%. Of the bypass sites, the average population change was 7.1%. Of the widening sites, the average population change was -15.1%. Flippin has the highest population density (734.4 people/ sq. mile), whereas the city of Hardy has the least population density (148.9 people/ sq miles) among the bypass study cities. In terms of demography, the city of Siloam Springs has higher population density (1343.5 people/ sq. miles) compared to Gould (770.8 people/ sq. mile) (**Figure 9**). Per capita income, referenced to 2013 dollars, ranged from around $23,000 to $52,000 before each project to $23,000 to $77,000 after project completion (**Figure 10**). The largest change was seen in Siloam Springs, likely due to high income earners from surrounding cities migrating to Siloam Springs for housing opportunities. The average change in per capita income was 10% for bypass sites and 30.4% for widening sites. Note that the reference year used in the before and after categories are not the same for each study site. Instead, they reference the one year before project start and five years after the project completion. For cities with no improvement, they reference one year before and five years after the environmental assessment.

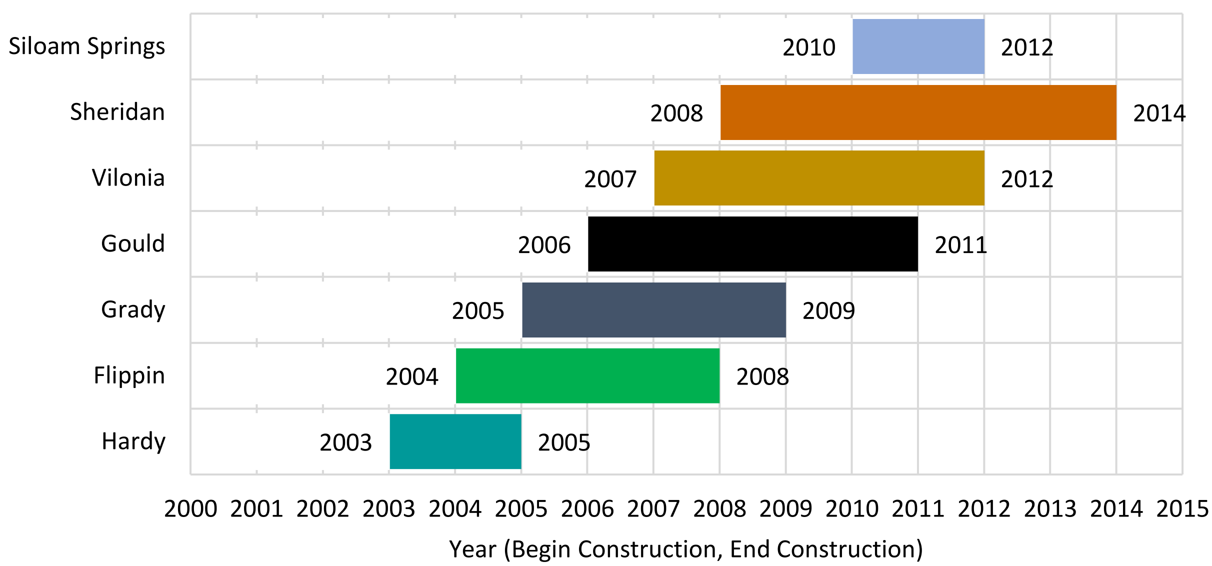


Figure 5. Project Construction Timeline

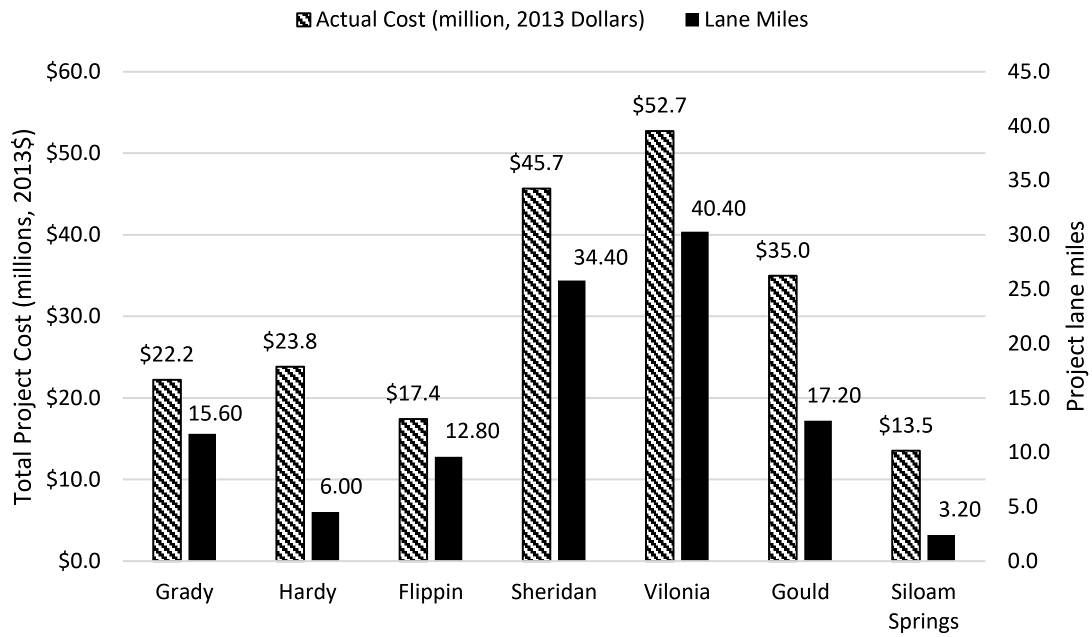


Figure 6. Study Site Project Cost and Length

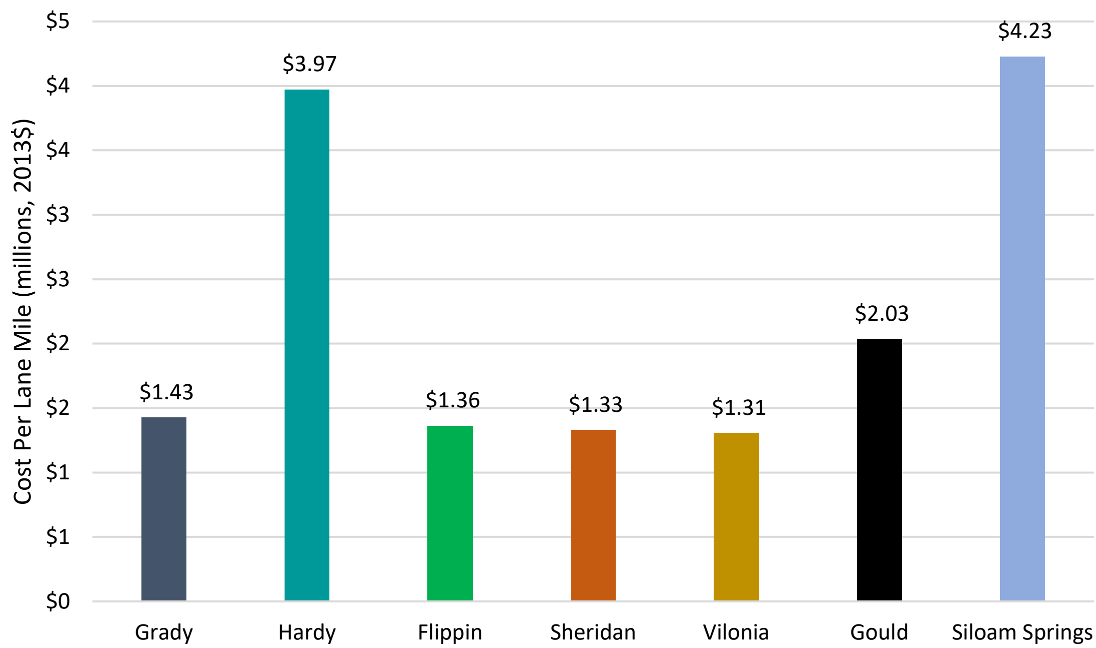


Figure 7. Study Sites by Cost per Lane Mile

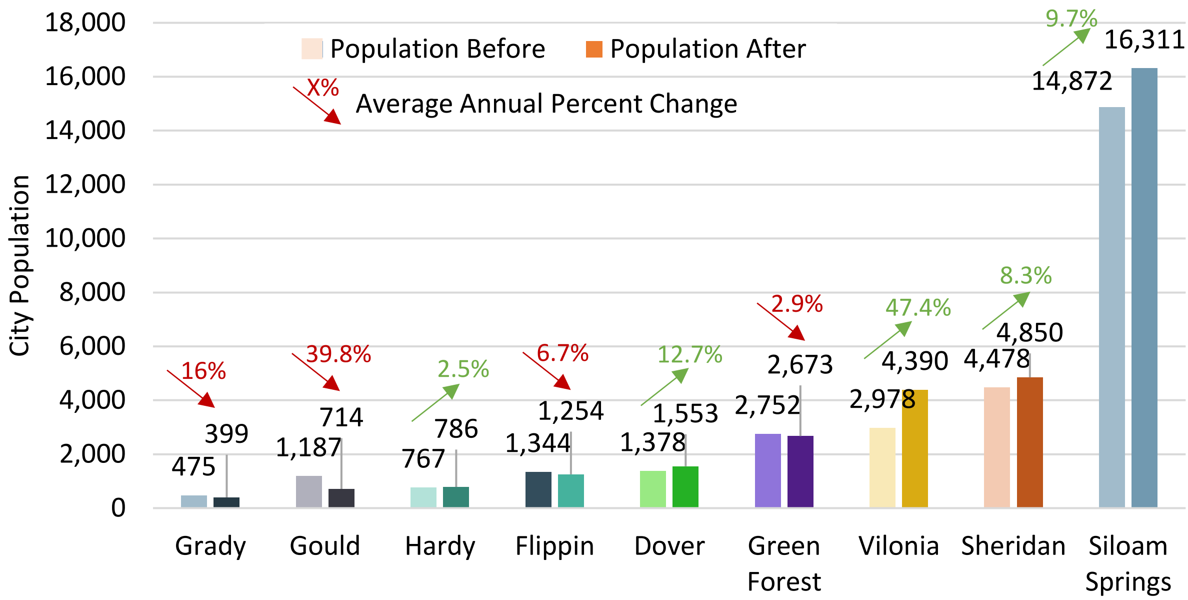


Figure 8. Study Site Population Before and After Project

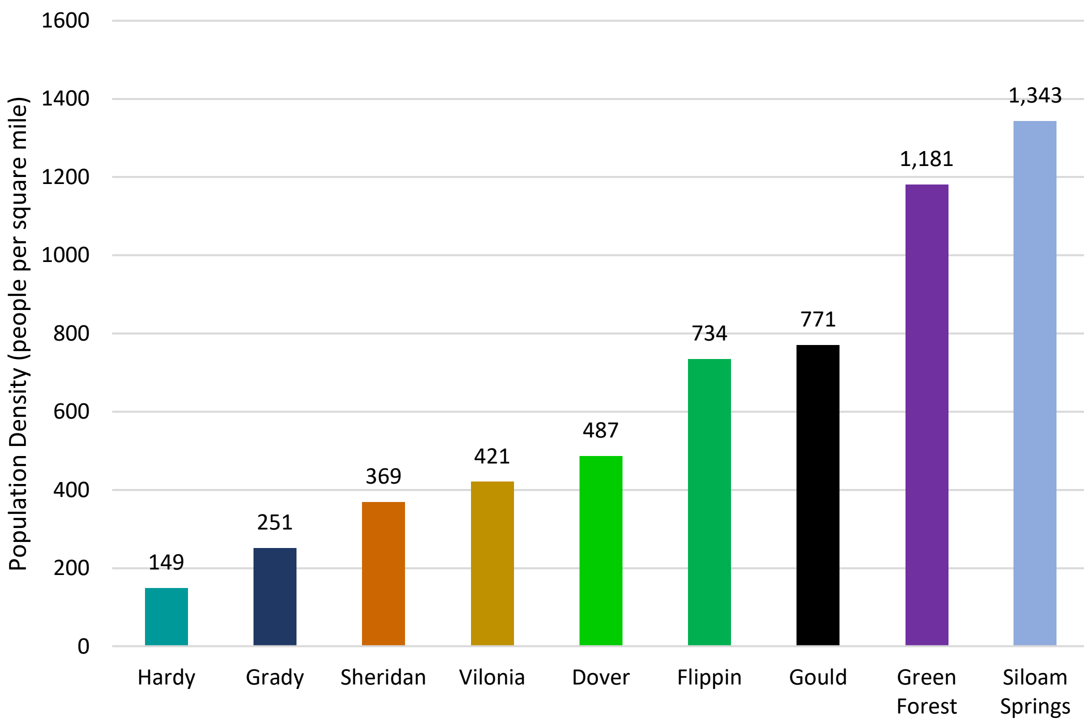


Figure 9. Study Site Population Density at Beginning of Each Project

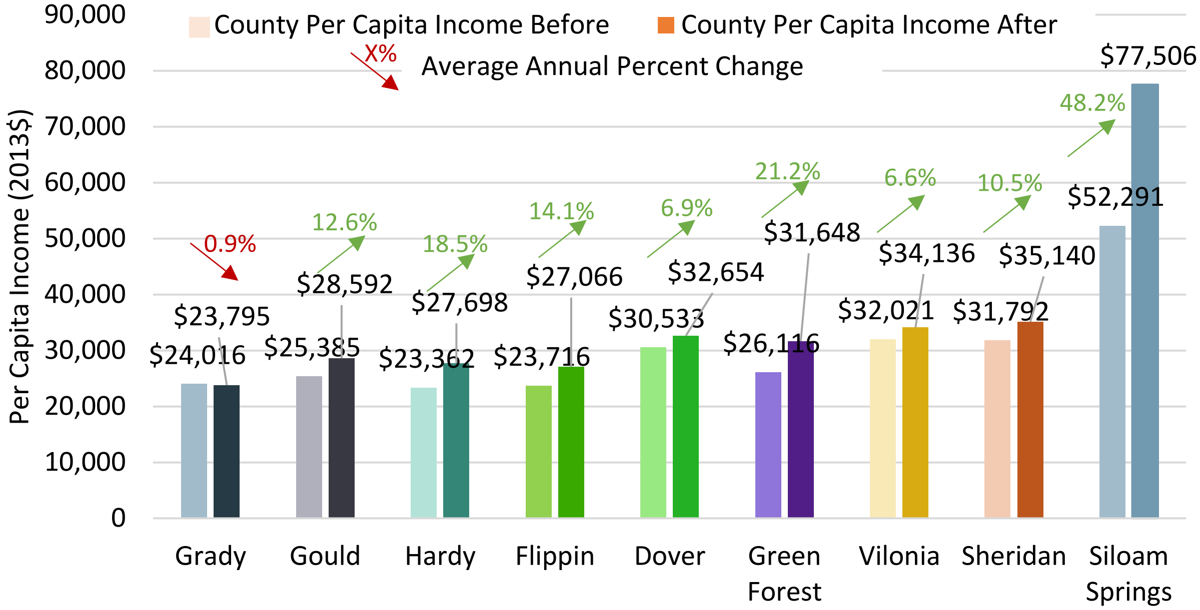


Figure 10. Study Site Per Capita Income Before and After Project

Annual average daily traffic (AADT) along the main route through each study site ranged from around 640 to 28,000 vehicles per day before each project to 570 to 27,000 vehicles per day after project completion (**Figure 11**). There was a decrease in AADT along the main route for all project sites and an increase in AADT for the sites with no improvement. The average change in AADT was -36.5% for bypass sites and -2.6% for widening sites. Note that the reference year used in the before and after categories are not the same for each study site. Instead, they reference the one year before the project start date and five years after the project completion. For cities with no improvement, they reference one year before and five years after the environmental assessment.

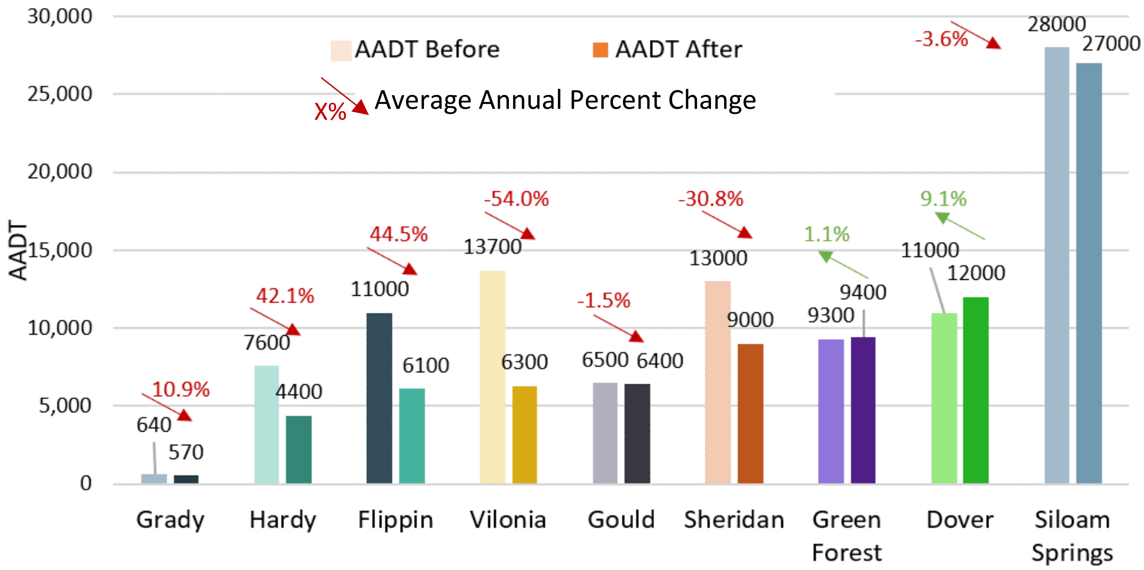


Figure 11. Study Site AADT Along the Main Road Before and After Project

Five sites including Grady, Sheridan, Vilonia, Siloam Springs, and Dover are considered Metro Areas defined as being part of a Core Statistical Area as defined in the US Census (**Figure 12**). Three sites including Hardy, Flippin, and Green Forest are in Rural Areas defined as not being part of a Core Statistical Area. Gould is considered to be in a Mixed Area meaning that it spans counties that are part of and not part of core statistical areas. By project type, three of the five bypass projects are in Metro Areas with the remaining two in Rural Areas. One of the widening projects (Siloam Springs) is in a Metro Area and the other (Gould) is mixed.

In terms of economic setting, Grady, Hardy, and Gould are in distressed areas (**Figure 13**). Distressed areas are defined as having the ratio of county unemployment to national employment greater than 1.2. Meaning their unemployment rate is more than 1.2 times as high as the national rate *[9]*. The remaining six sites including Sheridan, Vilonia, Flippin, Siloam Springs, Dover, and Green Forest are in non-distressed areas. The conditions for determining economic setting are based on the start date of each project. By project type, two of the five bypass sites (Grady and Hardy) are in distressed settings and the remaining three (Sheridan, Vilonia, and Flippin) are in non-distressed settings. One widening project (Gould) is in a distressed setting, and the other (Siloam Springs) is in a non-distressed setting.

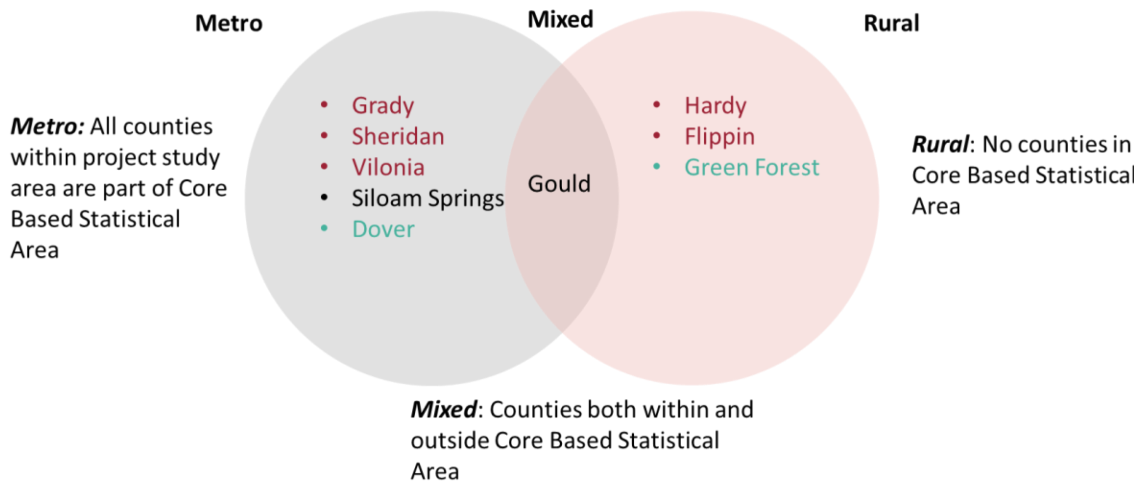


Figure 12. Study Sites Compared by Area

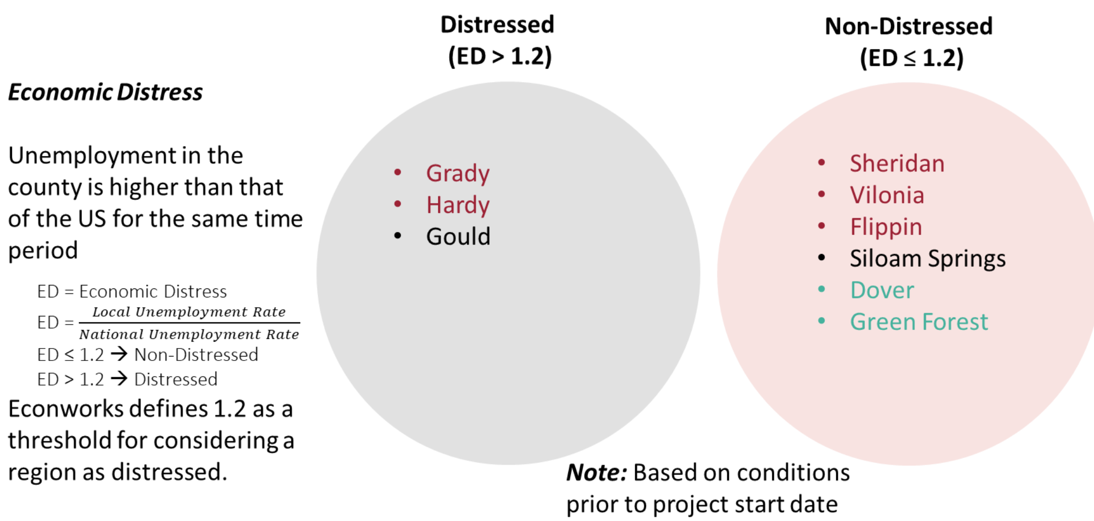


Figure 13. Study Sites by Economic Setting

3.1.2 Data Resources

In addition to the basic demographic and setting data (i.e., population, employment, per capita income, rural/urban setting, etc.) described in the prior section, ten economic variables were collected for each of the study sites to use for the impact evaluation carried out in this project (**Table 6**). The list of economic variables is based on the most commonly used economic impact estimators distilled from the review of state DOT reports, academic literature, and federal guidance. Additionally, these seventeen variables are required for development of case studies in the EconWorks project database. It is important that all data described are available for a study site if it is to be submitted to the EconWorks database. Submitting the seven study sites into the EconWorks database is an objective of this project.

All variables were used in the impact analyses and are publicly available. Property values and transfers, although available from the County Assessors' offices, were gathered from a data provider called Data Scout. Data Scout compiles county property records on behalf of the county. Instead of using the county assessor websites to look up properties individually, Data Scout was able to provide a direct data download for each county and/or city of interest. This helped to streamline the process of acquiring property value and transfer data.

The geography of the data collected ranged from a section of highway (e.g., ADT) to the ZIP code area (e.g., establishment data). When city level data (i.e., employment, establishments, and per capita gross domestic product) were not available, they were estimated with county level data (**Equation 1**). This method is a commonly used to disaggregate county level data to the city level. It is based on the assumption that population and employment growth are simultaneous*[18]*.

$$Augmented\ city\ data_t = \frac{City\ Population_t}{County\ Population_t} * County\ Data_t \qquad \textbf{Equation 1}$$

Where,

City population	=	Population of the city for year t
County population	=	Population of the county for year t
County data	=	Variable of interest for the county in year t

Table 6. Variable Description

Variable Name	Data Elements	Geography	Data Source
1. Transfers	Total Sale Amount of all the Transfer of Commercial Properties	City	Arkansas GIS Office*[19]* and DataScout *[20]*
2. Sales Tax Revenue	Sales tax revenue		Arkansas Department of Finance and Administration (DFA)*[21]*
3. Population Density	Number of people residing per unit sq. miles		American Community Survey (ACS)*[22]*, Decennial Census*[23]*, Arkansas Economic Development Institute (AEDI)*[10]*
4. Home Price	Zillow House Value Index for single-family residence		Zillow*[24]*
5. GDPPC RRL	Real Estate, Rental, and Leasing	County augmented to city	Augmented from county level data from Bureau of Economic Analysis*[25]*
6. GDPPC Retail Trade	Retail Trade		
7. GDPPC ALL	All sectors of the economy		
8. Establishments City	Number of establishments		Augmented from county level data from Bureau of Labor Statistics (BLS)*[26]*
9. Employees City	Number of employees		
10. ADT Main	ADT of the Main Road	Highway section	ArDOT*[27]*

3.1.3 Criteria for EconWorks Case Study Development

A goal of this project is to submit Arkansas study sites into the EconWorks case study database to better represent the Southeast region of the US within EconWorks. In this way, EconWorks can be a more accurate method to apply to new project sites in Arkansas. As such, EconWorks has a number of criteria that must be met for a case study to be included in its database. These criteria were compared against the study sites recommended by the research project subcommittee to ensure that the study sites could later be submitted into the EconWorks database. According to the *Case Study Design and Development* guide, case studies sites must meet the following conditions *[28]*:

1. Has been completed for at least five years;
2. Economic development was a key motivation for the project;
3. Has a highway component;
4. Fits into one of ten project categories (bypass and widening are two of these categories);
5. Has available contact information of a person knowledgeable about the project;
6. Possess all required project data.

All selected study sites meet Requirements 3, 4, and 5 (**Table 7**). Sheridan is an exception to Requirement 1 as it has not been completed for at least five years (although project data is available through 2017). For Requirement 2, economic development was not reported as the key motivation, rather, congestion mitigation was the key motivator for all listed projects. The project team decided this was acceptable given that economic development could be argued to be a likely additional project motivator considering that congestion mitigation along the main route through town and new development along the bypass could spur economic development. Most, but not all, of the required data (Requirement 6) are available for all the cities (**Table 8**). Specifically, most of the data is available for the post-study period but is limited for the pre-study period. Therefore, it was concluded that all study sites could be developed into EconWorks case studies for submission into the EconWorks database at the conclusion of the project.

Table 7. Summary of EconWorks Requirements by Project Study Site

Project	Completion Year	Five Years	Economic Development as a Key Motivation	Highway	Project Category	Contact Information
	Requirement (Req.) 1		***Req. 2***	***Req. 3***	***Req. 4***	***Req. 5***
Grady	2009	Yes	Congestion Mitigation	Highway 65	Bypass	Available
Hardy	2005	Yes	Congestion Mitigation	Highway 412	Bypass	Available
Sheridan	2014	No	Congestion Mitigation	Highway 167	Bypass	Available
Vilonia	2012	Yes	Congestion Mitigation	Highway 64	Bypass	Available
Flippin	2008	Yes	Congestion Mitigation	Highway 412	Bypass	Available
Gould	2011	Yes	Congestion Mitigation	Highway 65	Widening	Available
Siloam Springs	2012	Yes	Congestion Mitigation	Highway 412	Widening	Available

Table 8. Summary of Data Indicators Identified by EconWorks by Project Study Site (Requirement 6)

	Data	Grady	Hardy	Sheridan	Vilonia	Flippin	Gould	Siloam Springs
Project Indicators	Description of project	☒	☒	☒	☒	☒	☒	☒
	Project type	☒	☒	☒	☒	☒	☒	☒
	Project motivation	☒	☒	☒	☒	☒	☒	☒
	Project cost	☒	☒	☒	☒	☒	☒	☒
	Start/end dates	☒	☒	☒	☒	☒	☒	☒
	Project sponsor	☒	☒	☒	☒	☒	☒	☒
	Post-construct study date	☒	☒	☒	☒	☒	☒	☒
	Project magnitude (length, lane-miles)	☒	☒	☒	☒	☒	☒	☒
	GIS coordinates	☒	☒	☒	☒	☒	☒	☒
	Related links	☒	☒	☒	☒	☒	☒	☒
	Relevant attachments	☒	☒	☒	☒	☒	☒	☒
Location Indicators	Region	☒	☒	☒	☒	☒	☒	☒
	Class level	☒	☒	☒	☒	☒	☒	☒
	Population density	☒	☒	☒	☒	☒	☒	☒
	Economic distress	☒	☒	☒	☒	☒	☒	☒
	Employment growth rate	☒	☒	☒	☒	☒	☒	☒
	Population growth rate	☒	☒	☒	☒	☒	☒	☒
	Economic market size	☒	☒	☒	☒	☒	☒	☒
	Airport travel distance	☒	☒	☒	☒	☒	☒	☐
	Travel distance to interstate	☒	☒	☒	☒	☒	☒	☒
	Travel distance to major market	☒	☒	☒	☒	☒	☒	☒
	Extent of mountain terrain	☐	☐	☐	☐	☐	☐	☐
Impact Indicators	Per capita income	☒*	☒*	☒*	☒*	☒*	☒*	☒
	Economic distress	☒*	☒*	☒*	☒*	☒*	☒*	☒
	Number of jobs	☒	☒*	☒	☒	☒	☒	☒
	Population	☒	☒	☒	☒	☒	☒	☒
	Wages and other income	☐	☐	☐	☐	☐	☐	☐
	Business sales	☐	☐	☐	☐	☐	☐	☐
	Capital investment	☐	☐	☐	☐	☐	☐	☐
	Property values	☒	☒	☒	☒	☒*	☒*	☒
	Tax revenues and costs	☒	☒*	☒	☒	☒	☒	☒
	Annual Average Daily Traffic	☒	☒	☒	☒	☒	☒	☒
	Direct jobs	☒	☒	☒	☒	☒	☒	☒
	Direct property values	☒	☒	☒	☒	☒	☒	☒

☒ indicates data is directly available, ☐ indicates data is not available or missing, * indicates that the data is not available for pre-study year

3.2 ECONOMIC IMPACT ASSESSMENT

Three approaches were applied for economic impact estimation in this project. These include: (1) a regional economic impact estimation using IMPLAN, (2) statistical comparisons, and (3) econometric analysis. The results of the economic impact analysis are used to develop case studies for each of the study sites and compared to the results of the impact estimates from EconWorks. In Chapter 4, a simplified methodology to estimate project impacts is developed and based on the more detailed analyses found in the following sections.

3.2.1 Regional Economic Impact Estimation

For regional economic impact estimation, the research project applied an IMPLAN model. IMPLAN is a regional impact model that enables the evaluation of the economic impact of specific activities such as construction or operation of public works projects, as well as retail, wholesale, manufacturing, and service sales within an economy. IMPLAN was originally developed by the U.S. Department of Agriculture in cooperation with the Federal Emergency Management Agency (FEMA), the U.S. Department of Interior Bureau of Land Management, and the University of Minnesota to assist the US Forest Service in land and resource management planning. The IMPLAN analysis presented here estimates the impact of construction expenditures. Construction expenditures include costs for professional engineering, right of way, utilities, construction, and construction engineering. The economic impacts are assessed at the county level, and, in cases where the project lies in more than one county, a combination of counties is included in the model. The econometric models and survey also performed in this study are meant to capture the impacts of a project on local business revenue, job growth, business retention/attrition, and sales. The IMPLAN analysis reflects one-time investments while the econometric and survey analysis reflects continued changes over time that may be the result of mobility and accessibility impacts of the new bypass or widening project.

Methodology

The basic data sources for the current edition of the IMPLAN database and the models used in this study are the Input-Output Accounts of the US, developed by the U.S. Department of Commerce, Bureau of Economic Analysis (BEA), and county income and employment data published by BEA and the Bureau of Labor Statistics (BLS). The model reflects 2017 industrial structure and technology and 2017 prices. Trade flows and the results of this analysis were adjusted to reflect prices for their respective years. Economic output values and state and local tax revenues are presented in 2019 dollars.

IMPLAN uses a 536-sector input-output model to measure the effects of three types of impacts: direct, indirect, and induced. ***Direct impacts*** consist of employment and purchases of goods and services in the region resulting from the activity being evaluated, in this case, construction and services related to it. ***Indirect impacts*** (inter-industry) consist of goods and services purchased by the firms, which supply inputs consumed in the direct activity. ***Induced impacts*** consist of increased household purchases of goods and services in the region by employees of direct and indirect employers. The model generates ***multipliers***, which summarize the magnitude of the indirect and induced effects generated by a given direct change to estimate changes in output, income, and employment. In other words, the multiplier is the ratio of total impact to direct impact. In the IMPLAN model, inter-industry relationships ('use' and 'make' coefficients) are quantified based on data on the production functions of the different industries in the region. The IMPLAN model was used to estimate multipliers based on those coefficients in the state of Arkansas. Direct spending, total economic activity, total labor income, total employment, and total property income were generated by this model.

Data

The IMPLAN model was based on the start and completion date of the project at each study site and the cost of the project. The data on start and completion date was obtained from the documents provided by ArDOT. Job numbers without a work order date were assigned the same date as the earliest work order date of the same project. If the work order date was after September (during the fourth quarter of the year), the work was listed in the next calendar year.

The cost data provided by ArDOT included the cost for each phase of construction (preliminary engineering, right of way, utilities, construction, construction engineering) for each job number included for the project. Preliminary engineering involves environmental review, design and parcel surveys, planning, and development of construction plans. Right of way covers the cost for acquisition of any necessary land for the project, appraisal of properties, any necessary relocation affiliated with a project, and right of way plans for design purposes. For economic impact modeling, land acquisition is not included (real estate transfers don't involve any production), so an assumption of 6% of the amount listed under right of way is used to account for costs of surveying, real estate agents, etc. Engineering and cost for relocation of any reimbursable utilities is aggregated under utilities. Construction includes the costs associated with the construction of the project, primarily by construction contractors on most projects around the state. This includes increased/decreased costs from change orders. Construction engineering covers charges by ArDOT (or consultant) staff for inspection, billing review, and general oversight of the project during the construction phase. All monetary results from IMPLAN analysis are expressed in 2019 dollars.

Results and Key Findings

Results are presented as per capita impacts for each county in which the project was located. Per capita impacts help compare projects in different sized regions. The results for the total county impacts are provided for reference in **Appendix B**. The per capita values are calculated as the total county impacts divided by the population of the county for the year the impacts were estimated, which varies by project. The results of the IMPLAN analysis are presented for the following scenarios:

1. Per Capita Total Effects
2. Per Capita Direct, Indirect, and Induced Effects
3. Per Capita Total Effects by Lane-Mile

Per Capita Total Effects

Total employment is the total number of jobs in the county supported by construction activities. Total tax generated includes the taxes from employment compensation, production and imports, households, and corporations. Total labor income and total output are the incomes of labor and total economic impact, respectively, generated by the construction activities. The output multiplier is the amount of economic impact generated from every dollar of construction expenditure. All values are reported per capita such that the total impacts at the county level are divided by the county population.

Among the projects included in the study, the Gould widening project had the highest per capita total effects in each of the impact categories (employment, labor income, value added, output, and tax generated), whereas the Siloam Springs project had the lowest per capita total effects **(Figure 14)**.

Overall, the average per capita total employment of the bypass projects (15 jobs per 1,000 people or 0.015 jobs per capita) was higher than the average total employment of the widening projects (13 jobs per thousand people). The average per capita total labor income of the bypass projects ($549) was higher than the average for the widening projects ($526). On average, total value added of the bypass projects ($767) was higher compared to the widening projects ($719). The average total output of bypass projects ($2,123) was higher than the average total output of widening projects ($1,910). Average total tax generated by bypass projects ($55) was higher than the widening projects ($52).

Per Capita Direct, Indirect, and Induced Effects

Among the projects in this study, the Gould widening project had the highest per capita direct and induced effects in each of the impact categories (employment, labor income, value added, and output), whereas the Hardy bypass had the highest per capita indirect effects in each of the impact categories. Siloam Springs had the lowest per capita direct, indirect, and induced impacts.

Overall, the average per capita direct employment of the bypass projects (10 jobs per 1000 people or 0.01 jobs per capita) was higher than the average per capita direct employment of the widening projects (9 jobs per 1000 people or 0.009 jobs per capita) (**Figure 15**). The average per capita direct labor income of the bypass projects ($439) was higher than the average for the widening projects ($424). On average, per capita direct value added by the bypass projects ($536) was higher compared to the widening projects ($510). The average per capita direct output of bypass projects ($1,645) was higher than the average direct output of widening projects ($1,477).

Overall, the average per capita indirect employment of the bypass projects (1.9 jobs per 1000 people) was higher than the average per capita indirect employment of the widening projects (1.6 jobs per thousand people) (**Figure 16**). The average per capita indirect labor income of the bypass projects ($67) was higher than the average for the widening projects ($65). On average, per capita indirect value added by the bypass projects ($137) was higher compared to the widening projects ($122). The average per capita indirect output of bypass projects ($298) was higher than the average per capita indirect output of widening projects ($276).

Overall, the average per capita induced employment of the bypass projects (1.5 jobs per 1000 people) was higher than the average per capita induced employment of the widening projects (1.3 jobs per 1000 people) (**Figure 17**). The average per capita induced labor income of the bypass projects ($40) was higher than the average for the widening projects ($38). On average, per capita induced value added by the bypass projects ($94) was higher compared to the widening projects ($86). The average per capita induced output of bypass projects ($178) was higher than the average induced output of widening projects ($161).

Per Capita Total Effects by Lane-Mile

Considering the varied sizes of each project, for instance, Vilonia had a 41.6 lane-mile bypass while Siloam Springs had a 3.2 lane-mile widening project, more equitable comparisons among projects may be observed by examining impacts on a per lane-mile basis for bypass and widening projects. Note that the analysis of Total Effects by lane-mile is a post-processing analysis in that the Total Effects estimated by IMPLAN are divided by lane-mile. This is not the same as re-running the IMPLAN analysis with per lane-mile cost inputs.

Among the projects in the study, the Hardy bypass had the highest per capita total impacts per lane-mile in employment, labor income, value added, output, and tax generated (**Figure 18**). Vilonia bypass had the lowest per capita total impacts per lane-mile in each of the impact categories. The impact of bypass projects was higher compared to that of widening in terms of per capita total effects per lane-mile. The bypass projects had higher per capita total employment, total labor income, total output, and total tax generated per lane-mile added compared to the bypass projects.

Overall, the average per capita total employment per lane-mile of the bypass projects (1.2 jobs per 1000 people) was higher than the average per capita total employment per lane-mile of the widening projects (0.8 jobs per 1000 people). The average per capita total labor income per lane-mile of the bypass projects ($41) was higher than the average for the widening projects ($34). On average, per capita total value added per lane-mile of the bypass projects ($58) was higher compared to the widening projects ($47). The average per capita total output per lane-mile of bypass project ($170) was higher than the average total output per lane-mile of widening projects ($122). The average per capita tax generated per mile by bypass ($5) was higher than that by widening project ($3).

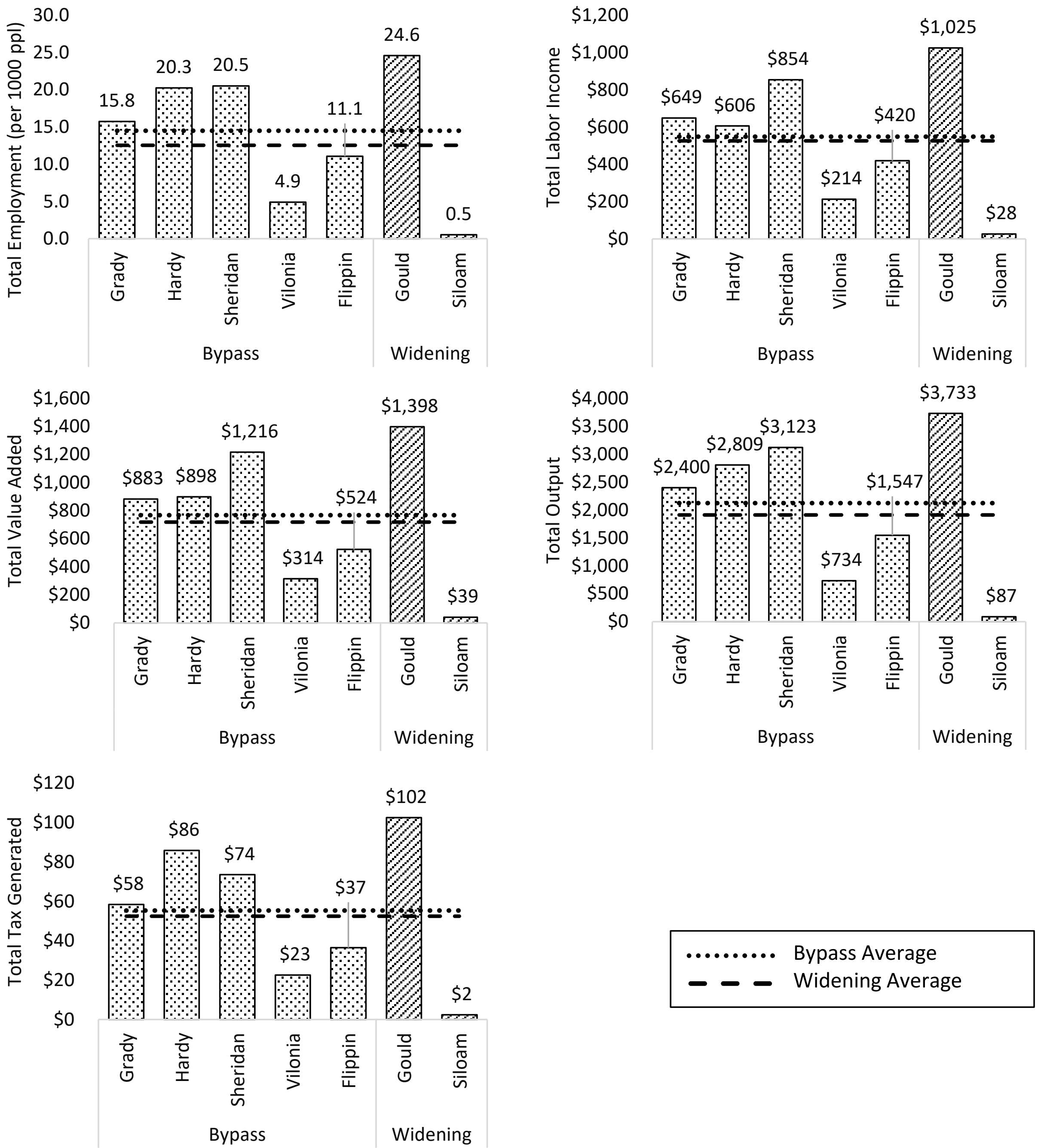


Figure 14. Summary of IMPLAN Per Capita Results for Total Effects

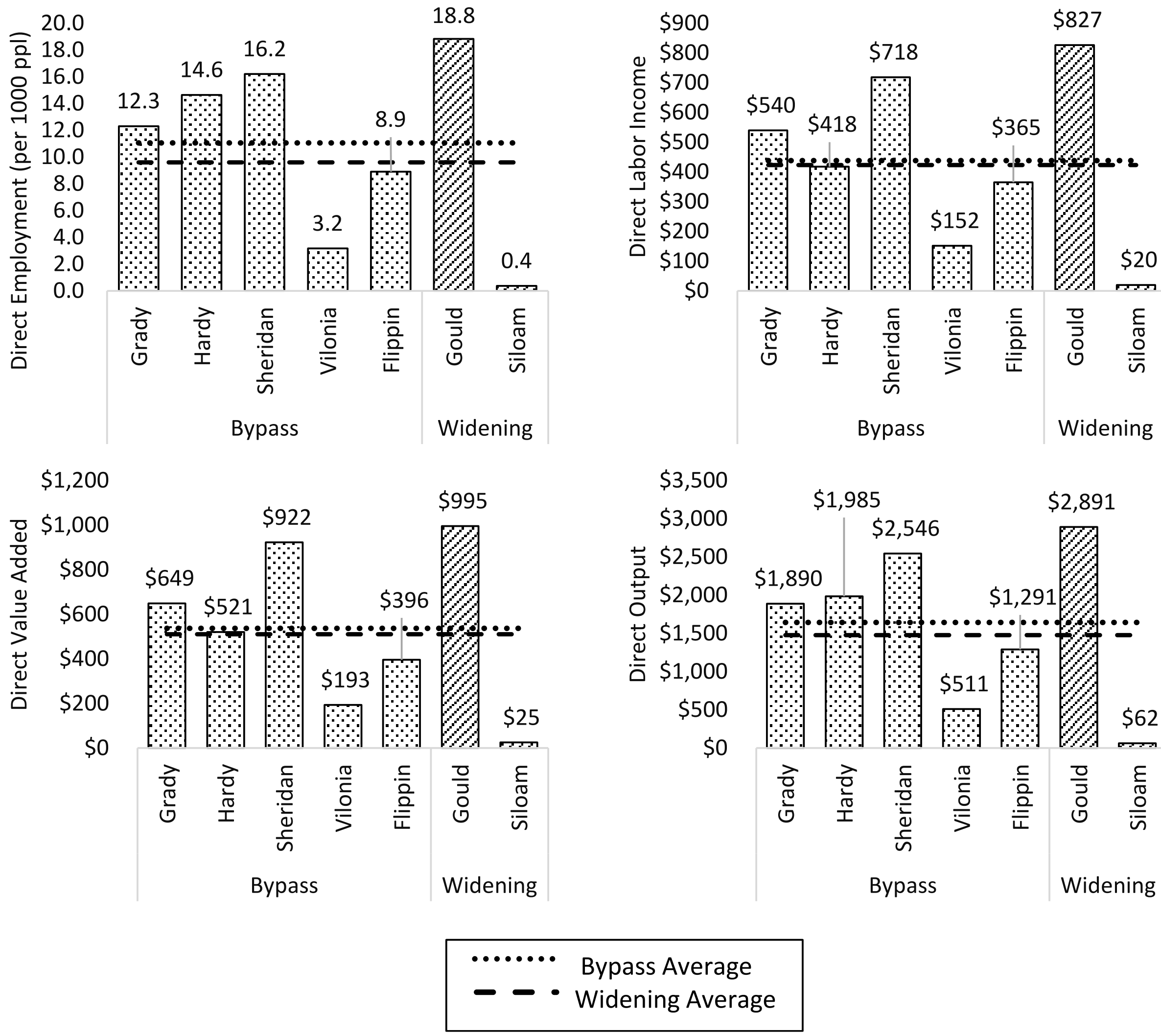


Figure 15. Summary of Per Capita IMPLAN Results for Direct Effects

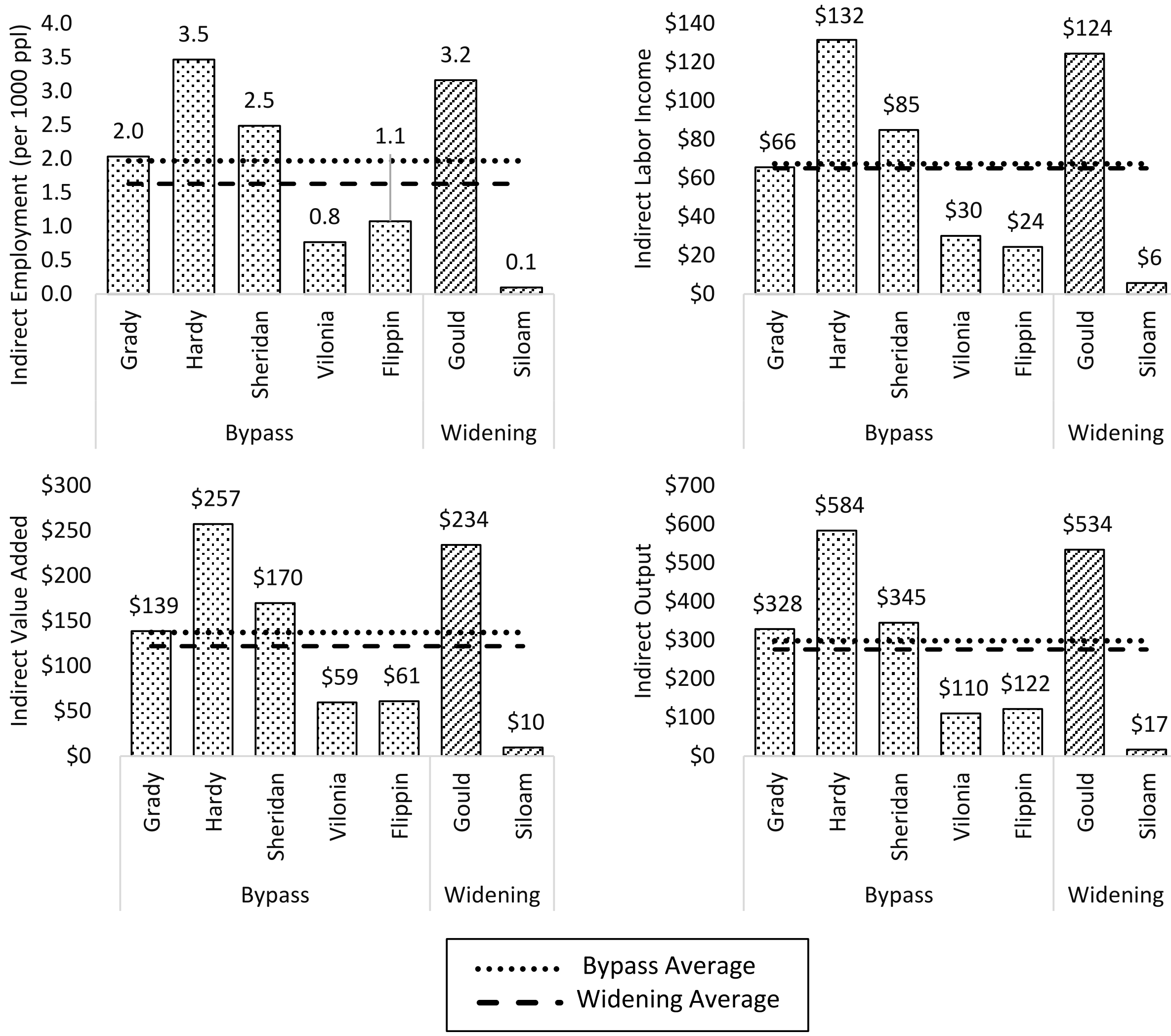


Figure 16. Summary of Per Capita IMPLAN Results for Indirect Effects

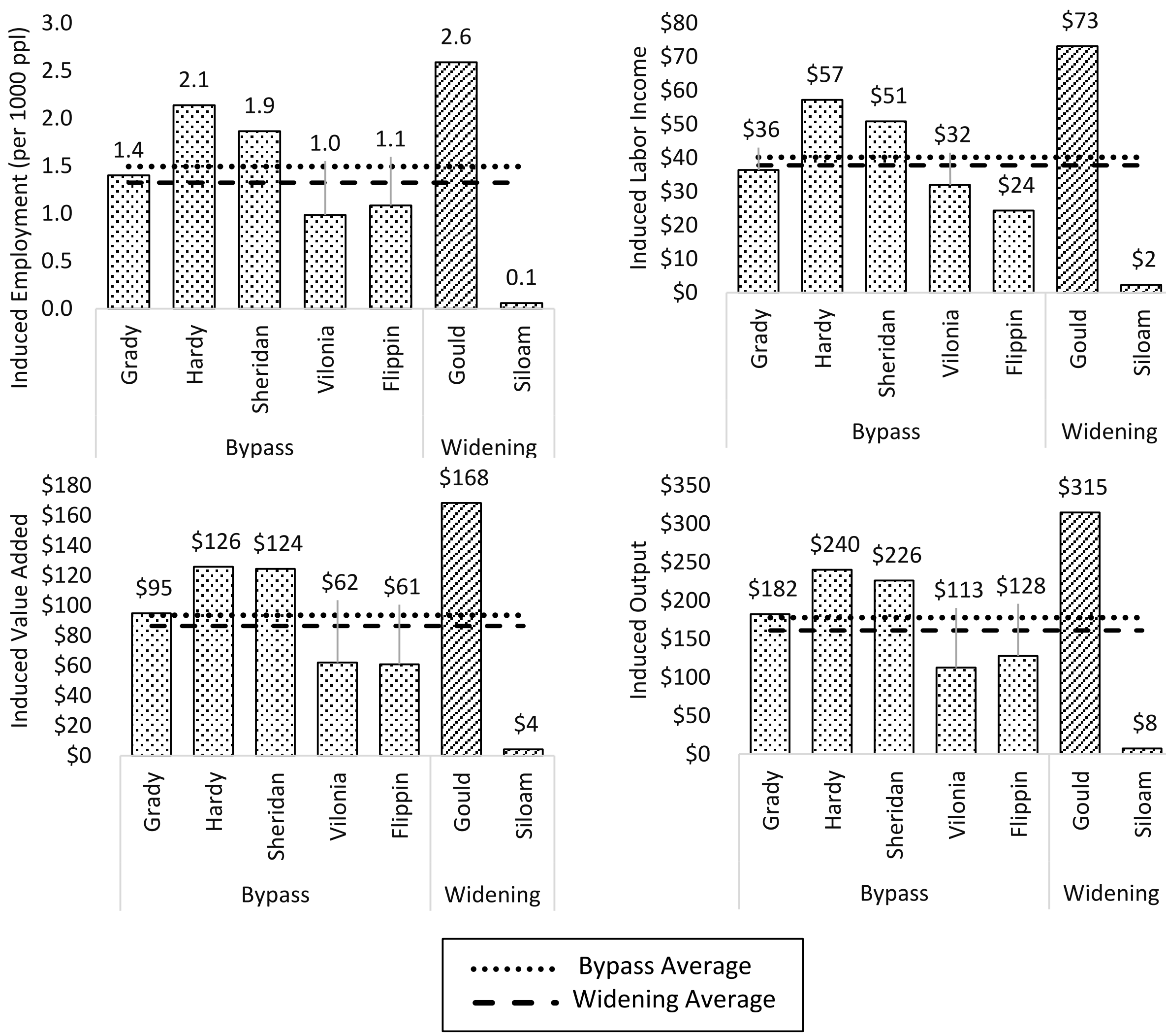


Figure 17. Summary of Per Capita IMPLAN Results for Induced Effects

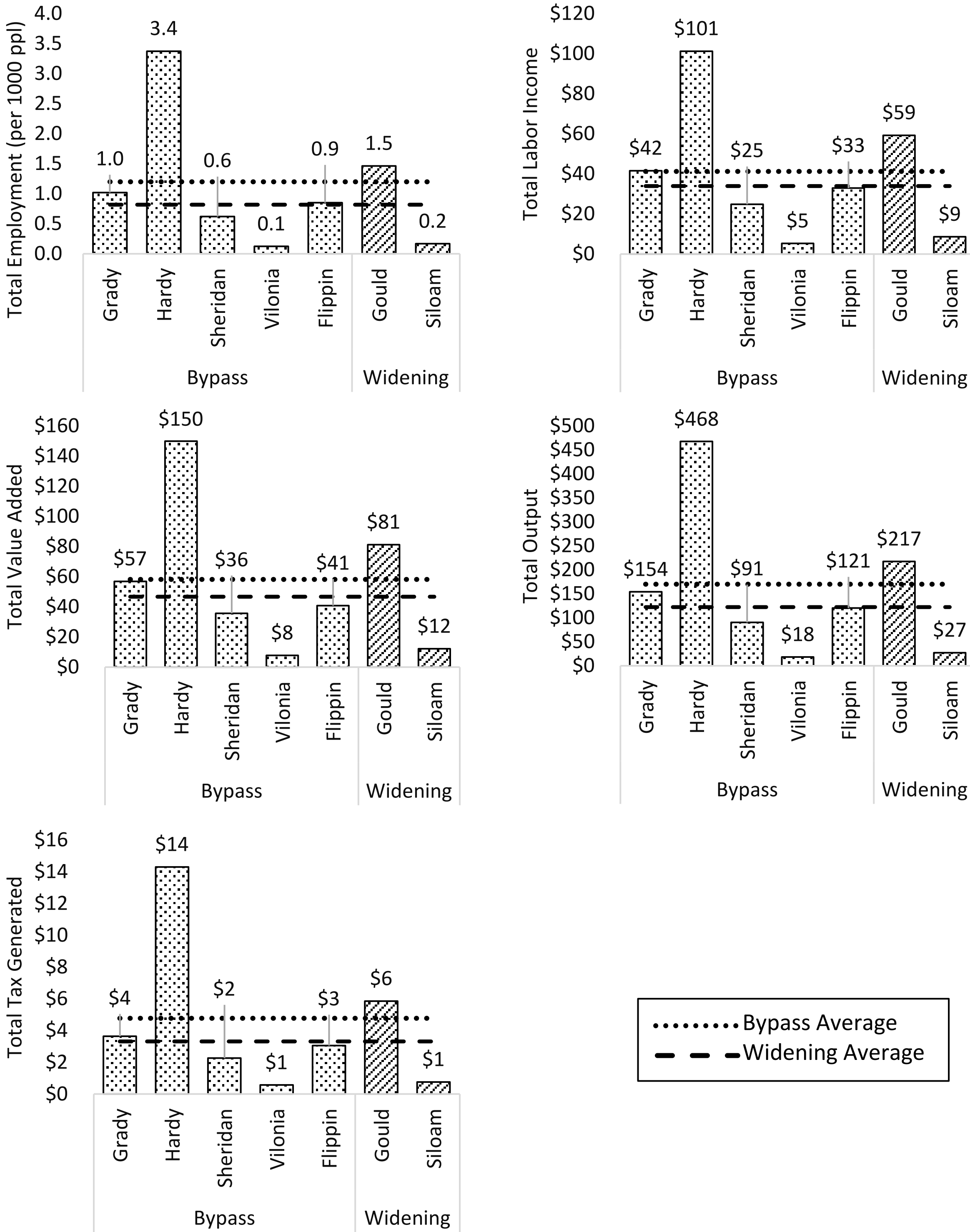


Figure 18. Summary of Per Capita IMPLAN Results for Total Impacts per Lane-Mile

3.2.2 Statistical Approaches

Two different statistical approaches were used to analyze the pre- and post-construction data for the study sites. First, time series analysis was used to compare linear projections of pre-construction trends to the post-construction period. Second, statistical comparisons (hypothesis test, e.g., t-tests) were conducted to compare changes in economic variables during pre- and post- construction periods to draw conclusions about the statistical significance of construction activity on economic changes. The methods presented in this section were developed using Microsoft (MS) Excel tools.

