If you have questions or need additional information concerning our approval and the FPF, please contact Ms. Michelle Allen of the FHWA Indiana Division at (317) 226-7344, or by email at michelle.allen@dot.gov, or Mr. Jason Ciavarella of the FTA Region 5 Office at (312) 353-1653, or by email at jason.ciavarella@dot.gov.

Sincerely,

KELLEY BROOKINS Digitally signed by KELLEY BROOKINS Date: 2022.06.13 10:08:34 -05'00'

Kelley Brookins
Regional Administrator
FTA Region V

Sincerely,

JERMAINE R HANNON Digitally signed by JERMAINE R HANNON Date: 2022.06.13 15:57:46 -04'00'

Jermaine R. Hannon
Division Administrator
FHWA Indiana Division

cc: (transmitted by e-mail)
Louis Feagans, INDOT
Roy Nunnally, INDOT
Karen Hicks, INDOT

Attachments have been removed for the purposes of this NEPA document.

Note: The IRTIP has been updated in a November 17, 2022 Indianapolis MPO Administrative Modification. Additional funding updates were made after the approval of the approval of Administrative Modification. The IRTIP and STIP documents will be updated prior to RFC.

INDOT	1702943	Greenfield		SR 9	Intersect. Improv. W/ Added Turn Lanes SR 9 at CR 300 N Dist:N/A	Intersection Improvement	Y	CON	FY 2021	STPSM	$25,000	$20,000	80%	$0	0%	$5,000	20%	$9,414,957	$9,414,957
								CON	FY 2022	STPSM	$1,116,010	$892,808	80%	$0	0%	$223,202	20%	$9,414,957	$9,414,957
								PE/PL	FY 2020	STPSM	$81,878	$65,502	80%	$0	0%	$16,376	20%	$9,414,957	$9,414,957
								ROW	FY 2021	STPSM	$40,000	$32,000	80%	$0	0%	$8,000	20%	$9,414,957	$9,414,957
INDOT	1802062	Greenfield			Install Lighting Intersection Lighting I-70 at SR 227, I-74 at London Rd, US 31 at SR 38, and I-65 at Raymond St Dist:N/A	Install Lighting	Y	CON	FY 2022	HSIP-ST	$395,576	$356,018	90%	$0	0%	$39,558	10%	$500,666	$500,666
								PE/PL	FY 2020	HSIP-ST	$105,090	$94,581	90%	$0	0%	$10,509	10%	$500,666	$500,666
INDOT	1802071	Greenfield			Signal Project (New/Modernized) Traffic Signals Dist:N/A	Traffic Signals Modernization	Y	CON	FY 2022	HSIP-ST	$1,545,000	$1,236,000	80%	$0	0%	$309,000	20%	$1,555,000	$1,555,000
								ROW	FY 2022	HSIP-ST	$10,000	$8,000	80%	$0	0%	$2,000	20%	$1,555,000	$1,555,000
INDOT	1900213	Greenfield		I- 65	District Small Structure Project I-65 over , 1.288 N MARION/JOHNSON Dist:N/A	Small Structure Pipe Lining	Y	CON	FY 2024	NHPP	$243,000	$194,000	80%	$0	0%	$49,000	20%	$489,000	$489,000
								ROW	FY 2022	NHPP	$20,000	$18,000	90%	$0	0%	$2,000	10%	$489,000	$489,000
								ROW	FY 2023	NHPP	$20,000	$16,000	80%	$0	0%	$4,000	20%	$489,000	$489,000
INDOT	1900221	Greenfield		I- 74	District Small Structure Project I-74 over 2.398 MI E of I 465 Dist:N/A	Small Structure Pipe Lining	Y	CON	FY 2024	STPSM	$211,000	$168,800	80%	$0	0%	$42,200	20%	$489,000	$489,000
								ROW	FY 2023	STPSM	$15,000	$12,000	80%	$0	0%	$3,000	20%	$489,000	$489,000
INDOT	1900223	Greenfield		I- 865	District Small Structure Project I-865 over 1.810 MI E of I65 Dist:N/A	Small Structure Pipe Lining	Y	CON	FY 2024	STPSM	$178,000	$142,400	80%	$0	0%	$35,600	20%	$198,000	$198,000
								ROW	FY 2022	STPSM	$20,000	$16,000	80%	$0	0%	$4,000	20%	$198,000	$198,000
INDOT	1900247	Greenfield		Girls School Rd.	District Pavement Project (Non-I) SR 134 0.38 mi S of US 136 to US 136 Dist:.38	HMA Overlay Minor Structural	Y	CON	FY 2024	STPSM	$294,898	$235,918	80%	$0	0%	$58,980	20%	$294,898	$294,898
INDOT	1900226	Greenfield		I- 65	District Bridge Project (Rehabilitation) I-65 NB over Big Eagle Creek Dist:N/A	Scour Protection (Erosion)	Y	CON	FY 2024	NHPP	$603,056	$542,750	90%	$0	0%	$60,306	10%	$670,062	$670,062
INDOT	1900227	Greenfield		I- 65	District Bridge Project (Rehabilitation) Dist:N/A	Scour Protection (Erosion)	Y	CON	FY 2024	NHPP	$335,031	$268,025	80%	$0	0%	$67,006	20%	$670,062	$670,062
INDOT	1901481	Greenfield		I- 465	1901481 Concrete Pavement Restoration 1.15 mi S of I-70 W junct to 0.77 mi N of I-74 W junct, 1700817 I 465 NB & ramp over US 40 EB/WB (W Jct), 1700818 I 465 SB over US 40 EB/WB (W. Jct.), 1700819 I 465 NB over CSX RR, 00.25 S US 36, 1700820 I 465 SB over CSX RR, 00.25 S US 36, 1700821 I 465 NB over CSX RR, 00.31 S US 40, 1700822 I 465 SB OVER CSX RR, 00.31 S US 40, 1700823 I 465 NB over Minnesota Street, 00.38 S US 40, 1700824 I 465 SB over Minnesota Street, 00.38 S US 40, 1700839 I 465 W 10TH STREET OVER I-465 NB/SB, RAMP, 01.05 N US 36, 1700844 I 465 US 36/ROCKVILLE RD OVER I-465 SB/NB, RAMP, 1700848 I 465 WEST HANNA AVENUE OVER I-465 NB/SB, 00.44 S I-70, 1700849 I 465 W 34TH STREET OVER I-465 NB/SB, 00.71 N I-74, 1700850 I 465 W 46TH STREET OVER I-465 NB/SB, 01.81 S I-65, 1700876 I 465 RAMP TO I-465 SB OVER BIKE PATH, 01.26 N I-65, 1901520 I 465 over I-465 & RAMPS, 0.12 W MERIDIAN ST, 2000481 I 70 over I-70, 01.18 E I-465. Dist:7.37	Concrete Pavement Restoration (CPR)	Y	CON	FY 2024	NHPP	$10,927,587	$9,138,229	84%	$0	0%	$1,789,358	16%	$11,693,916	$11,693,916
INDOT	1901524	Greenfield		I- 465	District Bridge Project (Rehabilitation) over I-465 EB/WB, 02.54 E SR 431 Dist:N/A	Bridge Thin Deck Overlay	Y	CON	FY 2022	NHPP	$716,000	$572,800	80%	$0	0%	$143,200	20%	$716,000	$716,000
INDOT	1900173	Greenfield		SR 32	This project is located on SR 32 east of downtown Noblesville in Hamilton County. It is considered a principal arterial west of SR 37 and a minor arterial east of SR 37. The project begins at the signalized intersection with 19th Street and extends east to the intersection of Presley Drive. This facility is a two lane undivided highway that expands and contracts in different directions through the project limits. Dist:.64	Added Travel Lanes	N	CON	FY 2024	STPSM	$2,819,427	$2,255,542	80%	$0	0%	$563,885	20%	$3,169,427	$3,169,427
								ROW	FY 2022	STPSM	$350,000	$280,000	80%	$0	0%	$70,000	20%	$3,169,427	$3,169,427
INDOT	1800082	Seymour		US 31	Added travel lanes as part of the US 31 intersection improvements. Includes 9 baby des numbers, 1800081, 1900380,1900379,1900363,1800261,1800259,1800258,1800241,and 1800083. Dist:1.25	Added Travel Lanes	N	CON	FY 2023	NHPP	$16,250,500	$13,000,400	80%	$0	0%	$3,250,100	20%	$46,004,096	$46,004,096
								CON	FY 2024	NHPP	$27,693,596	$22,154,877	80%	$0	0%	$5,538,719	20%	$46,004,096	$46,004,096
INDOT	1900670	Crawfordsville		SR 32	SR 32 @ 2.26 mi W of US 421 (over Mounts Run) Dist:N/A	Scour Protection (Erosion)	Y	CON	FY 2022	STPSM	$76,427	$61,142	80%	$0	0%	$15,285	20%	$101,427	$101,427
								PE/PL	FY 2021	STPSM	$20,000	$16,000	80%	$0	0%	$4,000	20%	$101,427	$101,427
								PE/PL	FY 2022	STPSM	$5,000	$4,000	80%	$0	0%	$1,000	20%	$101,427	$101,427