<u>Trend Analysis of Study Sites for Pre- and Post-Construction Periods</u>

Methodology

The trend analysis compares the time series behavior of pre- to post-construction periods. A linear projection based on the pre-construction period is compared to the post-construction period so that qualitative remarks can be made as to overall deviation, trend, and volatility. Deviation can be insignificant, moderate, or significant, respectively, in order of increasing deviation. Trend can be increasing, decreasing, or converging. A trend is said to be converging when the post-construction trend line is like the pre-construction trend line. Volatility refers to the year-to-year fluctuations and can be low, moderate, or high. Three indicators are compared: (i) population density, (ii) Average Daily Traffic or 'ADT', and (iii) land transfers for commercial properties or 'transfer' (**Table 9**). Note the assessments of the trends are subjective and are thus provided for context for the statistical analysis in the next section. Time series graphs are shown for each site in **Appendix C.**

Results and Key Findings

- *ADT* on the main road in bypassed cities significantly decreased in four of five cities with respect to a linear projected trend line. In Grady, the ADT on the main road did not change. The *ADT* in the widening sites had mixed trends. These results are as anticipated considering the purpose of the bypass is to shift traffic away from the main road through town.
- The trends in *population density* were mixed. There was significant increase in population density in Grady. Population density in Hardy and Flippin decreased. Population density in Sheridan and Vilonia did not change after the construction of the bypass. Trends were mixed for the widening sites. Changes in population density help to indicate the degree to which housing structure may change over time.
- The trends in commercial *property transfer* were mixed in bypassed cities, but transfers increased in cities with widening projects. The amount of commercial property transfers significantly decreased in Grady, Hardy, and Flippin but increased in Sheridan and Vilonia. In cities with widening projects, the amount of commercial property transfers significantly increased. Trends in community property transfers indicate shifts in local economic conditions.

Table 9. Trend Analysis Summary

(A) Bypass Study Sites

Measure	Post-Construction	Grady	Hardy	Sheridan	Vilonia	Flippin	Overall Trend
Population	Deviation	Significant	Significant	Not Significant	Not Significant	Moderate	Mixed
	Trend	Increase	Decrease	Converge	Converge	Decrease	Mixed
	Volatility	High	Moderate	Low	Low	High	Mixed
ADT	Deviation	Moderate	Significant	Significant	Significant	Significant	Mixed but more significant
	Trend	Converge	Decrease	Decrease	Decrease	Decrease	Mixed with more decrease
	Volatility	High	Moderate	Moderate	Low	Moderate	Mixed with more moderate
Transfer	Deviation	Significant	Significant	Significant	Significant	Significant	Significant
	Trend	Decrease	Decrease	Increase	Increase	Decrease	Mixed with more decrease
	Volatility	High	High	High	High	High	High

(B) Widening Study Sites

Measure	Post-Construction	Gould	Siloam Springs	Overall Trend
Population	Deviation	Moderate	Not significant	Mixed
	Trend	Decrease	Converge	Mixed
	Volatility	Moderate	Low	Mixed
ADT	Deviation	Moderate	Moderate	Moderate
	Trend	Increase	Decrease	Mixed
	Volatility	High	Moderate	Mixed
Transfer	Deviation	Significant	Significant	Significant
	Trend	Increase	Increase	Increase
	Volatility	High	High	High

<u>Statistical Comparisons of Pre- and Post-Construction Periods</u>

Methodology

The statistical analysis compares sociodemographic and economic variables during the pre- and post-construction periods using a hypothesis test (e.g., a t-test). This test indicates the existence of a 'structural break' in the trend in economic activities brought about by the construction projects. If the construction project created structural breaks, we would expect the mean values of the variables to be significantly different between the pre- and post-construction periods, therefore rejecting the null hypothesis that the mean value of the variables between pre- and post- construction are equal (p-value ≥ 0.05) and indicating that the project had an impact on the variable in question. Statistical significance of discrepancies in the pre- and post-construction periods are based on a 95% confidence interval.

Results and Key Findings

- Results show strong evidence in favor of structural breaks caused by the construction projects in target cities, especially for bypass construction with some specific differences in the sets of variables that exhibit structural breaks (**Table 10**).

- Overall, *establishments* in the city, total *per capita GDP*, and *per capita GDP* for real estate were found to differ pre- and post-construction (**Table 10**).
- For widening sites*, home price* was found to be the same pre- and post-construction (**Table 10**).

Table 10. Statistical Comparisons of Structural Breaks by Project Study Site

(A) Bypass Study Sites

Measure	Grady	Hardy	Sheridan	Vilonia	Flippin	Overall Effect
Transfers	No Dif.**	Dif.**	No Dif.**	No Dif.**	No Dif.**	Mixed but showing no difference
Sales Tax Revenue	Dif.**	No Dif.**	Dif.**	Dif.**	Dif. *	Mixed but showing difference
Pop. Density	No Dif.**	Dif.**	Dif.**	Dif.**	Dif.**	Mixed but showing difference
Home Price	Dif.**	Dif.**	Dif.**	Dif.**	-	Difference
GDPPC RRL	Dif.**	Dif.**	Dif.**	Dif.**	Dif.**	Difference
GDPPC Retail	Dif.**	Dif.**	Dif.**	Dif.**	Dif.**	Difference
GDPPC All	Dif.*	Dif.**	Dif.**	Dif.**	Dif.**	Difference
Establish. City	Dif.*	Dif.**	Dif.*	Dif.**	Dif.**	Difference
Employees City	No Dif.**	Dif.*	Dif.**	Dif.**	No Dif.**	Mixed
ADT Main	No Dif.**	Dif.**	Dif.**	Dif.**	Dif.**	Mixed but showing difference

- Dif.** = pre and post construction variables are significantly different at the 95% confidence level (p-value < 0.05)
- Dif.*= pre and post construction variables are significantly different at the 90% confidence level (p-value < 0.10)
- No Dif.**= pre and post construction variables are not significantly different at the 95% confidence level (p-value < 0.05)
- '-' indicates data unavailability

(B) Widening Study Sites

Measure	Gould	Siloam Springs	Overall Effect
Transfers	No Dif.**	Dif.*	Mixed
Sales Tax Revenue	Dif.*	Dif.*	Difference
Pop. Density	Dif.*	Dif.*	Difference
Home Price	No Dif.*	No Dif.*	No difference
GDPPC RRL	Dif.*	Dif.*	Difference
GDPPC Retail	No Dif.*	Dif.*	Mixed
GDPPC All	Dif.*	Dif.*	Difference
Establish. City	Dif.*	Dif.*	Difference
Employees City	Dif.*	Dif.*	Difference
ADT Main	Dif.*	No Dif.*	Mixed

- Dif.* = pre and post construction variables are significantly different at the 95% confidence level (p-value < 0.05)
- No Dif.*= pre and post construction variables are not significantly different at the 90% confidence level (p-value < 0.10)
- No Dif.**= pre and post construction variables are not significantly different at the 95% confidence level (p-value < 0.05)

3.2.3 Econometric Analysis

Econometric models (regression) were used to relate the impacts in and of sociodemographic and economic variables to construction of bypass and widening projects. The first model (Model 1) compares the time series (annual) differences pre- and post- construction for each of the study sites. The second model (Model 2) compares the study sites to control (matched) cities. Control cities have similar sociodemographic (population, pop. density), economic (distress), and highway characteristics. The methods presented in this section were developed using Stata, a general-purpose commercial software for statistical analysis. All models can be developed and applied for any single study site using MS Excel, however Stata was used to handle the large amount of data from all study sites more efficiently.

<u>Model 1: Time Series Analysis of Pre- and Post-Construction Periods</u>

Methodology

The formulation in **Equation 2** was used to estimate the time series models to assess the impacts of various parameters on pre- and post-construction impacts. The model captures the year-to-year differences in the natural logarithm (ln) of study variables (home price, employment, etc.) on selected study variables (home price, employment, etc.), treating the 'years' variable as a dummy indicator variable (e.g., '0' before the construction and '1' after the construction) (**Equation 2**). The goal was to determine if the construction project had an effect on any economic and/or demographic variables.

$$lnY_t = BlnX_{t-1} + D_t + \epsilon_t \quad \textbf{Equation 2}$$

Where,

Y	=	Dependent variable, one of each of the sociodemographic and economic variables in **Table 6**
X_{t-1}	=	Vector of one period (one year) lagged independent variables
B	=	Vector of regression coefficients for X_t
D_t	=	1 for years after the construction/improvement 0 for before the construction/improvement
ϵ_t	=	Error term

Results and Key Findings

- Overall, ADT decreased (negative coefficient) in cities with a bypass and increased (positive coefficient) in cities with widening projects. Construction of bypass and widening projects significantly boosted components of GDP and generally had positive effects on the local economy (**Table 11**).
- Results of bypass construction on local economies appear to be consistent across study sites with the following noted specific trends (**Table 11**). Each of these effects are significant and wide ranging, e.g., an 80% decline in transfer for Flippin to a 116% increase in transfers for Vilonia. Among the bypass cities, construction appears to have
  - *<u>increased</u> per capita GDP* for all industries and specifically for *retail* (except for Grady), *real estate*, *population density, sales tax revenue* (except for Grady), *the number of employees and establishments in the city*, and *home price* (except for Sheridan);
  - *<u>reduced</u> ADT along the main road*;
  - *<u>had mixed effects</u>* on *commercial property transfers*, decreasing in two cities (Grady and Hardy) while increasing in two others (Sheridan and Vilonia);

- *increased (significant) population density* which may indicate that people moved in or moved back to these cities. Retail services such as gas stations, departmental stores, restaurants, and hotels also tend to see growth as a result of population increase and rise in employment and establishments which, in turn, contributes to the rise in sales tax revenue and a growth in home prices and estate rental, and leasing.

- Results of widening construction on local economies appear to be consistent across study sites for fewer variables compared to bypass projects (**Table 11**). Each noted effect is significant and wide ranging, e.g., a 37% decline in city level employment in Gould to a 160% increase in transfers for Gould. Among the widening cities, construction appears to have
  - consistently *increased* per capita GDP for all industries and *ADT on the main road, sales tax revenue, and transfers*;
  - *had mixed effects* on number of employees and establishments of the city, home price, and population density, and per capita GDP for the retail and real estate industries

The difference in several macroeconomic experiences between the two widening project sites suggests a more fundamental difference between these two cities and how road widening affected them. Gould is a farming community with rural land uses. Siloam Springs is close to several big cities such as Bentonville and Rogers and has considerably more commercial business along the widened road than in Gould.

Table 11. Results of Pre- and Post-Construction Time Series Econometric Analysis

(A) Bypass Study Sites

Variable	Percentage Change in Key Variables After Improvement (%)					Overall Effect
	Bypass					
	Grady	Hardy	Sheridan	Vilonia	Flippin	
Transfers	-76.0	-80.4**	80.9**	116.4**	-32.3*	Mixed
Sales Tax Revenue	-18.8**	8.7**	14.7**	50.5**	25.7**	Mixed
Population Density	56.3**	11.5**	4.2**	16**	10.2**	Increase
Home Price	17.0**	19.1**	-17.4**	6.3**	-	Mixed
GDPPC RRL	20.5**	28.3**	4.8**	17.7**	16.4**	Increase
GDPPC Retail trade	-16.3**	6.4**	10.9**	8.9**	13**	Mixed
GDPPC All	11.3**	6.1**	7.2**	2.5	26.5**	Increase
Establishments in City	60.9**	14.7**	8.2**	28.2**	14.6**	Increase
Employees in City	68.4**	15.2**	5.9**	23.4**	40**	Increase
ADT Main	-7.1	-49.9**	-39.3**	-54.7**	-58.1**	Decrease

- Unless otherwise noted, all the estimation results are not significant.
- **Statistically significant at 5% level of significance
- *Statistically significant at 10% level of significance
- '-' cells indicate the unavailability of data for the analysis of the respective variable.
- Overall Effect summarizes the positive, negative, or mixed change in percentage of key variables for bypass and widening projects.

Table 11. Results of Pre- and Post-Construction Time Series Econometric Analysis (Cont.)

(B) Widening Study Sites

Variable	Percentage Change in Key Variables After Improvement (%)		Overall Effect
	Widening		
	Gould	Siloam Springs	
Transfers	168.7**	112.6**	Increase
Sales Tax Revenue	56.5**	41.4**	Increase
Population Density	-36.0**	10.7**	Mixed
Home Price	11.1**	-9.9**	Mixed
GDPPC RRL	19.2**	-7.4**	Mixed
GDPPC Retail trade	-15.8**	17.7**	Mixed
GDPPC All	14.1**	10.4**	Increase
Establishments in City	-15.6**	20.2**	Mixed
Employees in City	-37.3**	11.3**	Mixed
ADT Main	6.0**	7.5**	Increase

- Unless otherwise noted, all the estimation results are not significant.
- **Statistically significant at 5% level of significance
- '-' cells indicate the unavailability of data for the analysis of the respective variable.
- Overall Effect summarizes the positive, negative or mixed change in percentage of key variables in bypass and widening.

Model 2: Matched-Pair Analysis

Methodology

The formulation in **Equation 3** was used to estimate the change in a dependent variable (home price, population, etc.) for target (study) cities relative to control (matched) cities .As suggested by the literature *[29-31]*, four matched cities were selected for each study site. To select control cities, the more than 500 cities in Arkansas were ranked based on similarity to each study site. For this, the average percentage difference in population, population density, per capita income, and median house value was calculated between each study site and each possible control city. Due to unavailability of time series data on per capita income and median house value at the city level, the average difference was calculated based on year 2000 data. The control cities were then ordered in ascending order based on the average difference.

$$D(Y_t) = BD(X_{t-1}) + Z_{t-1} + D_t + \epsilon_t \quad \textbf{Equation 3}$$

Where,

$D(Y_t)$ = The difference between the dependent variable for the target city and average value of the dependent variable from the control cities

$D(X_{t-1})$ = Vector of difference between a set of lagged independent variables for the target cities and the average value of their counterpart from the control cities

B = Vector of regression coefficients for $D(X_t)$

D_t = 1 for years after the construction/improvement
0 for before the construction/improvement

Z_{t-1} = Vector of lagged independent variables from the target cities, $X \cap Z = \emptyset$

The matched cities were then manually selected from among the top 10 to 15 statistically similar cities based on the following additional criteria:

1. *Project Setting:* The control city was discarded if the project setting (rural or urban), based on the Core Based Statistical Area, did not match that of the study city.
2. *Location:* The control city was discarded if it was located in close proximity to the main interstate highways since none of the study cities were located close to interstate highways.
3. *Highway Characteristics:* Highway functional classification was used to compare the highway characteristics between the control and study cities. For example, if the study city had a highway of functional class 2, priority was given to control city that also contained a functional class 2 highway. However, if the functional classes did not match but all other comparative parameters did match, further analysis was made by looking at the number of lanes and type of median of the control and study city highways. For example, if the study city had highway of functional class 2, and control city had functional class 3, then number of lanes and type of median were compared. If they match, then the city was not discarded even though they had a difference in functional class.
4. *Data Availability:* As most of the time series data was limited to the city level, priority was given to the control city that had data on sales and use tax collected at the city level.

The comparison between the study cities and control cities is based on the average of the four control cities.

Results and Key Findings

- Overall, results indicate that the bypass and widening projects had a significantly positive macroeconomic effect on study sites, boosting various types of macroeconomic activities **(Table 12**).
- For bypass cities:
    - *Increases* relative to control cities were found to be significant *for per capita GDP for all industries* specifically for *real estate, sales tax revenue, city employment,* and *city establishments*.
    - *Decreases* relative to control cities were found for *ADT* along the main road.
    - There were mixed results for *per capita GDP* for retail industry and *home prices*.
- Among the two widening study sites:
    - *Increases* relative to control cities were found to be significant for *per capita GDP for all industries*, specifically for *retail, sales tax revenue, and ADT*.
    - There were mixed results for *per capita GDP* for *real estate*, *population density*, *city employment*, *city establishments*, and *home prices*.

Table 12. Results of Pre- and Post-Construction Relative to Control Cities

(A) Bypass Study Sites

Measure	Percentage (%) Change					Overall Effects
	Grady	Hardy	Sheridan	Vilonia	Flippin	
Sales Tax Revenue	(-) ≤ 180.0	(+) ≤ 22.3**	(+) ≤ 2.1	(+) ≥ 91.0	(+) ≥ 77.3**	Increase
Population Density	(+) ≥ 503.4	(+) ≤ 0.3**	(+) ≤ 0.0**	-	(+) ≥ 24.4	Increase
Home Price	(+) ≥ 38.3**	(+) ≥ 0.8**	(-) ≥ 0.2**	(+) ≥ 34.8**	-	Mixed but more increase
GDPPC RRL	(+) ≤ 47.3**	(+) ≤ 115.6**	(+) ≥ 0.4**	(+) ≤ 56.6**	(+) ≥ 297.4**	Increase
GDPPC Retail trade	(-) ≤ 17.2**	(+) ≥ 136.6**	(+) ≥ 0.2**	(+) ≥ 61.5**	(+) ≤ 0.2	Mixed but more increase
GDPPC All	(+) ≥ 25.2**	(+) ≤ 151.6**	(+) ≥ 29.2**	(+) ≥ 6.16	(+) ≥ 134.7**	Increase
Establishments in City	(+) ≥ 85.8	(+) ≥ 38.4**	(+) ≥ 0.1**	(+) ≥ 66.1**	(+) ≤ 29.8**	Increase
Employees in City	(+) ≥ 54.8*	(+) ≥ 172.8**	(+) ≥ 0.1**	-	(+) ≤ 188.9*	Increase
ADT Main	(-) ≤ 17.8**	(-) ≤ 152.6**	(-) ≤ 0.10*	(-) ≤ 197.6**	(-) ≤ 543.0**	Decrease

- Cells can be interpreted as: "(-)≤ 152.6" can be read as "the percentage decrease is less than or equal to 152.6%" and "(+) ≥ 172.8" can be read as "the percentage increase is more than or equal to 172.8%".
- Unless otherwise noted, all the estimation results are not significant.
- **Statistically significant at 5% level of significance
- *Statistically significant at 10% level of significance
- All the variables are represented as the difference between the control and study cities for the same year.
- '-' cells indicate the unavailability of data for the analysis of the respective variable.

(B) Widening Study Sites

Measure	Percentage (%) Change		
	Gould	Siloam Springs	
Sales Tax Revenue	(+) ≤ 28.5**	(+) ≤ 170.4*	Increase
Population Density	(-) ≤ 116.0**	(+) ≥ 69.6**	Mixed
Home Price	(+) ≥ 13.6**	(-) ≥ 34.3**	Mixed
GDPPC RRL	(+) ≤ 55.8**	(-) ≤ 212.8*	Mixed
GDPPC Retail trade	(+) ≥ 25.3**	(+) ≥ 156.7*	Increase
GDPPC All	(+) ≥ 15.1**	(+) ≤ 100.2*	Increase
Establishments in City	(-) ≤ 43.4**	(+) ≥ 40.5**	Mixed
Employees in City	(-) ≤ 41.1**	(+) ≥ 95.1**	Mixed
ADT Main	(+) ≤ 191.1*	(+) ≤ 37.5**	Increase

- Cells can be interpreted as: "(-)≤ 152.6" can be read as "the percentage decrease is less than or equal to 152.6%" and "(+) ≥ 172.8" can be read as "the percentage increase is more than or equal to 172.8%".
- Unless otherwise noted, all the estimation results are not significant.
- **Statistically significant at 5% level of significance
- *Statistically significant at 10% level of significance
- All the variables are represented as the difference between the control and study cities for the same year.
- '-' cells indicate the unavailability of data for the analysis of the respective variable.

3.2.4 Synthesis of Economic Impact Findings

In addition to the regional economic impact analysis using IMPLAN, three statistical approaches were applied to assess the impacts of bypass and widening projects on a number of sociodemographic variables. These included an analysis of structural breaks in the time series of each variable, regression of pre- and post-construction time series, and comparisons of sociodemographic conditions relative to matched cities. The purpose of the analyses was to determine if the projects had a statistically significant impact on the socioeconomic structures of the communities in which they were built. Comparing per capita impacts on the region by project lane-mile, bypass study sites had a higher median employment, labor income, value added, output, and tax revenue generated than widening sites (**Table 13**). Hardy had significantly higher impacts than any other project across all categories. This can be attributed to the timing of construction and project cost. The Hardy bypass was constructed between 2003 to 2005 while all other projects were constructed around the time of the economic recession from 2007 to 2009. Hardy had the highest cost per lane mile after Siloam Springs.

Table 13. Summary of Regional Economic Impact Analysis using IMPLAN

Project Type	**Bypass Projects**						**Widening**		
Study Site Value Added per capita per lane-mile	**Grady**	**Hardy**	**Sheridan**	**Vilonia**	**Flippin**	***Median***	**Gould**	**Siloam Springs**	***Median***
Employment (jobs per 1000 ppl)	1.0	3.4	0.6	0.1	0.9	0.9	1.5	0.2	0.8
Labor income	$42	$101	$25	$5	$33	$33	$59	$9	$34
Value added	$57	$150	$36	$8	$41	$41	$81	$12	$47
Output	$154	$468	$91	$18	$121	$121	$217	$27	$122
Tax generated	$4	$14	$2	$1	$3	$3	$6	$1	$3

For bypass study sites, the statistical analyses support the conclusion that bypass projects cause a statistically significant increase in the per capita GDP for real estate and rentals, per capita GDP overall, and the number of establishments in the city (**Table 14**). Weaker evidence was found to support the statistical significance of bypass projects causing increases in sales tax revenue, population density, home price, per capita GDP for retail, and the number of employees in the city. Overall, there were no statistically significant decreases in the sociodemographic variables analyzed in the study that could be attributed to the construction of a highway bypass. In all bypass study sites, there was a decrease in ADT along the main route through town, and this could be statistically attributed to the construction of the bypass. For widening study sites, considering there were only two sites, less definitive conclusions could be drawn (**Table 15**). For most sociodemographic variables, the effect of the widening project in Gould was incongruent with the effect in Siloam Springs. Thus, the conclusion drawn from examining these two projects is either mixed (increase in one city and decrease in another) or unknown (one city had insignificant statistical results). Like the bypass sites, by examining the time series regression, it was found that there were statistically significant increases in sales tax revenue and per capita GDP for all categories. However, these increases were not found to be statistically significant for both study sites when compared to control cities. This means that without investigating additional widening study sites, no definitive conclusions can be drawn.

Table 14. Synthesis of Economic Impact Assessments for Bypass Study Sites

Measure	Structural Breaks (statistical hypothesis test)	Time Series (regression)	Matched Cities (regression)
Method explanation	Evaluates shifts (breaks) in the time series at the point in time when the project was completed. This method only determines if there was a shift in the variable at a certain point in time not if the project had an impact on that variable. A finding of "difference" indicates there was a statistically significant shift in the variable at the time when the bypass construction was completed. A finding of "no difference" indicates there was no change in the trend of the variable at the point in time when the bypass construction was completed. A finding of "mixed" indicates that while some study sites had significant breaks, other study sites did not.	Evaluates the impact of a project on a variable over time. Unlike the structural breaks, the time series analysis detects if the project had an impact on the variable over time. The findings indicate the degree to which the variable was impacted by the project. A finding of "mixed" indicates that some study sites experienced an increase in the variable while others experienced a decrease in the variable due to the project. A finding of "increase" indicates that the project had an overall positive effect of increasing the variable. A finding of "decrease" means the project had a negative effect on the variable. A finding of "mixed but showing increase" means that for all statistically significant results, the majority (but not all) study sites showed the project had a positive impact on the variable.	Evaluates the impact of a project on a study site relative to a set of matched cities. Unlike the time series analysis, the matched city analysis indicates if there was a statistically significant impact on a variable relative to other cities with the same highway and sociodemographic characteristics. A finding of "increase relative to control cities" indicates that the project contributed to an increase in the variable above what was observed at similar cities without bypass projects. A finding of "mixed but more increase" indicates that while the majority of study sites experienced an increase in the variable relative to control cities, other study sites experienced a decrease. A finding of "decrease relative to control cities" indicates that the project contributed to a decrease in the variable above what was observed at similar cities without bypass projects.
Transfers	Mixed but showing no difference for a majority of sites	Mixed	N/A (data not available for matched cities)
Sales Tax Revenue	Mixed but showing a difference for the majority of sites	Mixed but showing increase	Increase relative to control cities
Pop. Density	Mixed but showing a difference for the majority of sites	Increase	Increase relative to control cities
Home Price	Difference	Mixed but showing increase	Mixed but more increase
GDPPC RRL	Difference	Increase	Increase relative to control cities
GDPPC Retail	Difference	Mixed but showing increase	Mixed but more increase
GDPPC All	Difference	Increase	Increase relative to control cities
Establish. in City	Difference	Increase	Increase relative to control cities
Employees in City	Mixed	Increase	Increase relative to control cities
ADT Main	Mixed but showing a difference for the majority of sites	Decrease	Decrease relative to control cities

Table 15. Synthesis of Economic Impact Assessments for Widening Study Sites

Measure	Structural Breaks (statistical hypothesis test)	Time Series (regression)	Matched Cities (regression)
Method explanation	Evaluates shifts (breaks) in the time series at the point in time when the project was completed. This method only determines if there was a shift in the variable at a certain point in time not if the project had an impact on that variable. A finding of "difference" indicates there was a statistically significant shift in the variable at the time when the bypass construction was completed. A finding of "no difference" indicates there was no change in the trend of the variable at the point in time when the bypass construction was completed. A finding of "mixed" indicates that while some study sites had significant breaks, other study sites did not.	Evaluates the impact of a project on a variable over time. Unlike the structural breaks, the time series analysis detects if the project had an impact on the variable over time. The findings indicate the degree to which the variable was impacted by the project. A finding of "mixed" indicates that some study sites experienced an increase in the variable while others experienced a decrease in the variable due to the project. A finding of "increase" indicates that the project had an overall positive effect of increasing the variable. A finding of "decrease" means the project had a negative effect on the variable. A finding of "mixed but showing increase" means that for all statistically significant results, the majority (but not all) study sites showed the project had a positive impact on the variable.	Evaluates the impact of a project on a study site relative to a set of matched cities. Unlike the time series analysis, the matched city analysis indicates if there was a statistically significant impact on a variable relative to other cities with the same highway and sociodemographic characteristics. A finding of "increase relative to control cities" indicates that the project contributed to an increase in the variable above what was observed at similar cities without bypass projects. A finding of "mixed but more increase" indicates that while the majority of study sites experienced an increase in the variable relative to control cities, other study sites experienced a decrease. A finding of "decrease relative to control cities" indicates that the project contributed to a decrease in the variable above what was observed at similar cities without bypass projects. A finding of "unknown" indicates the one of the study sites had insignificant results so no conclusions can be drawn.
Transfers	Mixed	Increase	N/A
Sales Tax Revenue	Difference	Increase	Increase
Pop. Density	Difference	Mixed	Mixed
Home Price	No Difference	Mixed	Mixed
GDPPC RRL	Difference	Mixed	Mixed
GDPPC Retail	Mixed	Mixed	Increase
GDPPC All	Difference	Increase	Increase
Establish. City	Difference	Mixed	Mixed
Employees City	Difference	Mixed	Mixed
ADT Main	Mixed	Increase	Increase

3.3 PUBLIC PERCEPTIONS OF ECONOMIC IMPACTS

Public perceptions of economic impacts include an assessment of community development through interviews with local community leaders and members. This allowed the research team to capture factors influencing economic changes that may/may not be attributed to the highway improvement project.

3.3.1 Survey Development

Survey question themes centered on business, crash occurrence, economic development, property values, tourism, and traffic following recommended question themes provided in EconWorks. For bypass projects, the interviewees were asked about observed changes on the main road, the bypass road, and if there were any other factors besides the construction of the bypass which could affect changes in the city. For widening projects, questions were phrased to capture perceived changes in the widened road before and after its construction. For cities with no treatment implemented, the interview questions were tailored to capture the observed changes before and after it was communicated to the public that no project would be put forward.

3.3.2 Survey Implementation

According to EconWorks, the following parties should be included in the interview and survey process:

(a) *State DOT and Local planning agency staff*: to provide information on project planning and implementation, and changes in local land use and ways in which the highway project influenced land-use changes,
(b) *Local chamber of commerce and community members*: to provide information on how the project affected business growth, investment, and community development, and
(c) *Private business owners*: to provide information about the role of the construction project in business growth, location, etc.

After working with the ARDOT project coordinator, it was determined that many ARDOT staff involved in the original construction project planning phases have retired and were not able to be contacted for this project. Therefore, interviews with Group (a) were not conducted.

Interviews were conducted by phone (10-20 minutes) with community members (Group b) and business owners (Group c) who were involved in the original project development and planning public hearing meetings. Contact information was gathered from sign-in documents from past public hearing meetings provided by ARDOT. The research team mailed invitation letters to participants stating the objectives of the survey and asking for follow-up contact by phone or email. **Appendix D** contains the invitation letter and surveys developed for each party involved in the survey process. Significant effort was made to update addresses. Additionally, business owners who were in the study area after the original public hearing meetings were identified through visual inspection of the study corridor using Google Maps.

The first round of invitation letters was sent on February 21st, 2020, with several repeat mailings occurring through June 5th, 2020 (**Table 16**). Overall, we conducted 24 interviews as of October 20th, 2020, representing a response rate of approximately 14%. This is in line with typical mail-out, call-back surveys. By city, response rates varied, with several cities resulting in a zero percent response rate (**Table 17**). It should be noted that because of the current COVID-19 pandemic, the UA suspended on-campus operations on March 18th, 2020, at which time mailings to local businesses and chambers of commerce were suspended by the project team. We suspect that the low response of businesses could be due to the pandemic, e.g., of the 72 invitation letters for businesses, only two responded with interest to complete the surveys.

Table 16. Interview Contact Dates and Response Rates

Date	Letters Sent	Justification	Response Rate (%)
1. February 21st	241	First rounds of invitations to business (72) and community members (169)	10 (4.1%)
2. March 12th	158	Follow-up invitations to community members with verified addresses from the first round of invitations	9 (5.7%)
3. May 17th	68	Expansion of the survey participant database for cities with no response	0 (0%)
4. June 5th	57	Follow-up invitations to community members with verified addresses from the third round of invitations	3 (5.3%)
5. September 1st	19	Expansion of the survey participant database for chamber of commerce and city officials	2 (10.5%)

Table 17. City Response Rate to the Community Members Surveys

Project Type	Project Location	No. of Invitations	Proportion of Invitations (%)	Invitation Responses	Response Rate (%)
Bypass	Grady	13	6%	0	0%
	Hardy	23	10%	0	0%
	Vilonia	39	17%	7	18%
	Sheridan	28	12%	5	18%
	Flippin	36	16%	2	6%
Widening	Gould	49	21%	1	2%
	Siloam Springs	2	1%	1	50%
No Improvement	Dover	14	6%	4	29%
	Green Forest	26	11%	2	8%
Total		**230**	**100%**	**20**	**14%**

Interviews were audio-recorded, transcribed, and then their content was analyzed by survey theme (**Table 18**). Survey themes cover impacts to businesses, crash occurrences, property values, tourism, and traffic. These themes were recommended by the literature, notably the EconWorks reports and manuals. Interviews were open coded for extraction of direct quotes and close coded to quantify themes. Open coding entails labeling concepts and developing categories. Closed coding entails identifying and marking statements according to an established thematic scheme. The open coding created and expanded the set of themes, and the closed coding quantified the responses by theme.

Table 18. Key Topics of Interest in the Survey Development Process

Survey Theme	Description
Businesses (type, existing, new, and shoppers)	Changes in businesses along and near the project site. Here, a business is any commercial venture of any industry, type, or size.
Crash Occurrence	Relate to the participant perception and experience with changes in the crash occurrence that may be a result of the project.
Economic Development Programs	This refers to the process of expanding economic activity in an area to provide more jobs and income for the residents. Economic development programs, led by city leaders, state agencies, or local business groups, may lead to increased productivity and improved competitive position of the city.
Property Value	Consider property values to be the amount of money someone is willing to pay for a property and how much the seller of the property is willing to accept.
Tourism	Potential observable changes in tourism can be attributed to new hotels and business growth, for example. The term "tourist" refers to someone who travels for pleasure rather than for business.
Vehicular Traffic	This set of questions relates to the participant perception of changes in traffic congestion or volume that may be a result of the project.

3.3.3 Survey Findings

The interviews were used to identify area context and specific impacts related to the transportation projects and to provide context and support for the quantitative results. A 'content' analysis was performed on the interview transcripts. Content analysis is the labeling of interview responses using key words and connotations. Once the interview transcripts are labeled, it is then possible to summarize responses in categorical bins such as 'positive' and 'negative' responses.

An example of the quantitative results from the survey for the bypass shows a total of thirteen responses which represented an 9.3% response rate (**Figure 19**). Each response was quantified using keywords from the participants such as increased, decreased, and no change perceived pre- and post-construction. Then a frequency distribution from the keywords was performed by category. Note that **Figure 19** also has a category for "No Comment." This refers to questions where the participant stated they did not know enough to make an informed remark. At the end of every survey, participants were asked if they consider the project a success. **Figure 20** shows the results of this statement for all bypassed towns where 77% considered the project to be successful. A common reason for this being the relief of congestion traffic on the main street. Figure for all individual study sites are included in **Appendix E**: **Survey Results**.

Another example of the quantitative results from the survey is for the widening projects. **Figure 21** shows a total of two responses which represented an 3.9% response rate. In contrast with the bypass projects, the results of this statement for all widened roads where that 50% considered the project to be successful. A common reason for this being that the residents near the area of construction were subject to relocation.

Content analysis post-project completion yielded several key insights. For instance, bypass projects were noted to have a substantial effect on traffic reduction on the main road. Bypass projects were perceived to increase the crash occurrence, but crashes were noted to occur at the intersections of the main road and the bypass. Economically, the bypass was not found to attract new or relocated businesses. This was often attributed to the lack of proper utility and water/sewer infrastructure along the bypass which limited the ability of businesses to readily locate to the bypass.

Specific project context was noted in several interviews. For Vilonia, in 2011 and in 2014, tornadoes damaged houses and businesses. Interviewees noted that much of the economic changes could be attributed to the tornadoes more than the bypass construction. In Vilonia, interviewees suggested that the bypass beneficially alleviated congestion caused by school traffic along the main route. In Siloam Springs, interviewees suggested that increased traffic was due to commuters coming through Siloam Springs from larger surrounding cities, and that this traffic was likely the cause of business relocations. Specifically, in Vilonia, an example of the major grocery chain relocating out of the town limits to better capture through traffic was highlighted. Also, in Vilonia, interviewees mentioned noise pollution from the higher speed bypass noting that this was a perceived negative consequence of the bypass. Interviews with local community members in Sheridan also revealed that on the main thoroughfare many residents observed an increase in small-and-medium businesses moving into town near the bypass but not on the bypass. Some of these businesses include clinics, pharmacies, and gas stations. Further, residents observed high business turnover. This phenomenon was attributed in part to the reduced traffic along the main thoroughfare.

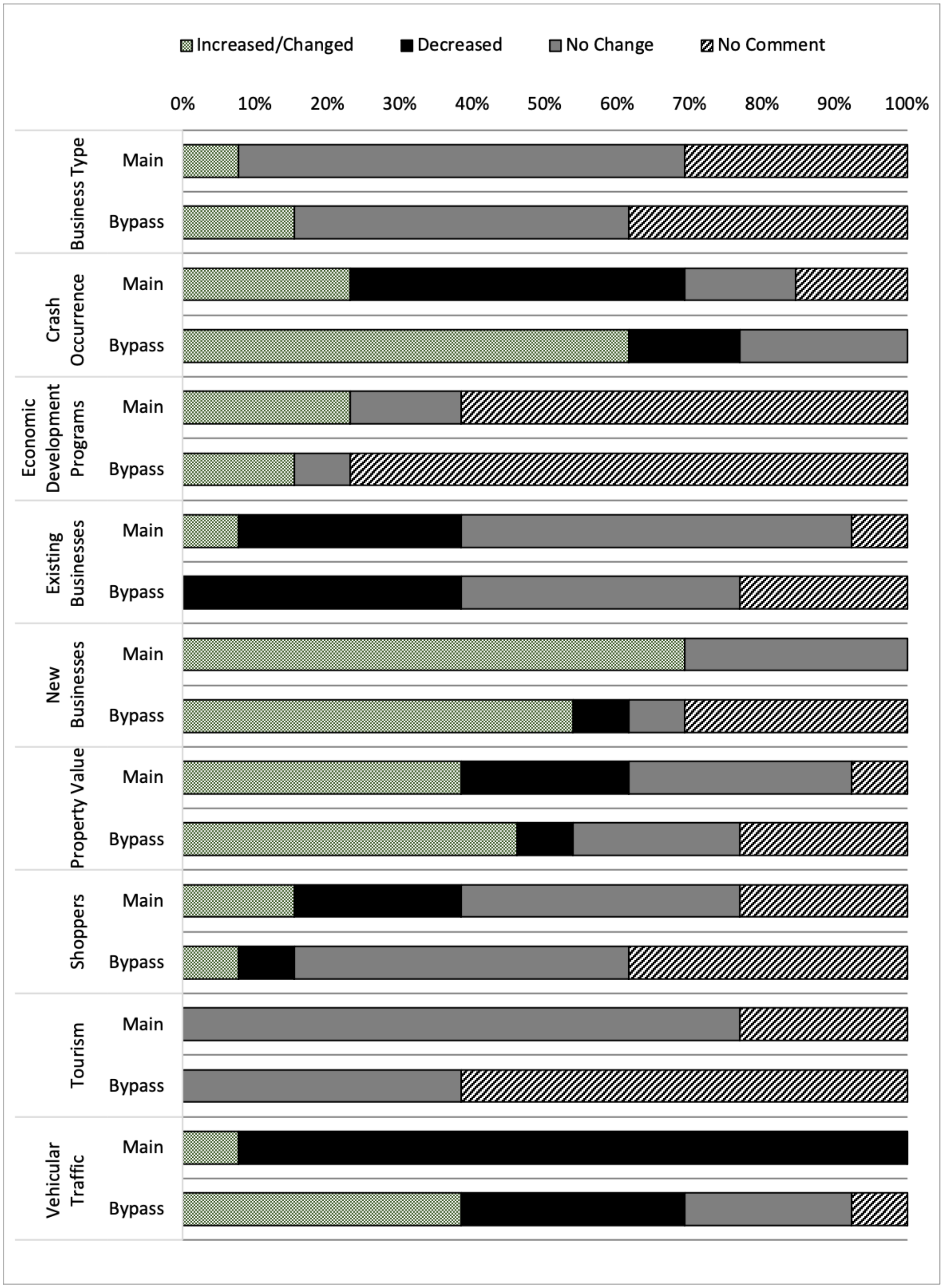
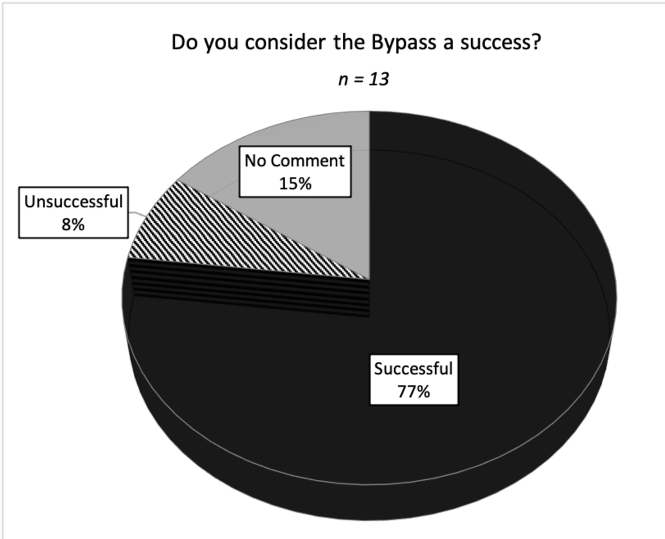


Figure 19. Community Member Response Summary for All Bypass Projects



Sample Responses:

"I do consider it's a success, and it relieved the congestion traffic on Main Street in Vilonia because it took the thru traffic going from East West of Conway"

Participant 10

"I don't think I would think of it like that, I feel like it was a lot of money put out, and it really hurt our town"

Figure 20. Community Member Perception of Project Success for all Bypass Projects

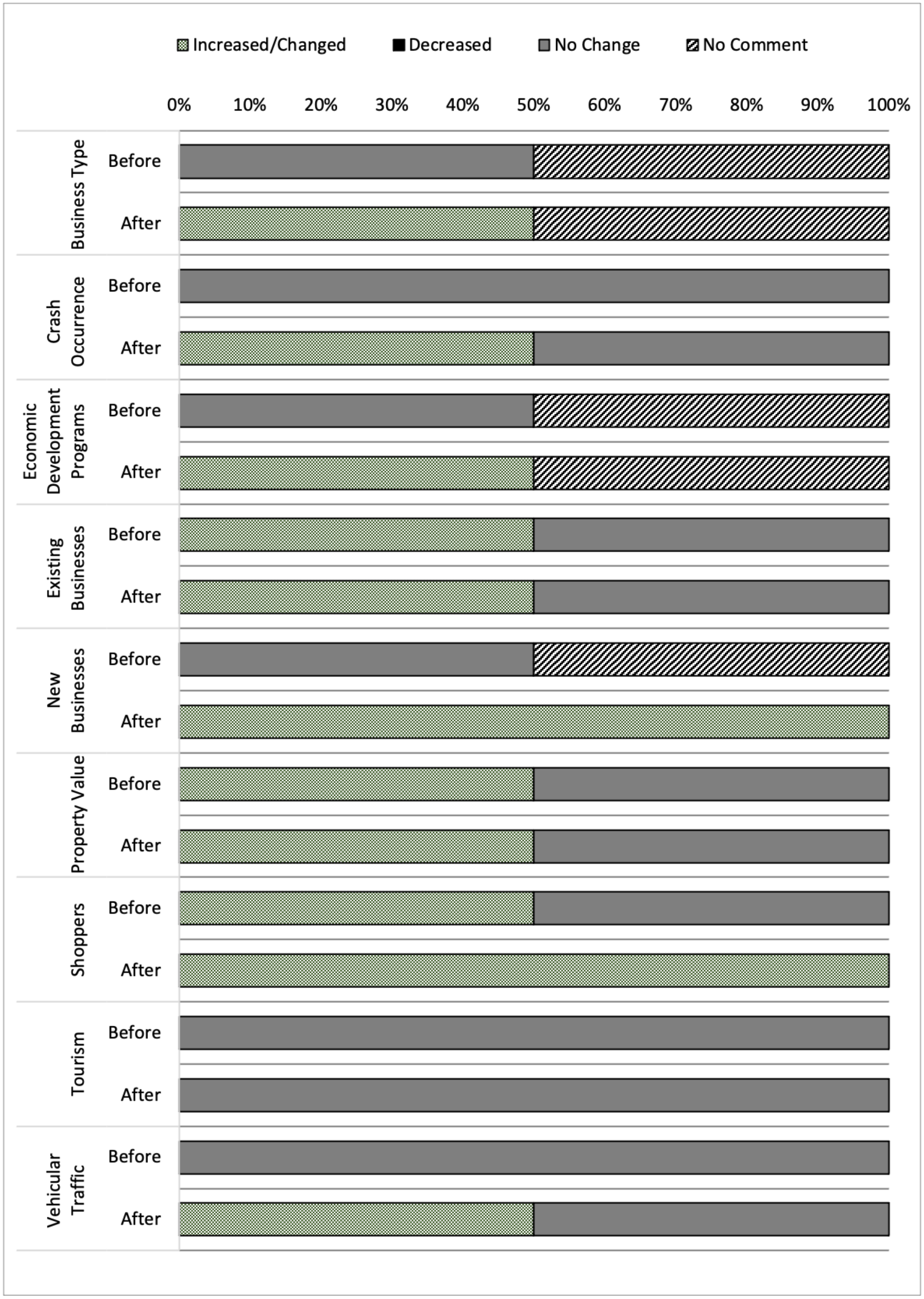


Figure 21. Community Member Response Summary for All Widening Projects

3.3.4 Synthesis of Public Perception Findings

The perceived economic impacts generated from the surveys tended to agree with the estimated impacts resulting from the economic impact analyses, but, in most cases, residents did not attribute the economic changes to the bypass or widening projects **(Table 19** and **Table 20)**. Most residents in towns with bypass projects agreed that there was an increase in the small and mid-sized businesses near the bypass but not on the bypass. This finding was also reflected in the economic analysis as increases in GDP, establishments, and employees as well as positive regional impacts including 0.9 jobs per capita per lane-mile, $33 per capita per lane-mile of labor income, and $41 per capita per lane-mile of value added. Residents cited the lack of utilities on the bypass as the main reason that new business were not opening on the bypass. For sites with widening projects, residents noted a decrease in the businesses in operation along the widened segment but did not think the widening project was the cause. This is reflected in the econometric and statistical analyses, which showed mixed impacts on GDP and the number of establishments and employees in the study area.

Residents commented that though property values increased in cities with bypass projects, they did not attribute this to the projects. The economic impact analyses also showed an increase in property values. Residents did not perceive any changes in population density, although this was observed in the statistical analysis. Residents stated that, in many cases, growth in housing was a result of growth in the region and not attributed to the highway project.

All residents agreed that ADT along the main road was impacted (lessened) by the bypass which was corroborated by the statistical analysis. To add context, residents stated that high volumes of heavy truck traffic was diverted from the main road to the bypass. From a safety perspective, residents perceived a decrease in crashes on the main road but observed that the decrease was countered by an increase in crashes at the intersections of the main road and the bypass. They attributed this to the bypass. For widening locations, residents noted improvements in safety for pedestrians but did not have specific comments on vehicle crashes. Residents did not come to a consensus on whether the widening project changed ADT, although the statistical evidence showed an increase in ADT for both study sites.