The scope and Des numbers associated with Des 1800082 has been updated in a November 17, 2022 Indianapolis MPO Administrative Modification.

INDOT	1800864	Multiple	VARIOUS		Camera/Communications/Detection/DMS Replacements in Indianapolis ATMS area - FY 22 Dist:N/A	Its Traffic Management Systems	Y	CON	FY 2022	IM	$600,000	$540,000	90%	$0	0%	$60,000	10%	$600,000	$600,000
INDOT	1600854	Greenfield	Boone Co., Hamilton Co., Marion Co.	I- 465	ATL on I-465 from 86th Street to US 31; Interchange Modification at I-865 and I-465 Dist:8.24	Added Travel Lanes	N	CE	FY 2023	NHS	$7,000,000	$6,300,000	90%	$0	0%	$700,000	10%	$248,700,000	$248,700,000
								CON	FY 2023	NHS	$225,000,000	$202,500,000	90%	$0	0%	$22,500,000	10%	$248,700,000	$248,700,000
								PE/PL	FY 2019	NHS	$11,700,000	$10,530,000	90%	$0	0%	$1,170,000	10%	$248,700,000	$248,700,000
								ROW	FY 2021	NHS	$5,000,000	$4,500,000	90%	$0	0%	$500,000	10%	$248,700,000	$248,700,000
INDOT	1800072	Greenfield	Marion Co.	SR 67	2.77 miles south of I-465 at Ameriplex Parkway Dist:N/A	Intersect. Improv. W/ Added Turn Lanes	Y	CON	FY 2023	STPSM	$4,392,786	$3,514,229	80%	$0	0%	$878,557	20%	$4,892,786	$4,892,786
INDOT	1800950	Greenfield	VARIOUS		Various locations with Railroad signal preemptions Dist:N/A	Railroad Work	Y	CON	FY 2022	STPRH	$315,721	$252,577	80%	$0	0%	$63,144	20%	$355,721	$355,721
								PE/PL	FY 2020	STPRH	$40,000	$36,000	90%	$0	0%	$4,000	10%	$355,721	$355,721
INDOT	1802053	Greenfield	Marion Co.	I- 65	I-65 at Raymond St Interchange des numbers 1802053, 1702090, 1702093 Dist:N/A	Bike/Pedestrian Facilities	Y	CON	FY 2022	HSIP-ST	$450,846	$405,761	90%	$0	0%	$45,085	10%	$450,846	$450,846
INDOT	1801041	Seymour	Morgan Co.	SR 67	Small structure replacement on SR 67, 5.08 miles N of SR 39 Dist:N/A	Small Structure Replacement	Y	CE	FY 2024	NHPP	$18,700	$14,960	80%	$0	0%	$3,740	20%	$980,072	$980,072
								CON	FY 2024	NHPP	$745,491	$596,393	80%	$0	0%	$149,098	20%	$980,072	$980,072
								ROW	FY 2021	NHPP	$20,000	$16,000	80%	$0	0%	$4,000	20%	$980,072	$980,072
INDOT	1702395	Multiple	VARIOUS		Statewide TMC Dispatcher Operations contract for FY 22 Dist:N/A	Its Program Contracted Services	Y	PE/PL	FY 2022	STPSM	$1,500,000	$1,350,000	90%	$0	0%	$150,000	10%	$1,500,000	$1,500,000
INDOT	1800649	Seymour	Johnson Co.	I- 65	CCTV/DMS from 1.0 mile south of SR 252 to 3.0 miles north of SR 44 Dist:N/A	Its Communications Systems	Y	CON	FY 2022	CMAQ-ST	$1,175,000	$940,000	80%	$0	0%	$235,000	20%	$1,265,000	$1,265,000
								PE/PL	FY 2021	CMAQ-ST	$90,000	$72,000	80%	$0	0%	$18,000	20%	$1,265,000	$1,265,000
INDOT	1801060	Multiple	VARIOUS		Statewide O&M fee for CARS (Condition Acquisition & Reporting System) for FY 23 Dist:N/A	Its Operations And Maintenance Contracts	Y	PE/PL	FY 2023	STP-ST	$500,000	$400,000	80%	$0	0%	$100,000	20%	$500,000	$500,000
INDOT	1800272	Seymour	Johnson Co.	US 31	District Bridge Replacement project on US 31 at Canary Ditch, 1.30 mile N of SR 44. Dist:N/A	Bridge Replacement, Pipe Arch Or Culvert	Y	CON	FY 2023	NHPP	$919,551	$735,641	80%	$0	0%	$183,910	20%	$2,453,878	$2,453,878
								CON	FY 2024	NHPP	$1,244,327	$995,462	80%	$0	0%	$248,865	20%	$2,453,878	$2,453,878
								PE/PL	FY 2021	NHPP	$250,000	$200,000	80%	$0	0%	$50,000	20%	$2,453,878	$2,453,878
								ROW	FY 2021	NHPP	$40,000	$32,000	80%	$0	0%	$8,000	20%	$2,453,878	$2,453,878
INDOT	1801020	Seymour	Johnson Co.	SR 135	Small structure replacement on SR 135 in Johnson County, 3.43 miles N of SR 144 Dist:N/A	Small Structure Replacement	Y	CE	FY 2023	NHPP	$17,700	$14,160	80%	$0	0%	$3,540	20%	$969,333	$969,333
								CON	FY 2023	NHPP	$718,469	$574,775	80%	$0	0%	$143,694	20%	$969,333	$969,333
								PE/PL	FY 2020	NHPP	$223,164	$178,531	80%	$0	0%	$44,633	20%	$969,333	$969,333
								ROW	FY 2022	NHPP	$10,000	$8,000	80%	$0	0%	$2,000	20%	$969,333	$969,333
INDOT	1801058	Multiple	VARIOUS		Software License for Statewide ATMS for FY 22 Dist:N/A	Its Program Contracted Services	Y	PE/PL	FY 2022	STP-ST	$1,200,000	$1,080,000	90%	$0	0%	$120,000	10%	$1,200,000	$1,200,000
INDOT	1800878	Multiple	VARIOUS		Camera/Communications/Detection/DMS Replacements in Indianapolis ATMS area - FY 23 Dist:N/A	Its Traffic Management Systems	Y	CON	FY 2023	IM	$400,000	$360,000	90%	$0	0%	$40,000	10%	$400,000	$400,000
INDOT	1702396	Multiple	VARIOUS		Statewide O&M fee for CARS (Condition Acquisition & Reporting System) for FY 22 Dist:N/A	Its Operations And Maintenance Contracts	Y	PE/PL	FY 2022	STP-ST	$475,000	$380,000	80%	$0	0%	$95,000	20%	$475,000	$475,000
INDOT	1800035	Greenfield	Marion Co.	US 36	Add 1 lane each from approx. 3 miles west of I465 to I 465 . Will include intersection improvements and Bridge Widening. Des numbers 1800035, 1800037, 1900340, 1900341 Dist:1.5	Added Travel Lanes	N	CON	FY 2023	STPSM	$18,406,813	$14,725,450	80%	$0	0%	$3,681,363	20%	$20,106,813	$20,106,813
								ROW	FY 2022	STPSM	$1,700,000	$1,360,000	80%	$0	0%	$340,000	20%	$20,106,813	$20,106,813
INDOT	1800466	Greenfield	Marion Co.	I- 465	1800466 I 465 NB over W 86th Street, 3.39 miles N of I-65 N. Jct., 1800467 I 465 SB over West 86th Street, 3.39 miles N of I-65 N. Jct., 1800468 I 465 SB over US 136 (Crawfordsville Road), 1800469 I 465 NB over Big Eagle Creek (Trail), 2.45 miles N of US 36 west jct., 1800470 I 465 SB over Big Eagle Creek (Trail), 2.57 miles N of US 36 W. Jct., 1800472 I 465 NB@.-US 136/CRAWFORDSVILLE RD, 1800473 I 465 NW loop ramp over W. 86th St., 3.39 miles N of I-65 N. Jct., 1800475 I 465 NB RAMP@.-BIG EAGLE CREEK, TRAIL, 2.45 miles N of US 36 W. Jct., 1800479 I 465 SB RAMP over BIG EAGLE CREEK, TRAIL 2.45 Miles N of US 36 W. Jct., 1800480 I 465 W 38TH ST. over I-465 NB/SB, 2-RAMPS, 1.23 miles N of I-74 W. Jct., 1800482 I 465 RAMP I-74EB to I-465NB W. Jct., 1800483 I 465 W 21ST STREET over I-465, 0.80 Miles S. of I-74 W Jct., 1800487 I 465 W 79th St. over I-465, 2.39 miles N of I-65 N Jct., 1800507 I 74 WB ramp over I-465 (W. Jct.), 1800508 I 74 Ramp to EB I-74 over I-465 W. Jct., 1800509 I 74 RAMP EB > I-465 SB@.-I-465 SB EXIT RAMP W. Jct. Dist:N/A	Bridge Deck Overlay	Y	CON	FY 2023	NHPP	$6,893,216	$6,203,895	90%	$0	0%	$689,321	10%	$6,893,216	$6,893,216
INDOT	1702397	Multiple	VARIOUS		Statewide INRIX Traffic Data for FY 22 Dist:N/A	Its Program Contracted Services	Y	PE/PL	FY 2022	STPSM	$500,000	$450,000	90%	$0	0%	$50,000	10%	$500,000	$500,000
INDOT	1801040	Seymour	Morgan Co.	SR 67	District small structure replacement on SR 67 in Morgan County, 5.88 miles N of SR 39. Dist:N/A	Small Structure Replacement	Y	CE	FY 2024	NHPP	$13,900	$11,120	80%	$0	0%	$2,780	20%	$777,052	$777,052