Table 19. Synthesis of Public Perceptions for Bypass Study Sites Compared to the Economic Impacts Findings

Survey Theme	Measure	Econometric Analyses	Regional Impacts	Public Perception Findings
Business, Economic Development, and Tourism	Transfers	Mixed but showing no change	N/A	The bypass was **not perceived as a significant attractor** of new business or as a reason for existing business to relocate. This was attributed to the lack of utility infrastructure along the bypass.
	Sales Tax Revenue	Mixed but showing increase	$3 generated per capita per lane-mile	Most residents were **not able to comment** on the sales tax revenue changes. Some residents noted that predicted impacts on sales tax revenue as mentioned in the planning meetings did not come to fruition.
	GDPPC RRL	Increase	$41 value added per capita per lane-mile $121 output per capita per lane-mile	Residents observed an **increase** in small and medium sized businesses near the bypass, often at the intersection of the bypass and the main route. Some of these businesses include clinics, pharmacies, and gas stations. This phenomenon was attributed to reduced traffic along the main thoroughfare.
	GDPPC Retail	Mixed but showing increase		
	GDPPC All	Increase		
	Establish. City	Increase	0.9 jobs added per capita per lane-mile $33 generated per capita per lane-mile	There was **no consensus** among residents at any bypass study site about changes in the number of establishments or employees.
	Employees City	Increase		
Property Values	Pop. Density	Increase	N/A	**Mixed** impacts were noted by residents in terms of changes in population density. While some residents noted increase in population due to new housing developments, there were no comments on pop. density.
	Home Price	Mixed but showing increase	N/A	Residents perceived an **increase** in property values near the bypass, but this increase was tapered by the lack of utilities along the bypass to encourage new residents or businesses.
Traffic	ADT Main	Decrease	N/A	Residents noted substantial **reductions** along the main road in bypass locations and expressed that after the construction of the bypass, heavy truck traffic was drastically reduced along the main road.
Crash Occurrence*	Crash rates (RMVM)	Decrease in crash rates on the main route after construction of the bypass; Crash rates comparable for the bypass and main route		Residents noted a **decrease in crashes along the main road** but noted a significant **increase in crashes along the bypass**. Residents mentioned increased crashes at the intersections of the bypass and the main road.

**Analysis of crash rates explained in Section 3.5. Crash rates are not part of the economic analysis.*

Table 20. Synthesis of Public Perception Assessments for Widening Study Sites Compared to the Economic Impact Findings

Survey Theme	Measure	Econometric Analyses	Regional Economic Impacts	Public Perception Findings
Business, Economic Development, and Tourism	**Transfers**	Increase	N/A	Residents were **not able to comment** on sales tax revenue impacts. Anecdotal comments were made about reluctance to sell property.
	Sales Tax Revenue	Increase	$3 generated per capita per lane-mile	
	GDPPC RRL	Mixed	$47 value added per capita per lane-mile $122 output per capita per lane-mile	Residents noted a **decrease in the number of businesses in operation before the widening project** along the main road, but the residents did not attribute the decrease directly to the widening project. Residents noted an **increase in tourists and shoppers** visiting the town and residents attributed this to the widening project.
	GDPPC Retail	Mixed		
	GDPPC All	Increase		
	Establish. City	Mixed	0.8 jobs added per capita per lane-mile $34 generated per capita per lane-mil	There was an **increase in the number of new businesses** along the main road, but residents did not attribute this to the widening project.
	Employees City	Mixed		
Property Values	**Pop. Density**	Mixed	N/A	Residents were **not able to comment** on population growth or density.
	Home Price	Mixed	N/A	There was **no consensus** among residents on the effect of the widening project on home prices.
Traffic	**ADT Main**	Increase	N/A	Residents reported **mixed** outcomes in terms of traffic. Some residents noted an increase in traffic after the widening project was completed. Other participants mentioned travel time reductions along the main road due to less traffic.
Crash Occurrence	**Crash rates (RMVM)**	No change in crash rates over time resulting from the widening project; Crash rates on main road were different from state wide after before the project and the same after the project.		Residents noted **improvements** in safety especially for pedestrians and attributed this to the provision of sidewalks provided with the widening project.

3.4 SAFETY IMPACTS

To determine if changes in crash rates could be attributed to the bypass and widening projects, the following comparisons were made:

- For *bypass* projects:
  1. A comparison of the crash rates during the pre- and post-construction periods of the bypass project along the main route;
  2. A comparison of the crash rates on the bypass to the crash rates on the main route for the post-construction time period;
  3. A comparison of the crash rates on the bypass to the average crash rate for the state of Arkansas in the post-construction time period;
- For *widening* projects:
  4. A comparison of the crash rates during the pre- and post-construction periods of the widening project along the main route ;
  5. A comparison of the crash rates on the main route to the average crash rate for the state of Arkansas in the pre-construction time period;
  6. A comparison of the crash rates on the main route to the average crash rate for the state of Arkansas in the post-construction time period;

3.4.1 Data and Crash Rate Calculations

Historical crash data was obtained from the Arkansas State Police for 1997 through 2016. This data dates back to pre-construction periods for all study sites. The data includes crash records, crash severity, date of the incidence, and crash circumstances. Crashes along the study segments (as defined in the Project Documents) were identified using Geographical Information Systems (GIS) tools.

Crash rates were calculated using the Rate per 100-Million Vehicle Miles Travelled (RMVM) formula (**Equation 4**). RMVM is calculated by dividing the total number of crashes along a given segment over a specified time (annual) by a measure of exposure. The measure of exposure is Vehicle Miles Travelled which is calculated as the Average Daily Traffic (ADT) multiplied 365 days per year and by the length of the segment in miles. Crash rate calculations are available for all study sites in **Appendix F.**

$$\boldsymbol{RMVM = \left(\frac{A \times 100{,}000{,}000}{VMT}\right)} \qquad \textbf{Equation 4}$$

Where,

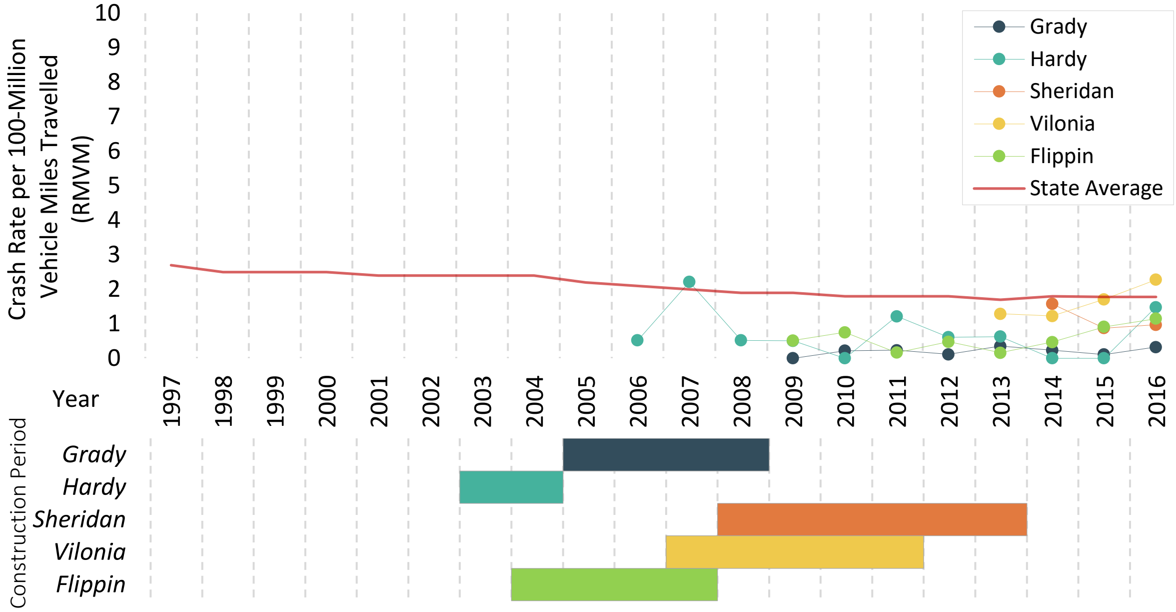
$RMVM$	=	Crash rate for the road segment expressed as crashes per 100-million vehicles miles travelled
A	=	Number of crashes in the study period
VMT	=	Vehicle Miles Travelled during the study period, $VMT = ADT \times 365 \times L$ where ADT is the Average Daily Traffic, 365 is the days per year, and L is the length of the roadway segment

3.4.2 Graphical Comparisons of Crash Rates by Study Site

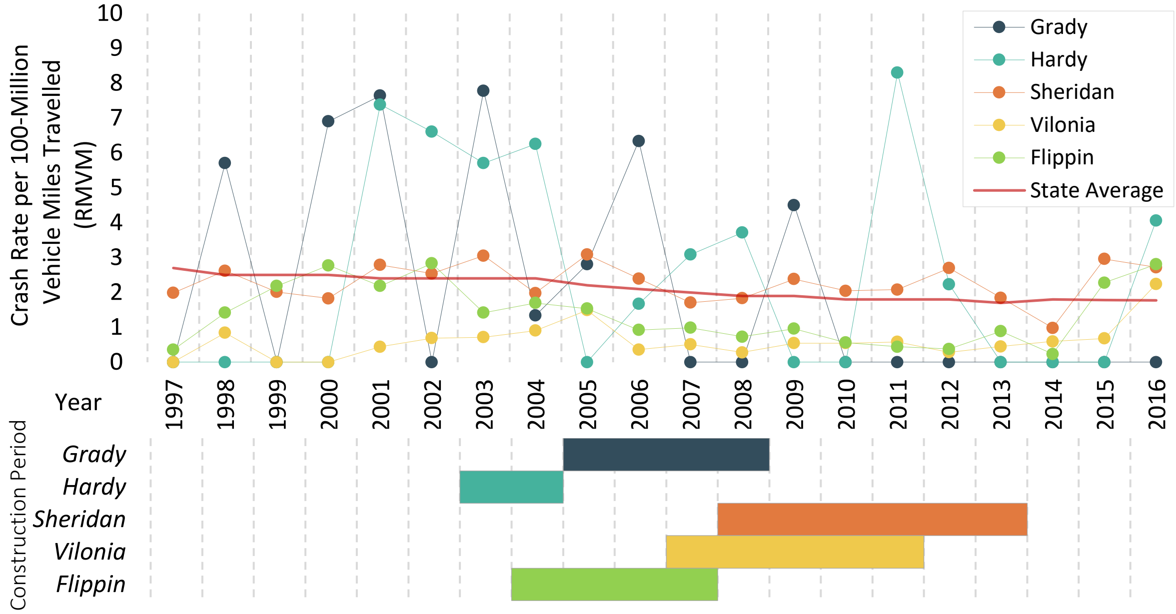
Statewide crash rates have steadily decreased since 2007 with a maximum of 2.7 *crashes per 100-million vehicle miles travelled* reported in 1997 and a minimum of 1.7 *crashes per 100-million vehicle miles travelled* in 2013. The average annual crash rate of the bypass sites varied widely with a general upward trend after all projects were completed but remains below the state average (**Figure 22**). On the other hand, after the completion of the bypass projects, there is an observed decrease in annual average crash rates for the main road for the cities of Grady and Hardy. It should be noted that in 2011, Hardy experienced severe flooding and the community was evacuated. Coincidently in 2011, Hardy experienced the highest peak of crash rates on the main road (*8.30 crashes per 100-million vehicle miles travelled*) and the third-highest crash rate reported on the bypass (*1.22 crashes per 100-million vehicle miles travelled*). In Sheridan and Vilonia, the crash rate does not dramatically change over time, even after the implementation of the bypass. In Flippin, a general decrease in crash rates was observed after the completion of the bypass; however, starting in 2014 there appears to be an increase in the crash rate.

Between the widening sites, crash rates in Gould were below the average annual statewide crash rates and trending in the same downward direction (**Figure 23**). There was no increase in crash rates attributed to the widening projects. For the widening project in Siloam Springs, crash rates varied widely. Before construction, Siloam Springs reported their highest crash rate in 1997 (*8.42 crashes per 100-million vehicle miles travelled*) and a second highest in 2005 (*7.44 crashes per 100-million vehicle miles travelled*), five years before construction began. After the road was widened, Siloam Springs reported its third-highest historical crash rate in 2015 (*6.92 crashes per 100-million vehicle miles travelled*), three years after the widening. Overall, crash rates for the widening sites are trending downward at approximately the same rate as the statewide average.

For no improvement sites, crash rates were examined over time for each city and both cities combined (**Figure 24**). Crash rates in Dover and Green Forest were below the annual average statewide crash rates and trending in the same downward direction. Dover experienced its highest crash rate in 2003 (*2.72 crashes per 100-million vehicle miles travelled*), above the statewide crash rate annual average.



(a) Crash rates along the bypass route



(b) Crash rates along the main road

Figure 22. Crash Rates for Bypass Study Sites

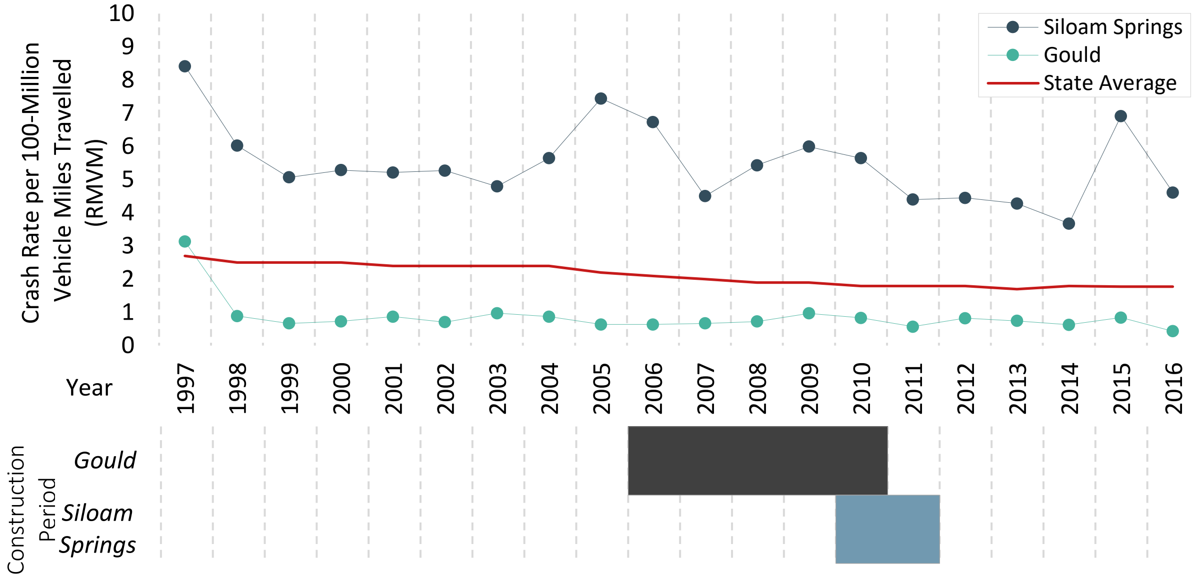


Figure 23. Crash Rates for Widening Projects

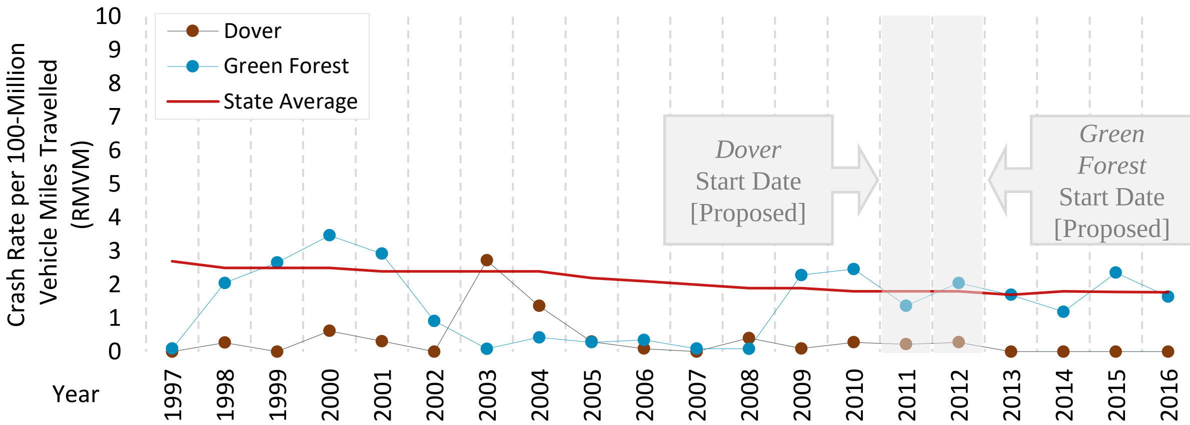


Figure 24. Crash Rates for Sites with No Improvement

3.4.3 Statistical Evaluation of Crash Rates

A statistical evaluation was performed to evaluate if the changes in crash rates over time as measured by RMVM at the study sites can be attributed to the project or to random fluctuations over time. Statistical hypothesis testing was used for this analysis. Since the data is represented as a time series and thus correlated over time, the appropriate statistical procedure is a Wilcoxon Signed-Rank Test for Paired Samples *[32]* . This test is a non-parametric for comparing two paired (dependent) data sets. It is an alternative to paired Student's t-test used when the sample size is small and the series is expected to be non-normal (non-parametric). This test evaluates if the median crash rate of the two samples is statistically different.

Since the crash data represents a time series, first, the trend in the time series is removed by fitting a linear trend line through the time series. Then each point in the time series is subtracted from the estimated trend. In this way, the time series is de-trended and stationary. Any remaining fluctuations are independent of the trend. The Wilcoxon Signed-Ranked Test evaluates the null hypothesis that the de-trended crash rates on the bypass are the same as the de-trended crash rates represented by the state average. The alternate hypothesis is that the crash rates are different (not equal) representing a two-tailed hypothesis test. For the Flippin example, the Wilcoxon signed-rank test shows that the crash rates representing the statewide average and crash rates along the bypass are not statistically different (fail to reject the null hypothesis that the crash rates are the same) (**Table 21**). Thus, we can conclude that there is no difference between the crash rates for the study site and the state average. In other words, the study site did not experience any change in crash rate related to the project, and any difference in crash rates over time was also seen at the state level. Complete calculations for the statistical tests for each study site and for all comparisons are available in **Appendix G.**

Table 21. Example of the Computations of Statistical Test for the Bypass in Flippin

	Statewide Crash Rates			Bypass Crash Rates			Wilcoxon Ranked-Signs		
Year	**[1] Observed**	**[2] Detrended**	**[3] Difference *[2] – [1]***	**[4] Observed**	**[5] Detrended**	**[6] Difference *[5] – [4]***	**[7] Diff. *[3] – [6]***	**[8] Absolute Diff.**	**[9] Rank**
2007	2.00	1.39	-0.61	0.00	-0.04	-0.04	-0.56	0.56	9
2008*	1.90	1.39	-0.51	0.00	-0.04	-0.04	-0.47	0.47	7
2009	1.90	1.39	-0.51	0.52	0.01	-0.51	0.00	0.00	1
2010	1.80	1.38	-0.42	0.75	0.03	-0.72	0.30	0.30	6
2011	1.80	1.38	-0.42	0.16	-0.03	-0.19	-0.23	0.23	5
2012	1.80	1.38	-0.42	0.48	0.00	-0.48	0.06	0.06	3
2013	1.70	1.37	-0.33	0.16	-0.03	-0.19	-0.14	0.14	4
2014	1.80	1.38	-0.42	0.47	0.00	-0.47	0.05	0.05	2
2015	1.78	1.38	-0.40	0.91	0.04	-0.87	0.47	0.47	8
2016	1.78	1.38	-0.40	1.15	0.06	-1.09	0.69	0.69	10

Wilcoxon Ranked-Sign Test Analysis

∑ Positive Rank (W^+)	30	**Result: P-value > α (0.05, 95% confidence interval), thus fail to reject H_o and conclude that samples are equal.**
∑ Negative Rank (W^-)	25	
H_o (Null Hypothesis)	Medians of the two samples are equal	
Sample size, n	10	
Test Statistic (WR)	25	
Critical Value (z_α)	-0.25	
P-value	0.8085	

**Year when the project was completed*
Note that values are rounded to two decimal places for ease of display

3.4.4 Synthesis of Safety Analysis Findings

Safety impacts of bypass projects were assessed by analyzing crash rates during the (1) pre- and post-completion years on the main route, (2) treatment (bypass or widening) versus the main route, and (3) treatment versus statewide average crash rates (**Table 22**). For widening projects, safety impacts were assessed by analyzing crash rates during (1) pre-and post-completion years on the main route, (2) main route versus state averages crash rates during the pre-completion years, and (3) main route versus state averages crash rates during the post-completion years (**Table 23**). Complete calculations for the statistical tests for each study site and all comparisons are available in **Appendix G.**

For bypass study sites, the statistical analysis shows that the crash rates pre-and post- bypass completion were not statistically different in three (Hardy, Vilonia, and Flippin) of the four sites. Based on this majority, we can conclude that the bypass did not have an impact on the crash rates on the main road. In Grady, there was a significant difference in crash rates on the main road pre- and post-construction of the bypass which may be attributed to the bypass. Relative to the main route, the median crash rate along the bypass was found to be the same as the main route in three (Grady, Hardy, and Flippin) of the four sites. In Vilonia, there was a significant difference between the crash rates on the main route and bypass. The results were mixed when comparing the bypass crash rates to the state average. Considering one goal of the bypass is to divert higher speed through traffic off of the main (lower speed) road in order to increase safety along the main road, the crash rate analysis is not able to conclude that this goal was realized for the majority of sites. In all bypass study sites, there was a decrease in ADT along the main route through town, and this could be statistically attributed to the construction of the bypass (see Section 3.2.3).

For widening study sites, both study sites experienced similar outcomes in crash rate comparisons. For both sites, the statistical evaluation showed that the sites did not experience a change in crash rates pre-completion and post-completion of the widening project. Both widening sites did experience a change in crash rates relative to the statewide averages when comparing crash rates before project completion. In contrast, there was no statistical difference in crash rates relative to the statewide averages after the project was completed. These three evaluations show that the widening projects had an effect on crash rates relative to statewide averages but not relative to their own historical patterns. In short, the widening project returned the crash rates along the widened road to the statewide average.

It should be noted that sample sizes were relatively small (less than 10 samples) for all comparisons. This has an effect on the power of the statistical tests. Future work can examine crash history by quarter or month and extend the analysis period as more crash data becomes available.

Table 22. Crash Rate Comparison for Bypass Study Sites

Statistical Summary	*Grady*	*Hardy*	*Sheridan* [*]	*Vilonia*	*Flippin*
(1) Pre- vs. Post- Main Route					
Number of samples (n)	8	8	3	5	9
P-Value	0.0168	0.8259	-	0.2501	0.7188
Sample means different?	Yes	No	*No results due to small sample size*	No	No
(2) Bypass vs. Main Route					
Number of samples (n)	9	13	4	6	10
P-Value	0.110	0.250	-	0.028	0.332
Sample means different?	No	No	*No results due to small sample size*	Yes	No
(3) Bypass vs. State Average					
Number of samples (n)	9	13	4	6	10
P-Value	0.015	0.424	-	0.027	0.808
Sample means different?	Yes	No	*No results due to small sample size*	Yes	No

[*] *With a sample of such small size, it is not possible to obtain significant test result.*
Note: Statistical evaluation carried out at the 95% level of confidence

Table 23. Crash Rate Comparison for Widening Study Sites

Statistical Summary	*Gould*	*Siloam Springs*
(4) Pre- vs. Post- Main Route		
Number of samples (n)	6	5
P-Value	0.3681	0.7039
Sample means different?	No	No
(5) Main Route vs. State Average Pre-construction		
Number of samples (n)	14	15
P-Value	0.0155	0.0264
Sample means different?	Yes	Yes
(6) Main Route vs. State Average Post-construction		
Number of samples (n)	6	5
P-Value	0.1728	0.1726
Sample means different?	No	No

Note: Statistical evaluation carried out at the 95% level of confidence

CHAPTER 4: SIMPLIFIED METHODOLOGY FOR ECONOMIC IMPACT ASSESSMENT

This chapter presents a simplified methodology to measure the impacts of highway bypass and widening projects. The simplified methodology is similar in structure to EconWorks but with Arkansas specific data, thus a discussion of EconWorks and its limitations is presented prior to a discussion of the simplified methodology. The simplified methodology accomplishes much of what the detailed regional impact analysis achieved, but without the need to use IMPLAN. Briefly, the simplified methodology estimates the number of jobs attributed to a bypass or widening project based on the AADT, economic setting (distressed or non-distressed), and length (miles) of the project. This chapter describes the approach to estimate and apply the simplified model including a comparison to EconWorks.

4.1 ECONWORKS

EconWorks provides an estimate of economic impacts for a hypothetical project based on project type, region, urban/class level, economic distress, and length of the project (**Figure 25**, left side toggle menu) *[15]*. With these criteria, EconWorks estimates the ranges of economic impacts including jobs, wages, and economic output. These estimates are adjusted based on average annual daily traffic (AADT), land use policies, infrastructure, and business climate.

Estimates derive from the 132 cases in the EconWorks database. However, of these 132 cases, only 28 cases are located in the Southeast (Arkansas' region), and of those, four are widening projects and two are bypass projects. Among these six projects, only two bypass projects are less than 20 miles in length (all of the case studies included in our project are less than 20 miles in length). Thus, there are a limited number of cases on which to base economic impact estimations for Arkansas. In fact, using EconWorks, no case studies are found for the ranges of project characteristics that match the Arkansas study sites (**Figure 25**, bottom right area shows no matching projects).

To determine the accuracy of the EconWorks estimates for the Arkansas case study sites, we compared the results of EconWorks to those we previously derived from IMPLAN (**Figure 26**). The difference in percent between the EconWorks estimate and the IMPLAN estimate for direct jobs shows errors of -44% in Hardy to 1,008% in Siloam Springs. In most cases, the AADT for the Arkansas case study sites is much lower than the EconWorks case studies on which the estimates are derived. This leads to large errors. Therefore, a simplified methodology that uses the IMPLAN results but does not require IMPLAN analysis or detailed time series data was developed to estimate impacts for future project sites in Arkansas.

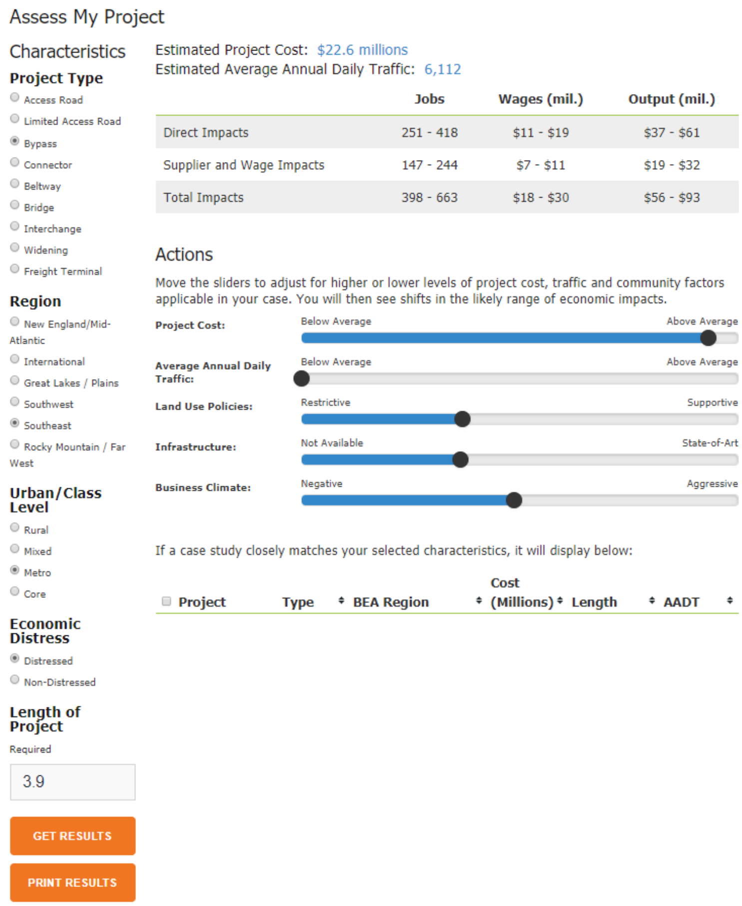


Figure 25. Example of Impact Estimation using EconWorks

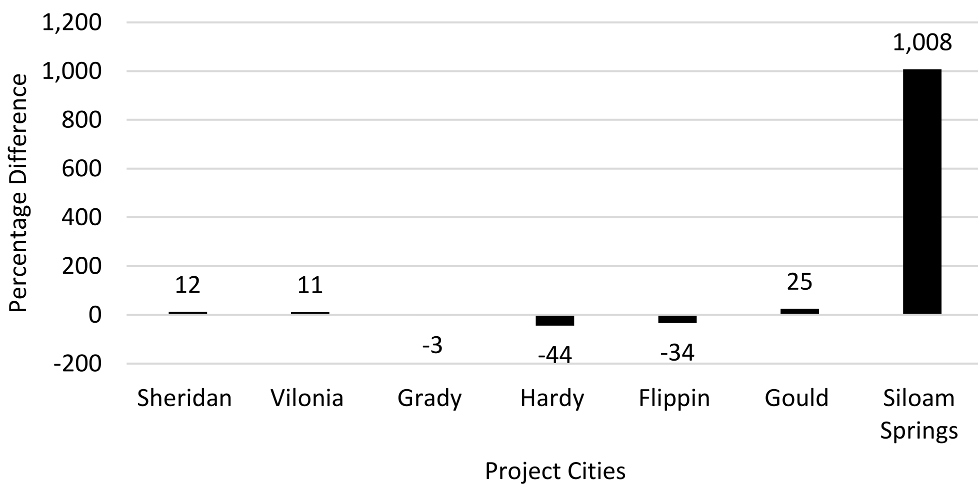


Figure 26. Percentage Difference Between Results from EconWorks and IMPLAN for Direct Jobs

4.2 SIMPLIFIED METHODOLOGY

The simplified methodology is a regression model in which the coefficients are estimated from both EconWorks case studies and Arkansas case studies. The approach is similar to what is used in EconWorks. Overall, we estimate a regression model to predict the number of jobs based on project length (in miles), AADT, and economic setting (distressed vs. non-distressed) (**Figure 27**). The regression model includes setting and calibration factors to adjust the model for project specific characteristics.

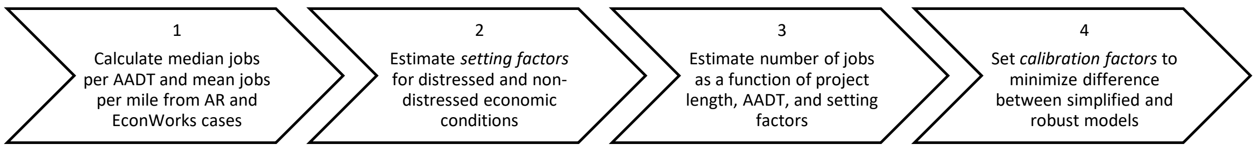


Figure 27. Overview of Key Steps to Generate the Simplified Methodology

In the simplified model, a study site is classified by its economic setting into two categories: distressed or non-distressed. Distressed areas are defined as having the ratio of county unemployment to national employment greater than 1.2. This means their unemployment rate is more than 1.2 times as high as the national rate. Economic distress can be calculated as shown in **Equation 5**.

$$Economic\ distress = \frac{City\ or\ County\ Unemployment\ Rate}{National\ Unemployment\ Rate} \qquad \textbf{Equation 5}$$

Where,
Distressed is defined as having economic distress greater than 1.2
Non-Distressed is defined as having economic distress less than or equal to 1.2

To develop the simplified methodology, the following steps were applied:

1. We gathered data from the existing EconWorks case studies of bypass (n = 5) and widening (n = 12) projects from all regions. We supplemented these studies with the seven Arkansas cases. Then, we calculate median jobs per AADT and mean jobs per mile from these case studies.

2. We calculated *setting factors* for distressed and non-distressed economic conditions using the calculated median jobs per AADT and mean jobs per mile from the Arkansas and EconWorks case studies (**Equation 6** and **Equation 7**). This approach was used in EconWorks. The setting factors are later used to adjust model outputs (number of jobs).

$$Setting\ Factor_{type,setting,median} = \frac{Median\ jobs\ per\ AADT\ of\ distressed\ cases}{Median\ jobs\ per\ AADT\ of\ all\ cases} \quad \textbf{Equation 6}$$

$$Setting\ Factor_{type,setting,mean} = \frac{Mean\ jobs\ per\ mile\ of\ distressed\ cases}{Mean\ jobs\ per\ mile\ of\ all\ cases} \quad \textbf{Equation 7}$$

Where,

type = [bypass, widening]

setting = [distressed, non-distressed]

3. We estimated the number of jobs based on project length (in miles), AADT (in vehicles per day), and our estimated setting factors (**Equation 8**).

$$Number\ of\ Jobs = Length \times Mean\ jobs\ per\ mile \times Setting\ Factor_{type,setting,mean} + AADT \times Median\ jobs\ per\ AADT \times Setting\ Factor_{type,setting,median} \quad \textbf{Equation 8}$$

4. We calculated *calibration factors* for each project type and setting. The calibration factors aim to minimize the average percentage difference between estimated number of jobs via **Equation 8** and the number of jobs estimated from a more robust model, IMPLAN. We use a goal setting optimization approach in MATLAB, a proprietary mathematical computing software, to determine the calibration factors. Note that this procedure is for model estimation, and MATLAB is not required for model application.

5. We predicted the number of jobs for project cities by applying the calibration factor to the original equation that included the setting factors (**Equation 9**). Again, this follows from the method used in EconWorks with the addition of the Arkansas specific calibration factors.

$$Number\ of\ Jobs = Calibrated\ Factor_{setting,type} \times [Length \times Mean\ jobs\ per\ mile \times Setting\ Factor_{type,setting,mean} + AADT \times Median\ jobs\ per\ AADT \times Setting\ Factor_{type,setting,median}] \quad \textbf{Equation 9}$$

The simplified model to estimate number of jobs for bypass and widening projects in distressed and non-distressed economic settings is given in **Table 24**. The coefficients for length and AADT, as well as the setting and calibration factors were estimated from the EconWorks case studies supplemented with Arkansas case studies. That is, in Steps 1 through 4, factors were based on the 16 EconWorks cases plus the seven Arkansas cases. It should be noted that the projects in the EconWorks case study database with a high number of jobs were removed from our analysis in an effort to match the conditions of our project sites.

Table 24. Simplified Model Equations for Estimation of Direct Jobs

Project	Setting	Formula ($\boldsymbol{Number\ of\ Jobs =}$)
Bypass	Non-Distressed	$0.047 \times (Length \times 118 \times 1.00 + AADT \times 0.04 \times 1.35)$
	Distressed	$0.464 \times (Length \times 118 \times 1.54 + AADT \times 0.04 \times 0.92)$
Widening	Non-Distressed	$0.008 \times (Length \times 158 \times 0.63 + AADT \times 0.04 \times 0.31)$
	Distressed	$0.003 \times (Length \times 158 \times 3.22 + AADT \times 0.04 \times 2.27)$

4.3 COMPARISON OF ECONWORKS AND SIMPLIFIED METHODS FOR ECONOMIC IMPACT ASSESSMENT

The estimated number of jobs for project cities using the simplified approach was compared to the results obtained from the IMPLAN analysis. It is assumed that the IMPLAN analysis estimates are the most accurate. Since universal calibration factors (rather than project specific factors) were applied in the model, there is still minor discrepancy between the estimated number of jobs when comparing the IMPLAN and simplified model approaches. The comparison is made by calculating the Percent Error (PE) and the Average Absolute Percent Error (AAPE) of the two models (EconWorks and Simplified Approach) relative to IMPLAN according to **Equation 10** and **Equation 11**.

$$PE = \frac{(IMPLAN_i - Model_i)}{IMPLAN_i} \times 100\% \qquad \textbf{Equation 10}$$

$$AAPE = \sum_i \left| \frac{(IMPLAN_i - Model_i)}{IMPLAN_i} \right| \times 100\% \qquad \textbf{Equation 11}$$

Where,

PE	=	Percent Error (%)
$IMPLAN_i$	=	Results of the IMPLAN analysis for site i
$Model_i$	=	Results of the simplified model or EconWorks
$AAPE$	=	Absolute Average Percent Error (%)

The results show the increased accuracy in estimation using the simplified model (AAPE of 54%) compared to EconWorks (AAPE of 161%) when all projects are compared (**Table 25** and **Figure 28**). EconWorks showed significant error (1008%) for the Siloam Spring study site. Although the Siloam Springs study site project cost and length are in line with the Arkansas study sites, the population of Siloam Springs can be considered an outlier relative to the Arkansas study sites. Although, it should be noted that the Siloam Springs study site characteristics are in line with the EconWorks case studies. Removing Siloam Springs from the analysis, the AAPE for EconWorks reduces to 20% and to 47% for the simplified model. The error in the estimation for EconWorks can be attributed to the low project cost ($14 million) relative to the short project length (1.6 miles, 2 lanes) and high AADT (27,000 vehicles per day) for Siloam Springs.

EconWorks uses urbanicity (rural, mixed, and metro), economic distress, AADT, and length to estimate project impacts while the simplified models use only economic distress, AADT, and length and the IMPLAN analysis uses only project cost and duration. Since Siloam Springs had a low project cost, it did not have high regional economic impacts, an effect that was accurately captured by IMPLAN. After removing Siloam Springs, even though the simplified method has higher AAPE, it provides more consistent accuracy than EconWorks.

Further, EconWorks had more accurate estimation for bypass projects in non-distressed regions and widening projects in distressed regions. On the other hand, the simplified model had more accurate estimation for bypasses in distressed regions and widening projects in non-distressed regions. Contributing to this outcome is the uneven distribution of the study sites by economic setting. Recall that 16 non-Arkansas sites (gathered from EconWorks) were used along with the Arkansas case studies. Only seven of these were in distressed regions of which only one was a bypass project. The remaining nine study sites were in non-distressed regions of which three were bypass locations. Ideally, if sites were to be selected in the future for detailed analysis, we would recommend finding a more equal distribution by economic setting so that the simplified methods can contain more representative case studies. Thus, for impact assessment it is recommended that both the simplified model and EconWorks be used based on the economic setting of the project location.

While the Percent Error for the study sites in larger cities like Sheridan and Vilonia (population greater than 4,000) results in higher error for the simplified method, there was also high error found for Gould which has relatively lower population. However, through a statistical evaluation, we conclude that the effect of population size on accuracy is not significant in the simplified model. Likewise, the correlation between population and error for EconWorks is not statistically significant if Siloam Springs is removed. If Siloam Springs is included in the analysis, then there is a statistically significant trend between population and model error for EconWorks. For AADT, an input to both the simplified model and EconWorks, there is no evidence of statistically significant correlation between model error and AADT.

Table 25. Model Accuracy Comparison by Project Economic Setting and Project Type

Project Type	Economic Setting	Number of Study Sites	Accuracy (AAPE, %)	
			EconWorks	Simplified Method
Bypass	Non-Distressed	2	7%	91%
	Distressed	3	27%	1%
	Average	***5***	***19%***	***37%***
Widening	Non-Distressed	1	1008%	95%
	Distressed	1	25%	98%
	Average	***2***	***517%***	***97%***
Average	***All***	***7***	***161%***	***54%***

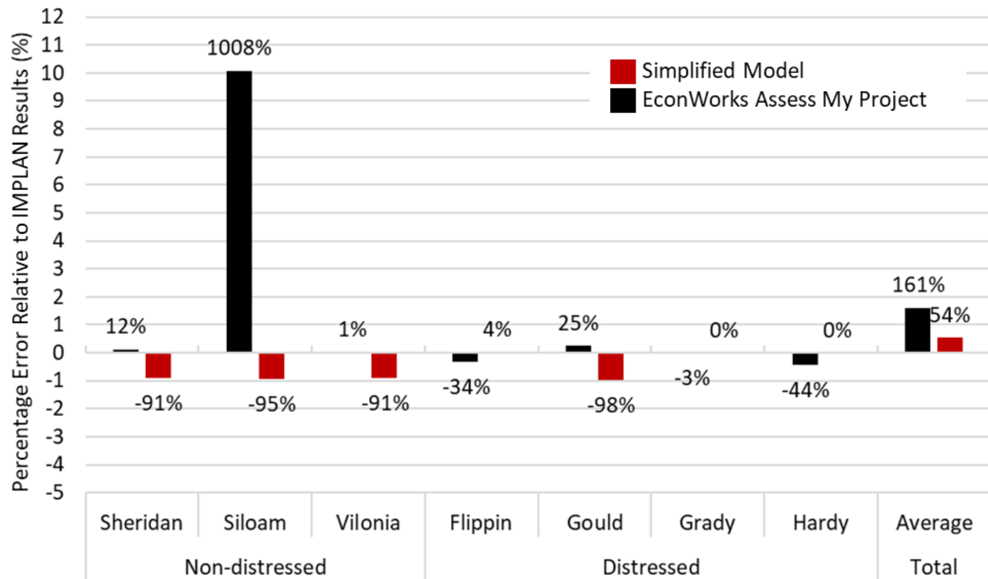


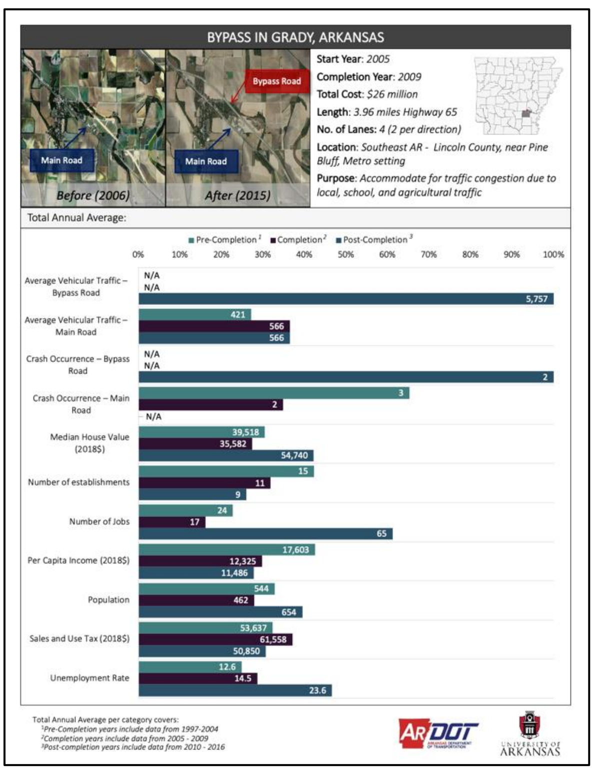
Figure 28. Comparison between the Simplified Model and EconWorks Relative to the Results of the IMPLAN Analysis

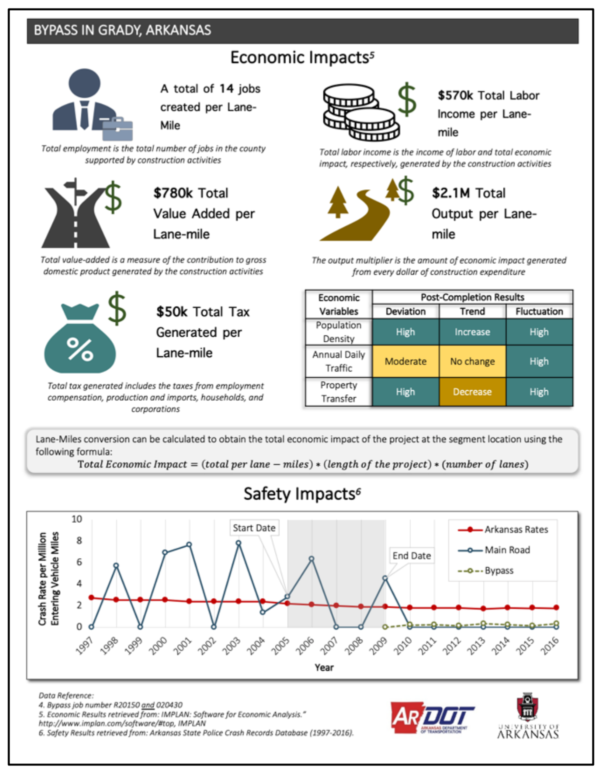
CHAPTER 5: RESEARCH PRODUCTS

This chapter provides a description of the public outreach resources and case study documents prepared for submission to EconWorks.

5.1 PUBLIC OUTREACH RESOURCES

A one-page (front and back) template for case study "quick information" was developed based in part on the EconWorks case study data. The front page of the pamphlet provides information on the characteristics of the project such as year constructed, length, location, and purpose. It also includes the comparison of socio-economic and transportation 'variables' for three time periods: pre-completion, completion, and post-completion. The back page of the pamphlet includes a summary of the economic and safety impacts resulting from the project identified through data analysis. The pamphlet is meant to serve as a public guidance document. **Figure 29** shows an example of pamphlet for the Grady bypass. In this example, the front of the pamphlet shows the change in population pre-, during, and post- project completion: the total annual average population in Grady before the construction was 544, and it dropped down to 462 during the completion period. After the completion of the project, the average population was 654. Public outreach documentation is available for all study sites in **Appendix H**: **Public Outreach Documents.**





(a) Front Page (b) Back Page

Figure 29. Case Study Public Outreach for Grady

5.2 INTEGRATION WITH ECONWORKS

In addition to the data to be submitted with each EconWorks case study, EconWorks also requires submission of a case narrative. The narrative consists of following sections:

1. *Synopsis*: This section includes a summary of the history of the project and its impacts in terms of jobs created or business attracted.
2. *Background*: This section provides the information on the local area (population, employment trends) and transportation connections (interstates, major highways, distance to airport).
3. *Project Description and Motives*: This section provides a description of the project (type, cost) and the motivation behind its construction.
4. *Transportation Impacts*: This section discusses the impacts of a project on local transportation, such as changes in average annual daily traffic and crash rates.
5. *Demographic, Economic, and Land Use Impacts*: This section explains the impact of the project on number of jobs, number of establishments, and changes in land use.
6. *Non-Transportation Factors*: This section discusses other factors beside the project that might have influenced the impact (Number of jobs, land use, crash rates, etc.).
7. *Citations*: This section includes a list of studies and links to websites used in the case study.
8. *Interviews Conducted*: This section includes organizations represented through the interview process.

Case narratives for the seven project cities are included in the **Appendix I**: **Case Studies**.