November 17, 2022

Indiana Department of Transportation
Seymour District
185 Agrico Lane
Seymour, IN 47274

RE: Approval of an Administrative Modification to the 2022-2025 IRTIP

Good afternoon,

This is to inform you of the approval of an administrative modification to the 2025-2025 IRTIP. The attachment details the modifications for the following projects:

- INDOT DES # 1800272

The revised 2022-2025 IRTIP is available through the MiTIP Public Access Portal on the MPO's website. Should you have any questions or comments please contact me at (317) 327-5137.

Sincerely,

Cole Jackson

Cole Jackson, Financial Analyst II
Indianapolis Metropolitan Planning Organization

cc: Kristyn Sanchez, IMPO

QUARTER Q4S, 2022 ADMIN MOD 22-04.1

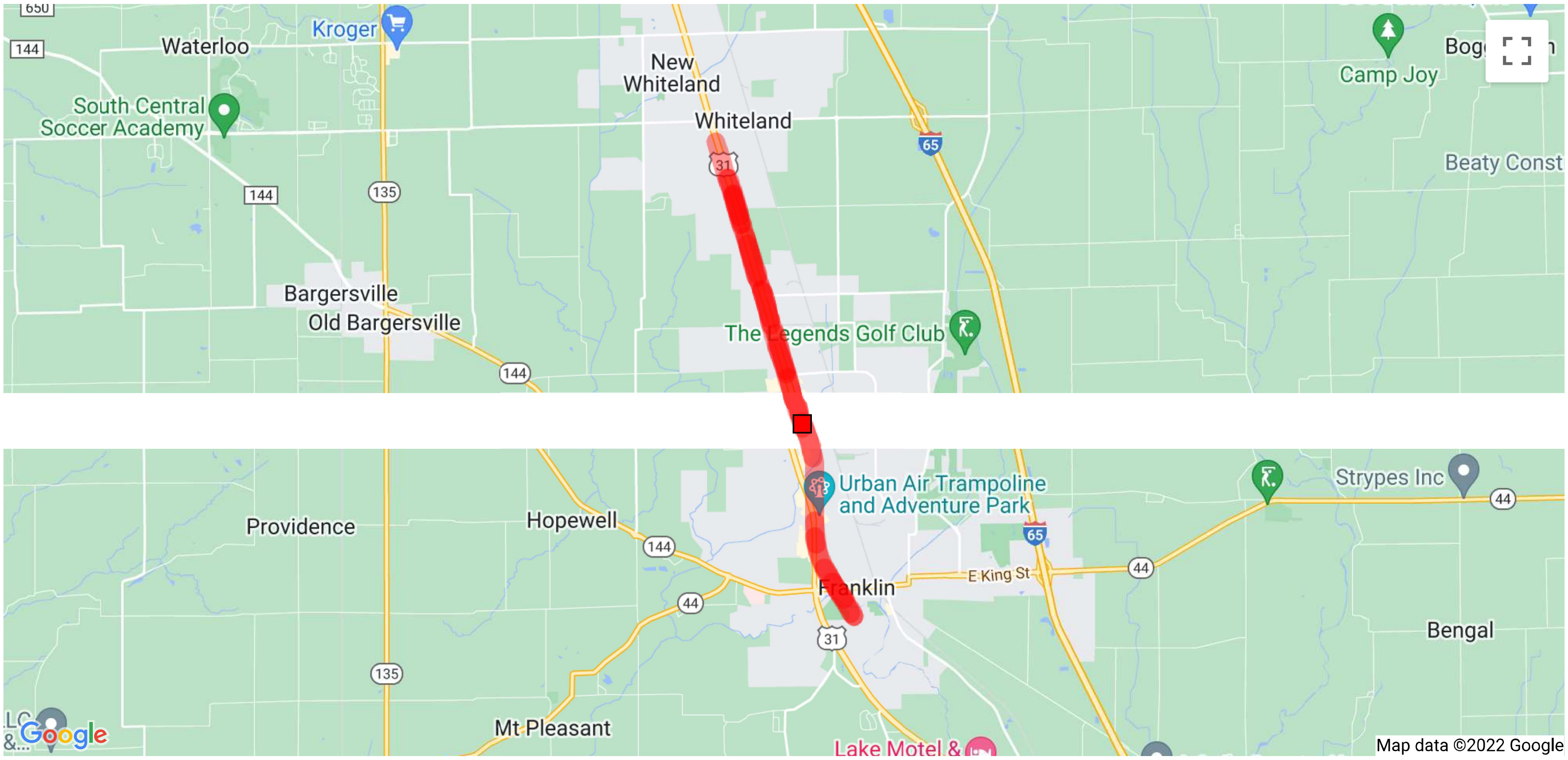
	LEAD AGENCY	DES NUM	DES NUM 2	ROAD/TRAIL	PROJECT TITLE	TYPE	EXEMPT?	TOTAL	TOTAL DIFF	PHASE	SFY	FED FUNDS	LINE TOTAL	FED TOTAL	FED %	MATCH TOTAL	MATCH %	JUSTIFICATION	ACTION PROPOSED