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APPENDIX A: REVIEW OF LITERATURE

Table A-1. Summary of State DOT Report and Research Articles

(A) State DOT Reports

Title	Data Collected		Methodology
Economic Impacts of Highway Bypasses *[33]*(TxDOT)-1992	Population Geographic location Retail Sales Gas Station Sales Restaurant Sales	Service Receipts Per Capita Income Distance to larger city Number of highways Average Daily Traffic	Matched Pair Analysis (paired t-test) Multivariate Regression Model Cluster Analysis
The Economic Impacts of Highway Bypasses on Communities *[34]* (WisDOT)-1998	Distance to larger city Number of highways Average Daily Traffic Retail Trade		Control Group Pre and Post Bypass Data Analysis Interviews and Surveys
Methodology for Determining the Impact of Highway Bypasses in Oklahoma *[35]* (OKDOT)-2001	Local Option Sales Tax Population General City Information Project Information Traffic volumes Underground Storage Tank Information Location and Proximity Features		Quasi-Experimental Control Group Analysis Difference-in-Difference Estimation Anecdotal Methods
The Impact of a New Bypass Route on the Local Economy and Quality of Life *[36]* (KYTC)-2001	Employment Retail sales Population Level of access control	Distance to CBD Vacancy Rates Business Mix	Matched Pair Analysis Before and After Analysis Site Visit Surveys and Interviews
Economic Effects of Highway Relief Routes on Small and Medium-Size Communities. An Econometric Analysis *[1]*(TxDOT)-2001	Per Capita Sales Number of Establishments Population Elderly Population	Unemployment Rate Per Capita Income Total Traffic (AADT) Distance of the routes	Random Effects model
Case Studies of the Economic Impact of Highway Bypasses in Kansas *[37]*(KDOT) -2004	Employment Retail sales		Matched Pair Analysis Interviews
California Bypass Study: Economic Impacts of Bypasses Volume 1 Planning Reference *[38]*(Caltrans)-2006	Retail sales Crashes Truck Traffic		Literature Review Survey and Interviews Before and After Case Study
Managing Decisions Regarding Rural Expressway Routes and Associated Highway Bypasses *[6]*(IowaDOT)-2009	Number of Crashes Vehicle Miles Travelled Traffic volume (AADT) Number of businesses	Number of Employees Population Real and Potential Sales Per Capita Income	Interviews Paired sample t-test Matched Pair Analysis
The Economic Impact of Upgrading Roads *[39]*(MnDOT)-2009	Parcel Data Road Network Improvement Property Sales Multiple Listing Service		Hedonic Regression Before and After Analysis

Title	Data Collected		Methodology
Analysis and Validation of Historical Transportation Investments *[17]* (NCDOT)-2018	Property Values Income Jobs	Number of businesses Population Economic Distress	IMPLAN TREDIS Annual Average Growth Rates Surveys and Interviews

(B) Research Articles

Title	Data Collected	Methodology
Review of Methods for Estimating the Economic Impact of Transportation Improvements ***[16]***-2008		Software tools for impact analysis Econometric Methods
Integrated Analysis of Economic Impacts of Bypasses on Communities ***[40]***-2011	Population Employment Payroll	Random Effects Panel Data Model Surveys and Interviews
The safety impact of land use changes resulting from bypass road constructions ***[41]***-2011	Crash rates Business and residential development	Negative Binomial Regression on bypass and control section
Managing the Indirect Impacts of Bypasses on Small and Medium-Sized Communities in Florida ***[3]***-2014	Population Distance to CBD Length of Bypass	Case Study Literature Review

Table A-2. Summary of EconWorks and NCHRP Research Reports

Title	Information Covered
Economic Impact Data Analysis Findings ***[42]***-2015	Range of Economic Impacts from various highway projects
Description and Interpretation of Case Studies: Handbook for Practitioners ***[43]***-2018	Interpretation of Case Studies Conduct of Future Case Studies
Highway Economic Impact Case Study Database and Analysis Findings ***[2]***-2015	Classification of Project Types and Settings Case selection and Data collection process Data Organization Data Tabulation Findings Statistical Analysis Construction of Narrative
EconWorks Data Dictionary ***[44]***-2018	Source and Description of Data Compatibility and Interpretation of Data
EconWorks Users Guide ***[15]***-2015	Instruction for Using the EconWorks Online Database and Project Tool
EconWorks Case Study Design***[28]*** -2018	Process for Conducting Case Studies
Effects of Highway Bypasses on Rural Communities and Small Urban Areas ***[45]***-1996	Literature review and survey on population, business sales. Land use, employment, traffic volumes, environmental conditions, and financial resources

APPENDIX B: REGIONAL ECONOMIC IMPACT ANALYSIS RESULTS

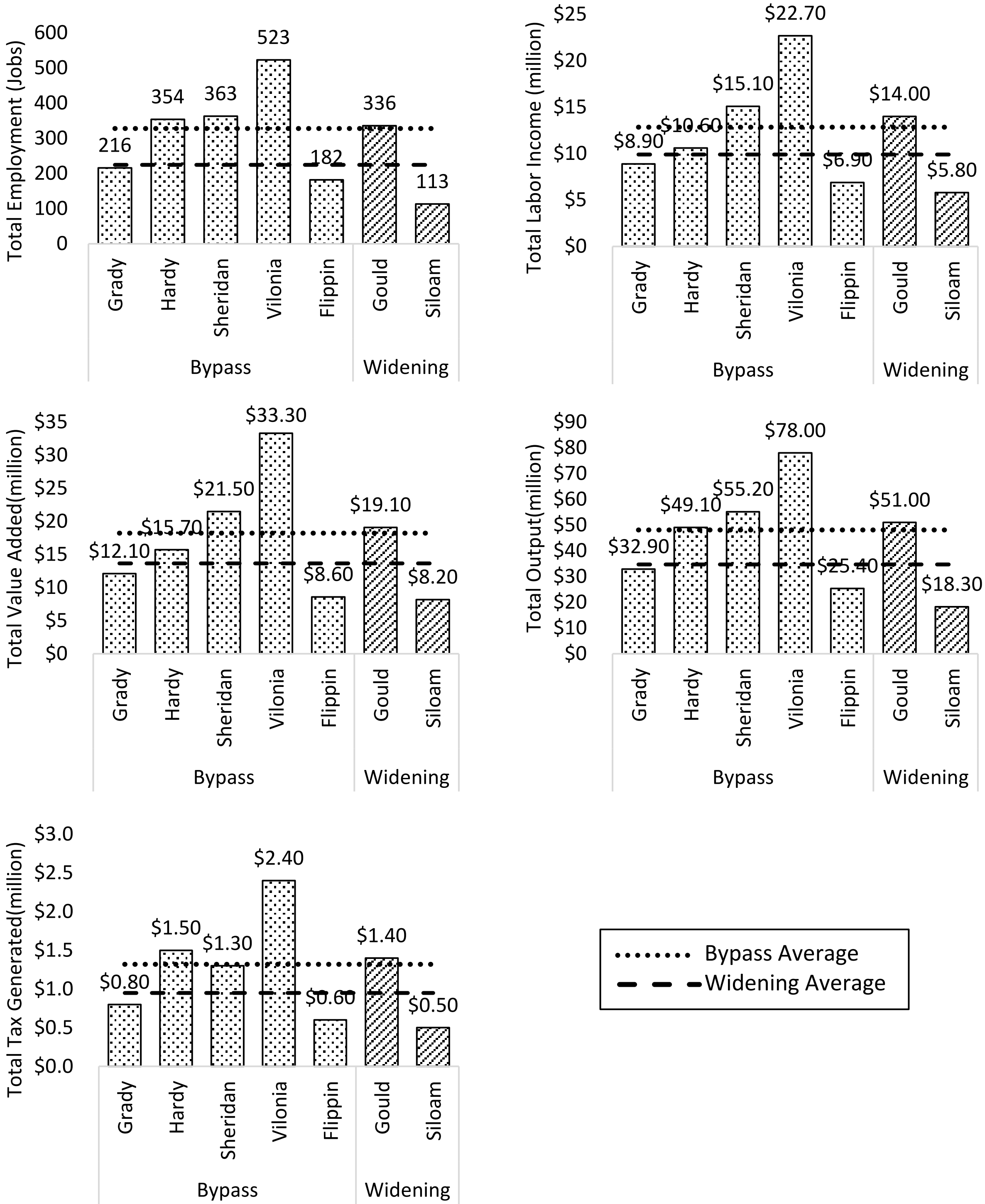


Figure B-1. Summary of IMPLAN Results for Total Impacts for County

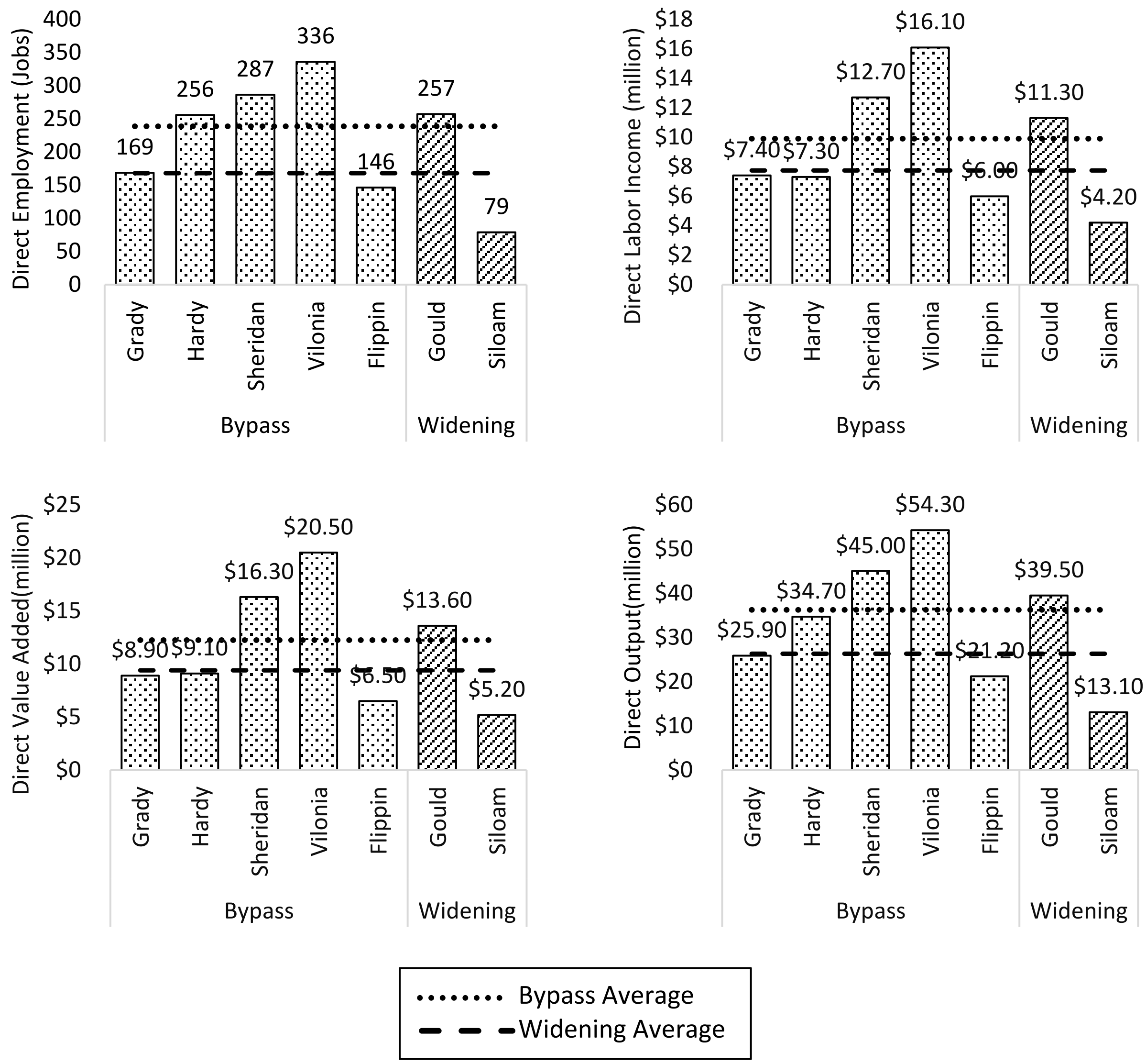


Figure B-2. Summary of IMPLAN Results for Direct Impacts for County

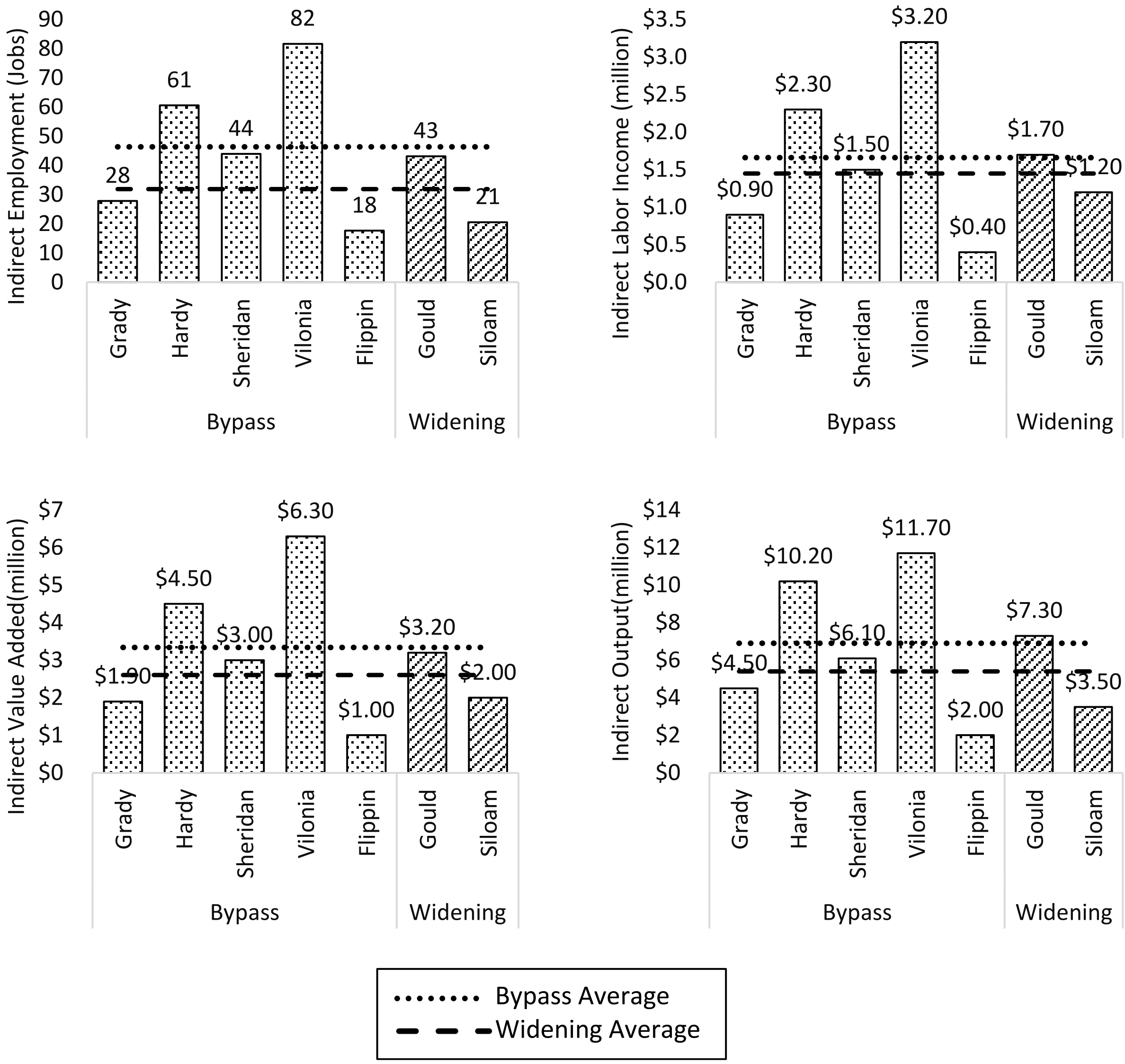


Figure B-3. Summary of IMPLAN Results for Indirect Impacts for County

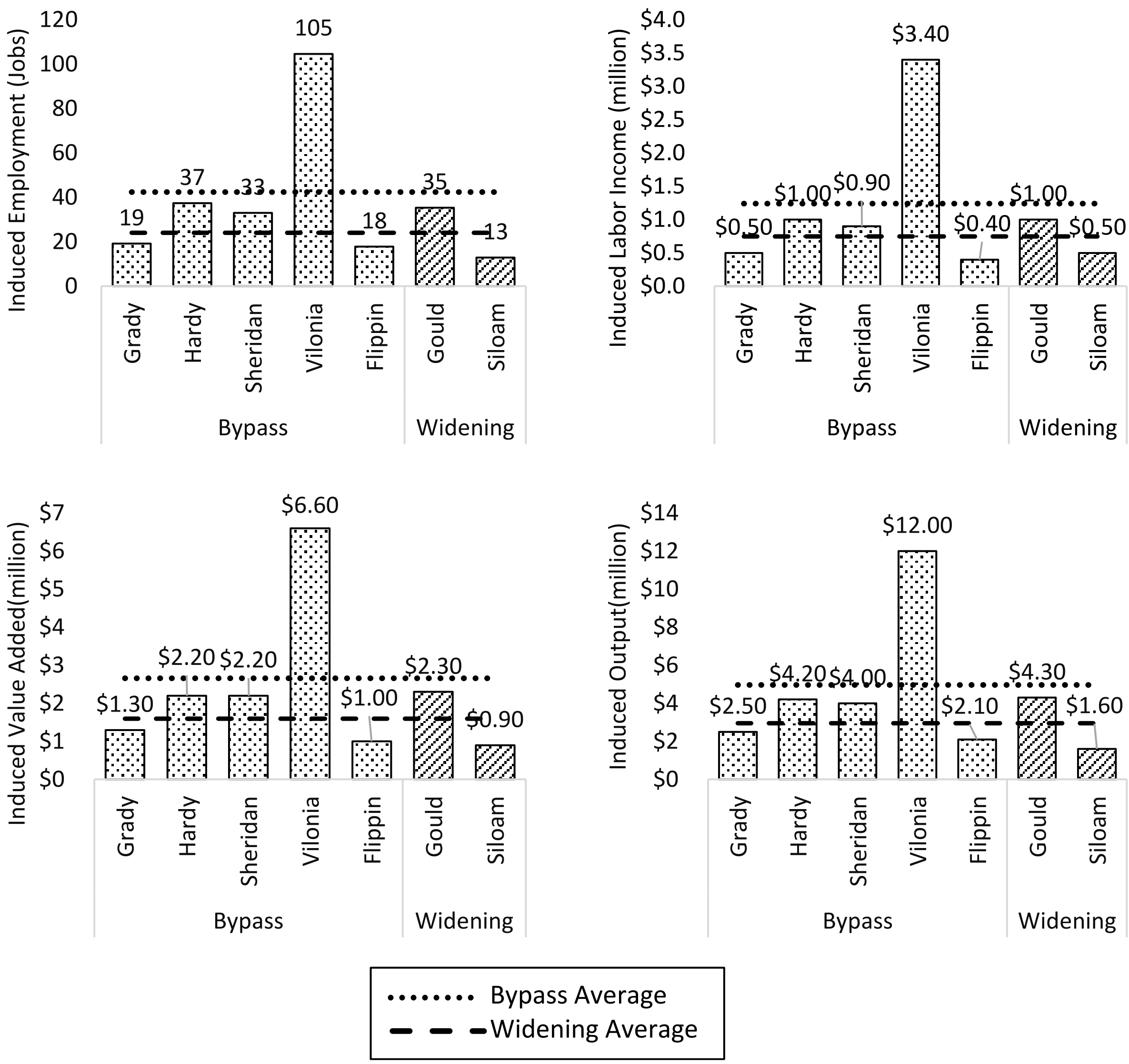


Figure B-4. Summary of IMPLAN Results for Induced Impacts for County

APPENDIX C: TIME SERIES TREND ANALYSIS FOR STUDY SITES

Grady (Bypass)

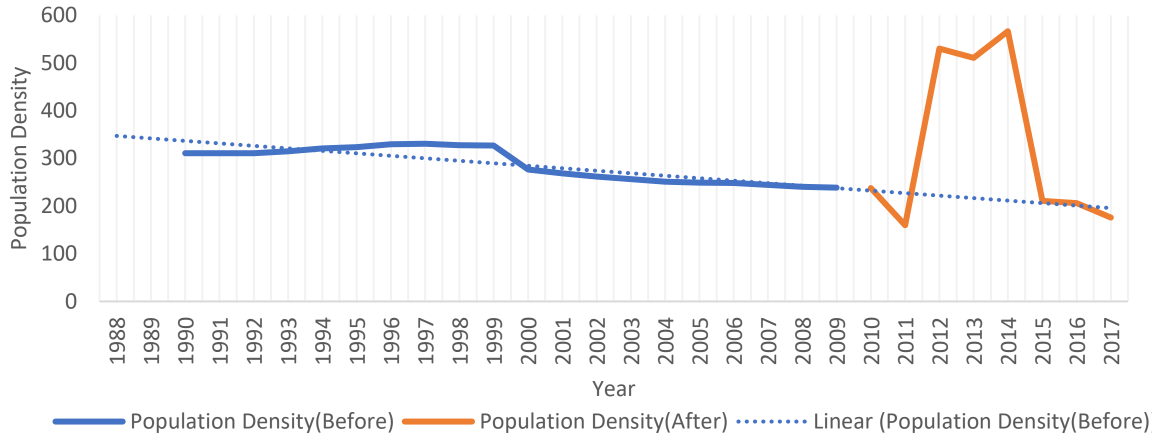


Figure C-1 Grady: Population Density

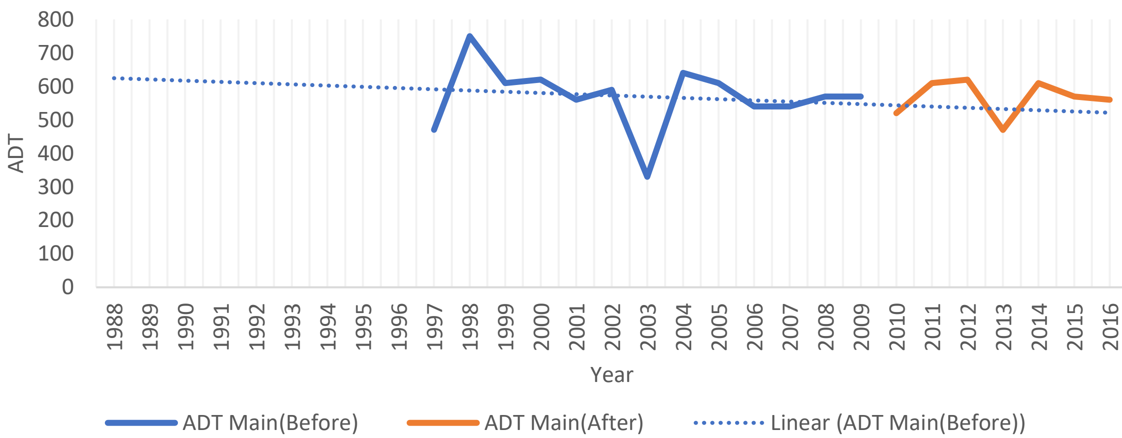


Figure C-2 Grady: ADT

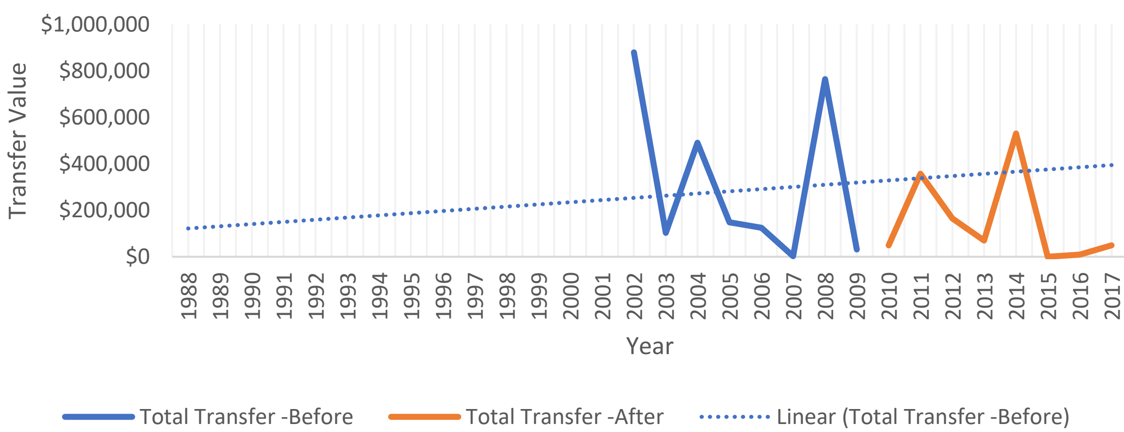


Figure C-3 Grady: Transfer Value

Hardy (Bypass)

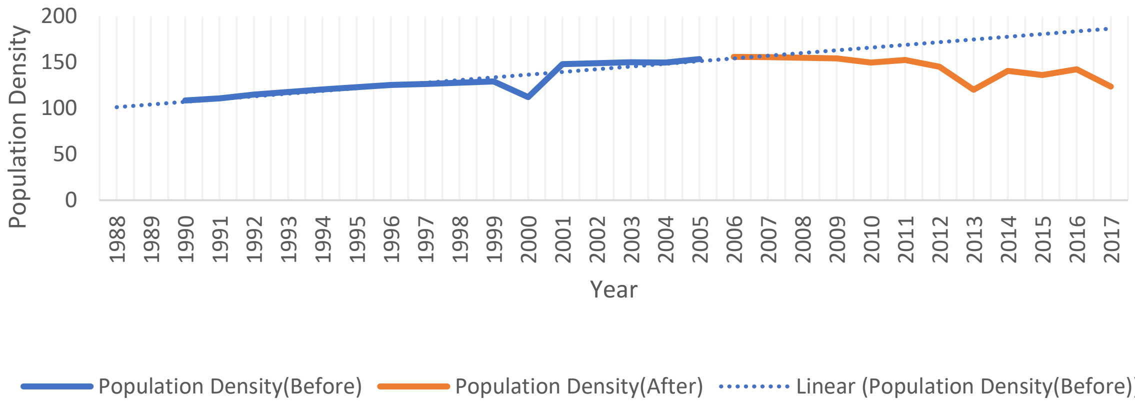


Figure C-4. Hardy: Population Density

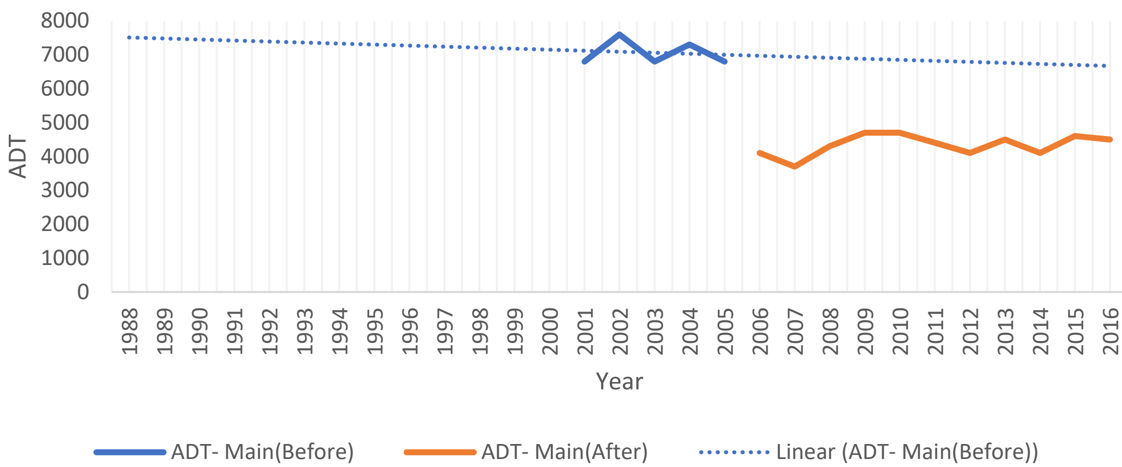


Figure C-5 Hardy: ADT

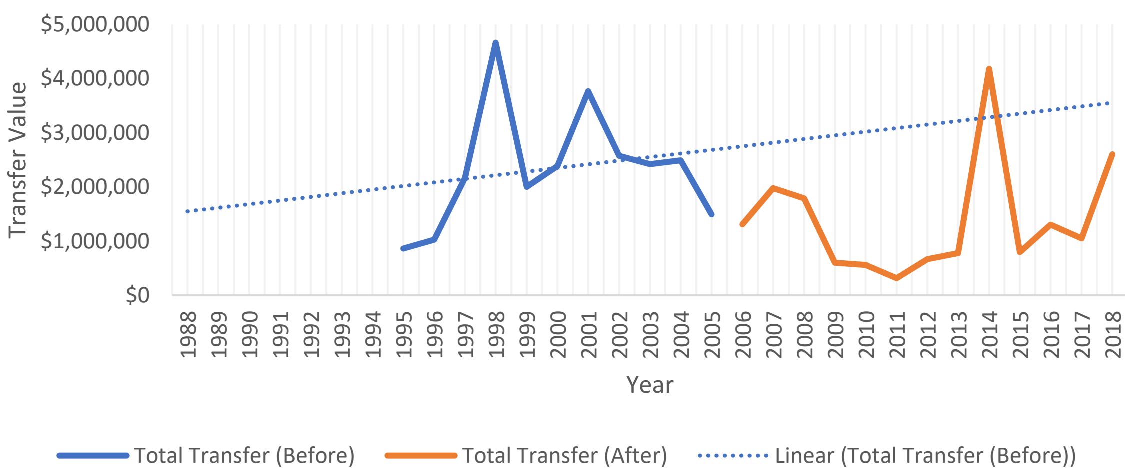


Figure C-6. Hardy: Transfer Value

Sheridan (Bypass)

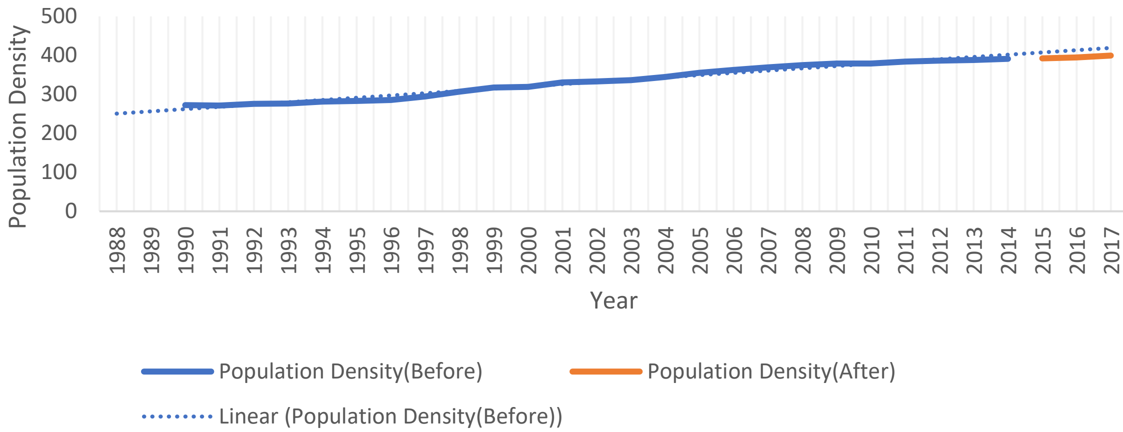


Figure C-7 Sheridan: Population Density

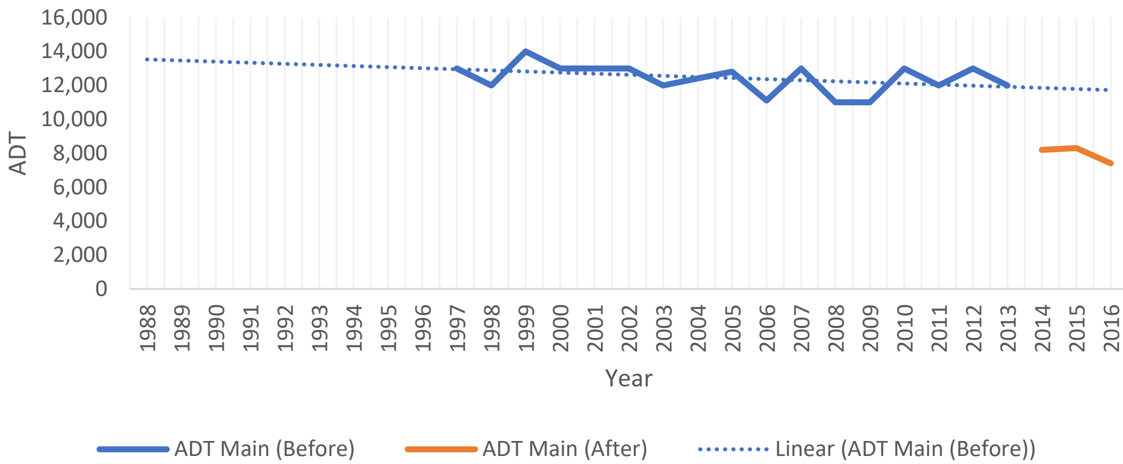


Figure C-8. Sheridan: ADT

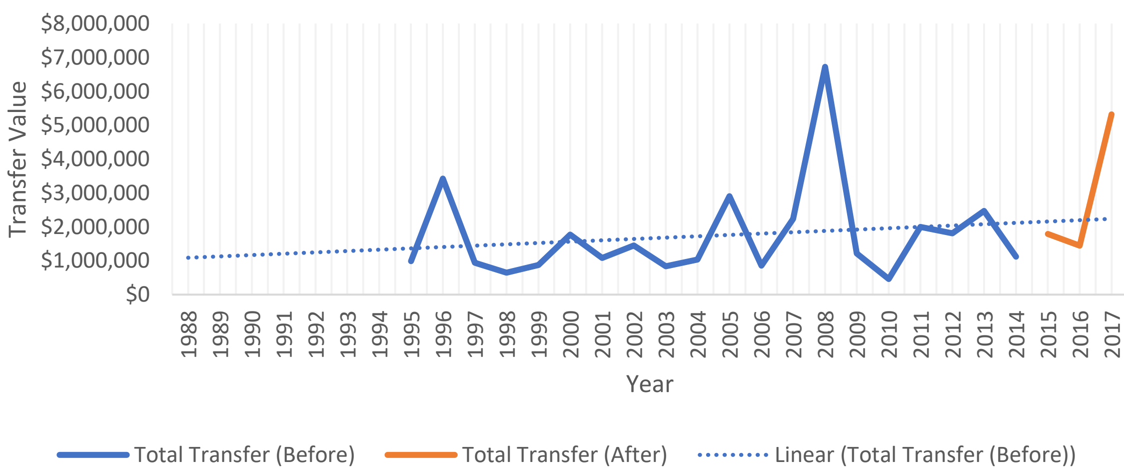


Figure C-9. Sheridan: Transfer Value

Vilonia (Bypass)

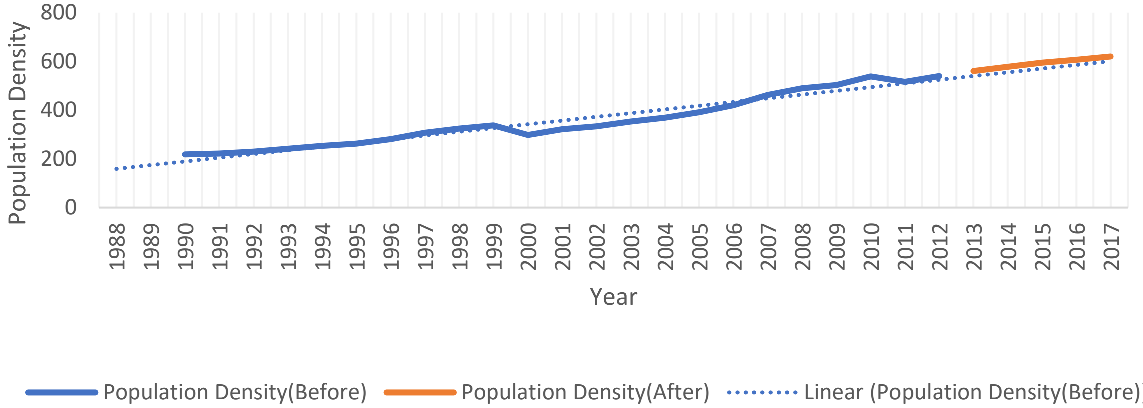


Figure C-10. Vilonia: Population Density

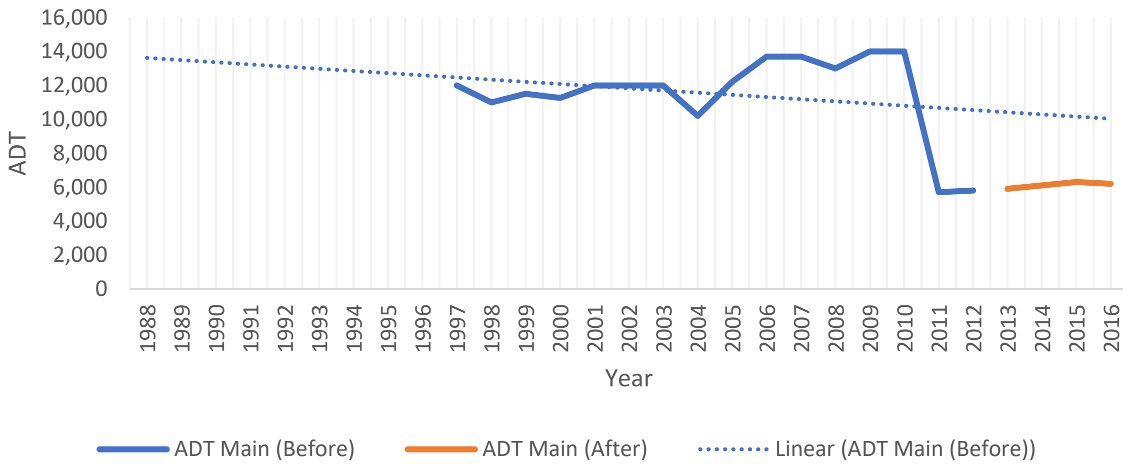


Figure C-11 Vilonia: ADT

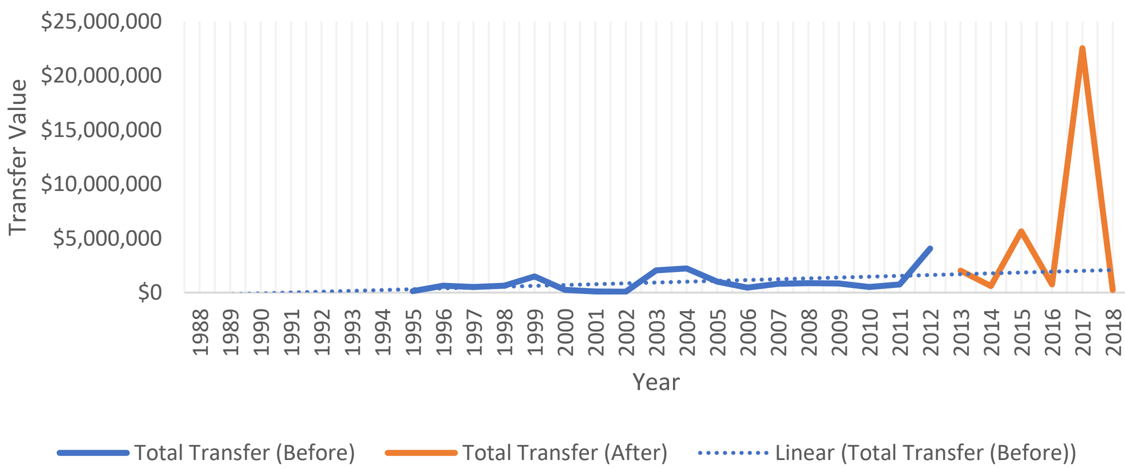


Figure C-12 Vilonia: Transfer Value

Flippin (Bypass)

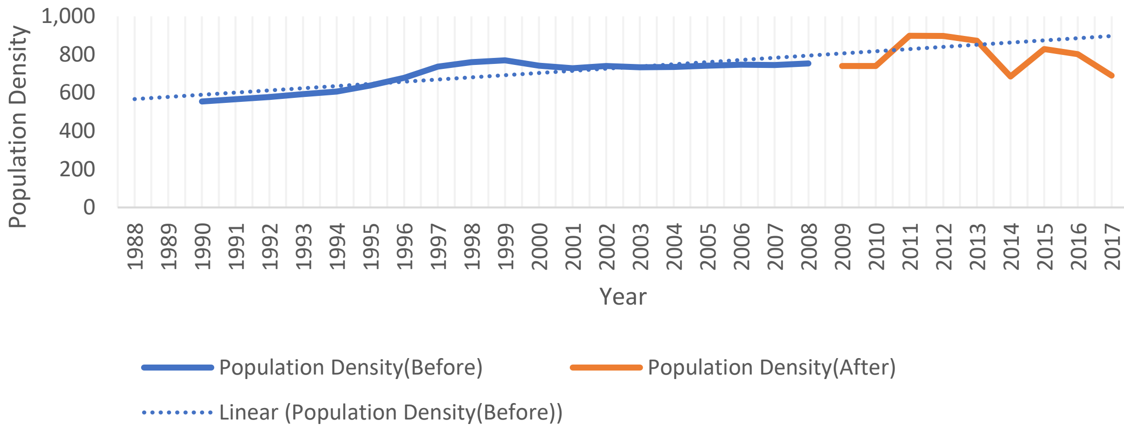


Figure C-13 Flippin: Population Density

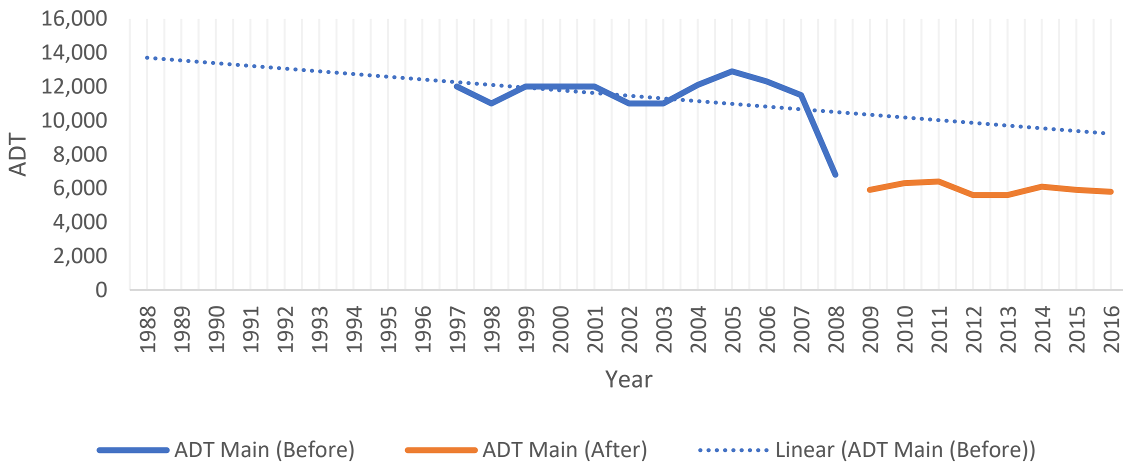


Figure C-14. Flippin: ADT

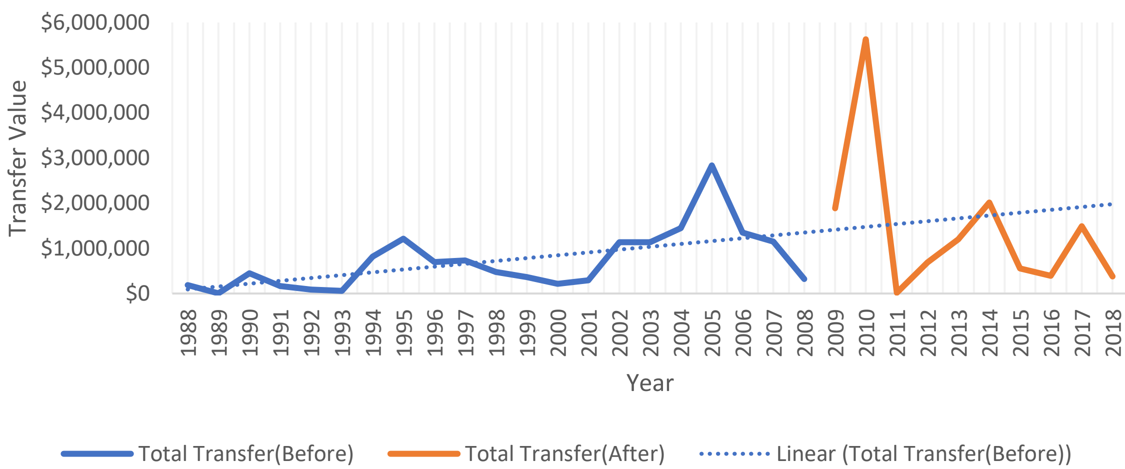


Figure C-15 Flippin: Transfer Value

Gould (Widening)

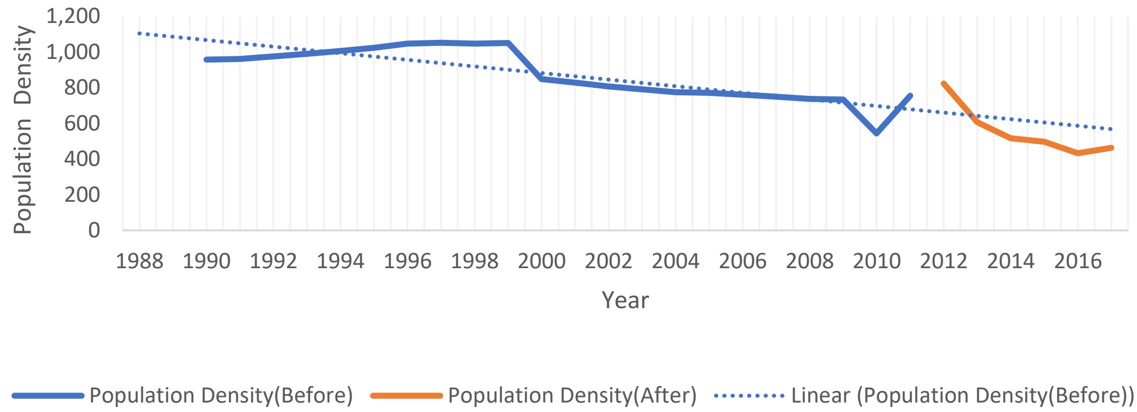


Figure C-16. Gould: Population Density

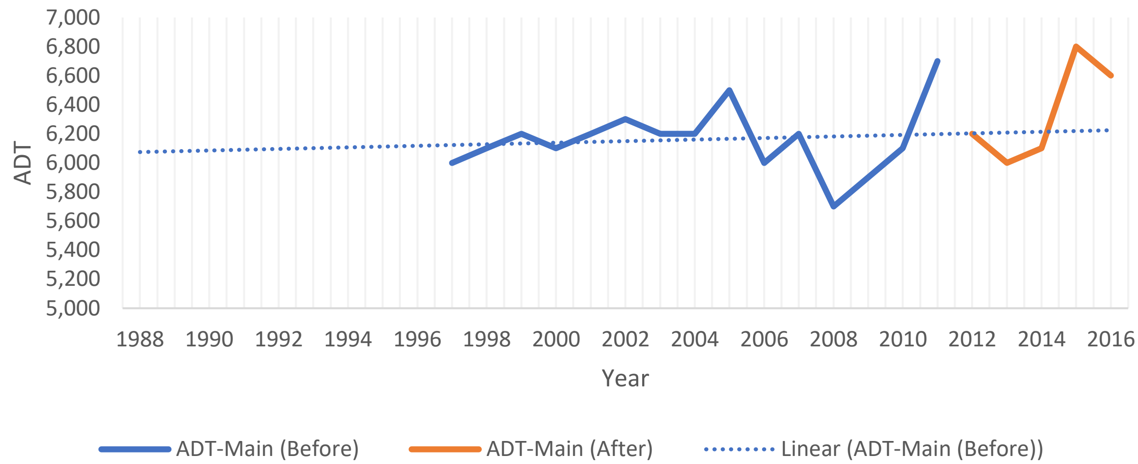


Figure C-17 Gould: ADT

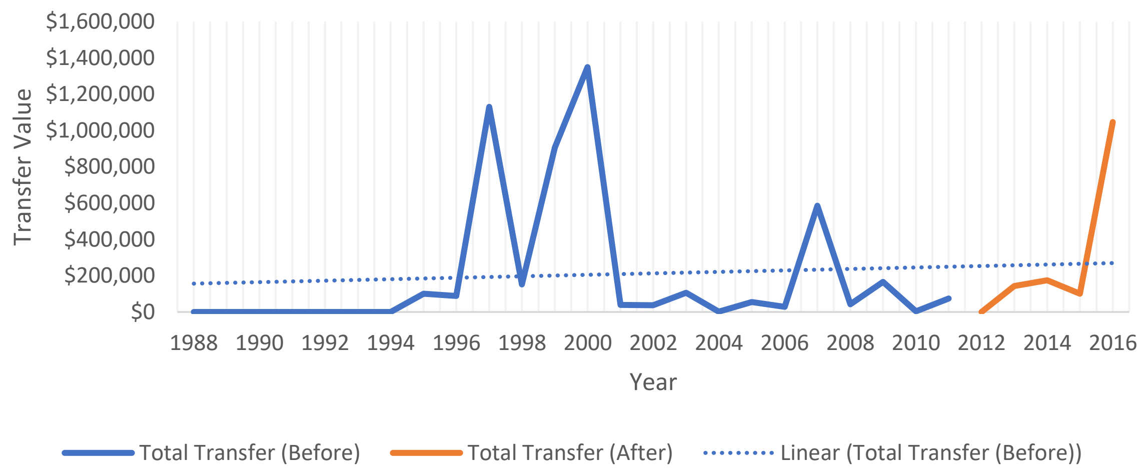


Figure C-18. Gould: Transfer Value

Siloam Springs (Widening)

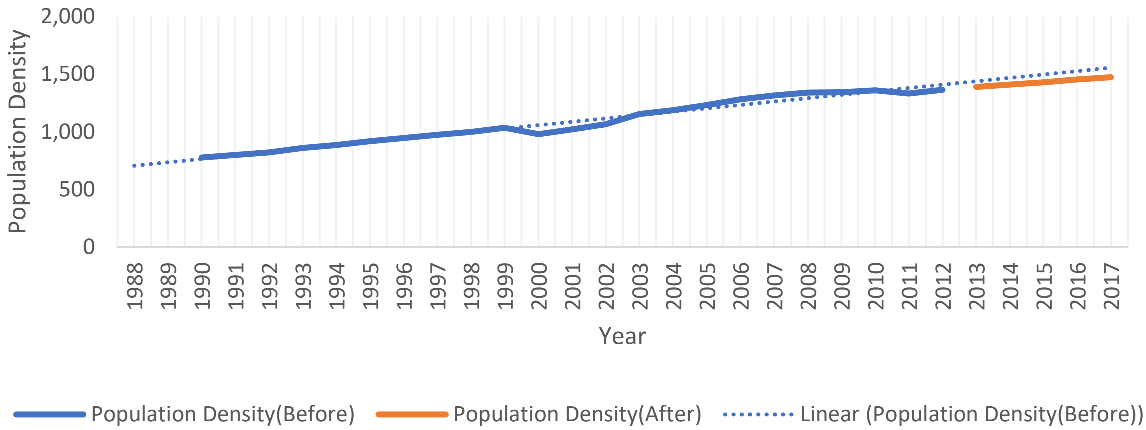


Figure C-19. Siloam Springs: Population Density

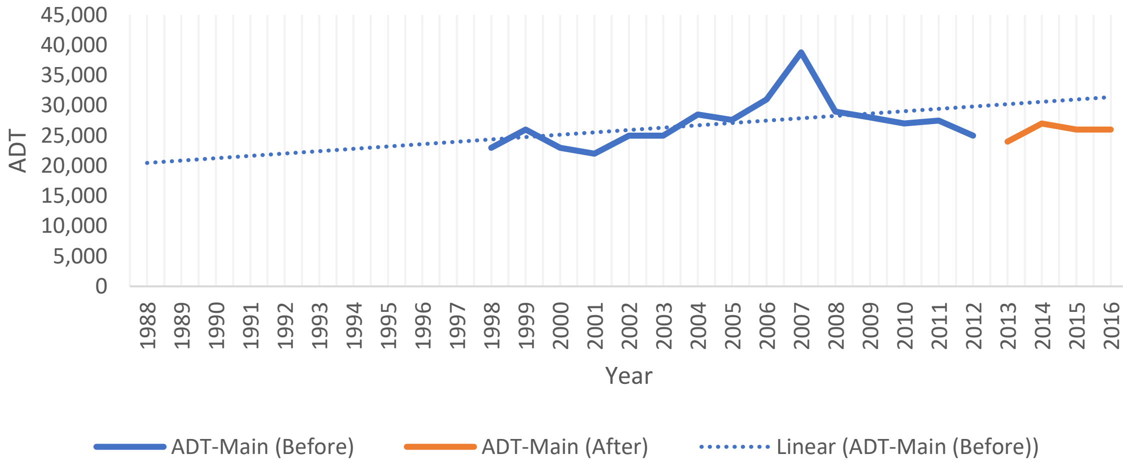


Figure C-20 Siloam Springs: ADT

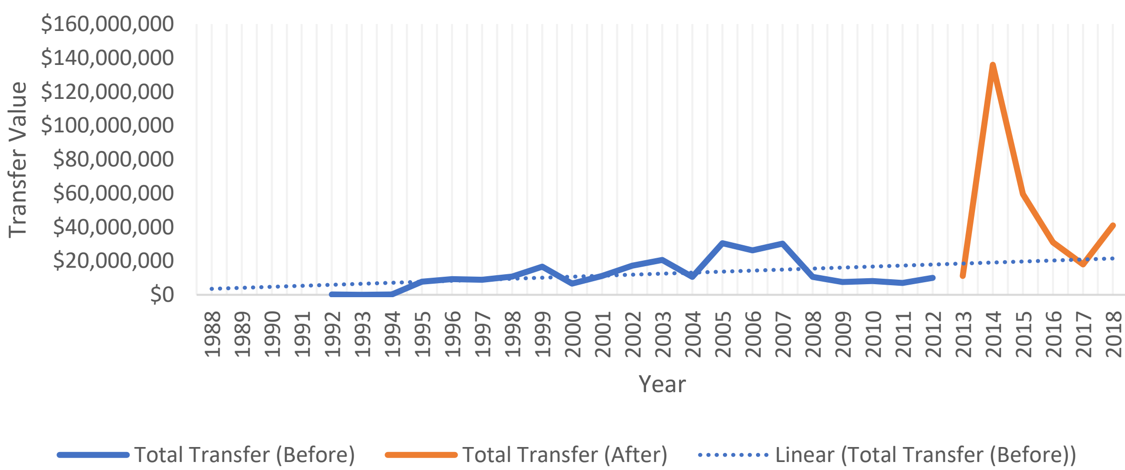


Figure C-21. Siloam Springs: Transfer Value

APPENDIX D: SURVEY QUESTIONNAIRE

Letter of Invitation (Structured Phone Interviews)

UNIVERSITY OF ARKANSAS
College of Engineering

[City] [Project Type]* on *[Project Location]

[date]

Dear [Name of Participant]:

You are invited to participate in a research study to measure the economic, social, and environmental effects of highway bypass and widening projects on Arkansas communities. We are conducting structured telephone interviews to better understand public perceptions about the impact of ***[Project Type]*** of ***[Project Location]***. Because you participated in past public involvement meetings related to this project, you are invited to participate in this research study***.***

We will work with you to find a convenient time and date for the phone interview. The interview will take approximately around 30 minutes. The discussion will consist of scripted questions read by the project research team followed by your responses. The data collected will provide useful information regarding the impacts of the ***[Project Type]*** of ***[Project Location]*** on community groups, businesses, and the local economy.

If you are willing to be interviewed, please contact Karla Diaz-Corro at kjdiazco@uark.edu or 479-575-8430, so that we can schedule a time and day.

If you require additional information, have questions, or would like a summary of the study results, please contact Dr. Sarah Hernandez at the number or email listed below. There is no compensation for responding nor is there any known risk. We will not collect your personal information during the focus groups. If you are not satisfied with the manner in which this study is being conducted, you may report (anonymously if you so choose) any complaints to the University of Arkansas Internal Review Board (IRB) Coordinator Ro Windwalker at 109 MLKG, Fayetteville, AR, 72701 or 479-575-2208.

Sincerely,

Karla Diaz-Corro
Graduate Research Assistant
Department of Civil Engineering
University of Arkansas
479-575-8430
kjdiazco@uark.edu

Sarah Hernandez, PhD
Assistant Professor
Department of Civil Engineering
University of Arkansas
479-575-4182
sarahvh@uark.edu

Figure D-1 Sample Letter of Invitation Mailed to the Community Leaders

Surveys by Parties Included (e.g. ARDOT Staff, Community Members, Businesses)

UNIVERSITY OF ARKANSAS

ARDOT Implementation Survey Form
[City] [Project Type] Impact

Survey #:

001

PERSONNEL CONTACT INFORMATION

Date: _____/_____/_______

Name: ___________________________________Telephone:_____________________

Address: ____

City/State/Zip: _________________/________________/_________

Role in this project: ______________________________

INTRODUCTION AND CONSENT

[Read the consent form script]

Introduction: *The purpose of this survey is to gather information about perceived and observed impacts of the [Project] in [City] on community members, traffic volumes, crashes, property values, and businesses. The project we are referring to is the [name and description of project]. The project construction began in [start date] and was completed in [end date]. Prior to this interview we gathered data on project impacts from property records, census data, and other public data sources. Now we wish to compare your observations and experiences to our data.*

We will go through a set of around 8 questions. After reading each question, we will ask for your input. We will record your responses and may ask for clarification to your statements. We plan to allow 45 minutes for this interview.

SURVEY QUESTIONS

1. Based on the planning and environmental process and supplementary documents for ***[Project Type]*** on ***[Project Location],*** the key motivations for the project were **[*Key Motivation*]**.
    a. How have these motivations been realized as a result of the construction of the ***[Project Type]*** on ***[Project Location]?***
    b. What qualitative and quantitative evidence to support this?

2. Do you think the **capacity for future economic development** has been affected by the construction of the ***[Project Type]*** on ***[Project Location]***?

3. Available demographic data show ***[steady, increasing, decreasing]*** population growth in the study area. Project documents state that ***[Number of non-Profit organization, businesses, or residential owner/tenants or minorities]*** were scheduled for relocation as a result of the construction of the ***[Project Type]*** on ***[Project Location].*** Environmental assessment documents state that environmental justice issues ***[Were/were not]*** raised. To what extent do these characteristics reflect the **social and environmental impacts** realized after the construction of the ***[Project Type]*** on ***[Project Location]***?

4. During the project development for ***[Project Type]*** on ***[Project Location], [number of public hearings]*** took place.

ARDOT Implementation Survey Form
[City] [Project Type] Impact

Survey #:

001

a. How would you describe the turn-out for the planning meetings in terms of number of participants, willingness to participate, diversity of attendees in regards to business owners and private citizens, etc.?
b. How would you describe general attitude of the **local community** as expressed during the public hearing meetings for ***[Project Type]*** on ***[Project Location]***?

5. How would you describe the **roles of stakeholders (e.g., Chambers of Commerce, local planning agencies, etc.) and public agencies** in the planning process for ***[Project Type]*** on ***[Project Location]***?

6. The general area surrounding the project in ***[Project Location]*** is primarily ***[Type of Area, e.g., commercial, residential, etc.]***. How would you describe the size of the **area of influence** of the construction of ***[Project Type]*** on ***[Project Location]***?

7. According to the environmental assessment for the construction of the ***[Project Type]*** on ***[Project Location]***, land use varies along the project route. For example, there are ***[Number of businesses]*** businesses, ***[Number of residential areas]*** residential areas, and ***[Number of recreational/other]*** other areas along the project route.
    a. To what extent do you think **land uses** along the project route affected planning decisions?
    b. To what extent do you think **land uses** along the project route affected community support and/or concern about the project?

8. A key indicator of economic conditions within an area is employment growth, e.g. number of jobs. Our analysis shows a growth of ***[Job growth rate]*** % from ***[One year before project]*** to ***[Five years after project]***.
    a. To what extent would you contribute this growth in employment to the project?
    b. Besides job growth, what other indicators of **economic impacts** should be considered for ***[Project Type]*** on ***[Project Location]***?

9. Do you have additional insights that would explain the data divergence found on ***[Topic]*** between the years ***[Range of Years]*** in ***[Project Location]***?

10. Is there anyone else with whom we should speak regarding assessing the impacts of this project?

Please provide contact information:
Name:____
Phone Number: ____________________________________
Reason(s) of suggesting this person for interview on this topic:
____
____

-- ***End of Survey*** --

Page 2 of 2

Figure D- 2 ARDOT Staff (Bypass and Widening Projects)

UNIVERSITY OF ARKANSAS

ARDOT Implementation Survey Form
[City] [Project Type] Impact

Survey #:

001

PERSONNEL CONTACT INFORMATION

Date: _____/_____/_______

Name: ___________________________________Telephone:_____________________

Address: ____

City/State/Zip: __________________/________________/_________

Role in this project: ______________________________

INTRODUCTION AND CONSENT

[Read the consent form script]

Introduction: *In **[Year]**, a proposed **[Project Type]** was considered to alleviate **[Project Motivations].** However, due to **[Decline reasons, local concerns, disapproval, lack of feasible improvement, etc]** the project was declined. The following questions are intended to capture the perceived changes within the city of **[Project Location]** as a result of deciding not to go forward with the proposed project. Prior to this interview we gathered data on project impacts from property records, census data, and other public data sources. Now we wish to compare your observations and experiences to our data.*

We will go through a set of around 8 questions. After reading each question, we will ask for your input. We will record your responses and may ask for clarification to your statements. We plan to allow 30 minutes for this interview.

SURVEY QUESTIONS

1. Based on the planning and environmental process and supplementary documents for ***[Project Type]*** on ***[Project Location],*** the key motivations for the project were **[*Key Motivation*]**.
    a. How have these motivations been realized over the past ***[Number of years since the decline]?***
    b. What qualitative and quantitative evidence support this?

2. Do you think the **capacity for future economic development** has been affected by the decline of the construction of the ***[Project Type]*** on ***[Project Location]***?

1. Available demographic data show ***[steady, increasing, decreasing]*** population growth in the study area. Project documents state that ***[Number of non-Profit organization, businesses, or residential owner/tenants or minorities]*** were scheduled for relocation as a result of the construction of the ***[Project Type]*** on ***[Project Location].*** Environmental assessment documents state that environmental justice issues ***[Were/were not]*** raised. How do these characteristics reflect the **social and environmental impacts** realized over the past ***[Number of years since the decline]***?

2. During the project development for ***[Project Type]*** on ***[Project Location], [number of public hearings]*** took place.
    a. How would you describe the turn-out for the planning meetings in terms of number of participants, willingness to participate, diversity of attendees in regards to business owners and private citizens, etc.?

ARDOT Implementation Survey Form
***[City] [Project Type]* Impact**

Survey #:
001

b. How would you describe general attitude of the **local community** as expressed during the public hearing meetings for ***[Project Type]*** on ***[Project Location]***?

3. How would you describe the **roles of stakeholders (e.g., Chambers of Commerce, local planning agencies, etc.) and public agencies** in the planning process for ***[Project Type]*** on ***[Project Location]***?

4. The general area surrounding the project in ***[Project Location]*** is primarily ***[Type of Area, e.g., commercial, residential, etc.]***. How would you describe the size of the **area of influence** due to the decision of taking no action towards the construction of a ***[Project Type]***?

5. According to the environmental assessment for the construction of the ***[Project Type]*** on ***[Project Location]***, land use varies along the project route. For example, there are ***[Number of businesses]*** businesses, ***[Number of residential areas]*** residential areas, and ***[Number of recreational/other]*** other areas along the project route.
   a. How do you think **land uses** along the project route affected planning decisions due to the decision of taking no action towards the construction of a ***[Project Type]***?
   b. How do you think **land uses** along the project route affected community support and/or concern about the project?

6. A key indicator of economic conditions within an area is employment growth, e.g. number of jobs. Our analysis shows a growth of ***[Job growth rate]*** % from ***[One year before project was proposed]*** to ***[Five years after project was proposed of completion]***.
   a. How would you contribute this growth in employment to the decision of taking no action towards the construction of a ***[Project Type]***?
   b. Besides job growth, what other indicators of **economic impacts** should have been considered for ***[Project Type]*** on ***[Project Location]***?

7. Do you have additional insights that would explain the data divergence found on ***[Topic]*** between the years ***[Range of Years]*** in ***[Project Location Proposed]***?

8. Is there anyone else with whom we should speak regarding assessing the impacts of this project?

Please provide contact information:
Name:____
Phone Number: ____
Reason(s) of suggesting this person for interview on this topic:
____
____

--- ***End of Survey*** ---

Page 2 of 2

Figure D- 3 ARDOT Staff (No Implementation Projects)

UNIVERSITY OF ARKANSAS

Community Survey
[*City*] [*Project Type*] Impact

Survey

#001

INTRODUCTION AND CONSENT

[Read the consent form script]

Introduction: The purpose of this survey is to gather information about perceived and observed impacts of the [Project] in [City] on community members, traffic volumes, crashes, property values, and businesses. The project we are referring to is the [name and description of project]. The project construction began in [start date] and was completed in [end date]. Prior to this interview we gathered data on project impacts from property records, census data, and other public data sources. Now we wish to compare your observations and experiences to our data.

We will go through a set of around 25 questions. The topic for each set of questions will be introduced by [name of interviewer] and then a set of questions will be asked. After reading each question, we will ask for your input. We will record your responses and may ask for clarification to your statements. We plan to allow 45 minutes for this interview.

VEHICULAR TRAFFIC

Introduction: One of the factors contributing to the need for the [Bypass/Widening] project was to ease traffic congestion along [Project Location]. The next set of questions relate to your perception of changes in traffic congestion or volume that may be a result from the project.

1. How do you think **vehicular traffic** along ***[Street Name]*** has changed as a result of the **[*Project Type*]** on ***[Project Location]***?

2. How do you think **vehicular traffic** has changed in the area surrounding ***[City]*** as a result of the ***[Project Type]*** on ***[Project Location]***?

3. How do you think **vehicular traffic** has changed due to any other factors since ***[Project Completion Date]***?

CRASH OCCURENCE

Introduction: Crash occurrence is one measure of traffic safety often used to compare the impacts of a new project. Historical data from before the project was started to after the project was completed show a [reduction/increase/no change] in the number of crashes occurred along ***[Street Name].*** *The next set of questions relate to your perception and experience with changes in crash occurrence that may be a result of the project.*

4. How do you think **crash occurrence** along ***[Street Name]*** has changed as a result of the **[*Project Type*]** on ***[Project Location]***?

5. How do you think **crash occurrence** has changed in the area surrounding ***[City]*** as a result of the ***[Project Type]*** on ***[Project Location]***?

6. How do you think **crash occurrence** has changed due to any other factors since ***[Project Start Date]***?

Community Survey
[*City*] [*Project Type*] Impact

Survey
#001

PROPERTY VALUE

Introduction: The next set of questions related to perceived or observed changes in property values that may be a result of the project. Here we consider property values to be the amount of money someone is willing to pay for a property and how much the seller of the property is willing to accept. Based on historical data, we see that property values have [increased/decreased/stayed the same] from the time before the project began to after the project was finished.

7. How do you think **property values** have changed in ***[City]*** as a result of the ***[Project Type]*** on ***[Project Location]***?

8. How do you think **property values** have changed in the area surrounding ***[City]*** as a result of the ***[Project Type]*** on ***[Project Location]***?

6. How do you think **property values** have changed due to any other factors since ***[Project Start Date]***?

BUSINESS

Introduction: The next questions refer to changes in businesses along and near the project site. Here, a business is considered to be any and all commercial ventures of any industry, type, or size.

7. How do you think **existing businesses** have changed in ***[City]*** as a result of the ***[Project Type]*** on ***[Project Location]***?

8. How do you think **existing businesses** have changed in the area surrounding ***[City]*** as a result of the ***[Project Type]*** in ***[Project Location]***?

9. How do you think **existing businesses** have changed due to any other factors since ***[Project Start Date]***?

10. How do you think **new businesses** have opened in ***[City]*** as a result of the ***[Project Type]*** on ***[Project Location]***?

11. How do you think **new businesses** have opened in the area surrounding ***[City]*** as a result of the ***[Project Type]*** on ***[Project Location]***?

12. How do you think **new businesses** have opened due to any other factors since ***[Project Start Date]***?

13. How do you think the mix of **business types** has changed in ***[City]*** as a result of the ***[Project Type]*** on ***[Project Location]***?

14. How do you think the mix of **business types** has changed in the area surrounding ***[City]*** as a result of the ***[Project Type]*** on ***[Project Location]***?

15. How do you think the mix of **business types** has changed due to any other factors since ***[Project Start Date]***?

16. How do you think the number of **shoppers** visiting local businesses has changed in ***[City]*** as a result of the **[*Project Type*]** on ***[Project Location]***?

17. How do you think the number of **shoppers** has changed in the area surrounding ***[City]*** as a result of the ***[Project Type]*** on ***[Project Location]***?

18. How do you think the number of **shoppers** has changed due to any other factors since ***[Project Start Date]***?

TOURISM

Introduction: Promotion of tourism can be a motivating factor for transportation projects. Potential observable changes in tourism can be attributed to new hotels and business growth, for example. The term tourist refers to someone who travels for pleasure rather than for business. The following questions relate to how the project may have impacted tourism.

19. How do you think **tourism** has changed in ***[City]*** as a result of the [***Project Type]*** on ***[Project Location]***?

20. How do you think **tourism** has changed in the area surrounding ***[City]*** as a result of the ***[Project Type]*** on ***[Project Location]***?

21. How do you think **tourism** has changed due to any other factors since ***[Project Start Date]***?

ECONOMIC DEVELOPMENT PROGRAMS (Planners or chamber of commerce representative only)

Introduction: The next set of questions relate to perceptions and observations of economic development resulting from the project. Economic development refers to the process of expanding the economic activity in an area to provide more jobs and income for the residents. Economic development programs, led by city leaders, state agencies, or local business groups, may lead to increased productivity and improved competitive position of the city. Examples of economic development programs include, new distribution facilities, incentives to manufacturers to stay at an existing location, or expansion of current businesses. Based on your knowledge about any type of business assistance and attraction programs currently offered by the city, please answer the following questions:

22. How do you think **economic development programs** have changed in ***[City]*** as a result of the ***[Project Type]*** on ***[Project Location]***?

23. How do you think **economic development programs** have changed in the area surrounding ***[City]*** as a result of the ***[Project Type]*** on ***[Project Location]***?

24. How do you think **economic development programs** have changed due to any other factors since ***[Project Start Date]***?

GENERAL QUESTIONS

25. Do you have additional insights that would explain the data divergence found on ***[Topic]*** between the years ***[Range of Years]*** in ***[Project Location]***?

UNIVERSITY OF ARKANSAS

Community Survey
[*City*] [*Project Type*] Impact

Survey

#001

26. Do you consider ***[Project Type]*** on ***[Project Location]*** a success?

27. Is there anyone else with whom we should speak?

    Please provide contact information:

    Name:____

    Phone Number: ____

    Reason(s) for suggesting this person for an interview:

    ____
    ____
    ____

-- ***End of Survey*** --

Page 4 of 4

Figure D- 4 Community Survey (Bypass and Widening Projects)

UNIVERSITY OF ARKANSAS

Community Survey
[*City*] [*Project Type*] Impact

Survey

#001

INTRODUCTION AND CONSENT

[Read the consent form script]

Introduction: *In* ***[Year]****, a proposed* ***[Project Type]*** *was considered to alleviate* ***[Project Motivations].*** *However, due to* ***[Decline reasons, local concerns, disapproval, lack of feasible improvement, etc]*** *the project was declined. The following questions are intended to capture the perceived changes within the city of* ***[Project Location]*** *as a result of deciding not to go forward with the proposed project. Prior to this interview we gathered data on project impacts from property records, census data, and other public data sources. Now we wish to compare your observations and experiences to our data.*

We will go through a set of around 25 questions. The topic for each set of questions will be introduced by [name of interviewer] and then a set of questions will be asked. After reading each question, we will ask for your input. We will record your responses and may ask for clarification to your statements. We plan to allow 30 minutes for this interview.

VEHICULAR TRAFFIC

Introduction: One of the factors contributing to the need for the [Bypass/Widening] project was to ease traffic congestion along [Project Location]. The next set of questions relate to your perception of changes in traffic congestion or volume since the project decline in [Year].

1. How do you think **vehicular traffic** along ***[Street Name]*** has changed over the last ***[Number of years since the decline]***?
2. How do you think **vehicular traffic** has changed in the area surrounding ***[City]*** over the last ***[Number of years since the decline]***?
3. How do you think **vehicular traffic** has changed due to any other factors other than the decline of the ***[Project Type]*** on ***[Project Location]*** over the last ***[Number of years since the decline]***?

CRASH OCCURRENCE

Introduction: Crash occurrence is one measure of traffic safety often used to compare the impacts of a new project. Historical data over the last [Number of years since the decline] show a [reduction/increase/no change] in the number of crashes occurred along ***[Street Name].*** *The next set of questions relate to your perception and experience with changes in crash occurrence that may be a result of the project.*

4. How do you think **crash occurrence** along ***[Street Name]*** has changed over the last ***[Number of years since the decline]***?
5. How do you think **crash occurrence** has changed in the area surrounding ***[City]*** over the last ***[Number of years since the decline]***?
6. How do you think **crash occurrence** has changed due to any other factors other than the decline of the ***[Project Type]*** on ***[Project Location]*** over the last ***[Number of years since the decline]***?

PROPERTY VALUE

Introduction: The next set of questions related to perceived or observed changes in property values over the last [Number of years since the decline]. Here we consider property values to be the amount of money someone is willing to pay for a property and how much the seller of the property is willing to accept. Based on historical data, we see that property values have [increased/decreased/stayed the same] from over the last [Number of years since the decline].

7. How do you think **property values** have changed in ***[City]*** over the last ***[Number of years since the decline]***?

8. How do you think **property values** have changed in the area surrounding ***[City]*** over the last ***[Number of years since the decline]***?

9. 6. How do you think **property values** have changed due to any other factors other than the decline of the ***[Project Type]*** on ***[Project Location]*** over the last ***[Number of years since the decline]***?

BUSINESS

Introduction: The next questions refer to changes in businesses along and near the proposed project site. Here, a business is considered to be any and all commercial ventures of any industry, type, or size.

10. How do you think **existing businesses** have changed in ***[City]*** over the last ***[Number of years since the decline]***?

11. How do you think **existing businesses** have changed in the area surrounding ***[City]*** over the last ***[Number of years since the decline]***?

12. How do you think **existing businesses** have changed due to any other factors other than the decline of the ***[Project Type]*** on ***[Project Location]*** over the last ***[Number of years since the decline]***?

13. How do you think **new businesses** have opened in ***[City]*** over the last ***[Number of years since the decline]***?

14. How do you think **new businesses** have opened in the area surrounding ***[City]*** over the last ***[Number of years since the decline]***?

15. How do you think **new businesses** have opened due to any other factors other than the decline of the ***[Project Type]*** on ***[Project Location]*** over the last ***[Number of years since the decline]***?

16. How do you think the mix of **business types** has changed in ***[City]*** over the last ***[Number of years since the decline]***?

17. How do you think the mix of **business types** has changed in the area surrounding ***[City]*** over the last ***[Number of years since the decline]***?

18. How do you think the mix of **business types** has changed due to any other factors other than the decline of the ***[Project Type]*** on ***[Project Location]*** over the last ***[Number of years since the decline]***?

19. How do you think the number of **shoppers** visiting local businesses has changed in ***[City]*** over the last ***[Number of years since the decline]***?

20. How do you think the number of **shoppers** has changed in the area surrounding ***[City]*** over the last ***[Number of years since the decline]***?

21. How do you think the number of **shoppers** has changed due to any other factors other than the decline of the ***[Project Type]*** on ***[Project Location]*** over the last ***[Number of years since the decline]***?

TOURISM

Introduction: Promotion of tourism can be a motivating factor for transportation projects. Potential observable changes in tourism can be attributed to new hotels and business growth, for example. The term tourist refers to someone who travels for pleasure rather than for business. The following questions relate to impacts on tourism over the last [Number of Years since the decline].

22. How do you think **tourism** has changed in ***[City]*** over the last ***[Number of years since the decline]***?

23. How do you think **tourism** has changed in the area surrounding ***[City]*** over the last ***[Number of years since the decline]***?

24. How do you think **tourism** has changed due to any other factors other than the decline of the ***[Project Type]*** on ***[Project Location]*** over the last ***[Number of years since the decline]***?

ECONOMIC DEVELOPMENT PROGRAMS (Planners or chamber of commerce representative only)

Introduction: The next set of questions relate to perceptions and observations of economic development over the last [Number of Years since the decline]. Economic development refers to the process of expanding the economic activity in an area to provide more jobs and income for the residents. Economic development programs, led by city leaders, state agencies, or local business groups, may lead to increased productivity and improved competitive position of the city. Examples of economic development programs include, new distribution facilities, incentives to manufacturers to stay at an existing location, or expansion of current businesses. Based on your knowledge about any type of business assistance and attraction programs currently offered by the city, please answer the following questions:

25. How do you think **economic development programs** have changed in ***[City]*** over the last ***[Number of years since the decline]***?

26. How do you think **economic development programs** have changed in the area surrounding ***[City]*** over the last ***[Number of years since the decline]***?

27. How do you think **economic development programs** have changed due to any other factors other than the decline of the ***[Project Type]*** on ***[Project Location]*** over the last ***[Number of years since the decline]***?

UNIVERSITY OF ARKANSAS

Community Survey
[*City*] [*Project Type*] Impact

Survey
#001

GENERAL QUESTIONS

7. Do you have additional insights that would explain the data divergence found on ***[Topic]*** between the years ***[Range of Years]*** in ***[Project Location]***?

8. What general opinion do you have about the decision made in ***[Year of decline]*** about the construction of ***[Project Type]*** on ***[Project Location]***?

9. Is there anyone else with whom we should speak?

   Please provide contact information:

   Name:____

   Phone Number: ____

   Reason(s) for suggesting this person for an interview:

   ____

   ____

   ____

--- ***End of Survey*** ---

Page 4 of 4

Figure D- 5 Community Survey (No Implementation Projects)

UNIVERSITY OF ARKANSAS

Business Survey Form
[*City*] [*Project Type*] Impact

Survey
001

BUSINESS PROFILE INFORMATION

1. Date: _____/_____/_______

2. Name of Company: ____________________________________ Telephone:___________________________

   Address: ____

   City/State/Zip: __________________/________________/_________

   Contact Name(s):____

INTRODUCTION AND CONSENT

[Read the consent form script]

Introduction: The purpose of this survey is to gather information about perceived and observed impacts of the [Project] in [City] on businesses. The project we are referring to is the [name and description of project]. The project construction began in [start date] and was completed in [end date]. Prior to this interview we gathered data on project impacts from property records, census data, and other public data sources. Now we wish to compare your observations and experiences to our data.

We will go through a set of around 25 questions. The topic for each set of questions will be introduced by [name of interviewer] and then a set of questions will be asked. After reading each question, we will ask for your input. We will record your responses and may ask for clarification to your statements. We plan to allow 30 minutes for this interview.

SURVEY QUESTIONS

3. Please select a category that best represents the principal products/services your business offers: *(check one)*

☐ restaurant or bar	☐ gas station	☐ hotel / motel
☐ retail store	☐ trucking / transportation	☐ wholesale/warehouse
☐ business services	☐ personal services	☐ banking / finance
☐ manufacturing	☐ other (specify) ______________________________________	

4. Which of the following categories best describes the primary market for your company's product? *(check one)*

☐ pass-by traffic	☐ local residents	☐ county/region
☐ within 500 miles	☐ national	☐ international

5. How do customers get to your business or otherwise obtain your products or services?

☐Driving	☐ Bus passenger	☐Other (specify) ______________________________
☐ Air or Taxi	☐ Mail, Tel or Internet	

6. Has the size of your **customer base** has changed by the implementation of the ***[Project Type]*** on ***[Project Location]***?

7. Has **retaining your existing customers** been impacted by the implementation of the ***[Project Type]*** on ***[Project Location]***?

8. Does any portion of **shipments** pertaining to your business travel on the ***[Project Type]*** on ***[Project Location]***?

9. In terms of the cost of supplies, delivery time, and suppliers, has the ability to obtain **materials and supplies** been affected by the implementation of the ***[Project Type]*** on ***[Project Location]***?

10. Roughly how many people do you employ?

11. Do your employees **commute** to work using the ***[Project Type]*** on ***[Project Location]***?

12. Has **retaining employees** been affected by the implementation of the ***[Project Type]*** on ***[Project Location]***?

13. Has **recruiting new employees** been affected by the implementation of the ***[Project Type]*** on ***[Project Location]***?

14. Were you satisfied with the existing roadway, traffic, and access conditions in the area **before** the implementation of the ***[Project Type]*** on ***[Project Location]***?

15. Are you satisfied with the existing roadway, traffic, and access conditions in the area **after** the implementation of the ***[Project Type]*** on ***[Project Location]***?

16. Has the **size** of your business operation changed as a result of the ***[Project Type]*** on ***[Project Location]***?

17. Has the **profitability** of your business changed by the implementation of the ***[Project Type]*** on ***[Project Location]***?

18. Has the **sales volume** of your business changed by the implementation of the ***[Project Type]*** on ***[Project Location]***?

19. How long has your company been at its current location (in years)? _________

20. Is this your original location? ☐ Yes (*skip to #22*) ☐ No

21. Has the decision to operate in this area been influenced by the implementation of the ***[Project Type]*** on ***[Project Location]***?

22. In terms of advantages and disadvantages, do you consider the ***[Project Type]*** on ***[Project Location]*** as a place to do business?

23. Has the number of companies in your line of business changed after the implementation of the ***[Project Type]*** on ***[Project Location]***?

24. What types of companies do you think will be more attracted to the area by the implementation of the ***[Project Type]*** on ***[Project Location]***?

25. Do you have additional insights that would explain the data divergence found on ***[Topic]*** between the years ***[Range of Years]*** in ***[Project Location]***?

UNIVERSITY OF ARKANSAS

Business Survey Form
[*City*] [*Project Type*] Impact

Survey 001

26. Is there anyone else with whom we should speak?

Please provide contact information:

Name: ____

Phone Number: ____

Reason(s) of suggesting this person for interview on this topic:

____

____

____

-- *End of Survey* ---

Page 3 of 3

Figure D- 6 Private Businesses (Bypass and Widening Projects)

Survey 001

Business Survey Form
[*City*] [*Project Type*] Impact

UNIVERSITY OF ARKANSAS

BUSINESS PROFILE INFORMATION

1.Date: _____/_____/_______

2.Name of Company: ____________________________________ Telephone:___________________________

Address: ____

City/State/Zip: __________________/________________/_________

Contact Name(s):____

INTRODUCTION AND CONSENT

[Read the consent form script]

Introduction: *In* ***[Year]****, a proposed* ***[Project Type]*** *was considered to alleviate* ***[Project Motivations].*** *However, due to* ***[Decline reasons, local concerns, disapproval, lack of feasible improvement, etc]*** *the project was declined. The following questions are intended to capture the perceived changes to businesses in* ***[Project Location]*** *as a result of deciding not to go forward with the proposed project. Prior to this interview we gathered data on project impacts from property records, census data, and other public data sources. Now we wish to compare your observations and experiences to our data.*

We will go through a set of around 25 questions. The topic for each set of questions will be introduced by [name of interviewer] and then a set of questions will be asked. After reading each question, we will ask for your input. We will record your responses and may ask for clarification to your statements. We plan to allow 30 minutes for this interview.

SURVEY QUESTIONS

3.Please select a category that best represents the principal products/services your business offers: *(check one)*

- ☐ restaurant or bar
- ☐ gas station
- ☐ hotel / motel
- ☐ retail store
- ☐ trucking / transportation
- ☐ wholesale/warehouse
- ☐ business services
- ☐ personal services
- ☐ banking / finance
- ☐ manufacturing
- ☐ other (specify) _____________________________________

4. Which of the following categories best describes the primary market for your company's product? *(check one)*

- ☐ pass-by traffic
- ☐ local residents
- ☐ county/region
- ☐ within 500 miles
- ☐ national
- ☐ international

5. How do customers get to your business or otherwise obtain your products or services?

- ☐Driving
- ☐ Bus passenger
- ☐Other (specify) ______________________________
- ☐ Air or Taxi
- ☐ Mail, Tel or Internet

6. Has the size of your **customer base** has changed over the past ***[Number of years since the decline]***?

7. Has **retaining your existing customers** been impacted over the past ***[Number of years since the decline]***?

8. Does any portion of **shipments** pertaining to your business travel on the ***[Project Type Proposed]*** on ***[Project Location]***?

9. In terms of the cost of supplies, delivery time, and suppliers, has the ability to obtain **materials and supplies** been affected over the past ***[Number of years since the decline]***?

10. Roughly how many people do you employ?

11. Do your employees **commute** to work using the ***[Street Name]*** on ***[Project Location]***?

12. Has **retaining employees** been affected over the past ***[Number of years since the decline]***?

13. Has **recruiting new employees** been affected over the past ***[Number of years since the decline]***?

14. Were you satisfied with the existing roadway, traffic, and access conditions in the area **before** the proposal of the ***[Project Type Proposed]*** on ***[Project Location]***?

15. Are you satisfied with the existing roadway, traffic, and access conditions in the area **after** the decline of the ***[Project Type Proposed]*** on ***[Project Location]***?

16. Has the **size** of your business operation changed over the past ***[Number of years since the decline]***?

17. Has the **profitability** of your business changed over the past ***[Number of years since the decline]***?

18. Has the **sales volume** of your business changed over the past ***[Number of years since the decline]***?

19. How long has your company been at its current location (in years)? _________

20. Is this your original location?

    Yes (*skip to #22*) No

21. What were the factors that influenced the decision to operate in this area?
22. In terms of advantages and disadvantages, do you consider the ***[Project Location]*** as a place to do business?

23. Has the number of companies in your line of business changed over the past ***[Number of years since the decline]***?

24. What types of companies do you think will be more attracted to the area if there was an implementation of the ***[Project Type]*** on ***[Project Location]***?

25. Do you have additional insights that would explain the data divergence found on ***[Topic]*** between the years ***[Range of Years]*** in ***[Project Location]***?

UNIVERSITY OF ARKANSAS

Business Survey Form
[*City*] [*Project Type*] Impact

Survey 001

26. Is there anyone else with whom we should speak?

Please provide contact information:

Name: ____
Phone Number: ____
Reason(s) of suggesting this person for interview on this topic:
____
____
____

-- *End of Survey* --

Page 3 of 3

Figure D- 7 Private Businesses (No Implementation Projects)

APPENDIX E: SURVEY RESULTS

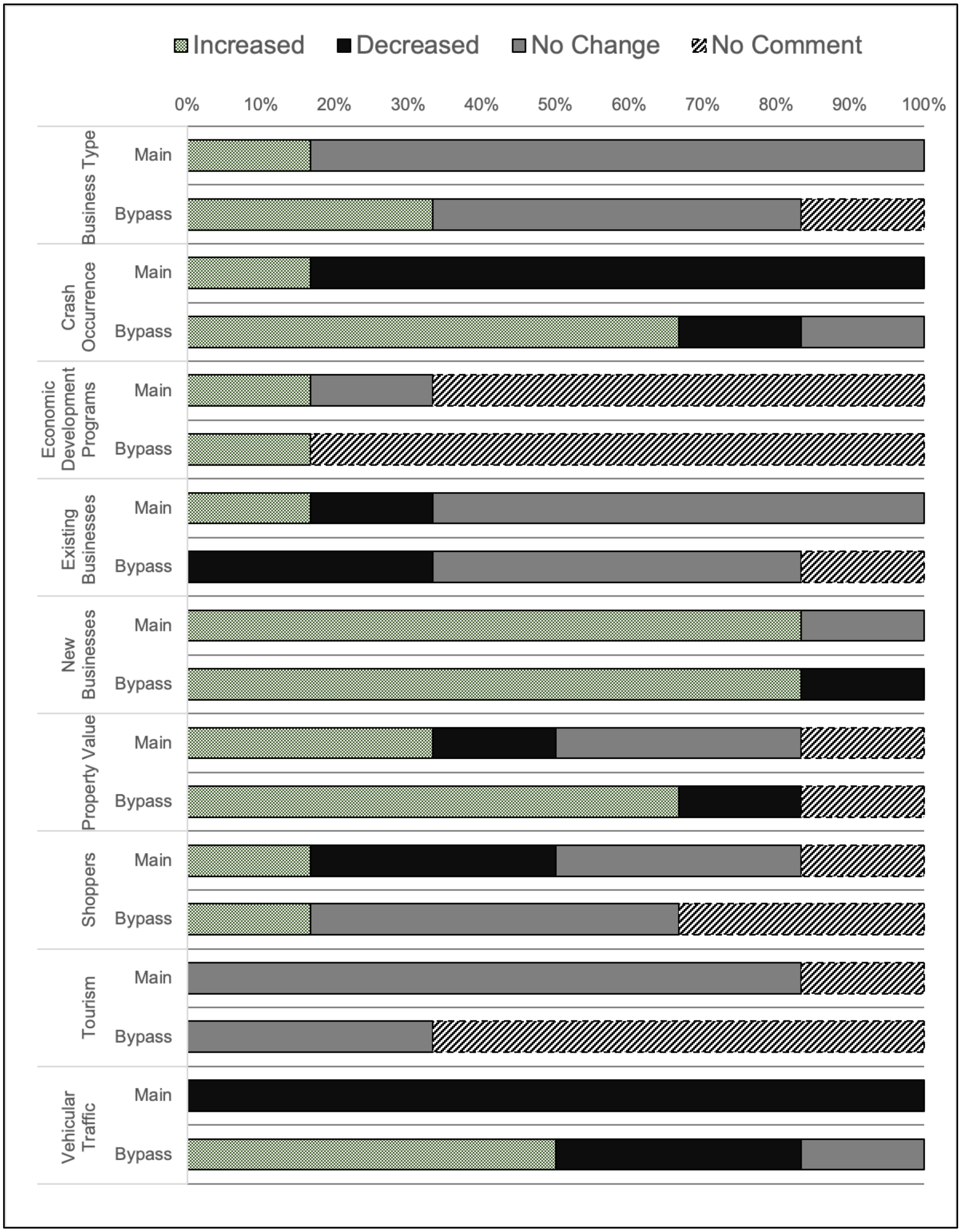


Figure E- 1 Community Member Response Summary for the US 167 Bypass in Sheridan

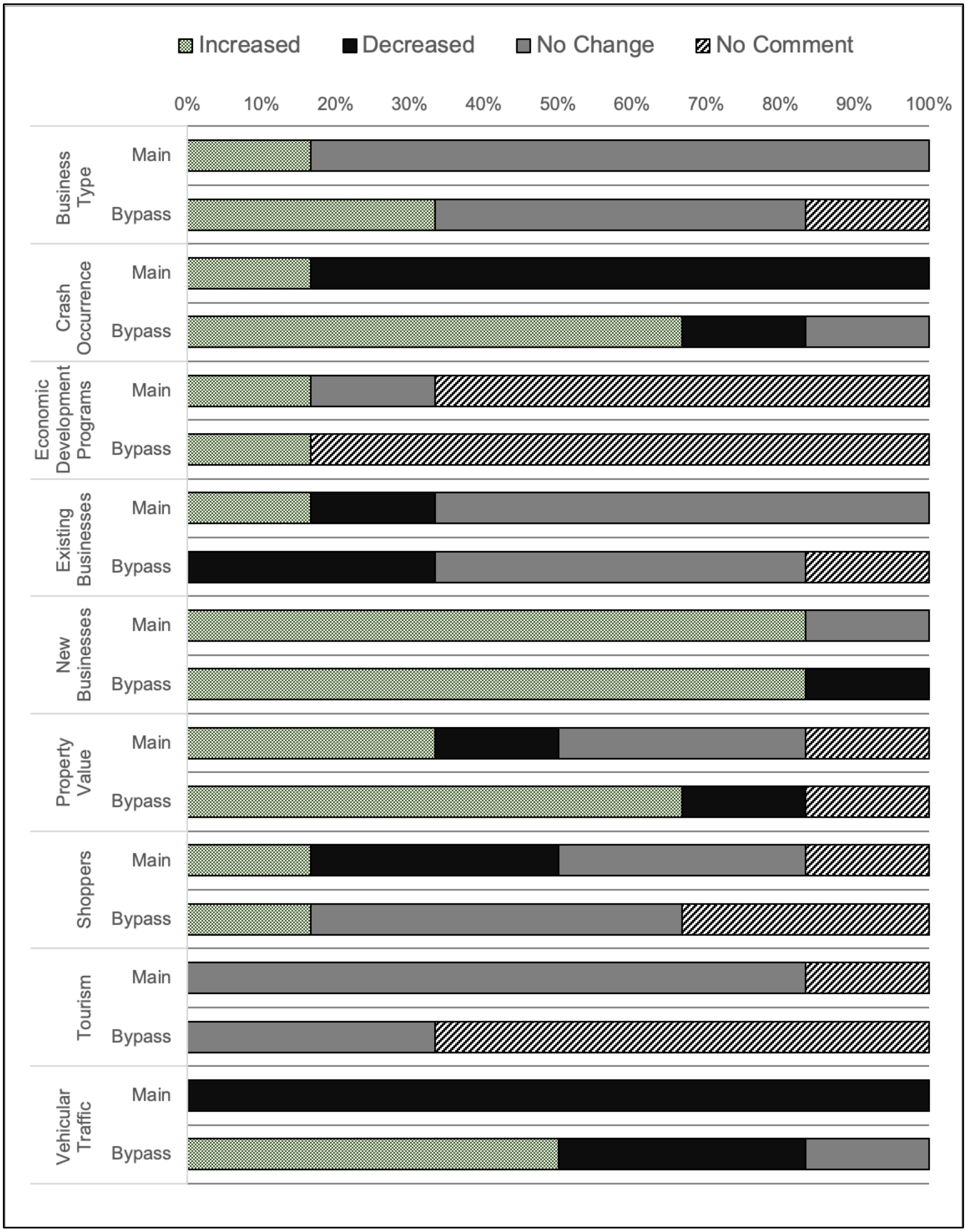


Figure E- 2 Community Member Response Summary for the Highway 64 Bypass in Vilonia

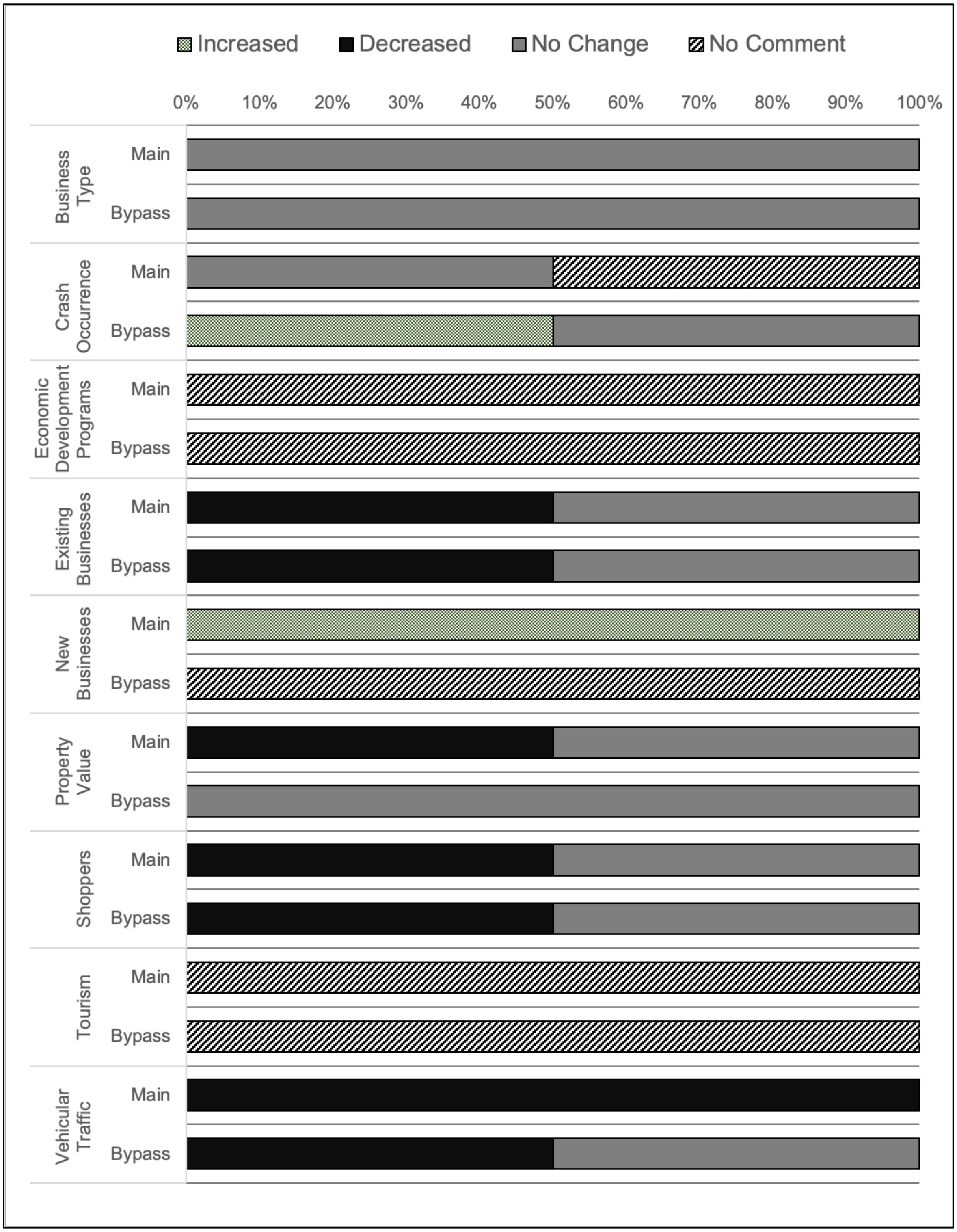


Figure E- 3 Community Member Response Summary for the Highway 412 Bypass in Flippin

Widening Projects

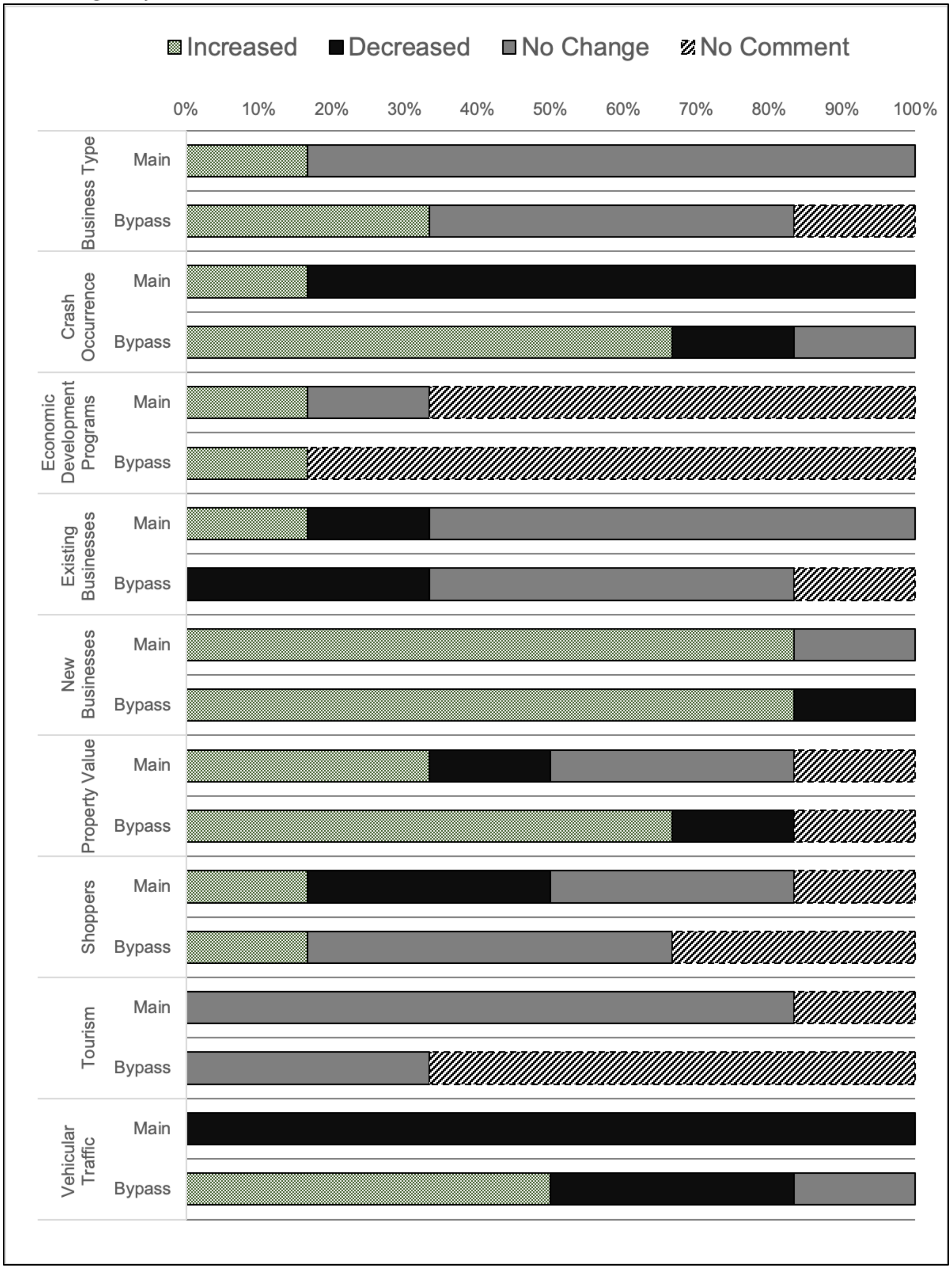


Figure E- 4 Community Member Response Summary for the Highway 65 Widening in Gould

No Treatment Applied

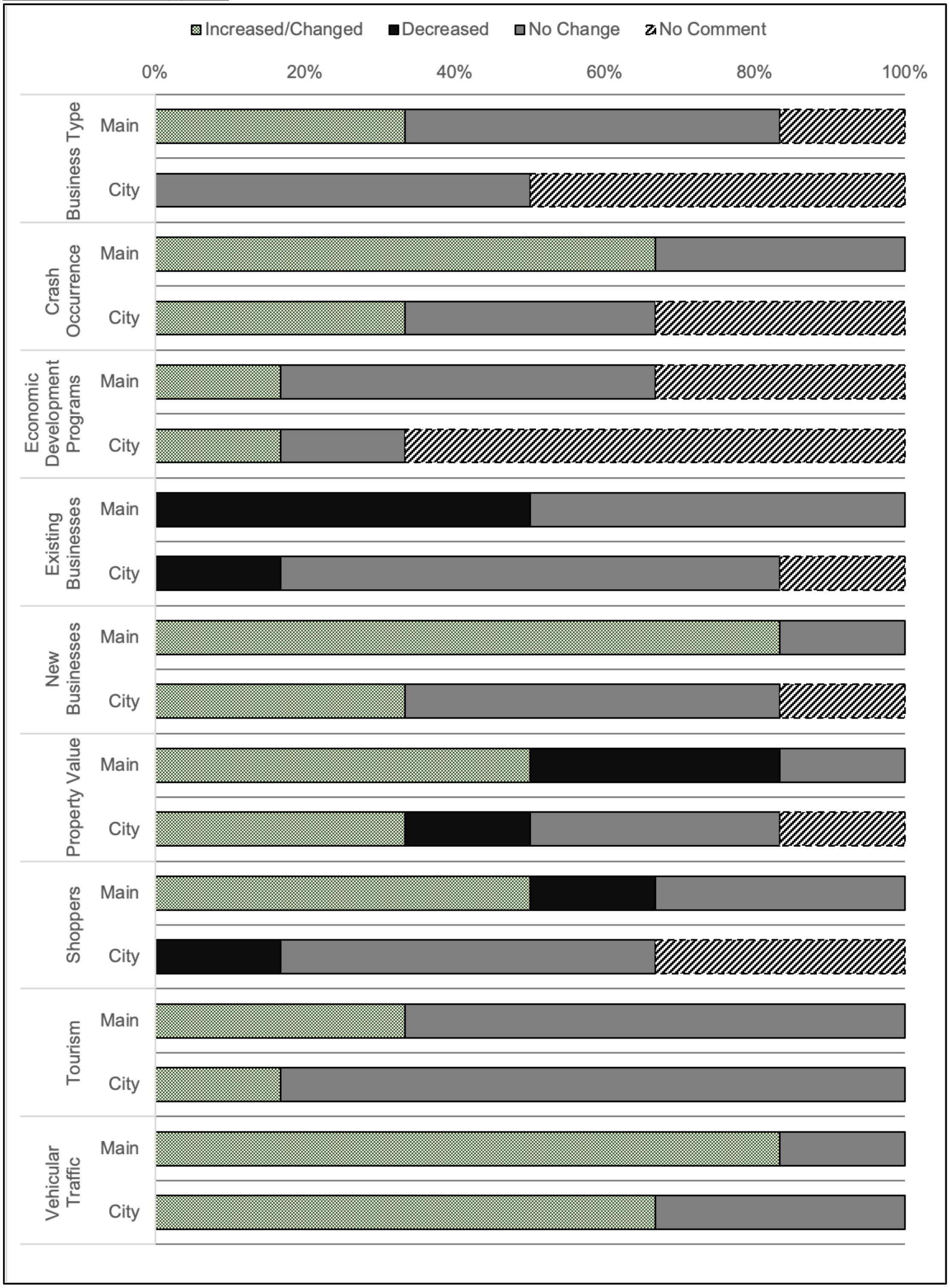


Figure E- 5 Community Member Response Summary Dover and Green Forest

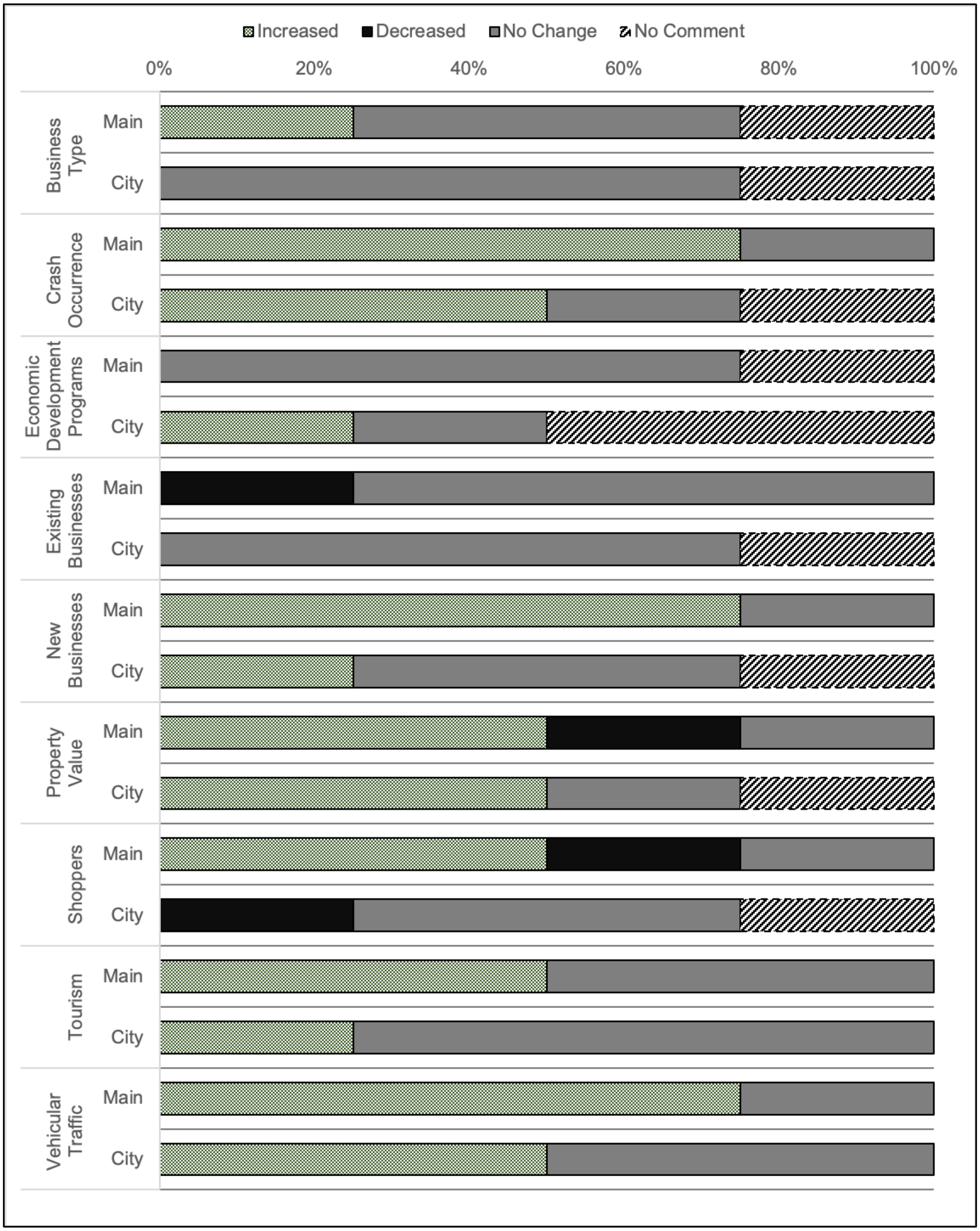


Figure E- 6 Community Member Response Summary for the Proposed Highway 7 Treatment in Dover