PRIOR	INDOT	1800082	N/A	US 31	US 31 from Hospital Rd to Cedar Ln	Added Travel Lanes	Non-Ex	$46,004,096		ROW	SFY 2022		$710,000	$-	0%	$710,000	100%		
PROPOSED			1800272, 2001610		Added Travel Lanes on US 31 from Hospital Rd to Cedar Ln			$37,037,720	$-8,966,376	ROW	SFY 2022		$40,000	$-	0%	$40,000	100%	Moved RW for $710,000 from SR 22 to FY23. Adjusted CN costs in FY 23 and FY 24. Removed 9 baby des # from project description and added 2	
PRIOR										-	-	-	$-	$-	-		0%		
PROPOSED										ROW	SFY 2023	NHPP	$710,000	$568,000	80%	$142,000	20%		
PRIOR										CN	SFY 2023	NHPP	$16,250,500	$13,000,400	80%	$3,250,100	20%		
PROPOSED										CN	SFY 2023	NHPP	$33,693,393	$26,954,715	80%	$6,738,678	20%		
PRIOR										CN	SFY 2024	NHPP	$27,693,596	$22,154,877	80%	$5,538,719	20%		
PROPOSED										CN	SFY 2024	NHPP	$1,244,327	$995,462	80%	$248,865	20%		

Intersection Improvements on US 31 from South Main St. to Israel Lane (1800082)

Des Number	1800082	*Amendment*	22-04.1 ADMIN MOD	*Exempt Category*	Exempt	*Est Total Project Cost*	$37,037,720
Lead Agency	INDOT	*Contact (ERC)*		*INDOT District*	Seymour	*County*	Johnson
Project Type	Intersect. Improv. W/ Added Turn Lanes	*Letting Date*		*Functional Classification*	Other Principal Arterial	*Bike/Ped Component(s)*	Yes TBD%

Seconday Des Number	1800272, 2001610
Title	Intersection Improvements on US 31 from South Main St. to Israel Lane
Limits	From S. Main St to Israel Lane of Distance (mile) 5.63 Milepost begins at 0 ends at
Description	Construct a series of reduced conflict intersections as part of the US 31 intersection improvements. 1800272 - bridge replacement on US 31 over Canary Ditch. Des 2001610 for tracking purposes only.

Phase	Fund Source	Prior SFY	SFY2022	SFY2023	SFY2024	SFY2025	SFY2026	Future SFY	Total
RW	FEDERAL - NHPP	-	-	$568,000	-	-	-	-	$568,000
RW	STATE - Other	$1,350,000	$40,000	$142,000	-	-	-	-	$1,532,000
	Total Right of Way	$1,350,000	$40,000	$710,000	-	-	-	-	$2,100,000
CN	FEDERAL - NHPP	-	-	$26,954,715	$995,462	-	-	-	$27,950,177
CN	STATE - Other	-	-	$6,738,678	$248,865	-	-	-	$6,987,543
	Total Construction	-	-	$33,693,393	$1,244,327	-	-	-	$34,937,720
	Total Programmed	**$1,350,000**	**$40,000**	**$34,403,393**	**$1,244,327**	**-**	**-**	**-**	**$37,037,720**



Lead Des 1800082

Appendix I

Additional Studies and Information

Indiana Department of Transportation

100 N. Senate Avenue, IGCN
Indianapolis, IN 46204

City of Franklin

70 East Monroe Street
Franklin IN 46131

Capacity Analysis Memo

US 31 Corridor

August 2017

CMT
Engineers and Consultants

8790 Purdue Road
Indianapolis, IN 46268

1.0 Introduction

This project will evaluate potential intersection types and corridor treatments on US Highway 31 (US 31) in Johnson County from South Main Street to Israel Lane. The proposed study area is in Franklin, Indiana, beginning approximately 1.1 miles south of SR 44/SR 144/Jefferson Street at S. Main Street and extending north to Israel Lane 0.67 miles south of CR E 500 N/Whiteland Road.

The City of Franklin is proposing to reconfigure the US 31 corridor intersections to meet local and regional transportation needs. The design of this new corridor will be completed in a manner that best meets the needs of INDOT, Johnson County, the City of Franklin, and the traveling public. The formal purpose and need for the project will be determined through the NEPA process, but initial components of the purpose and need utilized for this study may include:

- Reduce **congestion** at intersections along US 31.
- Improve **roadway mobility** for the US 31 corridor.
- Improve **safety** throughout the roadway network through a more efficient transportation system.
- Support **non-motorized** modes of transport by developing an accommodation plan to improve non-motorized access to the City of Franklin and Johnson County.