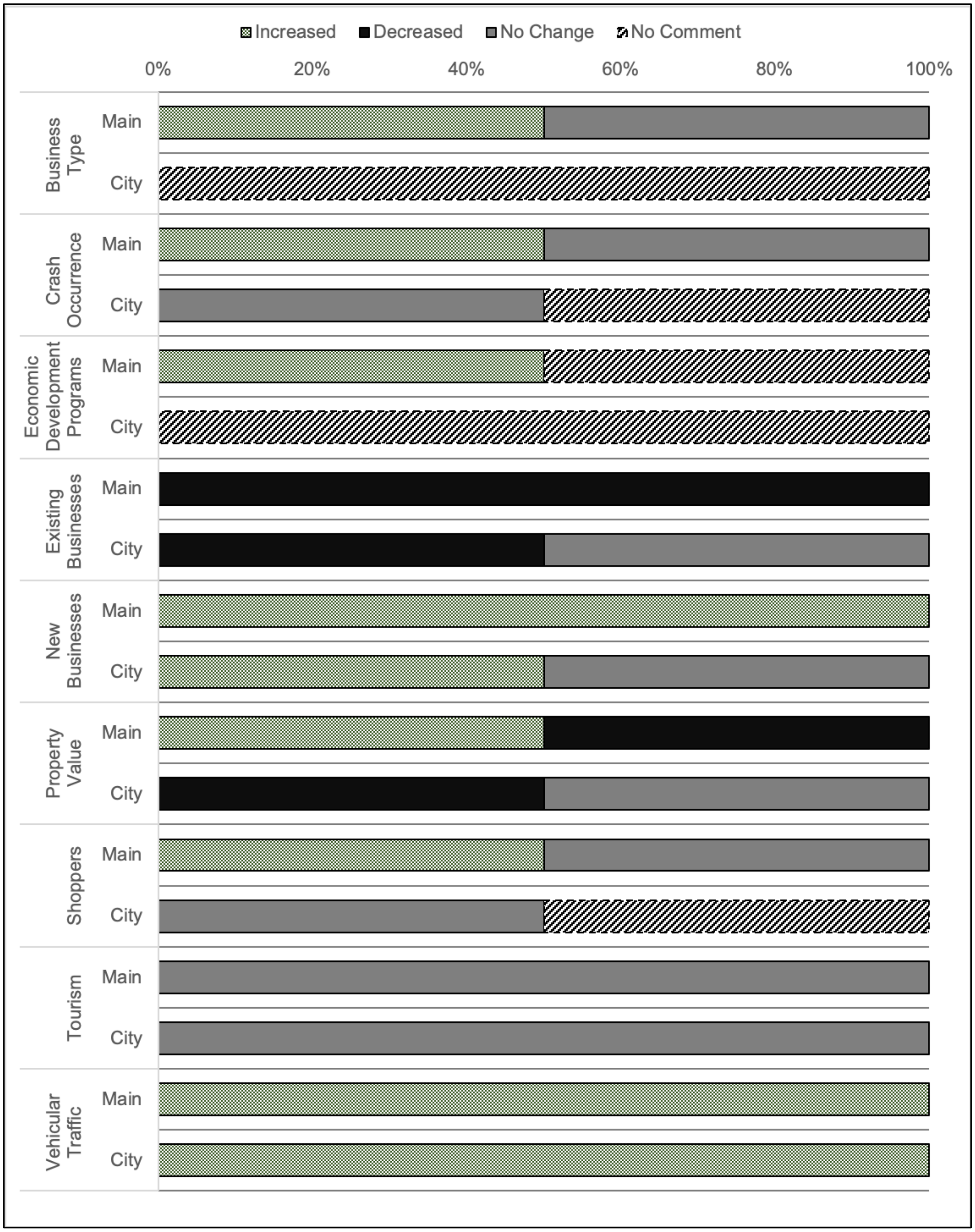


Figure E- 7 Community Member Response Summary for the Proposed Highway 62 Treatment in Green Forest

APPENDIX F: CRASH RATE CALCULATIONS

Bypass Projects

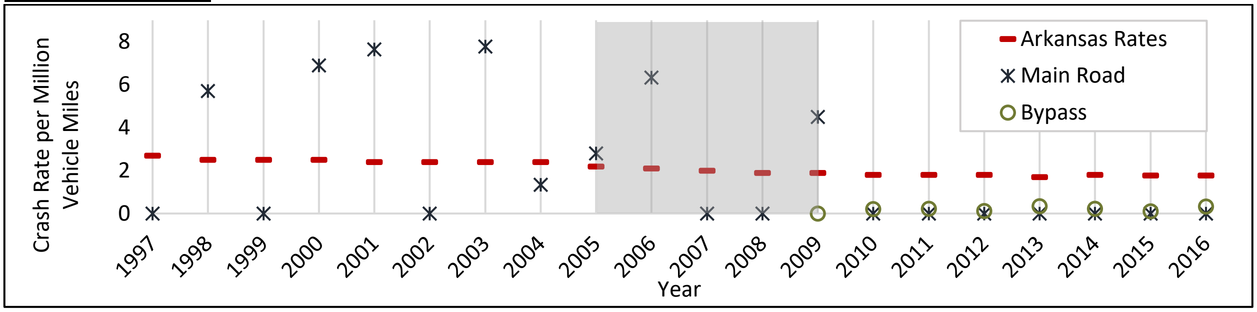


Figure F- 1 Crash Rates per Million Vehicles Miles for Grady

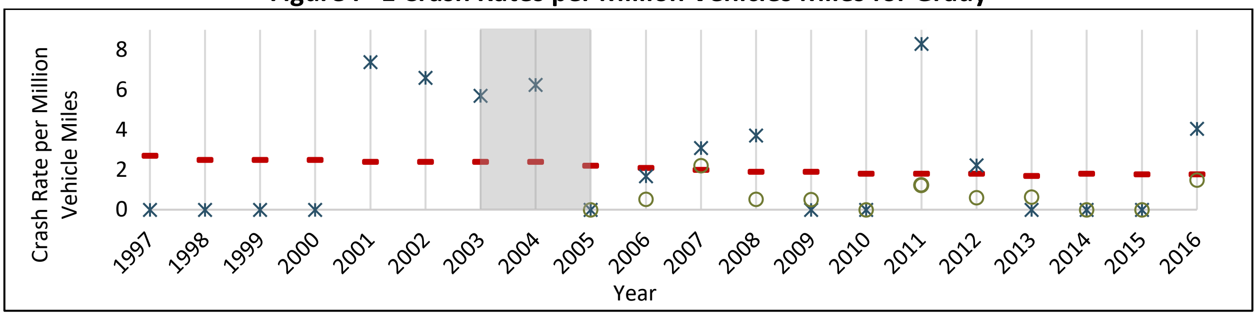


Figure F- 2 Crash Rates per Million Vehicles Miles for Hardy

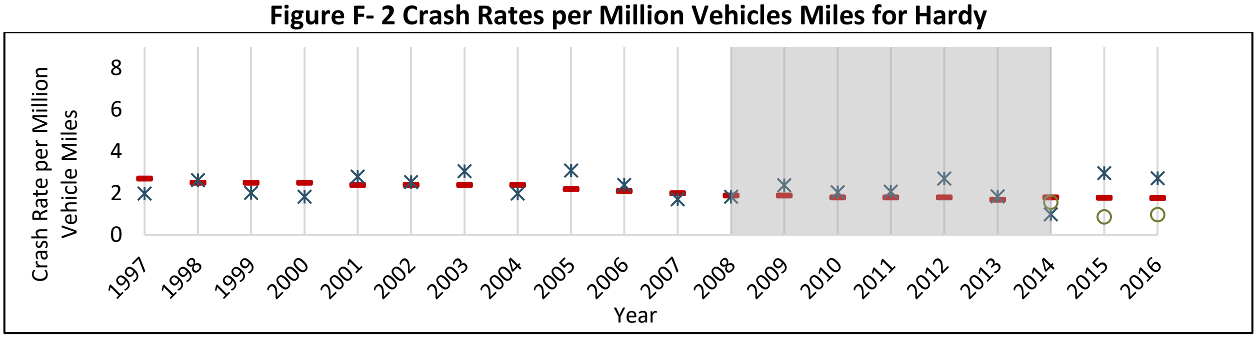


Figure F- 3 Crash Rates per Million Vehicles Miles for Sheridan

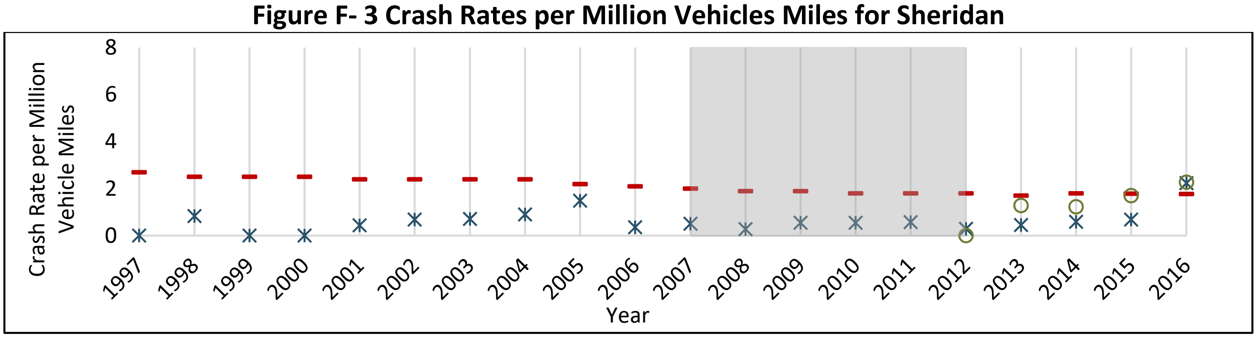


Figure F- 4 Crash Rates per Million Vehicles Miles for Vilonia

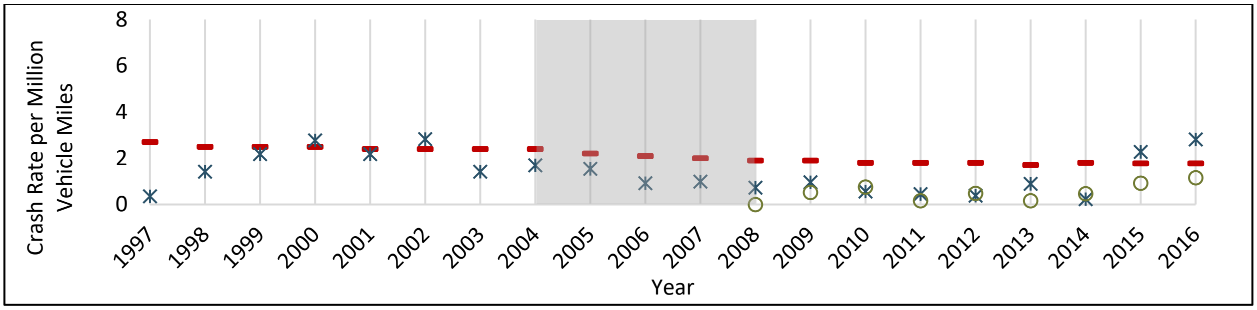


Figure F- 5 Crash Rates per Million Vehicles Miles for Flippin

Widening Projects

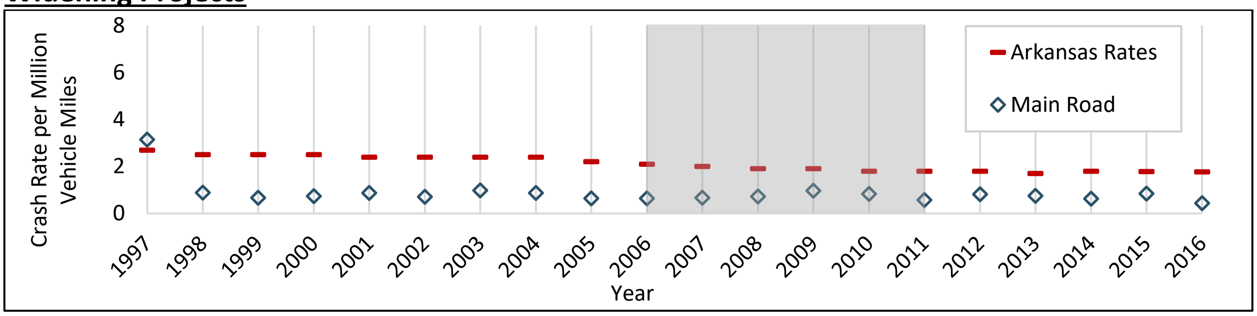


Figure F- 6 Crash Rates per Million Vehicles Miles for Gould

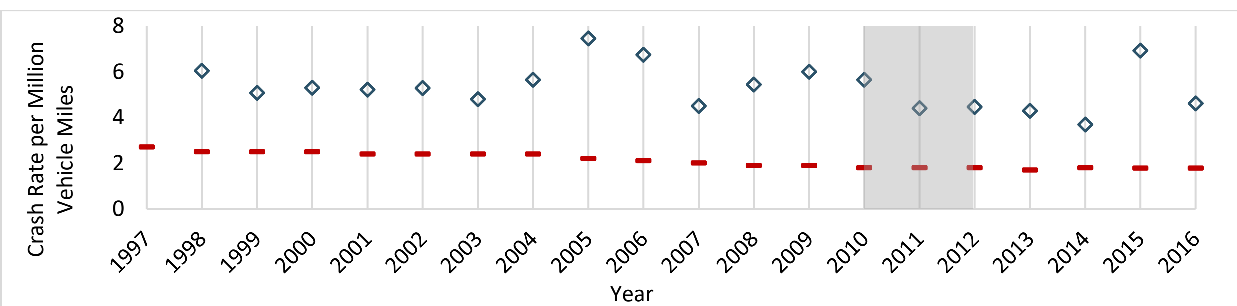


Figure F- 7 Crash Rates per Million Vehicles Miles for Siloam Springs

No Improvement Applied

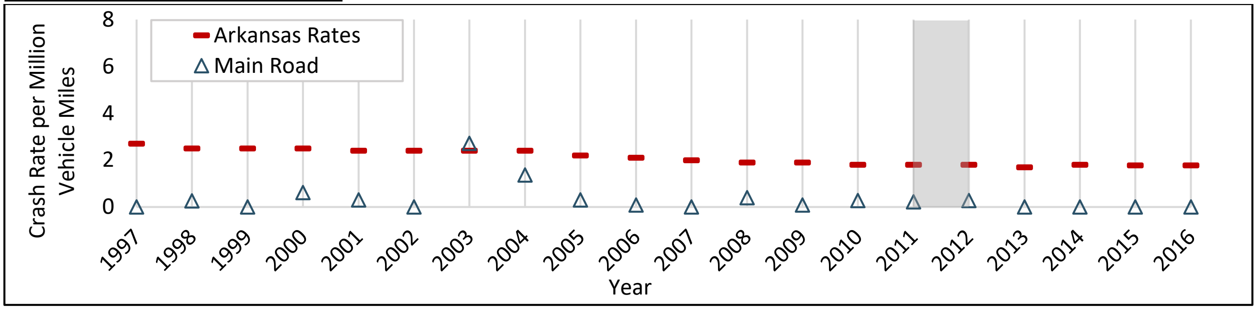


Figure F- 8 Crash Rates per Million Vehicles Miles for Dover

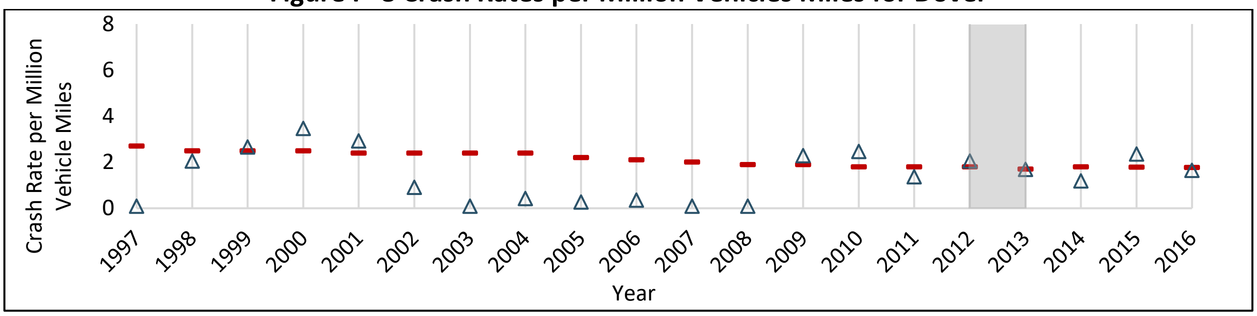


Figure F- 9 Crash Rates per Million Vehicles Miles for Green Forest

APPENDIX G: CRASH RATE STATISTICAL COMPUTATIONS

Bypass Projects

Table G-1a Statewide vs. Treatment Crash Rate Statistical Analysis in Grady

	Statewide Crash Rates			Bypass Crash Rates			Wilcoxon Ranked-Sign Test Analysis				
Year	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Diff.**	**Absolute Diff.**	**Rank**	**Analysis**	
2008	1.90	1.86	-0.04	0.00	0.03	0.03	-0.07	0.07	1	∑ Positive Rank (W^+)	41
2009*	1.90	1.86	-0.04	0.00	0.03	0.03	-0.07	0.07	1	∑ Negative Rank (W^-)	2
2010	1.80	1.86	0.06	0.22	0.03	-0.18	0.24	0.24	5	H_o: Medians of the two samples are equal	
2011	1.80	1.86	0.06	0.23	0.03	-0.20	0.26	0.26	6	Number of Samples (n)	9
2012	1.80	1.86	0.06	0.12	0.03	-0.09	0.14	0.14	3	Test Statistic (WR)	2
2013	1.70	1.86	0.16	0.35	0.04	-0.31	0.47	0.47	9	Critical Value (z_α)	-2.43
2014	1.80	1.86	0.06	0.23	0.03	-0.20	0.26	0.26	6	P-Value	0.0151
2015	1.78	1.86	0.08	0.11	0.03	-0.08	0.16	0.16	4	Result: P-value < α (0.05, 95% confidence interval), thus reject H0 and conclude that samples are not equal.	
2016	1.78	1.86	0.08	0.33	0.04	-0.29	0.37	0.37	8		

Year when the project was completed

Table G-1b Statewide vs. Main Road Crash Rate Statistical Analysis in Grady

	Statewide Crash Rates			Main Road Crash Rates			Wilcoxon Ranked-Sign Test Analysis				
Year	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Diff.**	**Absolute Diff.**	**Rank**	**Analysis**	
2008	1.90	1.86	-0.04	0.00	1.63	1.63	-1.67	1.67	8	∑ Positive Rank (W^+)	9
2009	1.90	1.86	-0.04	4.51	0.61	-3.89	3.85	3.85	9	∑ Negative Rank (W^-)	30
2010	1.80	1.86	0.06	0.00	1.63	1.63	-1.57	1.57	4	H_o: Medians of the two samples are equal	
2011	1.80	1.86	0.06	0.00	1.63	1.63	-1.57	1.57	4	Number of Samples (n)	9
2012	1.80	1.86	0.06	0.00	1.63	1.63	-1.57	1.57	4	Test Statistic (WR)	9
2013	1.70	1.86	0.16	0.00	1.63	1.63	-1.47	1.47	1	Critical Value (z_α)	-1.61
2014	1.80	1.86	0.06	0.00	1.63	1.63	-1.57	1.57	4	P-Value	0.1074
2015	1.78	1.86	0.08	0.00	1.63	1.63	-1.55	1.55	3	Result: P-value > α (0.05, 95% confidence interval), thus fail to reject Ho and conclude that samples are equal.	
2016	1.78	1.86	0.08	0.00	1.63	1.63	-1.55	1.55	2		

Table G-1c Treatment vs. Main Road Crash Rate Statistical Analysis in Grady

	Bypass Crash Rates			Main Road Crash Rates			Wilcoxon Ranked-Sign Test Analysis				
Year	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Diff.**	**Absolute Diff.**	**Rank**	**Analysis**	
2008	0.00	0.03	0.03	0.00	1.63	1.63	-1.60	1.60	1	∑ Positive Rank (W^+)	9
2009	0.00	0.03	0.03	4.51	0.61	-3.89	3.92	3.92	9	∑ Negative Rank (W^-)	35
2010	0.22	0.03	-0.18	0.00	1.63	1.63	-1.81	1.81	4	H_o: Medians of the two samples are equal	
2011	0.23	0.03	-0.20	0.00	1.63	1.63	-1.83	1.83	5	Number of Samples (n)	9
2012	0.12	0.03	-0.09	0.00	1.63	1.63	-1.71	1.71	3	Test Statistic (WR)	9
2013	0.35	0.04	-0.31	0.00	1.63	1.63	-1.94	1.94	8	Critical Value (z_α)	-1.60
2014	0.23	0.03	-0.20	0.00	1.63	1.63	-1.83	1.83	5	P-Value	0.1096
2015	0.11	0.03	-0.08	0.00	1.63	1.63	-1.71	1.71	2	Result: P-value > α (0.05, 95% confidence interval), thus fail to reject Ho and conclude that samples are equal.	
2016	0.33	0.04	-0.29	0.00	1.63	1.63	-1.92	1.92	7		

Table G-1d Pre- vs. Post- Main Road Crash Rate Statistical Analysis in Grady

	Main Road Pre-Bypass Crash Rates				Main Road Post-Bypass Crash Rates			Wilcoxon Ranked-Sign Test Analysis				
Pre-Years	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Post-Years**	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Diff.**	**Absolute Diff.**	**Rank**	**Analysis**	
2001	7.64	10.03	2.39	**2009***	4.51	0.40	-4.11	6.50	6.50	8	∑ Positive Rank (W^+)	32
2002	0.00	5.88	5.88	**2010**	0.00	2.57	2.57	3.30	3.30	5	∑ Negative Rank (W^-)	1
2003	7.78	10.11	2.33	**2011**	0.00	2.57	2.57	-0.25	0.25	1	H_o: Medians of the two samples are equal	
2004	1.34	6.60	5.27	**2012**	0.00	2.57	2.57	2.69	2.69	4	Number of Samples (n)	8
2005	2.81	7.40	4.60	**2013**	0.00	2.57	2.57	2.02	2.02	3	Test Statistic (WR)	1
2006	6.34	9.33	2.98	**2014**	0.00	2.57	2.57	0.41	0.41	2	Critical Value (z_α)	-2.39
2007	0.00	5.88	5.88	**2015**	0.00	2.57	2.57	3.30	3.30	5	P-Value	0.0168
2008	0.00	5.88	5.88	**2016**	0.00	2.57	2.57	3.30	3.30	5	Result: P-value < α (0.05, 95% confidence interval), thus reject Ho and conclude that samples are not equal.	
*Year when the project was completed												

Table G-2a Statewide vs. Treatment Crash Rate Statistical Analysis in Hardy

	Statewide Crash Rates			Bypass Crash Rates			Wilcoxon Ranked-Sign Test Analysis				
Year	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Diff.**	**Absolute Diff.**	**Rank**	**Analysis**	
2004	2.40	2.14	-0.26	0.00	0.65	0.65	-0.91	0.91	10	∑ Positive Rank (W^+)	56
2005*	2.20	2.15	-0.05	0.00	0.65	0.65	-0.70	0.70	9	∑ Negative Rank (W^-)	34
2006	2.10	2.16	0.06	0.52	0.64	0.12	-0.06	0.06	1	H_o: Medians of the two samples are equal	
2007	2.00	2.16	0.16	2.21	0.60	-1.61	1.77	1.77	13	Number of Samples (n)	13
2008	1.90	2.17	0.27	0.52	0.64	0.12	0.15	0.15	3	Test Statistic (WR)	34
2009	1.90	2.17	0.27	0.51	0.64	0.13	0.14	0.14	2	Critical Value (z_α)	-0.80
2010	1.80	2.17	0.37	0.00	0.65	0.65	-0.28	0.28	5	P-Value	0.4237
2011	1.80	2.17	0.37	1.22	0.62	-0.59	0.97	0.97	11	Result: P-value > α (0.05, 95% confidence interval), thus fail to reject Ho and conclude that samples are equal.	
2012	1.80	2.17	0.37	0.61	0.64	0.03	0.35	0.35	7		
2013	1.70	2.18	0.48	0.63	0.64	0.01	0.47	0.47	8		
2014	1.80	2.17	0.37	0.00	0.65	0.65	-0.28	0.28	5		
2015	1.78	2.17	0.39	0.00	0.65	0.65	-0.25	0.25	4		
2016	1.78	2.17	0.40	1.48	0.62	-0.86	1.26	1.26	12		

Year when the project was completed

Table G-2b Statewide vs. Main Road Crash Rate Statistical Analysis in Hardy

	Statewide Crash Rates			Main Road Crash Rates			Wilcoxon Ranked-Sign Test Analysis				
Year	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Diff.**	**Absolute Diff.**	**Rank**	**Analysis**	
2004	2.40	2.14	-0.26	6.26	2.35	-3.90	3.64	3.64	12.00	∑ Positive Rank (W^+)	36
2005*	2.20	2.15	-0.05	0.00	3.17	3.17	-3.22	3.22	11.00	∑ Negative Rank (W^-)	54
2006	2.10	2.16	0.06	1.67	2.95	1.28	-1.22	1.22	3.00	H_o: Medians of the two samples are equal	
2007	2.00	2.16	0.16	3.09	2.77	-0.32	0.48	0.48	2.00	Number of Samples (n)	13
2008	1.90	2.17	0.27	3.72	2.68	-1.03	1.30	1.30	4.00	Test Statistic (WR)	36
2009	1.90	2.17	0.27	0.00	3.17	3.17	-2.90	2.90	10.00	Critical Value (z_α)	-0.66
2010	1.80	2.17	0.37	0.00	3.17	3.17	-2.80	2.80	8.00	P-Value	0.5093
2011	1.80	2.17	0.37	8.30	2.09	-6.22	6.59	6.59	13.00	Result: P-value > α (0.05, 95% confidence interval), thus fail to reject Ho and conclude that samples are equal.	
2012	1.80	2.17	0.37	2.23	2.88	0.65	-0.28	0.28	1.00		
2013	1.70	2.18	0.48	0.00	3.17	3.17	-2.69	2.69	6.00		
2014	1.80	2.17	0.37	0.00	3.17	3.17	-2.80	2.80	8.00		
2015	1.78	2.17	0.39	0.00	3.17	3.17	-2.78	2.78	7.00		
2016	1.78	2.17	0.40	4.06	2.64	-1.42	1.82	1.82	5.00		

Table G-2c Treatment vs. Main Road Crash Rate Statistical Analysis in Hardy

	Bypass Crash Rates			Main Road Crash Rates			Wilcoxon Ranked-Sign Test Analysis				
Year	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Diff.**	**Absolute Diff.**	**Rank**	**Analysis**	
2004	0.00	0.65	0.65	6.26	2.35	-3.90	4.55	4.55	12	∑ Positive Rank (W^+)	29
2005*	0.00	0.65	0.65	0.00	3.17	3.17	-2.52	2.52	6	∑ Negative Rank (W^-)	56
2006	0.52	0.64	0.12	1.67	2.95	1.28	-1.17	1.17	4	H_o: Medians of the two samples are equal	
2007	2.21	0.60	-1.61	3.09	2.77	-0.32	-1.29	1.29	5	Number of Samples (n)	13
2008	0.52	0.64	0.12	3.72	2.68	-1.03	1.15	1.15	3	Test Statistic (WR)	29
2009	0.51	0.64	0.13	0.00	3.17	3.17	-3.04	3.04	10	Critical Value (z_α)	-1.15
2010	0.00	0.65	0.65	0.00	3.17	3.17	-2.52	2.52	6	P-Value	0.2501
2011	1.22	0.62	-0.59	8.30	2.09	-6.22	5.62	5.62	13	Result: P-value > α (0.05, 95% confidence interval), thus fail to reject Ho and conclude that samples are equal.	
2012	0.61	0.64	0.03	2.23	2.88	0.65	-0.62	0.62	2		
2013	0.63	0.64	0.01	0.00	3.17	3.17	-3.16	3.16	11		
2014	0.00	0.65	0.65	0.00	3.17	3.17	-2.52	2.52	6		
2015	0.00	0.65	0.65	0.00	3.17	3.17	-2.52	2.52	6		
2016	1.48	0.62	-0.86	4.06	2.64	-1.42	0.56	0.56	1		

Table G-2d Pre- vs. Post- Main Road Crash Rate Statistical Analysis in Hardy

	Main Road Pre-Bypass Crash Rates				Main Road Post-Bypass Crash Rates			Wilcoxon Ranked-Sign Test Analysis				
Pre-Years	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Post-Years**	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Diff.**	**Absolute Diff.**	**Rank**	**Analysis**	
1997	0.00	-2.57	-2.57	**2005***	0.00	-0.24	-0.24	-2.33	2.33	7	∑ Positive Rank (W^+)	13
2002	0.00	-2.57	-2.57	**2006**	1.67	0.86	-0.81	-1.76	1.76	6	∑ Negative Rank (W^-)	23
1999	0.00	-2.57	-2.57	**2007**	3.09	1.79	-1.29	-1.28	1.28	5	H_o: Medians of the two samples are equal	
2000	0.00	-2.57	-2.57	**2008**	3.72	2.21	-1.51	-1.07	1.07	4	Number of Samples (n)	8
2001	7.39	7.38	-0.01	**2009**	0.00	-0.24	-0.24	0.23	0.23	2	Test Statistic (WR)	13
2002	6.61	6.33	-0.28	**2010**	0.00	-0.24	-0.24	-0.04	0.04	1	Critical Value (z_α)	-0.22
2003	5.71	5.12	-0.59	**2011**	8.30	5.24	-3.07	2.47	2.47	8	P-Value	0.8259
2004	6.26	5.85	-0.40	**2012**	2.23	1.23	-1.00	0.60	0.60	3	Result: P-value > α (0.05, 95% confidence interval), thus fail to reject Ho and conclude that samples are equal.	
****Year when the project was completed***												

Table G-3a Statewide vs. Treatment Crash Rate Statistical Analysis in Sheridan

	Statewide Crash Rates			Bypass Crash Rates			Wilcoxon Ranked-Sign Test Analysis				
Year	Observed	Estimated *(Detrended)*	Residuals	Observed	Estimated *(Detrended)*	Residuals	Diff.	Absolute Diff.	Rank	Analysis	
2013	1.70	1.75	0.05	0.00	0.30	0.30	-0.26	0.26	1	∑ Positive Rank (W+)	9
2014*	1.80	1.75	-0.05	1.58	0.65	-0.93	0.88	0.88	4	∑ Negative Rank (W-)	1
2015	1.78	1.75	-0.03	0.87	0.50	-0.38	0.35	0.35	2	Ho: Medians of the two samples are equal	
2016	1.78	1.75	-0.03	0.97	0.52	-0.45	0.43	0.43	3	Number of Samples (n)	4
							Result: With a sample of such small size, it is not possible to obtain significant test result.			Test Statistic (WR)	1
										Critical Value (W)	-1
										Significance	No

Year when the project was completed

Table G-3b Statewide vs. Main Road Crash Rate Statistical Analysis in Sheridan

	Statewide Crash Rates			Main Road Crash Rates			Wilcoxon Ranked-Sign Test Analysis				
Year	Observed	Estimated *(Detrended)*	Residuals	Observed	Estimated *(Detrended)*	Residuals	Diff.	Absolute Diff.	Rank	Analysis	
2013	1.70	1.75	0.05	1.85	1.83	-0.02	0.07	0.07	1	∑ Positive Rank (W+)	7
2014*	1.80	1.75	-0.05	0.98	1.43	0.45	-0.50	0.50	3	∑ Negative Rank (W-)	3
2015	1.78	1.75	-0.03	2.96	2.34	-0.62	0.59	0.59	4	Ho: Medians of the two samples are equal	
2016	1.78	1.75	-0.03	2.72	2.23	-0.49	0.46	0.46	2	Number of Samples (n)	4
							Result: With a sample of such small size, it is not possible to obtain significant test result.			Test Statistic (WR)	3
										Critical Value (W)	-1
										Significance	No

Table G-3c Treatment vs. Main Road Crash Rate Statistical Analysis in Sheridan

	Bypass Crash Rates			Main Road Crash Rates			Wilcoxon Ranked-Sign Test Analysis				
Year	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Diff.**	**Absolute Diff.**	**Rank**	**Analysis**	
2013	0.0	0.3	0.3	1.8	1.8	0.0	0.3	0.3	3.0	∑ Positive Rank (W+)	6
2014*	1.6	0.7	-0.9	1.0	1.4	0.4	-1.4	1.4	4.0	∑ Negative Rank (W-)	4
2015	0.9	0.5	-0.4	3.0	2.3	-0.6	0.2	0.2	2.0	Ho: Medians of the two samples are equal	
2016	1.0	0.5	-0.5	2.7	2.2	-0.5	0.0	0.0	1.0	Number of Samples (n)	4
							Result: With a sample of such small size, it is not possible to obtain significant test result.			Test Statistic (WR)	4
										Critical Value (W)	-1
										Significance	No

Table G-3d Pre- vs. Post- Main Road Crash Rate Statistical Analysis in Sheridan

Pre-Years	Main Road Pre-Bypass Crash Rates			**Post-Years**	Main Road Post-Bypass Crash Rates			Wilcoxon Ranked-Sign Test Analysis				
	Observed	**Estimated *(Detrended)***	**Residuals**		**Observed**	**Estimated *(Detrended)***	**Residuals**	**Diff.**	**Absolute Diff.**	**Rank**	**Analysis**	
2011	2.08	2.20	0.12	**2014***	0.98	1.34	0.35	-0.24	0.24	1	∑ Positive Rank (W^+)	2
2012	2.70	2.13	-0.57	**2015**	2.96	3.06	0.10	-0.67	0.67	3	∑ Negative Rank (W^-)	4
2013	1.85	2.23	0.38	**2016**	2.72	2.85	0.13	0.25	0.25	2	H_o: Medians of the two samples are equal	
Year when the project was completed								Result: P-value > α (0.05, 95% confidence interval), thus fail to reject Ho and conclude that samples are equal.			Number of Samples (n)	3
											Test Statistic (WR)	2
											Critical Value (z_α)	-0.53
											P-Value	0.5961

Table G-4a Statewide vs. Treatment Crash Rate Statistical Analysis in Vilonia

	Statewide Crash Rates			Bypass Crash Rates			Wilcoxon Ranked-Sign Test Analysis				
Year	Observed	Estimated *(Detrended)*	Residuals	Observed	Estimated *(Detrended)*	Residuals	Diff.	Absolute Diff.	Rank	Analysis	
2011	1.80	1.11	-0.69	0.00	-0.71	-0.71	0.02	0.02	1	∑ Positive Rank (W^+)	21
2012*	1.80	1.11	-0.69	0.00	-0.71	-0.71	0.02	0.02	1	∑ Negative Rank (W^-)	0
2013	1.70	1.09	-0.61	1.29	-0.18	-1.47	0.86	0.86	4	H_o: Medians of the two samples are equal	
2014	1.80	1.11	-0.69	1.23	-0.21	-1.43	0.74	0.74	3	Number of Samples (n)	6
2015	1.78	1.10	-0.68	1.71	-0.01	-1.72	1.04	1.04	5	Test Statistic (WR)	0
2016	1.78	1.10	-0.67	2.28	0.22	-2.05	1.38	1.38	6	Critical Value (z_α)	-2.21
										P-Value	0.114
										Result: P-value < α (0.05, 95% confidence interval), thus reject Ho and conclude that samples are not equal.	

Year when the project was completed

Table G-4b Statewide vs. Main Road Crash Rate Statistical Analysis in Vilonia

	Statewide Crash Rates			Main Crash Rates			Wilcoxon Ranked-Sign Test Analysis				
Year	Observed	Estimated *(Detrended)*	Residuals	Observed	Estimated *(Detrended)*	Residuals	Diff.	Absolute Diff.	Rank	Analysis	
2011	1.80	1.11	-0.69	0.58	0.00	-0.58	-0.11	0.11	1.00	∑ Positive Rank (W^+)	0
2012*	1.80	1.11	-0.69	0.28	3.65	3.36	-4.06	4.06	6.00	∑ Negative Rank (W^-)	21
2013	1.70	1.09	-0.61	0.45	3.61	3.16	-3.77	3.77	5.00	H_o: Medians of the two samples are equal	
2014	1.80	1.11	-0.69	0.60	3.57	2.98	-3.67	3.67	4.00	Number of Samples (n)	6
2015	1.78	1.10	-0.68	0.68	3.55	2.87	-3.55	3.55	3.00	Test Statistic (WR)	0
2016	1.78	1.10	-0.67	2.24	3.16	0.93	-1.60	1.60	2.00	Critical Value (z_α)	-2.20
										P-Value	0.028
										Result: P-value < α (0.05, 95% confidence interval), thus reject H0 and conclude that samples are not equal.	

Table G-4c Treatment vs. Main Road Crash Rate Statistical Analysis in Vilonia

	Bypass Crash Rates			Main Road Crash Rates			Wilcoxon Ranked-Sign Test Analysis				
Year	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Diff.**	**Absolute Diff.**	**Rank**	**Analysis**	
2011	0.00	-0.71	-0.71	0.58	0.00	-0.58	-0.13	0.13	1	∑ Positive Rank (W^+)	0
2012*	0.00	-0.71	-0.71	0.28	3.65	3.36	-4.07	4.07	3	∑ Negative Rank (W^-)	21
2013	1.29	-0.18	-1.47	0.45	3.61	3.16	-4.63	4.63	6	H_o: Medians of the two samples are equal	
2014	1.23	-0.21	-1.43	0.60	3.57	2.98	-4.41	4.41	4	Number of Samples (n)	6
2015	1.71	-0.01	-1.72	0.68	3.55	2.87	-4.59	4.59	5	Test Statistic (WR)	0
2016	2.28	0.22	-2.05	2.24	3.16	0.93	-2.98	2.98	2	Critical Value (z_α)	-2.20
										P-Value	0.028
										Result: P-value < α (0.05, 95% confidence interval), thus reject H0 and conclude that samples are not equal.	

Table G-4d Pre- vs. Post- Main Road Crash Rate Statistical Analysis in Vilonia

	Main Road Pre-Bypass Crash Rates				Main Road Post-Bypass Crash Rates			Wilcoxon Ranked-Sign Test Analysis				
Pre-Years	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Post-Years**	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Diff.**	**Absolute Diff.**	**Rank**	**Analysis**	
2007	0.51	0.39	-0.12	**2012***	0.28	-0.27	-0.56	0.44	0.44	1	∑ Positive Rank (W^+)	15
2008	0.28	0.38	0.10	**2013**	0.45	-0.21	-0.65	0.75	0.75	4	∑ Negative Rank (W^-)	0
2009	0.54	0.39	-0.15	**2014**	0.60	-0.15	-0.74	0.59	0.59	2	H_o: Medians of the two samples are equal	
2010	0.54	0.39	-0.15	**2015**	0.68	-0.11	-0.79	0.64	0.64	3	Number of Samples (n)	5
2011	0.58	0.39	-0.19	**2016**	2.24	0.53	-1.70	1.51	1.51	5	Test Statistic (WR)	0
							Result: P-value > α (0.05, 95% confidence interval), thus fail to reject Ho and conclude that samples are equal.				Critical Value (z_α)	-1.15
											P-Value	0.2501

**Year when the project was completed*

Table G-5a Statewide vs. Treatment Crash Rate Statistical Analysis in Flippin

	Statewide Crash Rates			Bypass Crash Rates			Wilcoxon Ranked-Sign Test Analysis				
Year	Observed	Estimated *(Detrended)*	Residuals	Observed	Estimated *(Detrended)*	Residuals	Diff.	Absolute Diff.	Rank	Analysis	
2007	2.00	1.39	-0.61	0.00	-0.04	-0.04	-0.56	0.56	9	∑ Positive Rank (W^{+})	30
2008*	1.90	1.39	-0.51	0.00	-0.04	-0.04	-0.47	0.47	7	∑ Negative Rank (W^{-})	25
2009	1.90	1.39	-0.51	0.52	0.01	-0.51	0.00	0.00	1	H_o: Medians of the two samples are equal	
2010	1.80	1.38	-0.42	0.75	0.03	-0.72	0.30	0.30	6	Number of Samples (n)	10
2011	1.80	1.38	-0.42	0.16	-0.03	-0.19	-0.23	0.23	5	Test Statistic (WR)	25
2012	1.80	1.38	-0.42	0.48	0.00	-0.48	0.06	0.06	3	Critical Value (z_{α})	-0.25
2013	1.70	1.37	-0.33	0.16	-0.03	-0.19	-0.14	0.14	4	P-Value	0.8085
2014	1.80	1.38	-0.42	0.47	0.00	-0.47	0.05	0.05	2	Result: P-value > α (0.05, 95% confidence interval), thus fail to reject Ho and conclude that samples are equal.	
2015	1.78	1.38	-0.40	0.91	0.04	-0.87	0.47	0.47	8		
2016	1.78	1.38	-0.40	1.15	0.06	-1.09	0.69	0.69	10		

**Year when the project was completed*

Table G-5b Statewide vs. Main Road Crash Rate Statistical Analysis in Flippin

	Statewide Crash Rates			Main Road Crash Rates			Wilcoxon Ranked-Sign Test Analysis				
Year	Observed	Estimated *(Detrended)*	Residuals	Observed	Estimated *(Detrended)*	Residuals	Diff.	Absolute Diff.	Rank	Analysis	
2007	2.00	1.39	-0.61	0.98	0.35	-0.63	0.02	0.02	1.00	∑ Positive Rank (W^{+})	27
2008*	1.90	1.39	-0.51	0.73	0.32	-0.41	-0.10	0.10	3.00	∑ Negative Rank (W^{-})	28
2009	1.90	1.39	-0.51	0.96	0.35	-0.61	0.10	0.10	2.00	H_o: Medians of the two samples are equal	
2010	1.80	1.38	-0.42	0.56	0.29	-0.27	-0.15	0.15	4.00	Number of Samples (n)	10
2011	1.80	1.38	-0.42	0.44	0.27	-0.17	-0.25	0.25	6.00	Test Statistic (WR)	27
2012	1.80	1.38	-0.42	0.38	0.26	-0.11	-0.30	0.30	7.00	Critical Value (z_{α})	-0.05
2013	1.70	1.37	-0.33	0.88	0.34	-0.54	0.22	0.22	5.00	P-Value	0.9601
2014	1.80	1.38	-0.42	0.23	0.24	0.01	-0.43	0.43	8.00	Result: P-value > α (0.05, 95% confidence interval), thus fail to reject Ho and conclude that samples are equal.	
2015	1.78	1.38	-0.40	2.28	0.55	-1.73	1.33	1.33	9.00		
2016	1.78	1.38	-0.40	2.81	0.63	-2.18	1.79	1.79	10.00		

Table G-5c Treatment vs. Main Road Crash Rate Statistical Analysis in Flippin

	Bypass Crash Rates			Main Road Crash Rates			Wilcoxon Ranked-Sign Test Analysis				
Year	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Diff.**	**Absolute Diff.**	**Rank**	**Analysis**	
2007	0.00	-0.04	-0.04	0.98	0.35	-0.63	0.59	0.59	8	∑ Positive Rank (W^+)	37
2008*	0.00	-0.04	-0.04	0.73	0.32	-0.41	0.37	0.37	5	∑ Negative Rank (W^-)	18
2009	0.52	0.01	-0.51	0.96	0.35	-0.61	0.10	0.10	2	H_o: Medians of the two samples are equal	
2010	0.75	0.03	-0.72	0.56	0.29	-0.27	-0.45	0.45	6	Number of Samples (n)	10
2011	0.16	-0.03	-0.19	0.44	0.27	-0.17	-0.02	0.02	1	Test Statistic (WR)	18
2012	0.48	0.00	-0.48	0.38	0.26	-0.11	-0.36	0.36	4	Critical Value (z_α)	-0.97
2013	0.16	-0.03	-0.19	0.88	0.34	-0.54	0.36	0.36	3	P-Value	0.3320
2014	0.47	0.00	-0.47	0.23	0.24	0.01	-0.48	0.48	7	Result: P-value > α (0.05, 95% confidence interval), thus fail to reject Ho and conclude that samples are equal.	
2015	0.91	0.04	-0.87	2.28	0.55	-1.73	0.86	0.86	9		
2016	1.15	0.06	-1.09	2.81	0.63	-2.18	1.09	1.09	10		

Table G-5d Pre- vs. Post- Main Road Crash Rate Statistical Analysis in Vilonia

	Main Road Pre-Bypass Crash Rates				Main Road Post-Bypass Crash Rates			Wilcoxon Ranked-Sign Test Analysis				
Pre-Years	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Post-Years**	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Diff.**	**Absolute Diff.**	**Rank**	**Analysis**	
1999	2.18	2.40	0.22	**2008***	0.73	0.81	0.08	0.14	0.14	2	∑ Positive Rank (W^+)	34
2002	2.77	2.30	-0.47	**2009**	0.96	0.80	-0.16	-0.31	0.31	3	∑ Negative Rank (W^-)	11
2001	2.18	2.40	0.22	**2010**	0.56	0.82	0.26	-0.04	0.04	1	H_o: Medians of the two samples are equal	
2002	2.83	2.29	-0.54	**2011**	0.44	0.83	0.39	-0.93	0.93	7	Number of Samples (n)	9
2003	1.42	2.54	1.12	**2012**	0.38	0.83	0.45	0.67	0.67	5	Test Statistic (WR)	11
							Result: P-value > α (0.05, 95% confidence interval), thus fail to reject Ho and conclude that samples are equal.				Critical Value (z_α)	-0.36
											P-Value	0.7188

*Year when the project was completed

Widening Projects

Table G-6a Statewide vs. Treatment Crash Rate Statistical Analysis in Gould

	Statewide Crash Rates			Widening Crash Rates			Wilcoxon Ranked-Sign Test Analysis				
Year	Observed	Estimated *(Detrended)*	Residuals	Observed	Estimated *(Detrended)*	Residuals	Diff.	Absolute Diff.	Rank	Analysis	
2010	1.80	1.16	-0.64	0.84	0.47	-0.36	-0.27	0.27	2.00	∑ Positive Rank (W^+)	0
2011*	1.80	1.16	-0.64	0.57	0.46	-0.11	-0.53	0.53	6.00	∑ Negative Rank (W^-)	28
2012	1.80	1.16	-0.64	0.82	0.47	-0.35	-0.28	0.28	4.00	H_o: Medians of the two samples are equal	
2013	1.70	1.15	-0.55	0.74	0.47	-0.28	-0.28	0.28	3.00	Number of Samples (n)	7
2014	1.80	1.16	-0.64	0.63	0.46	-0.16	-0.47	0.47	5.00	Test Statistic (W^-)	0
2015	1.78	1.16	-0.62	0.84	0.47	-0.37	-0.25	0.25	1.00	Critical Value (z_α)	-2.37
2016	1.78	1.16	-0.62	0.43	0.46	0.02	-0.64	0.64	7.00	P-Value	0.0178
										Result: P-value < α (0.05, 95% confidence interval), thus reject H0 and conclude that samples are not equal.	

**Year when the project was completed*

Table G-6b Pre- vs. Post Widened Road Crash Rate Statistical Analysis in Gould

	Main Road Pre-Widening Crash Rates				Main Road Post-Widening Crash Rates			Wilcoxon Ranked-Sign Test Analysis				
Pre-Years	Observed	Estimated *(Detrended)*	Residuals	Post-Years	Observed	Estimated *(Detrended)*	Residuals	Diff.	Absolute Diff.	Rank	Analysis	
2005	0.64	0.58	-0.06	2011*	0.57	0.74	0.16	-0.22	0.22	3	∑ Positive Rank (W^+)	1
2006	0.64	0.58	-0.06	2012	0.82	0.73	-0.09	0.03	0.03	1	∑ Negative Rank (W^-)	20
2007	0.67	0.58	-0.09	2013	0.74	0.73	-0.01	-0.08	0.08	2	H_o: Medians of the two samples are equal	
2008	0.73	0.58	-0.14	2014	0.63	0.73	0.11	-0.25	0.25	4	Number of Samples (n)	6
2009	0.97	0.60	-0.37	2015	0.84	0.73	-0.11	-0.26	0.26	5	Test Statistic (WR)	1
							Result: P-value > α (0.05, 95% confidence interval), thus fail to reject Ho and conclude that samples are equal.				Critical Value (z_α)	-0.90
											P-Value	0.3681

**Year when the project was completed*

Table G-6c Main Route vs. State Average Pre-Construction Crash Rate Statistical Analysis in Gould

	Main Road Pre-Widening Crash Rates			Statewide Pre-Widening Crash Rates			Wilcoxon Ranked-Sign Test Analysis				
Pre-Years	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Diff.**	**Absolute Diff.**	**Rank**	**Analysis**	
1997	3.14	1.35	-1.78	2.70	2.54	-0.16	-1.62	1.62	14	∑ Positive Rank (W^+)	74
1998	0.89	1.76	0.87	2.50	2.55	0.05	0.82	0.82	10	∑ Negative Rank (W^-)	14
1999	0.67	1.80	1.13	2.50	2.55	0.05	1.08	1.08	13	H_o: Medians of the two samples are equal	
2000	0.73	1.79	1.05	2.50	2.55	0.05	1.01	1.01	12	Number of Samples (n)	14
2001	0.87	1.76	0.89	2.40	2.55	0.15	0.74	0.74	7	Test Statistic (WR)	14
2002	0.71	1.79	1.08	2.40	2.55	0.15	0.93	0.93	11	Critical Value (z_α)	-2.42
2003	0.98	1.74	0.76	2.40	2.55	0.15	0.61	0.61	5	P-Value	0.0155
2004	0.87	1.76	0.89	2.40	2.55	0.15	0.74	0.74	7	Result: P-value < α (0.05, 95% confidence interval), thus reject Ho and conclude that samples are not equal.	

Table G-6d Main Route vs. State Average Post-Construction Crash Rate Statistical Analysis in Gould

	Main Road Post-Widening Crash Rates			Statewide Post-Widening Crash Rates			Wilcoxon Ranked-Sign Test Analysis				
Pre-Years	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Diff.**	**Absolute Diff.**	**Rank**	**Analysis**	
2011*	0.57	0.74	0.16	1.80	1.78	-0.02	0.18	0.18	5	∑ Positive Rank (W^+)	15
2012	0.82	0.73	-0.09	1.80	1.78	-0.02	-0.07	0.07	1	∑ Negative Rank (W^-)	6
2013	0.74	0.73	-0.01	1.70	1.78	0.08	-0.09	0.09	2	H_o: Medians of the two samples are equal	
2014	0.63	0.73	0.11	1.80	1.78	-0.02	0.13	0.13	4	Number of Samples (n)	6
2015	0.84	0.73	-0.11	1.78	1.78	0.00	-0.11	0.11	3	Test Statistic (WR)	6
2016	0.43	0.74	0.30	1.78	1.78	0.00	0.30	0.30	6	Critical Value (z_α)	-0.94
					Result: P-value > α (0.05, 95% confidence interval), thus fail to reject Ho and conclude that samples are equal.					P-Value	0.3472
***Year when the project was completed**											

Table G-7 Statewide vs. Treatment Crash Rate Statistical Analysis in Siloam Springs

	Statewide Crash Rates			Widening Crash Rates			Wilcoxon Ranked-Sign Test Analysis				
Year	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Diff.**	**Absolute Diff.**	**Rank**	**Analysis**	
2011	1.80	1.11	-0.69	4.40	4.30	-0.09	-0.60	0.60	5.00	∑ Positive Rank (W^+)	1
2012*	1.80	1.11	-0.69	4.45	4.34	-0.11	-0.58	0.58	4.00	∑ Negative Rank (W^-)	20
2013	1.70	1.09	-0.61	4.28	4.23	-0.05	-0.56	0.56	3.00	H_o: Medians of the two samples are equal	
2014	1.80	1.11	-0.69	3.68	3.84	0.16	-0.85	0.85	6.00	Number of Samples (n)	6
2015	1.78	1.10	-0.68	6.92	5.93	-0.98	0.31	0.31	1.00	Test Statistic (WR)	1
2016	1.78	1.10	-0.67	4.61	4.44	-0.17	-0.51	0.51	2.00	Critical Value (z_α)	-1.99
										P-Value	0.0466
										Result: P-value < α (0.05, 95% confidence interval), thus reject H0 and conclude that samples are not equal.	

**Year when the project was completed* (*)

Table G-7b Pre- vs. Post Widened Road Crash Rate Statistical Analysis in Siloam Springs

	Main Road Pre-Widening Crash Rates				Main Road Post-Widening Crash Rates			Wilcoxon Ranked-Sign Test Analysis				
Pre-Years	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Post-Years**	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Diff.**	**Absolute Diff.**	**Rank**	**Analysis**	
2007	4.50	5.19	0.69	**2012***	4.45	5.22	0.76	-0.07	0.07	1	∑ Positive Rank (W^+)	5
2008	5.43	5.20	-0.24	**2013**	4.28	5.17	0.88	-1.12	1.12	4	∑ Negative Rank (W^-)	10
2009	5.99	5.20	-0.80	**2014**	3.68	4.99	1.31	-2.11	2.11	5	H_o: Medians of the two samples are equal	
2010	5.64	5.20	-0.45	**2015**	6.92	5.94	-0.97	0.52	0.52	3	Number of Samples (n)	5
2011	4.40	5.19	0.80	**2016**	4.61	5.26	0.65	0.14	0.14	2	Test Statistic (WR)	5
							Result: P-value > α (0.05, 95% confidence interval), thus fail to reject Ho and conclude that samples are equal.				Critical Value (z_α)	-0.38
											P-Value	0.7039

Table G-7c Main Route vs. State Average Pre-Construction Crash Rate Statistical Analysis in Siloam Springs

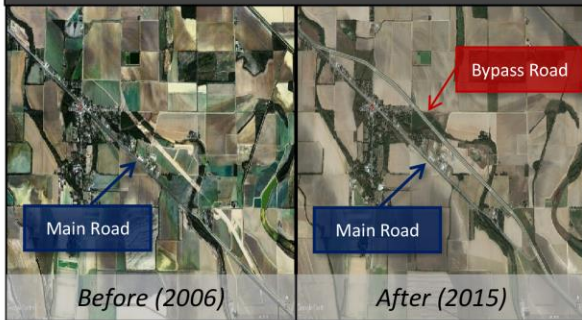
	Main Road Pre-Widening Crash Rates			Statewide Pre-Widening Crash Rates			Wilcoxon Ranked-Sign Test Analysis				
Pre-Years	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Diff.**	**Absolute Diff.**	**Rank**	**Analysis**	
1997	8.42	4.55	-3.87	2.70	2.54	-0.16	-3.71	3.71	15	∑ Positive Rank (W^+)	21
1998	6.03	5.26	-0.77	2.50	2.55	0.05	-0.82	0.82	10	∑ Negative Rank (W^-)	42
1999	5.07	5.55	0.48	2.50	2.55	0.05	0.43	0.43	5	H_o: Medians of the two samples are equal	
2000	5.29	5.48	0.20	2.50	2.55	0.05	0.15	0.15	3	Number of Samples (n)	15
2001	5.21	5.50	0.29	2.40	2.55	0.15	0.14	0.14	2	Test Statistic (WR)	21
2002	5.27	5.49	0.21	2.40	2.55	0.15	0.06	0.06	1	Critical Value (z_α)	-2.22
2003	4.79	5.63	0.83	2.40	2.55	0.15	0.68	0.68	9	P-Value	0.0264
2004	5.65	5.38	-0.27	2.40	2.55	0.15	-0.42	0.42	4	Result: P-value < α (0.05, 95% confidence interval), thus reject Ho and conclude that samples are not equal.	
2005	7.44	4.84	-2.61	2.20	2.56	0.36	-2.96	2.96	14		
2006	6.74	5.05	-1.69	2.10	2.56	0.46	-2.15	2.15	13		
2007	4.50	5.72	1.22	2.00	2.56	0.56	0.65	0.65	7		
2008	5.43	5.44	0.01	1.90	2.57	0.67	-0.66	0.66	8		
2009	5.99	5.27	-0.72	1.90	2.57	0.67	-1.39	1.39	12		
2010	5.64	5.38	-0.27	1.80	2.57	0.77	-1.04	1.04	11		
2011	4.40	5.75	1.35	1.80	2.57	0.77	0.58	0.58	6		

Table G-7d Main Route vs. State Average Post-Construction Crash Rate Statistical Analysis in Siloam Springs

	Main Road Post-Widening Crash Rates			Statewide Post-Widening Crash Rates			Wilcoxon Ranked-Sign Test Analysis				
Pre-Years	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Observed**	**Estimated *(Detrended)***	**Residuals**	**Diff.**	**Absolute Diff.**	**Rank**	**Analysis**	
2012*	4.45	5.22	0.76	1.80	1.77	-0.03	0.80	0.80	2	∑ Positive Rank (W^+)	11
2013	4.28	5.17	0.88	1.70	1.77	0.07	0.82	0.82	3	∑ Negative Rank (W^-)	4
2014	3.68	4.99	1.31	1.80	1.77	-0.03	1.34	1.34	5	H_o: Medians of the two samples are equal	
2015	6.92	5.94	-0.97	1.77	1.77	0.00	-0.97	0.97	4	Number of Samples (n)	5
2016	4.61	5.26	0.65	1.77	1.77	0.00	0.65	0.65	1	Test Statistic (WR)	4
***Year when the project was completed**				Result: P-value > α (0.05, 95% confidence interval), thus fail to reject Ho and conclude that samples are equal.						Critical Value (z_α)	-0.94
										P-Value	0.3472

APPENDIX H: PUBLIC OUTREACH DOCUMENTS

BYPASS IN GRADY, ARKANSAS



Start Year: 2005

Completion Year: 2009

Total Cost: $26 million

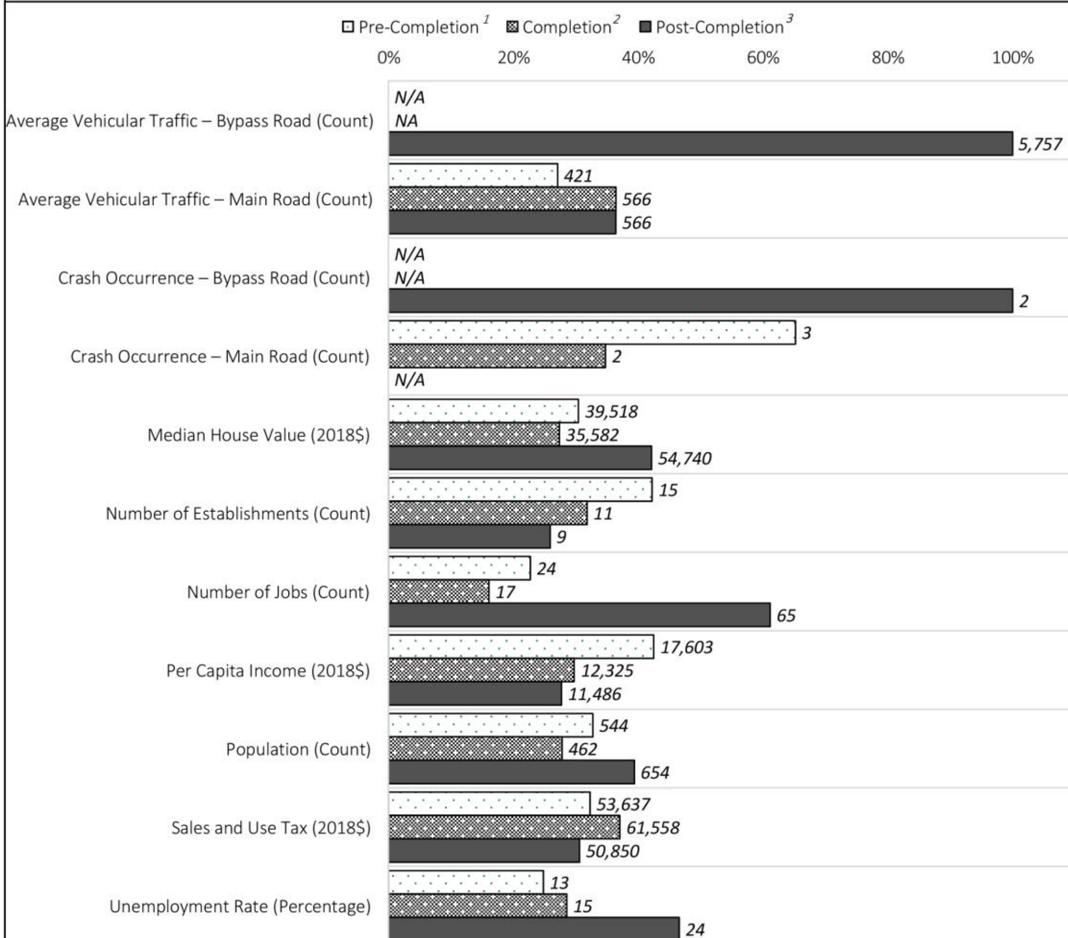
Length: 3.96 miles Highway 65

No. of Lanes: 4 (2 per direction)

Location: Southeast AR - Lincoln County, near Pine Bluff, Metro setting

Purpose: Accommodate for traffic congestion due to local, school, and agricultural traffic

Total Annual Average:



Total Annual Average per category covers:

[1] *Pre-Completion years include data from 1997-2004*

[2] *Completion years include data from 2005 - 2009*

[3] *Post-completion years include data from 2010 - 2016*

ARDOT Arkansas Department of Transportation

University of Arkansas

BYPASS IN GRADY, ARKANSAS

Economic Impacts[5]

A total of 14 jobs created per Lane-Mile

Total employment is the total number of jobs in the county supported by construction activities

$570k Total Labor Income per Lane-mile

Total labor income is the income of labor and total economic impact, respectively, generated by the construction activities

$780k Total Value Added per Lane-mile

Total value-added is a measure of the contribution to gross domestic product generated by the construction activities

$2.11M Total Output per Lane-mile

Total Output is the total value of a business' production and is the measure of the value added plus intermediate expenditures

$50k Total Tax Generated per Lane-mile

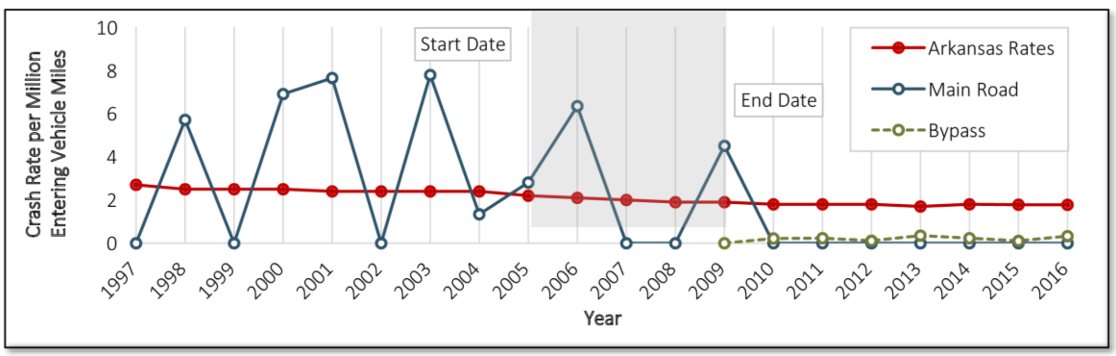
Total tax generated includes the taxes from employment compensation, production and imports, households, and corporations

Economic Variables	Post-Completion Results		
	Deviation	Trend	Fluctuation
Population Density	High	Increase	High
Annual Daily Traffic	Moderate	No change	High
Property Transfer	High	Decrease	High

Lane-Miles conversion can be calculated to obtain the total economic impact of the project at the segment location using the following formula:

$$Total\ Economic\ Impact = (total\ per\ lane - miles) * (length\ of\ the\ project) * (number\ of\ lanes)$$

Safety Impacts[6]



Data Reference:
4. Bypass job number R20150 and 020430
5. Economic Results retrieved from: IMPLAN: Software for Economic Analysis." http://www.implan.com/software/#top, IMPLAN
6. Safety Results retrieved from: Arkansas State Police Crash Records Database (1997-2016).

ARDOT ARKANSAS DEPARTMENT OF TRANSPORTATION

UNIVERSITY OF ARKANSAS

Figure H- 1 Public Outreach Document for Grady

BYPASS IN HARDY, ARKANSAS

Start Year: 2003

Completion Year: 2005

Total Cost: $26 million

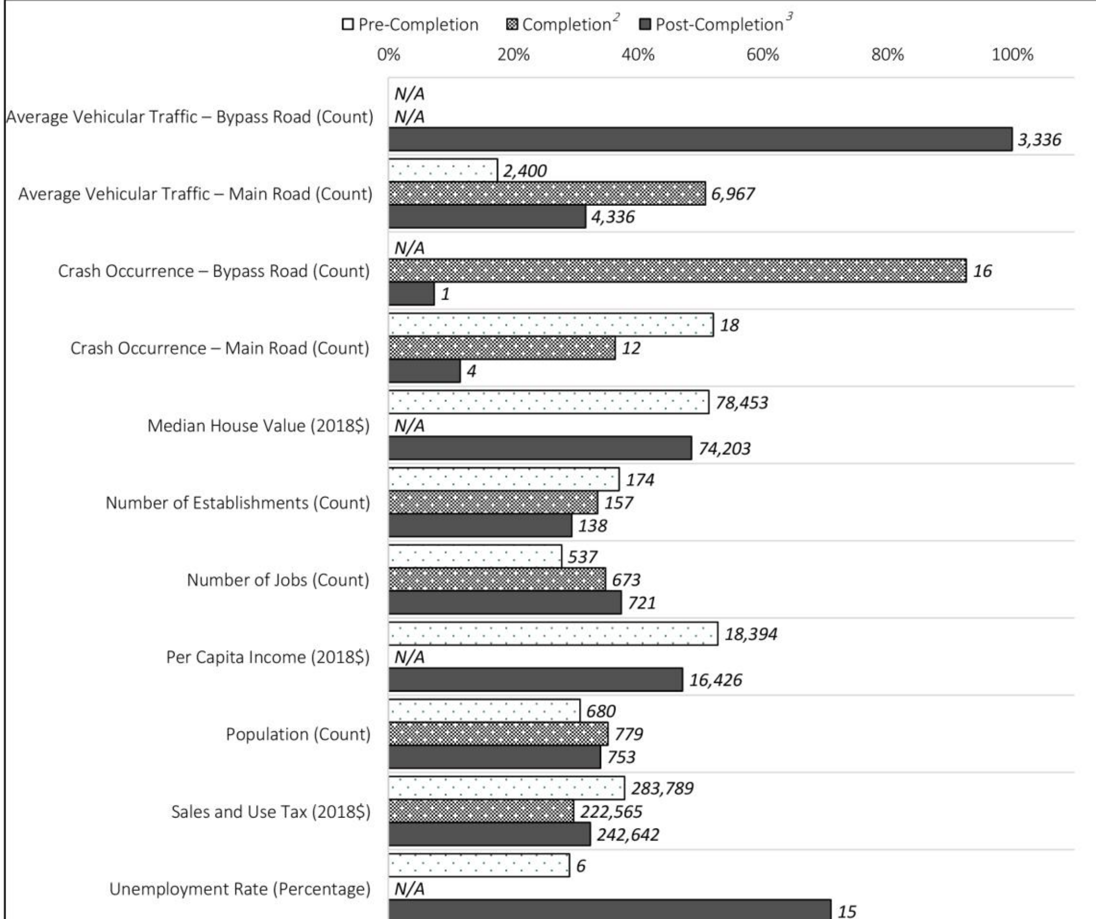
Length: 1.5 miles Highway 412

No. of Lanes: 4 (2 per direction)

Location: North-Central AR - Sharp County, Rural, Agricultural, Connects Springfield, MO –Jonesboro, AR, Rural setting

Purpose: Accommodate high traffic flows from trucks and recreational vehicles

Total Annual Average:



Total Annual Average per category covers:
[1]Pre-Completion include data from 1997 - 2002
[2]Completion years include data from 2003- 2005
[3]Post-completion years include data from 2006 - 2016

ARDOT ARKANSAS DEPARTMENT OF TRANSPORTATION

UNIVERSITY OF ARKANSAS

BYPASS IN HARDY, ARKANSAS

Economic Impacts[5]

A total of 59 jobs created per Lane-Mile

Total employment is the total number of jobs in the county supported by construction activities

$1.77M Total Labor Income per Lane-mile

Total labor income is the income of labor and total economic impact, respectively, generated by the construction activities

$2.62M Total Value Added per Lane-mile

Total value-added is a measure of the contribution to gross domestic product generated by the construction activities

$8.18M Total Output per Lane-mile

Total Output is the total value of a business' production and is the measure of the value added plus intermediate expenditures

$250k Total Tax Generated per Lane-mile

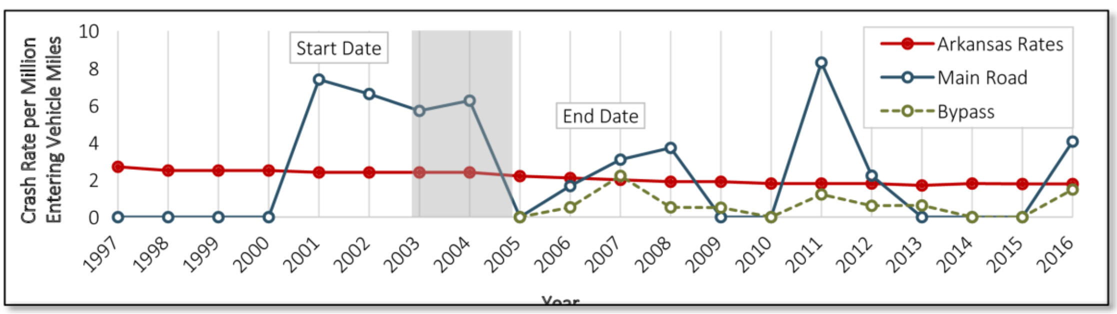
Total tax generated includes the taxes from employment compensation, production and imports, households, and corporations

Economic Variables	Post-Completion Results		
	Deviation	Trend	Fluctuation
Population Density	High	Decrease	Moderate
Annual Daily Traffic	High	Decrease	Moderate
Property Transfer	High	Decrease	High

Lane-Miles conversion can be calculated to obtain the total economic impact of the project at the segment location using the following formula:

$$Total\ Economic\ Impact = (total\ per\ lane-miles) * (length\ of\ the\ project) * (number\ of\ lanes)$$

Safety Impacts[6]



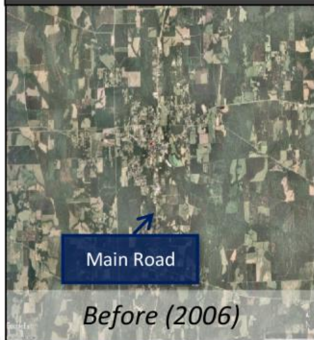
Data Reference:
4. Bypass job number 050064
5. Economic Results retrieved from: IMPLAN: Software for Economic Analysis." http://www.implan.com/software/#top, IMPLAN
6. Safety Results retrieved from: Arkansas State Police Crash Records Database (1997-2016).

ARDOT ARKANSAS DEPARTMENT OF TRANSPORTATION

UNIVERSITY OF ARKANSAS

Figure H- 2 Public Outreach Document for Hardy

BYPASS IN SHERIDAN, ARKANSAS



Start Year: 2008

Completion Year: 2014

Total Cost: $50 million

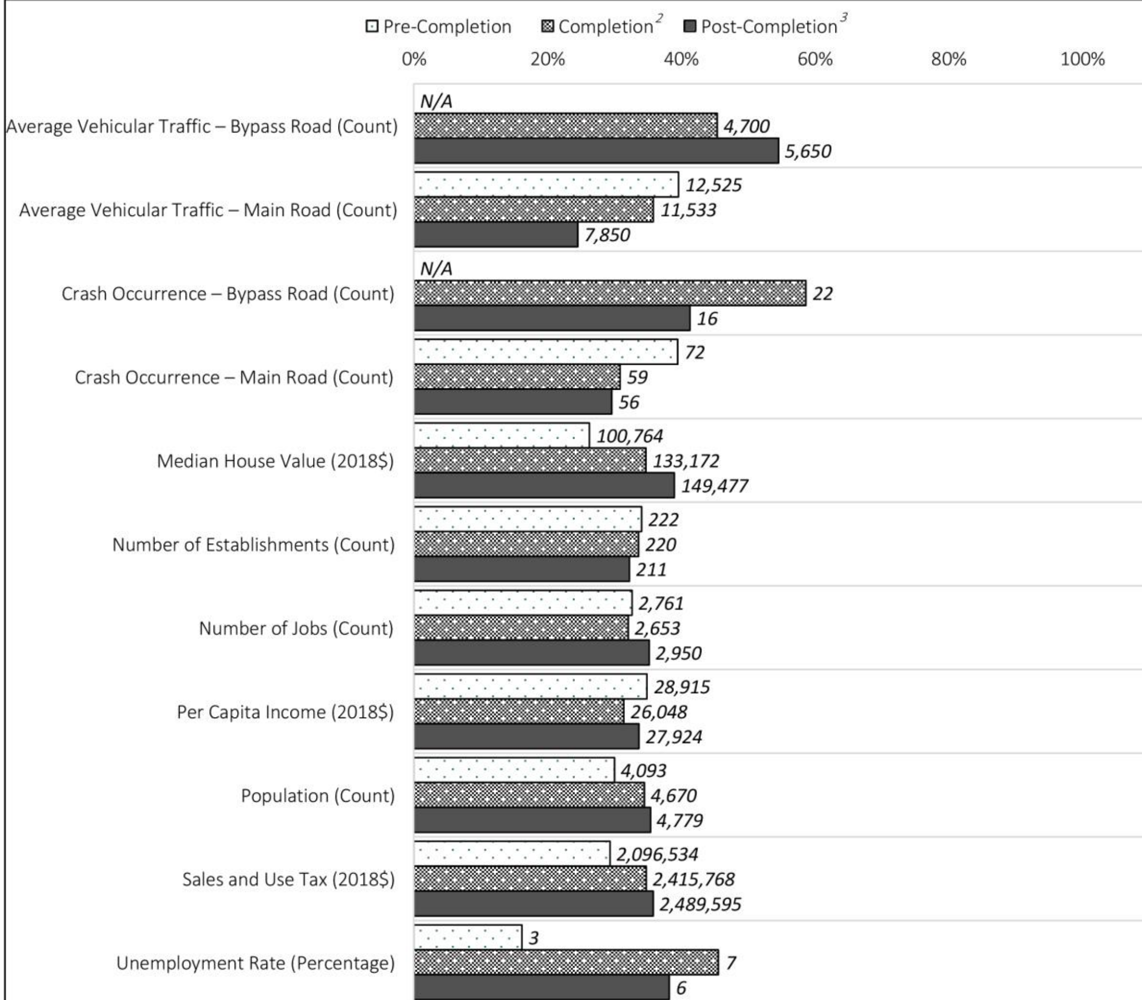
Length: 8.63 miles Highway 167

No. of Lanes: 4 (2 per direction)

Location: South of Little Rock – Grant County, Metro setting

Purpose: To eliminate the impediment to the flow of through traffic in Sheridan

Total Annual Average:



Total Annual Average per category covers:

* *Pre-Completion years include data from 1997 - 2007*

** *Completion years include data from 2008 - 2014*

*** *Post-completion years include data from 2015 - 2016*

ARDOT ARKANSAS DEPARTMENT OF TRANSPORTATION

UNIVERSITY OF ARKANSAS

BYPASS IN SHERIDAN, ARKANSAS

Economic Impacts[5]

A total of 11 jobs created per Lane-Mile

Total employment is the total number of jobs in the county supported by construction activities

$440k Total Labor Income per Lane-mile

Total labor income is the income of labor and total economic impact, respectively, generated by the construction activities

$630k Total Value Added per Lane-mile

Total value-added is a measure of the contribution to gross domestic product generated by the construction activities

$1.60M Total Output per Lane-mile

Total Output is the total value of a business' production and is the measure of the value added plus intermediate expenditures

$40k Total Tax Generated per Lane-mile

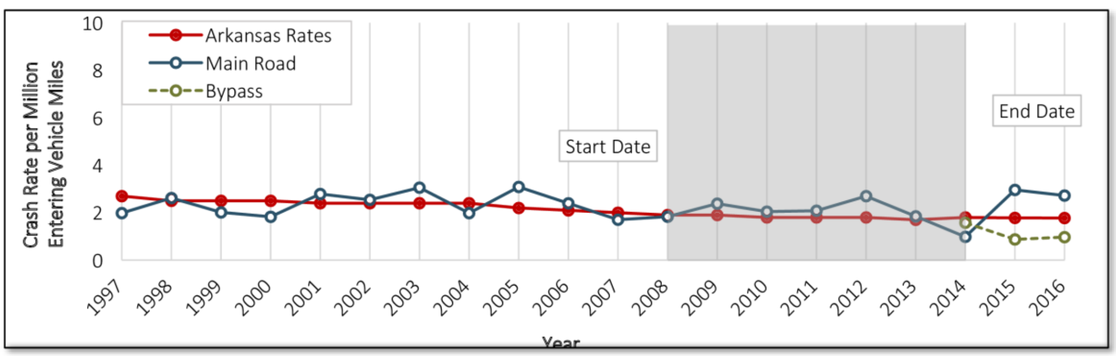
Total tax generated includes the taxes from employment compensation, production and imports, households, and corporations

Economic Variables	Post-Completion Results		
	Deviation	Trend	Fluctuation
Population Density	Low	No change	Low
Annual Daily Traffic	High	Decrease	Moderate
Property Transfer	High	Increase	High

Lane-Miles conversion can be calculated to obtain the total economic impact of the project at the segment location using the following formula:

$$Total\ Economic\ Impact = (total\ per\ lane - miles) * (length\ of\ the\ project) * (number\ of\ lanes)$$

Safety Impacts[6]



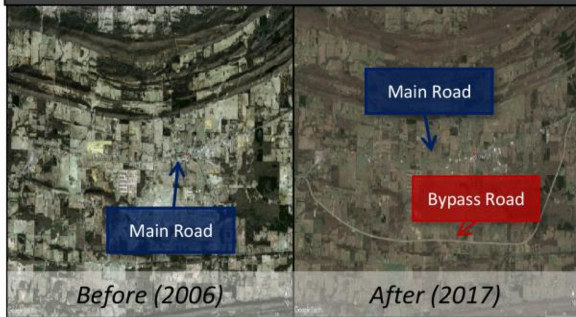
Data Reference:
4. Bypass job number 020275
5. Economic Results retrieved from: IMPLAN: Software for Economic Analysis." http://www.implan.com/software/#top, IMPLAN
6. Safety Results retrieved from: Arkansas State Police Crash Records Database (1997-2016).

ARDOT ARKANSAS DEPARTMENT OF TRANSPORTATION

UNIVERSITY OF ARKANSAS

Figure H- 3 Public Outreach Document for Sheridan

BYPASS IN VILONIA, ARKANSAS



Start Year: 2007

Completion Year: 2012

Total Cost: $59 million

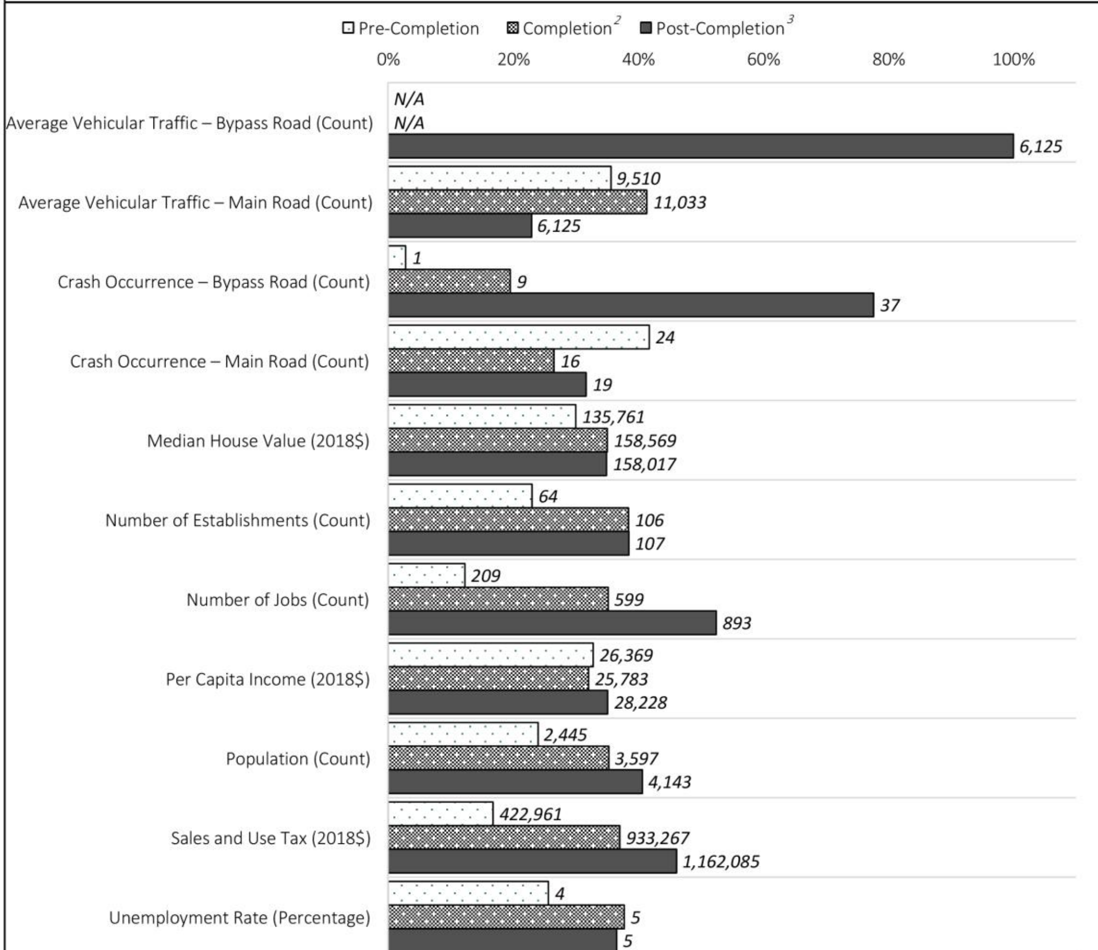
Length: 10.1 miles Highway 64

No. of Lanes: 4 (2 per direction)

Location: North of Little Rock – Faulkner County, Metro, Metro setting

Purpose: Alleviate the increasing congestion and address safety issues

Total Annual Average:



Footnote:

** Pre-Completion years include data from 1997 -2006*

*** Completion years include data from 2007 - 2012*

**** Post-completion years include data from 2013 - 2016*

ARDOT ARKANSAS DEPARTMENT OF TRANSPORTATION

UNIVERSITY OF ARKANSAS

BYPASS IN VILONIA, ARKANSAS

Economic Impacts[5]

A total of 13 jobs created per Lane-Mile

Total employment is the total number of jobs in the county supported by construction activities

$560k Total Labor Income per Lane-mile

Total labor income is the income of labor and total economic impact, respectively, generated by the construction activities

$820k Total Value Added per Lane-mile

Total value-added is a measure of the contribution to gross domestic product generated by the construction activities

$1.93M Total Output per Lane-mile

Total Output is the total value of a business' production and is the measure of the value added plus intermediate expenditures

$60k Total Tax Generated per Lane-mile

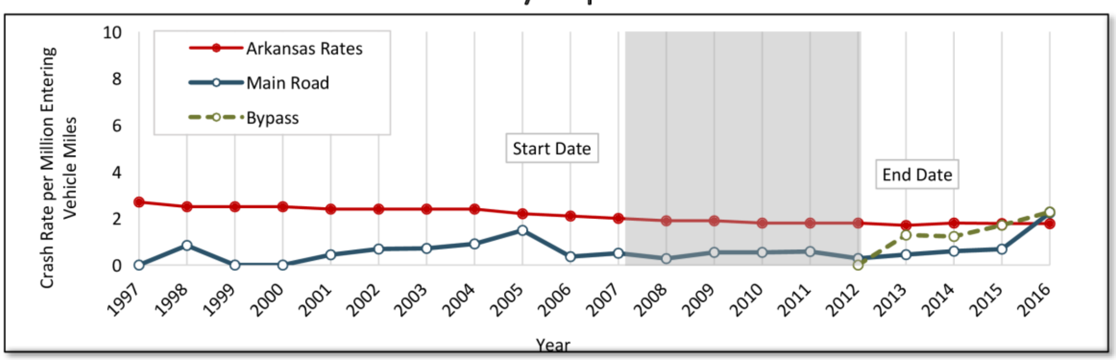
Total tax generated includes the taxes from employment compensation, production and imports, households, and corporations

Economic Variables	Post-Completion Results		
	Deviation	Trend	Fluctuation
Population Density	High	Increase	High
Annual Daily Traffic	Moderate	No change	High
Property Transfer	High	Decrease	High

Lane-Miles conversion can be calculated to obtain the total economic impact of the project at the segment location using the following formula:

$$Total\ Economic\ Impact = (total\ per\ lane - miles) * (length\ of\ the\ project) * (number\ of\ lanes)$$

Safety Impacts[6]



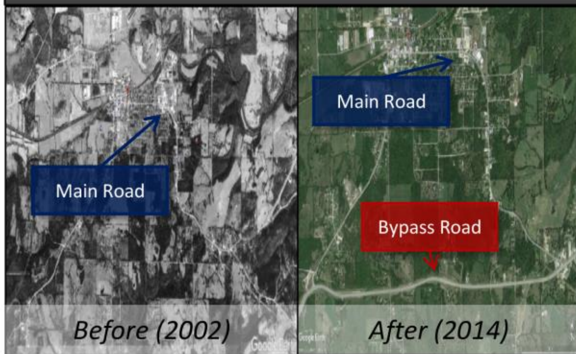
Data Reference:
4. Bypass job number 080149
5. Economic Results retrieved from: IMPLAN: Software for Economic Analysis." http://www.implan.com/software/#top, IMPLAN
6. Safety Results retrieved from: Arkansas State Police Crash Records Database (1997-2016).

ARDOT ARKANSAS DEPARTMENT OF TRANSPORTATION

UNIVERSITY OF ARKANSAS

Figure H- 4 Public Outreach Document for Vilonia

BYPASS IN FLIPPIN, ARKANSAS



Start Year: 2004

Completion Year: 2008

Total Cost: $20 million

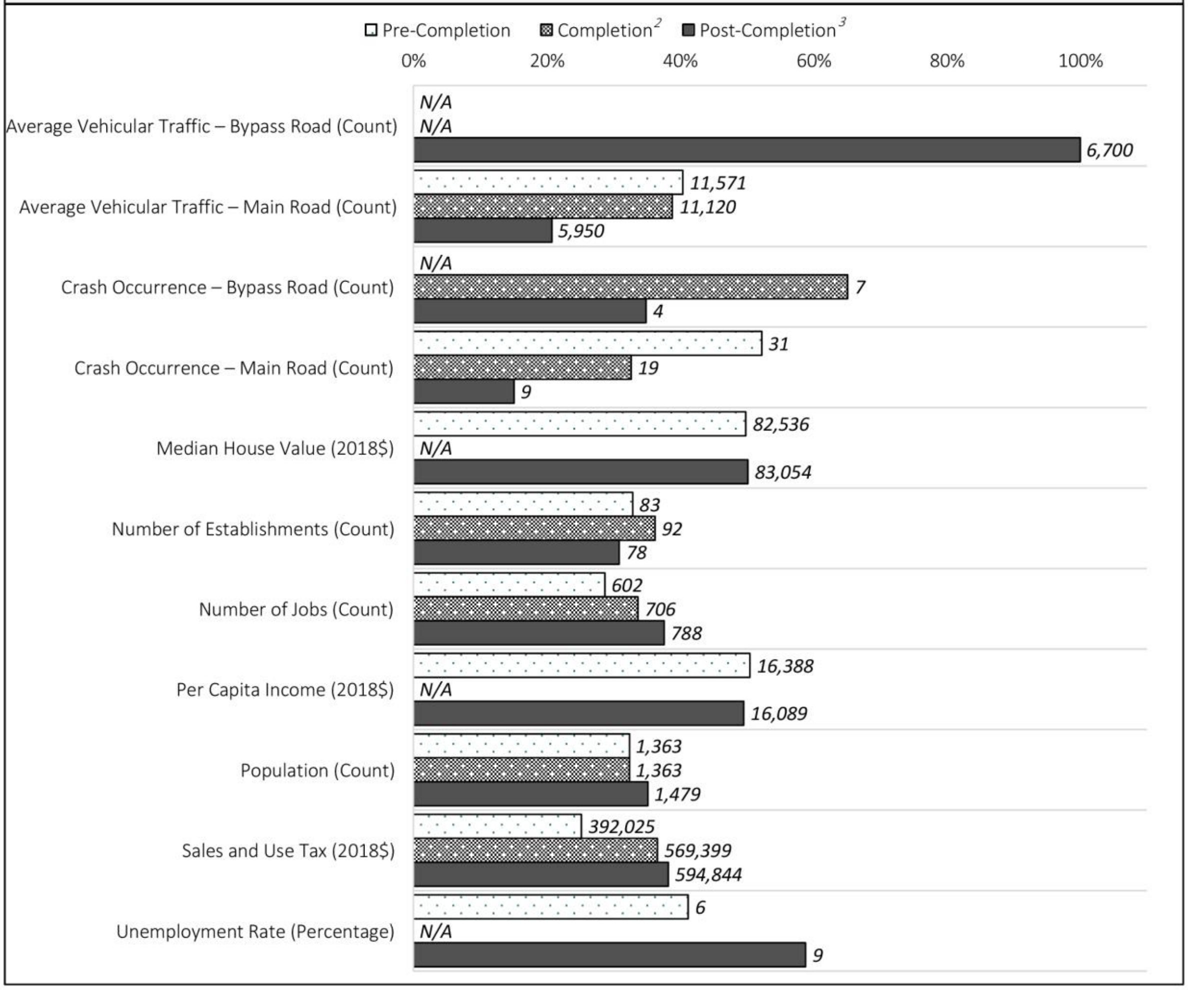
Length: 3.2 miles Highway 62

No. of Lanes: 4 (2 per direction)

Location: North of Little Rock –Marion County, Rural Setting

Purpose: Improve traffic flow, reduce number of 90-degree turns, and separate through traffic from local traffic

Total Annual Average:



Footnote:

** Pre-Completion years include data from 1997-2003*

*** Completion years include data from 2004-2008*

**** Post-completion years include data from 2009-2016*

BYPASS IN FLIPPIN, ARKANSAS

Economic Impacts[5]

A total of 14 jobs created per Lane-Mile

Total employment is the total number of jobs in the county supported by construction activities

$540k Total Labor Income per Lane-mile

Total labor income is the income of labor and total economic impact, respectively, generated by the construction activities

$670k Total Value Added per Lane-mile

Total value-added is a measure of the contribution to gross domestic product generated by the construction activities

$1.98M Total Output per Lane-mile

Total Output is the total value of a business' production and is the measure of the value added plus intermediate expenditures

$80k Total Tax Generated per Lane-mile

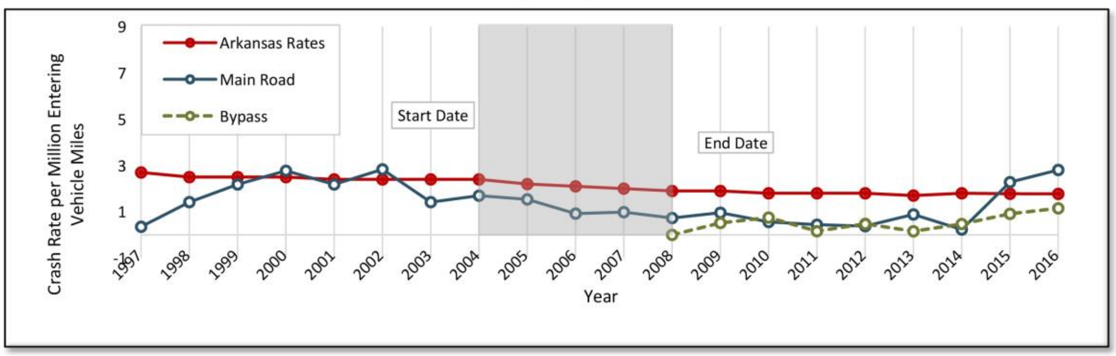
Total tax generated includes the taxes from employment compensation, production and imports, households, and corporations

Economic Variables	Post-Completion Results		
	Deviation	Trend	Fluctuation
Population Density	Moderate	Decrease	High
Annual Daily Traffic	High	Decrease	Moderate
Property Transfer	High	Decrease	High

Lane-Miles conversion can be calculated to obtain the total economic impact of the project at the segment location using the following formula:

$$Total\ Economic\ Impact = (total\ per\ lane - miles) * (length\ of\ the\ project) * (number\ of\ lanes)$$

Safety Impacts[6]



Data Reference:
4. Bypass job number R90096
5. Economic Results retrieved from: IMPLAN: Software for Economic Analysis." http://www.implan.com/software/#top, IMPLAN
6. Safety Results retrieved from: Arkansas State Police Crash Records Database (1997-2016).

ARDOT ARKANSAS DEPARTMENT OF TRANSPORTATION

UNIVERSITY OF ARKANSAS

Figure H- 5 Public Outreach Document for Flippin

WIDENING IN GOULD, ARKANSAS

Start Year: 2006

Completion Year: 2011

Total Cost: $40 million

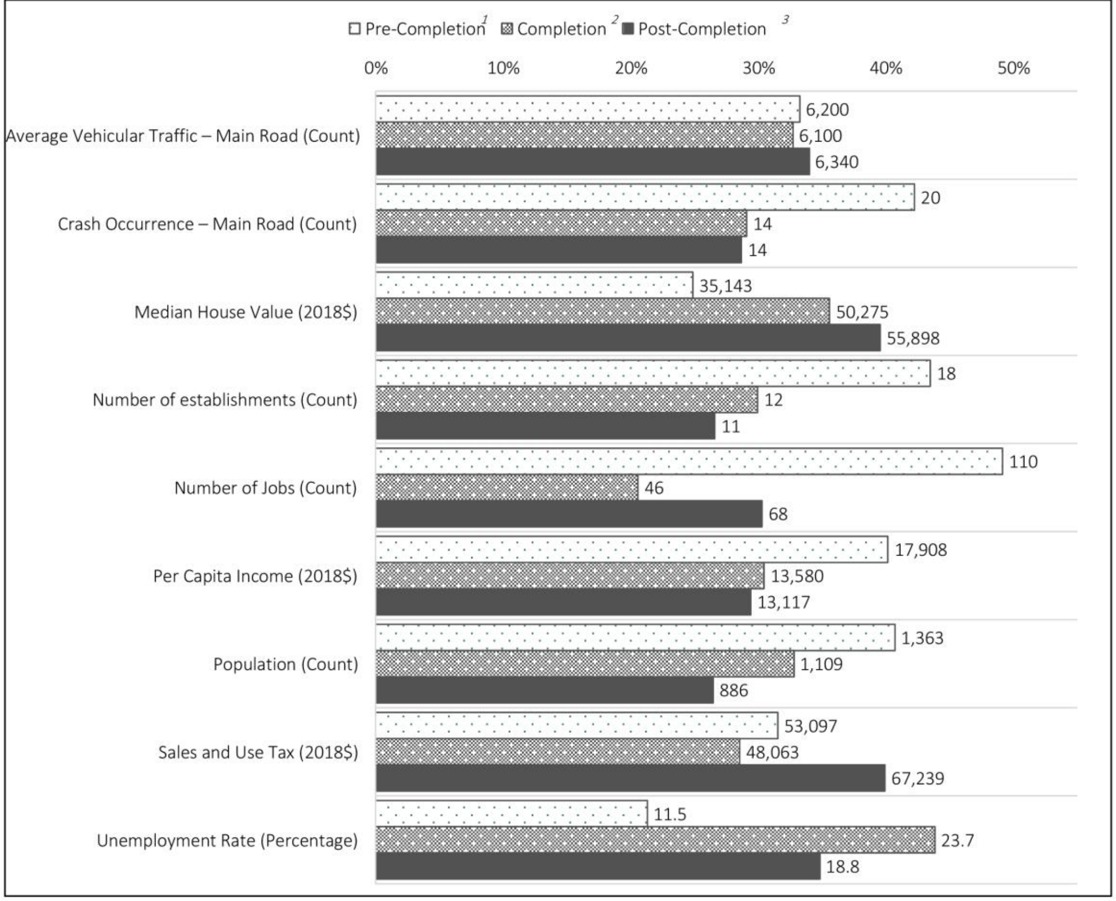
Length: 8.6 miles Highway 65

No. of Lanes: 2 (1 per direction)

Location: SE of Pine Bluff, Major farming community, Mixed Setting

Purpose: Improve traffic flow and enhance safety on Highway 65, mainly for market access for farms, cultural enhancement, and improved healthcare delivery

Total Annual Average:



Total Annual Average per category covers:

[1] *Pre-Completion years include data from 1997-2005*

[2] *Completion years include data from 2006 - 2011*

[3] *Post-completion years include data from 2012 - 2016*

ARDOT ARKANSAS DEPARTMENT OF TRANSPORTATION

UNIVERSITY OF ARKANSAS

WIDENING IN GOULD, ARKANSAS

Economic Impacts[5]

A total of 20 jobs created per Lane-Mile

Total employment is the total number of jobs in the county supported by construction activities

$810k Total Labor Income per Lane-mile

Total labor income is the income of labor and total economic impact, respectively, generated by the construction activities

$1.11M Total Value Added per Lane-mile

Total value-added is a measure of the contribution to gross domestic product generated by the construction activities

$2.97M Total Output per Lane-mile

Total Output is the total value of a business' production and is the measure of the value added plus intermediate expenditures

$80k Total Tax Generated per Lane-mile

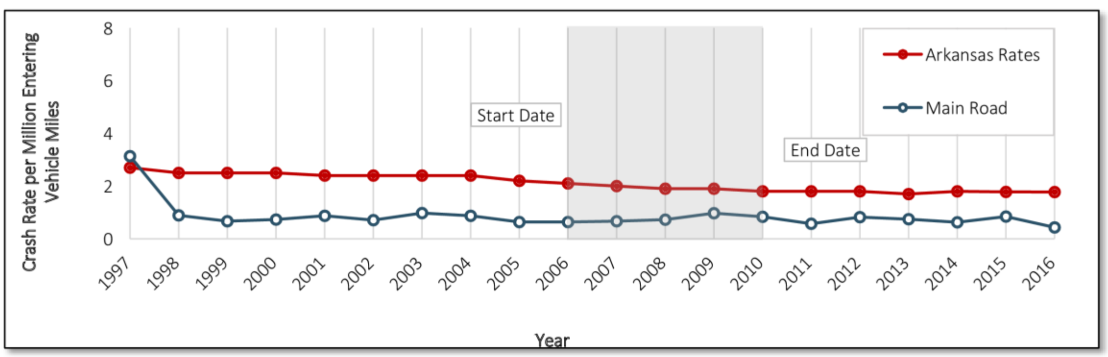
Total tax generated includes the taxes from employment compensation, production and imports, households, and corporations

Economic Variables	Post-Completion Results		
	Deviation	Trend	Fluctuation
Population Density	Moderate	Decrease	Moderate
Annual Daily Traffic	Moderate	Increase	High
Property Transfer	High	Increase	High

Lane-Miles conversion can be calculated to obtain the total economic impact of the project at the segment location using the following formula:

$$Total\ Economic\ Impact = (total\ per\ lane - miles) * (length\ of\ the\ project) * (number\ of\ lanes)$$

Safety Impacts[6]



Data Reference:

4. Bypass job number R20092 and 020137

5. Economic Results retrieved from: IMPLAN: Software for Economic Analysis." http://www.implan.com/software/#top, IMPLAN

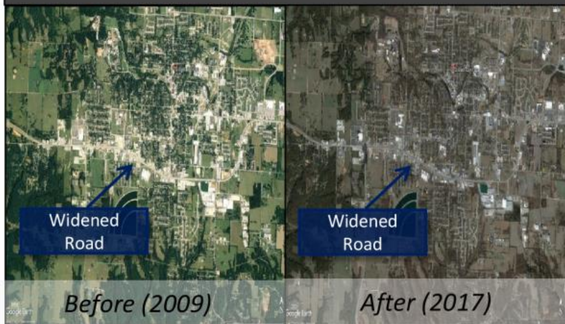
6. Safety Results retrieved from: Arkansas State Police Crash Records Database (1997-2016).

ARDOT ARKANSAS DEPARTMENT OF TRANSPORTATION

UNIVERSITY OF ARKANSAS

Figure H- 6 Public Outreach Document for Gould

WIDENING IN SILOAM SPRINGS, ARKANSAS



Start Year: 2010

Completion Year: 2012

Total Cost: $15 million

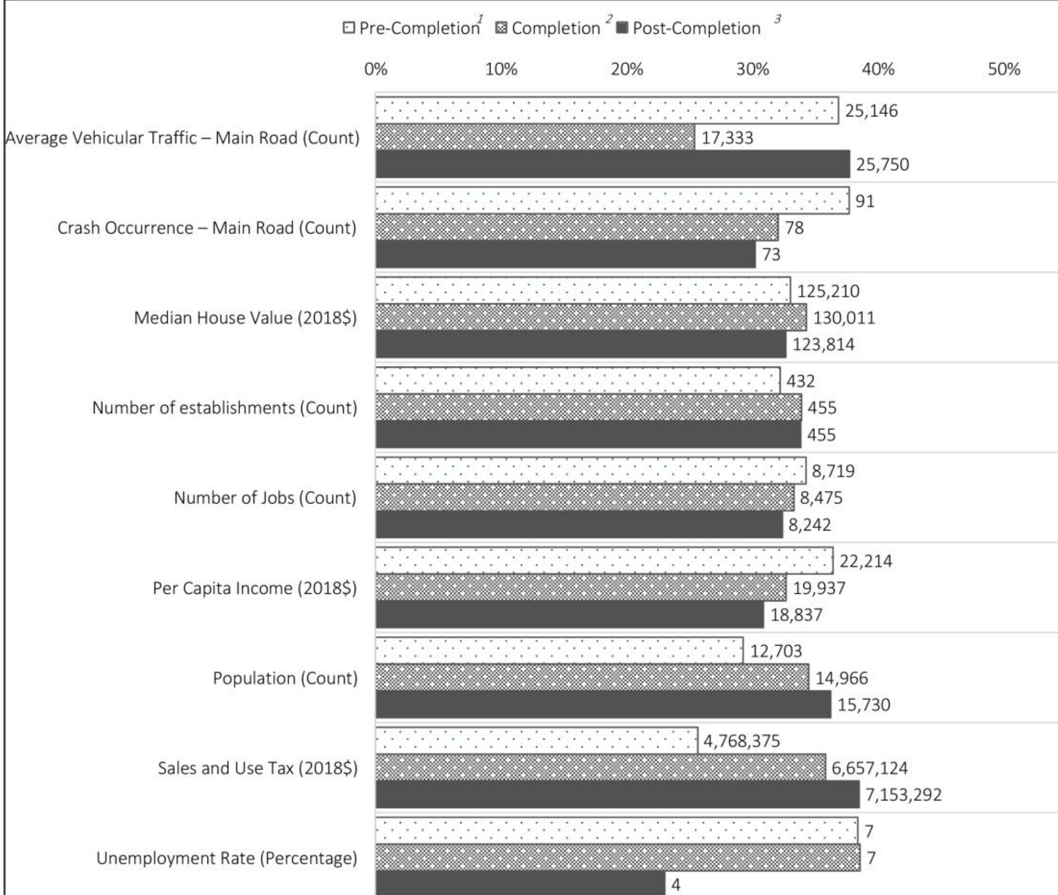
Length: 1.6 miles Highway 412

No. of Lanes: 2 (1 per direction)

Location: Northwest Arkansas at Benton County, Metro Settings

Purpose: Relieve increasing traffic congestion, reduce traffic delay, and improve travel safety on Highway 412

Total Annual Average:



Footnote:

** Pre-Completion years include data from 1997-2009*

*** Completion years include data from 2010 - 2012*

**** Post-completion years include data from 2013 - 2016*

ARDOT ARKANSAS DEPARTMENT OF TRANSPORTATION

UNIVERSITY OF ARKANSAS

WIDENING IN SILOAM SPRINGS, ARKANSAS

Economic Impacts[5]

A total of 35 jobs created per Lane-Mile

Total employment is the total number of jobs in the county supported by construction activities

$1.81M Total Labor Income per Lane-mile

Total labor income is the income of labor and total economic impact, respectively, generated by the construction activities

$2.56M Total Value Added per Lane-mile

Total value-added is a measure of the contribution to gross domestic product generated by the construction activities

$5.72M Total Output per Lane-mile

Total Output is the total value of a business' production and is the measure of the value added plus intermediate expenditures

$160k Total Tax Generated per Lane-mile

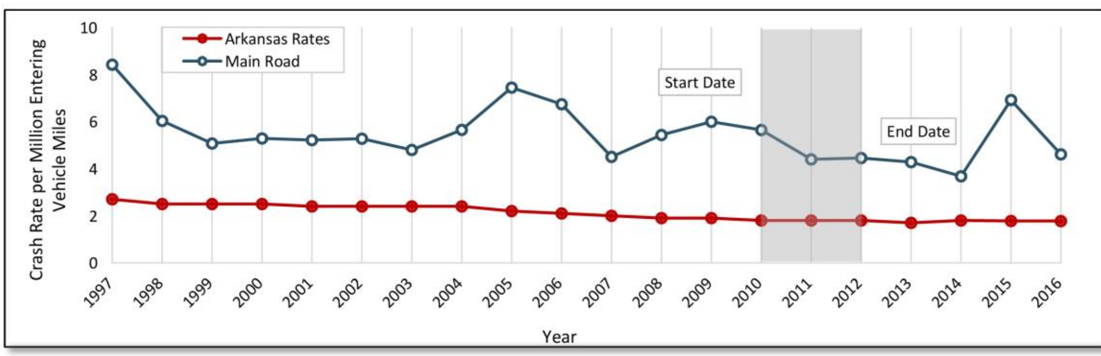
Total tax generated includes the taxes from employment compensation, production and imports, households, and corporations

Economic Variables	Post-Completion Results		
	Deviation	Trend	Fluctuation
Population Density	Low	Increase	Low
Annual Daily Traffic	Moderate	Decrease	Moderate
Property Transfer	High	Increase	High

Lane-Miles conversion can be calculated to obtain the total economic impact of the project at the segment location using the following formula:

$$Total\ Economic\ Impact = (total\ per\ lane - miles) * (length\ of\ the\ project) * (number\ of\ lanes)$$

Safety Impacts[6]



Data Reference:

4. Bypass job number 090155

5. Economic Results retrieved from: IMPLAN: Software for Economic Analysis." http://www.implan.com/software/#top, IMPLAN

6. Safety Results retrieved from: Arkansas State Police Crash Records Database (1997-2016).

ARDOT ARKANSAS DEPARTMENT OF TRANSPORTATION

UNIVERSITY OF ARKANSAS

Figure H- 7 Public Outreach Document for Siloam Springs

PROPOSED TREATMENT IN DOVER, ARKANSAS

Study Year: 2011

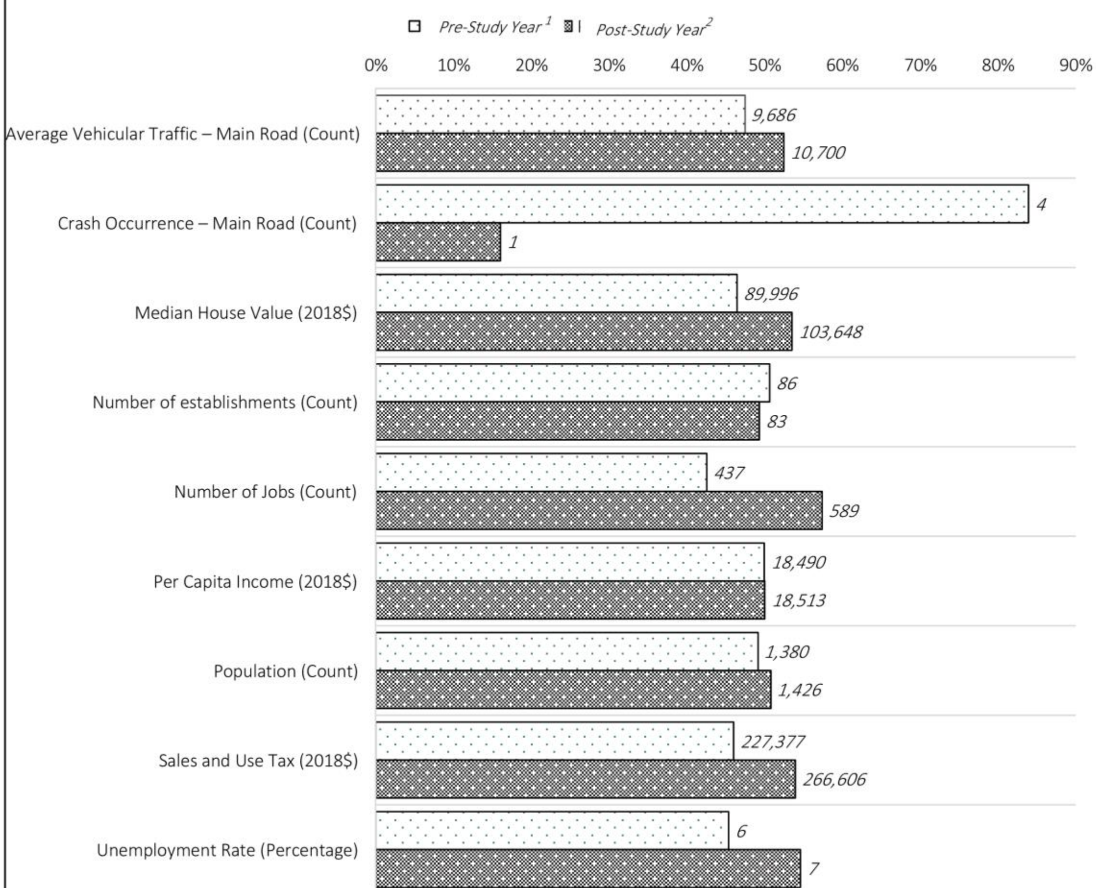
Estimated Total Cost $15.7 million

Proposed Length: 2.7 miles Highway 7

Location: Dover City of Pope County, Metro Setting

Purpose: Improve north-south travel and reduce congestion on Highway 7 in Dover

Total Annual Average:



Total Annual Average per category covers:
[1] *Pre-Study Year include data from 1997-2010*
[2] *Post-Study Year include data from 2011 – 2016*

ARDOT ARKANSAS DEPARTMENT OF TRANSPORTATION

UNIVERSITY OF ARKANSAS

PROPOSED TREATMENT IN DOVER, ARKANSAS

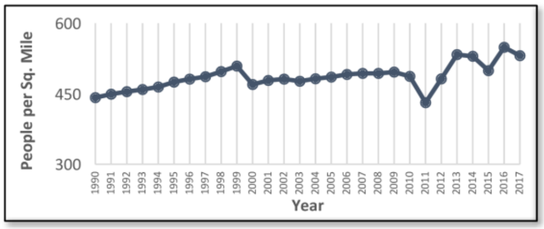
Economic Impacts[5]

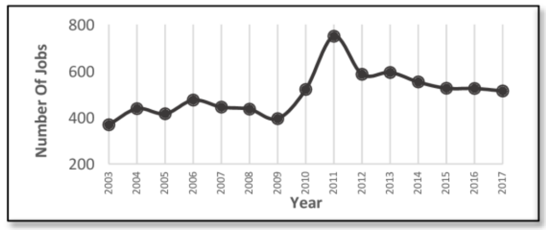
Population Density

This is a trend of the number of people residing per unit of area, quoted per square mile calculated for the city from the U.S. Census.

Number of Jobs

This is a trend of the full-time/part-time annual number of jobs calculated for the city from the Bureau of Labor Statistics.



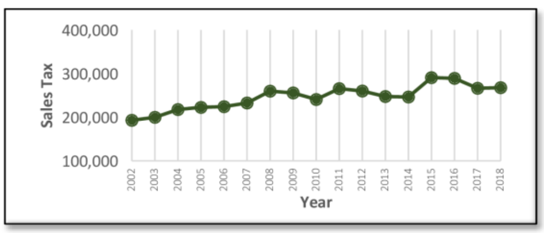


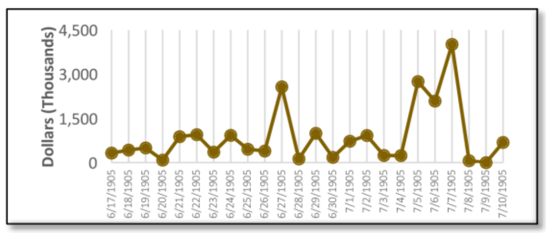
Sales Tax

This trend shows the change in sales tax calculated for the city from the Arkansas Department of Finance and Administration.

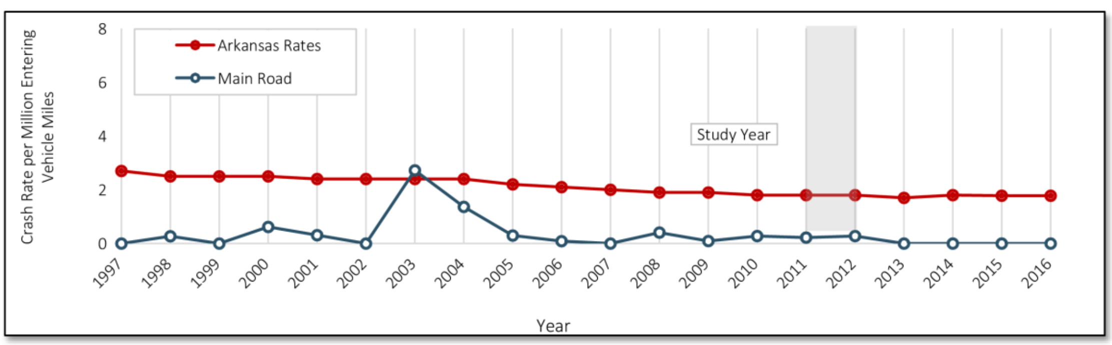
Property Transfer

This trend represents the total sale amount of all the transfer of commercial properties calculated for the city from the County Assessor's Office.





Safety Impacts[6]



Data Reference:

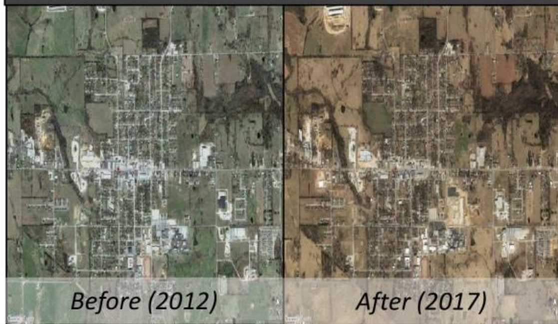
4. Proposed treatment job number 080164

5. Economic Results retrieved from: IMPLAN: Software for Economic Analysis." http://www.implan.com/software/#top, IMPLAN

6. Safety Results retrieved from: Arkansas State Police Crash Records Database (1997-2016).

Figure H- 8 Public Outreach Document for Dover

PROPOSED TREATMENT IN GREEN FOREST, ARKANSAS



Estimated Start Date: 2012

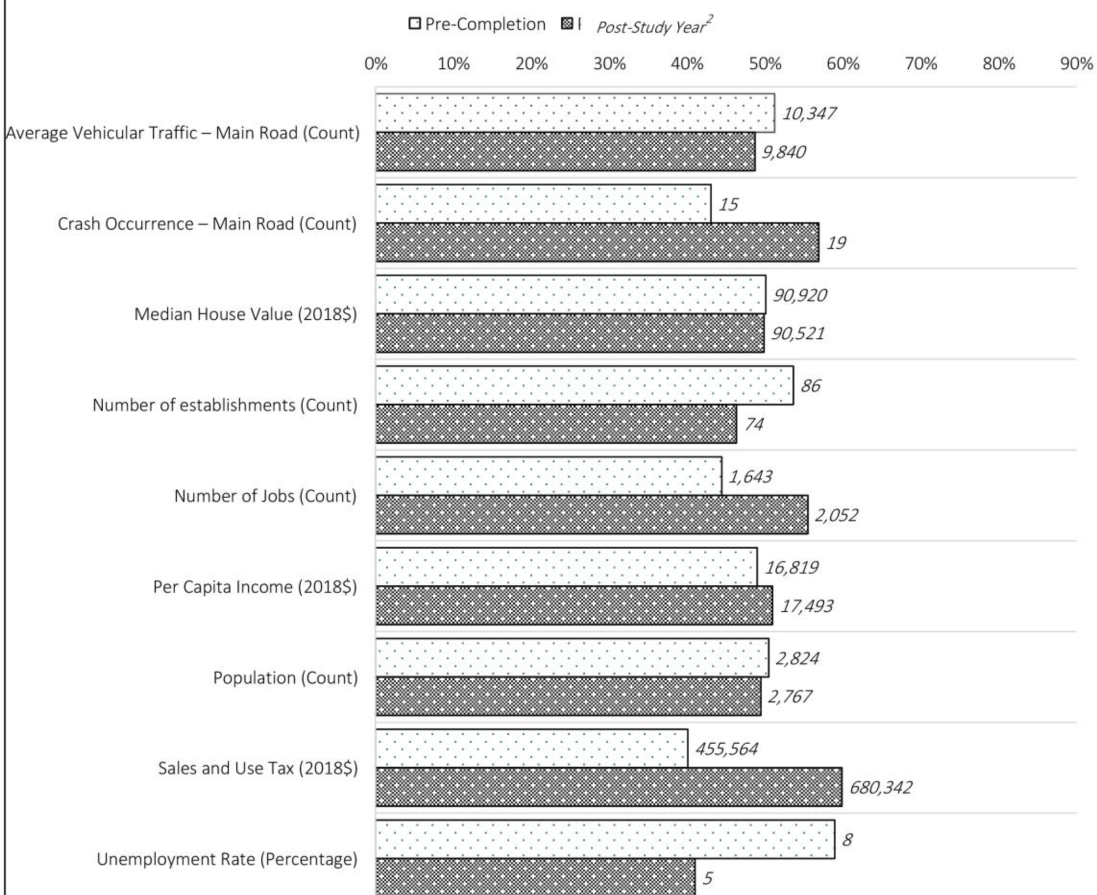
Estimated Total Cost: $7 million

Proposed Length: 3 miles Highway 62

Location: North of Arkansas at Carroll County, Rural Setting

Purpose: Improve east-west travel, reduce congestion, and enhance safety

Total Annual Average:



Footnote:

**Pre-Completion years include data from 1997-2011*

*** Post-Completion years include data from 2012 - 2016*

ARDOT ARKANSAS DEPARTMENT OF TRANSPORTATION

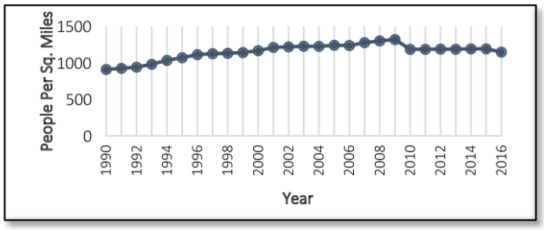
UNIVERSITY OF ARKANSAS

PROPOSED TREATMENT IN GREEN FOREST, ARKANSAS

Economic Impacts[5]

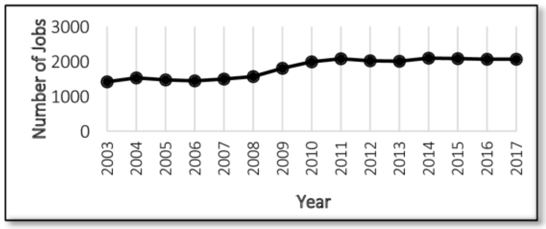
Population Density

This is a trend of the number of people residing per unit of area, quoted per square mile calculated for the city from the U.S. Census.



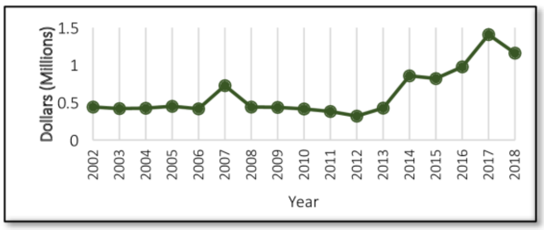
Number of Jobs

This is a trend of the full-time/part-time annual number of jobs calculated for the city from the Bureau of Labor Statistics.



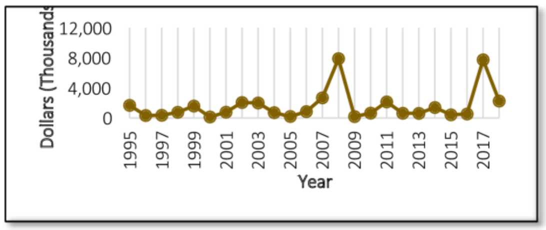
Sales Tax

This trend shows the change in sales tax calculated for the city from the Arkansas Department of Finance and Administration.

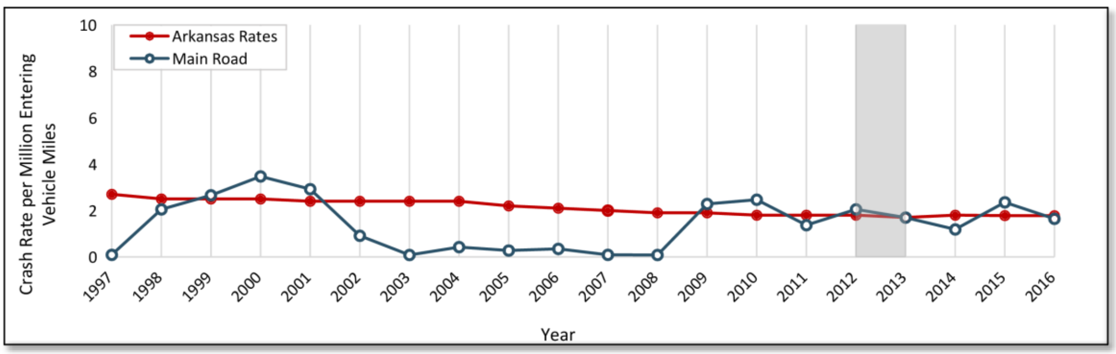


Property Transfer

This trend represents the total sale amount of all the transfer of commercial properties calculated for the city from the County Assessor's Office.



Safety Impacts[6]



Data Reference:

4. Proposed treatment job number 009702

5. Economic Results retrieved from: IMPLAN: Software for Economic Analysis." http://www.implan.com/software/#top, IMPLAN

6. Safety Results retrieved from: Arkansas State Police Crash Records Database (1997-2016).

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Figure H- 9 Public Outreach Document for Green Forest

APPENDIX I: CASE STUDIES

HIGHWAY 65 BYPASS IN GRADY, ARKANSAS

1. Synopsis

The Highway 65 bypass in Grady, Arkansas provides an alternative route to traffic that normally travels through the city. The bypass starts on US 65 near Choctaw Bayou, passes NE of Grady, and rejoins US 65 to the SE. The construction of a 3.9-mile bypass started in 2005 and was completed in 2009 with a cost of $22 million (in 2013$). The motivation behind the construction was to alleviate the traffic conditions on the existing route.

2. Background

a. Location and Transportation Connections

Grady in Lincoln County, AR is situated approximately 22 miles southeast of Pine Bluff AR, and 70 miles southeast of Little Rock, AR. The north terminus of US 65 highway is at Albert Lea, Minnesota, and the south terminus is at Clayton, Louisiana. The highway enters Arkansas from Missouri and travels through Harrison, Conway, Little Rock, Pine Bluff, Grady, Gould, and other small cities before entering Louisiana. Pine Bluff Regional Airport is 19.8 miles from Grady.

b. Community Character and Project Context

Grady is a small rural city with an area of 1.8 sq. miles located on the Mississippi River Alluvial Plain at the intersection of U.S. Highway 65 and State Highway 11 in Lincoln County, Arkansas. Grady is basically rural in nature with agriculture the main land use and source of employment. Prior to the construction of the bypass, the businesses located on existing U.S. Highway 65 were not highway oriented.

3. Project Description and Motives

The Highway 65 bypass in Grady is approximately 3.9 miles in length and diverts through traffic from the city. The bypass construction started in 2005 and was completed in 2009 with a cost of $22 million. There were two major key factors behind the construction of Highway 65 bypass in Grady. First, the Grady Elementary School created safety concerns for students crossing U.S. Highway 65. Second, the traffic condition on the existing route would deteriorate to Level of Service (LOS) D in the absence of improvement.

4. Project Impacts

a. Transportation Impacts

Before the construction of the bypass, the annual average crash rate in the thoroughfare was 3.7 crashes per million vehicle-miles travel (VMT). However, after the construction of the bypass, the crash rate decreased to 0.0 crashes per million vehicle-miles travel (VMT) on the main road. Variations in crash occurrences since the construction of the bypass road have been observed when comparing crash rates over time between the bypass route, the main thoroughfare, and the statewide average crash rates. Highway 64 in Grady has kept its crash rates well below the statewide average.

The implementation of the bypass succeeded in improvements to traffic safety in the thoroughfare. Furthermore, the average annual daily traffic (AADT) in thoroughfare has decreased after the construction of the bypass (pre-construction AADT: 640, post-construction AADT: 570).

b. Demographic, Economic and Land Use Impacts

The construction of the Highway 65 bypass sought to accommodate traffic congestion due to local, school, and agricultural traffic. Since the completion of the bypass, house pricing has reported a 17% increase in house prices and a 19% decrease in sales tax revenue. The number of employment and establishments increased by 68% and 61% respectively post-completion. Although the overall per capita gross domestic product (GDP) has increased post-construction, there is a decrease in per capita GDP from manufacturing, retail trade, and agricultural sector.

5. Non-Transportation Factors

The general trend of economic decline in rural towns in America is likely the largest factor affecting the economic trends in Grady. There is still some debate about the direct and indirect impacts of non-transportation factors on the change in trends concerning the impacts of the Highway 65 bypass in Grady.

6. Resources

a. Citations

1. Arkansas DOT: https://www.arkansashighways.com/
2. Arkansas Department of Finance and Administration: https://www.dfa.arkansas.gov/
3. Arkansas GIS Office: https://gis.arkansas.gov/
4. Bureau of Labor Statistics: https://www.bls.gov/
5. Bureau of Economic Analysis: https://www.bea.gov/
6. United States Census Bureau: https://data.census.gov/cedsci/
7. Arkansas Economic Development Institute: https://youraedi.com/
8. ActDataScout: https://www.actdatascout.com/

b. Interviews

Community Members

7. Attachments

Final Project Report

HIGHWAY 63 BYPASS IN HARDY, ARKANSAS

1. **Synopsis**

   The Highway 63 bypass in Hardy, Arkansas provides an alternative route to traffic that normally travels through the city. The bypass begins at U.S. 63 in northwest Hardy and heads east for approximately one mile before turning southeast and proceeds for approximately 0.5-mile intersecting U.S. 63 east of Hardy. The construction of a 1.5-mile bypass started in 2003 and was completed in 2005 with a cost of $24 million (in 2013$). The motivation behind the construction was to alleviate the traffic conditions on the existing route by removing a large portion of the total traffic and the majority of the heavy truck traffic from the business district.

2. **Background**

a. *Location and Transportation Connections*

   Hardy in Sharp County, AR is situated approximately 125 miles northwest of West Memphis AR, and 140 miles northeast of Little Rock, AR. The north terminus of US 63 highway is at Benoit, Wisconsin and the south terminus is in Ruston, Louisiana. U.S. 63 is a principal arterial that traverses northeast Arkansas from Interstate 55 through Jonesboro, Walnut Ridge/Hoxie, and Hardy to the Missouri border at Mammoth Spring. The highway serves as a major link between farming, mining, and business communities in northeast Arkansas and south and central Missouri. Sharp County Regional Airport is 8.40 miles from Hardy.

b. *Community Character and Project Context*

   Hardy in Sharp county is a small town located in the Ozark Mountains in north-central Arkansas with an area of 5.4 sq. miles. Hardy is low-density suburban with mainly upland forest and is a popular tourist destination because of the area's lakes and rivers. Small specialty and general trading stores make up most of the businesses along the highway, with the majority being craft and antique shops.

3. **Project Description and Motives**

   The Highway 63 bypass in Vilonia is approximately 1.5 miles in length and diverts through traffic from the city. The project's construction began in 2003 and was completed in 2005 with a cost of $23 million. There were two major key factors behind the construction of Highway 63 bypass in Hardy. First, the traffic condition on the existing route would deteriorate to Level of Service (LOS) F in the absence of improvement. Second, safety could be improved by removing the through traffic from Highway 63 lowering the likelihood and severity of crashes.

4. **Project Impacts**

a. *Transportation Impacts*

   Before the construction of the bypass, the annual average crash rate in the thoroughfare was 5.6 crashes per million vehicle-miles travel (VMT). However, after the construction of the bypass, the crash rate decreased to 2.24 crashes per million vehicle-miles travel (VMT) on the main road. Variations in crash occurrences since the construction of the bypass road have been observed when comparing crash rates over time between the bypass route, the main thoroughfare, and the statewide average crash rates. Highway 63 in Hardy has kept its crash rates below the statewide average, except for 2007, 2008, 2013, and 2016 where higher crash rates were observed for the thoroughfare in comparison to the statewide average crash rate. The higher volume (ADT) and speed along the bypass affect crash occurrence.

The implementation of the bypass succeeded in improvements to traffic safety in the thoroughfare. Furthermore, the average annual daily traffic (AADT) in thoroughfare has decreased (pre-construction AADT: 7600, post-construction AADT: 4400). Overall, the data shows that the bypass succeeded in diverting traffic from the city enhancing safety to the population of Hardy.

b. Demographic, Economic and Land Use Impacts

The construction of the Highway 63 bypass sought to accommodate traffic and ease congestion in the main thoroughfare by removing a large portion of the total traffic and the majority of the heavy truck traffic from the central business district. Since the completion of the bypass, Hardy has reported a 19% increase in house pricing and a 9% increase in sales tax revenue. The number of employment and establishments increased by 15% post-completion. Although overall per capita gross domestic product has increased post-construction, there is a decrease in per capita GDP from the manufacturing, construction, and agricultural sector.

5. Non-Transportation Factors

The general trend of economic decline in rural towns in America is likely the largest factor affecting the economic trends in Hardy. There is still some debate about the direct and indirect impacts of non-transportation factors on the change in trends concerning the impacts of the Highway 63 bypass in Hardy.

6. Resources

a. Citations

1. Arkansas DOT: https://www.arkansashighways.com/
2. Arkansas Department of Finance and Administration: https://www.dfa.arkansas.gov/
3. Arkansas GIS Office: https://gis.arkansas.gov/
4. Bureau of Labor Statistics: https://www.bls.gov/
5. Bureau of Economic Analysis: https://www.bea.gov/
6. United States Census Bureau: https://data.census.gov/cedsci/
7. Arkansas Economic Development Institute: https://youraedi.com/
8. ActDataScout: https://www.actdatascout.com/

b. Interviews

Community Members

7. Attachments

Final Project Report

HIGHWAY 167 BYPASS IN SHERIDAN, ARKANSAS

1. Synopsis

The Highway 167 bypass in Sheridan, Arkansas provides an alternative route to traffic that normally travels through the city. The bypass begins 1.3 miles south of the Sheridan city limit, bypasses Sheridan to the west for 8.13 miles and returns to existing Highway 167 approximately 0.5-mile north of the city limits. The construction of an 8.6-mile bypass started in 2008 and was completed in 2014 with a cost of $46 million (in 2013$). The motivation behind the construction was to eliminate the impediment to the flow of through traffic caused by signalized intersection by diverting the traffic around the city.

2. Background

a. Location and Transportation Connections

Sheridan in Grant County, AR is situated approximately 30 miles south of Little Rock on Highway 167. Highway 167 runs for 500 miles from Ash Flat, Arkansas at U.S. Route 62/US Route 412 to Abbeville, Louisiana at Louisiana Highway 14. It travels through the cities of Little Rock, Sheridan, El Dorado in Arkansas and enters Louisiana through Junction City. The highway is the main corridor to the hunting grounds of south-central Arkansas. A significant amount of recreational traffic is generated every fall during deer season when thousands of sportsmen travel to south-central Arkansas to hunt deer. Sheridan Municipal Airport is 3.7 miles from Sheridan.

b. Community Character and Project Context

Sheridan is a small town located within the West Gulf Coastal Plain Physiographic Region in the Grant county in south-central Arkansas with an area of 12.03 sq. miles. The landform is rolling hills to relatively flat, undulating land. The density is high around the area where Highway 35 intersects with Highway 270. There are several forests within and around the city boundary.

3. Project Description and Motives

Highway 167 bypass is approximately 8.6 miles in length and diverts through traffic from the city. The bypass construction started in 2008 and was completed in 2014 with a cost of $46 million. There were two major key factors behind the construction of the Highway 167 bypass in Sheridan. The major motivation behind the construction was to alleviate the traffic congestion at the signalized intersections and in the vicinity of the public schools that are located close to Highway 167. Furthermore, in absence of improvement, the level of service would deteriorate below traffic operation conditions.

4. Project Impacts

a. Transportation Impacts

Before the construction of the bypass, the annual average crash rate in the thoroughfare was 1.98 crashes per million vehicle-miles travel (VMT). However, after the construction of the bypass, the crash rate increased to 2.38 crashes per million vehicle-miles travel (VMT) on the main road. Variations in crash occurrences since the construction of the bypass road have been observed when comparing crash rates over time between the bypass route, the main thoroughfare, and the statewide average crash rates. Highway 167 in Sheridan has kept its crash rates well below the statewide average, except for 2015 and 2016 where higher crash rates were observed for thoroughfares in comparison to the statewide average crash rate. Higher volume (ADT), especially of heavy vehicles (e.g., trucks), and speed along the bypass affect crash occurrences. This statement agrees with the perceived changes from the surveys. Many residents expressed that after the construction of the bypass, the truck traffic that used to be extensive on the highway coming through the city has been drastically reduced, improving safety within the town of Sheridan. Nonetheless, residents have witnessed occasional crashes on the bypass that include large vehicles such as buses and trucks that sometimes carry hazardous materials. Pointed out by the residents was the need for an overpass. The lack of proper warning signs to anticipate the approach of two newly installed signal lights, for instance, is a cause for some of the most common accidents to occur in this area based on community perceived observation on crash occurrences. Furthermore, the average annual daily traffic (AADT) in thoroughfare has decreased (pre-construction AADT: 13000, post-construction AADT: 9000). When asked if the project was a success regarding the major key factors motivating the construction of the bypass, 80% considered the project to be successful. A common reason for this being the relief of impediment to the flow of through traffic in Sheridan; thus, ensuring safety, and alleviating the passage through the area for other pass-thru traffic over the bypass route. Because Highway 167 is the main corridor for hunting groups in south-central Arkansas, a significant amount of recreational traffic is generated every fall during the deer season. Consequently, the bypass succeeded in improving the delay factor due to a large amount of traffic generated.

b. *Demographic, Economic and Land Use Impacts*

The construction of the Highway 167 bypass sought to improve traffic flow and provide easier and more efficient transportation of timber products. The bypass provided access to undeveloped land for future development. Since the completion of the bypass, house pricing has decreased by 17% and sales tax revenue has increased by 15%. Even though there has not been much development around the bypass area, residents have begun to observe more people move into the community, which created the sense that more businesses are opening around the bypass in the future, making the town seem more developed. The number of employment and establishments increased by 6% and 8% respectively post-completion. Although the overall per capita gross domestic product has increased post-construction, there is a decrease in per capita GDP from the construction sector.

Interviews with local community members revealed that a few of the existing businesses before the bypass completion changed location to a different part of town once completed. On the main thoroughfare in recent years, many residents have observed an increase in small-and-medium businesses moving into town near the bypass. Some of these businesses include a clinic, a pharmacy, and a new gas station.

5. Non-Transportation Factors

To date, the lack of sewer lines along the bypass has constrained land development and economic growth. Residents of Sheridan believe that the lack of a proper sewer system has made infrastructure development nearly impossible along the bypass since its construction. Until this infrastructure is in place, the bypass is not likely to have measurable economic development impacts.

6. Resources

a. Citations

1. Arkansas DOT: https://www.arkansashighways.com/
2. Arkansas Department of Finance and Administration: https://www.dfa.arkansas.gov/
3. Arkansas GIS Office: https://gis.arkansas.gov/
4. Bureau of Labor Statistics: https://www.bls.gov/
5. Bureau of Economic Analysis: https://www.bea.gov/
6. United States Census Bureau: https://data.census.gov/cedsci/
7. Arkansas Economic Development Institute: https://youraedi.com/
8. ActDataScout: https://www.actdatascout.com/

b. Interviews

Community Members

7. Attachments

Final Project Report

HIGHWAY 64 BYPASS IN VILONIA, ARKANSAS

1. **Synopsis**

   The Highway 64 bypass in Vilonia, Arkansas provides an alternative route to traffic that normally travels through the city. The bypass begins at Highway 64 in the curve between the Highway 36 intersection and Vilonia Elementary School. It heads east to the intersection of U.S. 107 and steers northeast to merge into Highway 64 to the west of Cypress Valley Road. The construction of a 10.1-mile bypass started in 2007 and was completed in 2012 with a cost of $53 million (in 2013$). The motivation behind the construction was to alleviate the increasing congestion on Highway 64 and to address potential safety issues on the thoroughfare.

2. **Background**

a. *Location and Transportation Connections*

   Vilonia is situated at the intersection of Highway 64 and Highway 107 in southeastern Faulkner County in Arkansas. Highway 64 is an east-west principal arterial connecting Interstate 40 in Conway with Highway 67/167 in Beebe. It travels through the cities of Little Rock, Sheridan, El Dorado in Arkansas, and enters Louisiana through Junction City. Highway 64 is very important to the Little Rock-North Little Rock metropolitan area and the State as an east-west principal arterial connecting I-40 and Highway 67/167. The highway serves as a major route across the north side of the metropolitan area and is an important truck route. North Little Rock Municipal Airport is 20.6 miles from Vilonia.

b. *Community Character and Project Context*

   Vilonia is a small town located in north-central Arkansas with an area of 7.9 sq. miles located in Faulkner County, Arkansas. The intersection of Highway 64 and Highway 107 near the high school is the primary focus for development on the main thoroughfare. Land use along the thoroughfare is highway commercial in the Central Business District (CBD) with both low and high-density rural/residential areas east and west of CBD. Land use along the bypass includes both high and low-density rural residential and agricultural pastures and scattered woodlands. Pastures are utilized for grazing and hay production.

3. **Project Description and Motives**

   The Highway 64 bypass in Vilonia is approximately 10.1 miles in length and diverts through traffic from the city. The project's construction began in 2007 and was completed in 2012 with a cost of $53 million. There were two major key factors behind the construction of the Highway 64 bypass in Vilonia. First, to address the congestion and potential safety issues surrounding Vilonia's educational institutions at the developing activity center at the Highway 107 intersections. Second, to alleviate traffic congestion on the main thoroughfare due to the presence of a significant number of large pass-through trucks which raised concerns for safety and traffic operations, affecting the Level of Service (LOS E) in the absence of improvement for the population of Vilonia.

4. Project Impacts

a. *Transportation Impacts*

Before the construction of the bypass, the annual average crash rate in the thoroughfare was 0.63 crashes per million vehicle-miles travel (VMT). However, after the construction of the bypass, the crash rate increased to 0.81 crashes per million vehicle-miles travel (VMT) on the main road. Variations in crash occurrences since the construction of the bypass road have been observed when comparing crash rates over time between the bypass route, the main thoroughfare, and the statewide average crash rates. Highway 64 in Vilonia has kept its crash rates well below the statewide average, except for 2016 where higher crash rates were observed for the bypass and the thoroughfare in comparison to the statewide average crash rate. The higher volume (ADT) and speed along the bypass affect crash occurrence. This statement agrees with the perceived changes from the surveys. Many residents expressed that people tend to travel at faster speeds on the bypass, which is the main contributor for crashes to occur. The lack of proper warning signs to anticipate the approach to a signal light, for instance, is a cause for some of the most common accidents to occur in this area based on community perceived observation on crash occurrences. Nonetheless, the implementation of the bypass succeeded in improvements to traffic safety in the thoroughfare. Furthermore, the average annual daily traffic (AADT) in thoroughfare has decreased (pre-construction AADT: 13700, post-construction AADT: 6300). When asked if the project was a success regarding the major key factors motivating the construction of the bypass, 83% considered the project to be successful. A common reason for this being the relief of congestion traffic on the main street in Vilonia; thus, ensuring safety, and the timely passage through the area for other pass-thru traffic over the bypass route. Overall, the bypass succeeded in diverting the through traffic from the city enhancing safety to the population of Vilonia.

b. *Demographic, Economic and Land Use Impacts*

The construction of the Highway 64 bypass sought to improve traffic flow and provide easier and more efficient transportation of agricultural and manufactured products. The bypass provided access to undeveloped land for future development. Since the completion of the bypass, house pricing and sales tax revenue has reported a 6.3% and 51% increase, respectively. The number of employment and establishments increased by 23% and 28% respectively post-completion. Although the overall per capita gross domestic product (GDP) has increased post-completion, there is a decrease in per capita GDP from the construction sector.

There is still some debate about the direct and indirect impacts of the bypass as the principal contributor to the change in trends concerning the change in demographic, economic, and land use that Vilonia has experienced over the last several years. Interviews with local community members revealed that existing businesses before the bypass completion did not change location or productivity once it was completed. On the other hand, in recent years, many residents have observed an increase in small-and-medium businesses moving into town. These include a gas station, gift shop, and a concrete batching plant.

5. Non-Transportation Factors

To date, the lack of water and sewer facilities along the bypass has constrained land development and economic growth. Residents of Vilonia believe that the lack of proper water and sewer system has made economic development nearly impossible along the bypass since its construction. Another non-transportation factor pointed out by the interviewed residents is the occurrence of tornadoes while the bypass was constructed and after completion. A few local businesses were also closed after the completion of the bypass. However, as one resident described it, two tornadoes happened to pass-thru the city of Vilonia during the construction of the bypass that compromised the economic development of the city in terms of attracting new businesses right after the completion of the bypass. Natural disasters tend to be a contributing factor to both, the decrease in traffic in Vilonia and the increase in the number of crashes reported, as it was pointed out by the interviewed residents.

6. Resources

a. Citations

1. Arkansas DOT: https://www.arkansashighways.com/
2. Arkansas Department of Finance and Administration: https://www.dfa.arkansas.gov/
3. Arkansas GIS Office: https://gis.arkansas.gov/
4. Bureau of Labor Statistics: https://www.bls.gov/
5. Bureau of Economic Analysis: https://www.bea.gov/
6. United States Census Bureau: https://data.census.gov/cedsci/
7. Arkansas Economic Development Institute: https://youraedi.com/
8. ActDataScout: https://www.actdatascout.com/

b. Interviews

Community Members

7. Attachments

Final Project Report

HIGHWAY 62 BYPASS IN FLIPPIN, ARKANSAS

1. **Synopsis**

   The Highway 62 bypass in Flippin, Arkansas provides an alternative route to traffic that normally travels through the city. The bypass begins at Highway 62/412 southwest of Flippin and proceeds east for approximately 3 miles before intersecting Highway 62/412 east of Flippin near State Highway 101. The construction of a 3.2-mile bypass started in 2004 and was completed in 2008 with a cost of $17 million (in 2013$). The motivation behind the construction was to separate through traffic from local traffic and to address potential safety issues.

2. **Background**

a. *Location and Transportation Connections*

   Flippin is situated in the northern part of Arkansas in Marion County. Highway 412 provides a continuous east-west route from Siloam Springs on the western border of the state through Paragould to the Missouri state line to the east. Highway 62 connects Rogers to the west through Piggott to the Missouri state line to the east. Marion County Regional Airport is 1.3 miles from Flippin.

b. *Community Character and Project Context*

   Flippin is a small town in Marion County located in northern Arkansas with an area of 1.9 sq. miles. City government facilities, as well as most retail and service businesses, are located adjacent to the thoroughfare. Most of the residential development is south of thoroughfare and west of 8th Street. Land use along the bypass consists of low-density rural residences, agricultural pastures, and scattered wood lots.

3. **Project Description and Motives**

   The Highway 62 bypass in Flippin is approximately 3.2 miles in length and diverts through traffic from the city. The project's construction began in 2004 and was completed in 2008 with a cost of $17 million. There were two major key factors behind the construction of Vilonia bypass. First, the intersection of Highways 62/412 and 178 was operating at LOS F, and needed improvements to alleviate traffic flow. Second, there would be potential safety issues in the thoroughfare in the absence of improvement.

4. **Project Impacts**

a. *Transportation Impacts*

   Before the construction of the bypass, the annual average crash rate in the thoroughfare was 2.79 crashes per million vehicle-miles travel (VMT). However, after the construction of the bypass, the crash rate decreased to 0.86 crashes per million vehicle-miles travel (VMT) on the main road. Variations in crash occurrences since the construction of the bypass road have been observed when comparing crash rates over time between the bypass route, the main thoroughfare, and the statewide average crash rates. Highway 62 in Flippin has kept its crash rates well below the statewide average, except for 2015 and 2016 where higher crash rates were observed for the thoroughfare in comparison to the statewide average crash rate. The higher volume (ADT) and speed along the bypass affect crash occurrence.

This statement agrees with the perceived changes from the surveys. As pointed out by one of the residents, there is an observed increase in crash accidents because of the design of the road that goes into the main thoroughfare. People tend to travel at faster speeds on the bypass, which is the main contributor for crashes to occur. The lack of visibility to anticipate the approach to the road split to drive off to the main road, for instance, is a cause for some of the most common accidents to occur in this area.

Nonetheless, the implementation of the bypass succeeded in improvements to traffic safety in the thoroughfare. Furthermore, the average annual daily traffic (AADT) in thoroughfare has decreased (pre-construction AADT: 11,000, post-construction AADT: 6100). When asked if the project was a success regarding the major key factors motivating the construction of the bypass, every resident interviewed agreed that the construction of the bypass has improved safety and diverged the truck traffic out of the main thoroughfare. Overall, the bypass succeeded in diverting the through traffic from the city enhancing safety to the population of Flippin.

b. *Demographic, Economic and Land Use Impacts*

The construction of the Highway 64 bypass sought to improve traffic flow and provide easier and more efficient road geometric design to enhance safety. The bypass provided access to undeveloped land for future development. Since the completion of the bypass, sales tax revenue has reported an increase of 26%. The number of employment and establishments increased by 40% and 15% respectively post-completion. Although overall per capita gross domestic product has increased post-construction, there is a decrease in per capita GDP from the agriculture and construction sector.

There is still some debate about the direct and indirect impacts of the bypass as the principal contributor to the change in trends concerning the change in demographic, economic, and land use that Flippin has experienced over the last several years. Big companies are found in this rural area; companies such as Dollar General and Walmart Supercenter. Interviews with local community members revealed that existing businesses changed location and productivity once it was completed. Residents have observed many businesses moving into town and leaving every other month. This phenomenon was attributed to the lessen in traffic in the main thoroughfare.

5. Non-Transportation Factors

The general trend of economic decline in rural towns in America is likely the largest factor affecting the economic trends in Flippin. There is still some debate about the direct and indirect impacts of non-transportation factors on the change in trends concerning the impacts of the Highway 64 bypass in Flippin.

6. Resources

a. *Citations*

1. Arkansas DOT: https://www.arkansashighways.com/
2. Arkansas Department of Finance and Administration: https://www.dfa.arkansas.gov/
3. Arkansas GIS Office: https://gis.arkansas.gov/
4. Bureau of Labor Statistics: https://www.bls.gov/
5. Bureau of Economic Analysis: https://www.bea.gov/

6. United States Census Bureau: https://data.census.gov/cedsci/
7. Arkansas Economic Development Institute: https://youraedi.com/
8. ActDataScout: https://www.actdatascout.com/

b. Interviews

Community Members

7. Attachments

Final Project Report

HIGHWAY 65 WIDENING IN GOULD, ARKANSAS

1. **Synopsis**

   The Highway 65 widening in Gould, Arkansas provides four travel lanes from the southern city limits of Grady in Lincoln County to Highway 159 in Desha County. The widening of an 8.6-mile section started in 2006 and was completed in 2011 with a cost of $35 million (in 2013$). The motivation behind the construction was to alleviate traffic flow along the project area.

2. **Background**

a. *Location and Transportation Connections*

   Gould in Lincoln County, AR is situated approximately 34 miles southeast of Pine Bluff AR, and 79 miles southeast of Little Rock, AR. The north terminus of US 65 highway is at Albert Lea, Minnesota, and the south terminus is at Clayton, Louisiana. The highway enters Arkansas from Missouri and passes through Harrison, Conway, Little Rock, Pine Bluff, Grady, Gould, and other small cities before entering Louisiana. Pine Bluff Regional Airport is 30.1 miles from Gould.

b. *Community Character and Project Context*

   Gould is a small, rural city with an area of 1.5 sq. miles located at the intersection of U.S. Highway 65 and State Highway 212 and 114 in Lincoln County, Arkansas. Gould is rural in nature with agriculture the main land use and source of employment.

3. **Project Description and Motives**

   The Highway 65 widening in Gould is approximately 8.6 miles in length. The project's construction began in 2006 and was completed in 2011 with a cost of $35 million. There were two motivations behind the widening of Highway 65 in Gould. The first and major motivation was to improve traffic flow and enhance safety on Highway 65 in south Arkansas. Second, the improvement would benefit the project area in terms of interstate and farm to market access, expansions of commercial and industrial enterprises, increased access for tourism and cultural enhancement, and improved health care delivery.

4. **Project Impacts**

a. *Transportation Impacts*

   Before the construction of the bypass, the annual average crash rate in the thoroughfare was 1.06 crashes per million vehicle-miles travel (VMT). However, after the construction of the bypass, the crash rate decreased to 0.69 crashes per million vehicle-miles travel (VMT) on the main road. Variations in crash occurrences since the construction of the bypass road have been observed when comparing crash rates over time between the bypass route, the main thoroughfare, and the statewide average crash rates. Highway 65 in Gould has kept its crash rates well below the statewide average. This statement agrees with the perceived changes from the surveys. Residents interviewed expressed serenity that there has been a reduction in the number of accidents observed around the new wider route in recent years. Nonetheless, the implementation of the widened road succeeded in improvements to traffic safety in the thoroughfare. Furthermore, the average annual daily traffic (AADT) in thoroughfare has decreased (pre-construction AADT: 6500, post-construction AADT: 6400). When asked if the project was a success regarding the major key factors motivating the construction of the bypass, the residents considered the project to be successful. A common reason for this being the widening of the main thoroughfare relief of congestion traffic on the main street in Gould; thus, ensuring safety, and the timely passage through the area for other pass-thru traffic over the widened route, especially for the pedestrian who have accessibility to a sidewalk.

b. *Demographic, Economic and Land Use Impacts*

The widening of Highway 65 sought to improve traffic flow and enhance safety, mainly for market access for farms, cultural enhancement, and improved healthcare delivery. Since the completion of the bypass, house pricing and sales tax revenue has reported an 11% and 57% increase, respectively. The number of employment and establishments decreased by 37% and 16% respectively post-completion. Although overall per capita gross domestic product has increased post-construction, there is a decrease in per capita GDP from the manufacturing and retail trade sectors.

There is still some debate about the direct and indirect impacts of the widening road as the principal contributor to the change in trends concerning the change in demographic, economic, and land use that Gould has experienced over the last several years. Interviews with local community members revealed that existing businesses before the widening completion did not change location or productivity once the widening was completed. On the other hand, in recent years, residents have observed an increase in small-and-medium businesses moving into town. These include a restaurant, a clinic, and a Dollar General to the north of the town.

5. Non-Transportation Factors

There is still some debate about the direct and indirect impacts of non-transportation factors on the change in trends concerning the impacts of the Highway 65 widening in Gould.

6. Resources

a. *Citations*

1. Arkansas DOT: https://www.arkansashighways.com/
2. Arkansas Department of Finance and Administration: https://www.dfa.arkansas.gov/
3. Arkansas GIS Office: https://gis.arkansas.gov/
4. Bureau of Labor Statistics: https://www.bls.gov/
5. Bureau of Economic Analysis: https://www.bea.gov/
6. United States Census Bureau: https://data.census.gov/cedsci/
7. Arkansas Economic Development Institute: https://youraedi.com/
8. ActDataScout: https://www.actdatascout.com/

b. *Interviews*

Community Members

7. Attachments

Final Project Report

HIGHWAY 412 WIDENING IN SILOAM SPRINGS, ARKANSAS

1. Synopsis

Highway 412 widening in Siloam Springs, Arkansas provides six travel lanes from West Siloam Springs at the Arkansas-Oklahoma border to the intersection of Highway 412 and S Washington Street. The widening of 1.6 miles of Highway 412 started in 2010 and was completed in 2012 with a cost of $14 million (in 2013$). The motivation behind the construction was to alleviate traffic flow along the project area and to address potential safety issues.

2. Background

a. Location and Transportation Connections

Siloam Springs, in Benton County, AR is situated approximately 27 miles northwest of Fayetteville, AR, and 86 miles east of Tulsa, OK. The eastern terminus of Highway 412 is in Columbia, Tennessee and the western terminus is in Springer, New Mexico. The Arkansas section of the highway starts at the Oklahoma line, runs through Ozark mountains in the northern part of Arkansas, and exits the state at the Missouri Bootheel. The City of Siloam Springs Airport is 2.8 miles from the center of Siloam Springs.

b. Community Character and Project Context

Siloam Springs is a small city with an area of 11.55 sq. miles located in Benton County in Northwest Arkansas. Land use in the northern part of the city primarily consists of residential subdivisions, scattered single-family residences, agriculture, and open areas. Scattered single-family residences and small cattle grazing farms, with associated residences and outbuildings, predominate to the east. Land use in the southern part of the city is characterized primarily by scattered single-family residences and expansive undeveloped areas. Numerous poultry barns are scattered throughout the north-eastern portion of the city. Commercial establishments, especially auto-sales oriented businesses, predominate along the existing Highway 412 in Arkansas.

3. Project Description and Motives

Highway 412 widening in Siloam Springs is approximately 1.6 miles in length. The project's construction began in 2010 and was completed in 2012 with a cost of $14 million. There were two major key motivations behind the widening of the US 412 highway. First, the traffic operations and service would deteriorate with the increasing traffic volume. Second, some segments of Highway 412 had crash rates significantly higher than statewide averages. The crash rate would increase due to increasing traffic volumes and truck traffic in the absence of improvements.

4. Project Impacts

a. Transportation Impacts

Before the widening of the highway, the annual average crash rate in the highway section was 5.62 crashes per million vehicle-miles travel (VMT). However, after the widening, the crash rate decreased to 4.87 crashes per million vehicle-miles travel (VMT). Highway 412 in

Siloam Springs has crash rates above the statewide average. The higher volume (ADT) and speed along the bypass affect crash occurrence.
Nonetheless, the implementation of the widening succeeded in improvements to traffic safety in the thoroughfare. Furthermore, the average annual daily traffic (AADT) in highway section has decreased (pre-construction AADT: 28,000, post-construction AADT: 27,000).

b. *Demographic, Economic and Land Use Impacts*
The construction of the Highway 64 bypass sought to improve traffic flow and provide easier and more efficient transportation of agricultural and manufactured products. The bypass provided access to undeveloped land for future development. Since the completion of the widening, house pricing decreased by 10% and sales tax revenue has increased by 41% increase, respectively. The number of employment and establishments increased by 11% and 20% respectively post-completion. Although overall per capita gross domestic product has increased post-construction, there is a decrease in per capita GDP from construction, real estate, and transportation and utilities sectors.

5. Non-Transportation Factors

There is still some debate about the direct and indirect impacts of non-transportation factors on the change in trends concerning the impacts of the Highway 64 widening in Siloam Springs.

6. Resources

a. *Citations*

1. Arkansas DOT: https://www.arkansashighways.com/
2. Arkansas Department of Finance and Administration: https://www.dfa.arkansas.gov/
3. Arkansas GIS Office: https://gis.arkansas.gov/
4. Bureau of Labor Statistics: https://www.bls.gov/
5. Bureau of Economic Analysis: https://www.bea.gov/
6. United States Census Bureau: https://data.census.gov/cedsci/
7. Arkansas Economic Development Institute: https://youraedi.com/
8. ActDataScout: https://www.actdatascout.com/

b. *Interviews*
Community Members

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Final Project Report