1.1 Existing Conditions

1.1.1 Roadways

The proposed project will directly impact several state and local roads. ***Table 1*** summarizes existing roadway information within the study area. The study area extends from S. Main Street in the south to Israel Lane in the north. No intersections of concern were within one-quarter mile east or west of the corridor, so no intersections beyond the corridor were analyzed.

Table 1: Existing Facility Information

Facility	Functional Classification	Number of Primary Lanes	2017 AADT	Speed Limit
US 31	Principal Arterial	4	31,479	40 – 55 mph
S. Main St.	Minor Arterial	2	501	40 mph
Nineveh Rd.	Major Collector	2	2,968	35 mph
South St.	Major Collector	2	4,722	30 mph
Hospital Rd.	Major Collector	2	2,945	40 mph
Jefferson St.	Principal Arterial	2	8,038	30 mph
Banta St.	Major Collector	2	991	25 mph
Westview Dr./N. Main Street	Major Collector/Minor Arterial	2	10,101	20-30 mph
Commerce Dr.	Major Collector	2	6,598	40 mph
Earlywood Dr.	Major Collector	2	4,775	30 mph
All other project area roads	Local Street	2	138 – 4,216	25 - 40 mph

US Highway 31 - US Highway 31 is classified as a principle arterial by INDOT. US 31 travels north-south, connecting Spanish Fort, Alabama with Mackinaw City, Michigan. From south to north, the speed limit at the South end of the project is 55 mph. The posted speed switches from 55 mph to 45 mph between S. Main Street and Nineveh Road. The speed limit decreases to 40 mph south of Hospital Road. The speed limit remains 40 through Franklin until it is increased to 50 mph north of the Walmart entrance. The whole corridor has four twelve-foot lanes, two northbound lanes and two southbound lanes. Most of the corridor has a 30 to 40-foot median. The section from South St. to Lemley St. does not have a raised median, but does have a seventeen-foot two-way left-turn lane (TWLTL).

S. Main Street – S. Main Street is classified as a minor arterial by Johnson County. Main Street travels mostly north-south. The posted speed limit is 40 mph and S. Main Street creates a T-intersection at US 31. There is one travel lane in each direction on S. Main Street.

Nineveh Rd - Nineveh Road is classified as a major collector by Johnson County. Nineveh Road travels mostly north-south through Franklin. The speed limit of this road is 25 mph east of US 31 and 35 mph west of US 31. There is one lane in each direction on both sides of US 31.

South Street - South Street is classified as a major collector by Johnson County. To the west of US 31, South Street transitions to a local road and is called Franklin-Lakes Boulevard. South Street travels east-west through Franklin. There is one lane in each direction. The speed limit of this road is 30 mph.

Hospital Road - Hospital Road is classified as a major collector by Johnson County. Hospital Road travels east-west through Franklin and comes to a t-intersection on the west side of US 31. There is one travel lane in each direction. The posted speed limit is 40 mph.

SR 44 / SR 144 - SR 44 and SR 144 are also known as Jefferson Street between US 31 and I-65 and is under local jurisdiction. This road is classified as a principal arterial by the Indiana Department of Transportation. SR 144 travels east-west between Mooresville, IN and Franklin, IN. SR 44 travels east-west between Martinsville, IN and the Indiana/Ohio state line east of Liberty, IN. This major arterial has a posted speed limit of 30 mph at its intersection with US 31. This road has one lane in each direction.

Banta Street - Banta Street is classified as a major collector by Johnson County. There is one travel lane in each direction. The posted speed limit of Banta St is 25 mph. This road only approaches US 31 from the East and travels east-west through Franklin from US 31 to Main Street.

Westview Drive/N. Main Street - Main Street is classified as a minor arterial and Westview Drive is classified a major collector by Johnson County. Main Street travels mostly north-south and Westview Drive travels mostly east-west, but turns south to form the north approach of the SR 44/SR 144 intersection. The posted speed limit is 20 mph on N. Main Street and 30 mph on Westview Drive. For both roadways, there is one travel lane in each direction.

Commerce Drive - Commerce Drive is classified as a major collector by Johnson County. This road travels east-west through Franklin. A pedestrian path west of US 31 on the north side of Commerce connects to the high school. There is one travel lane in each direction.

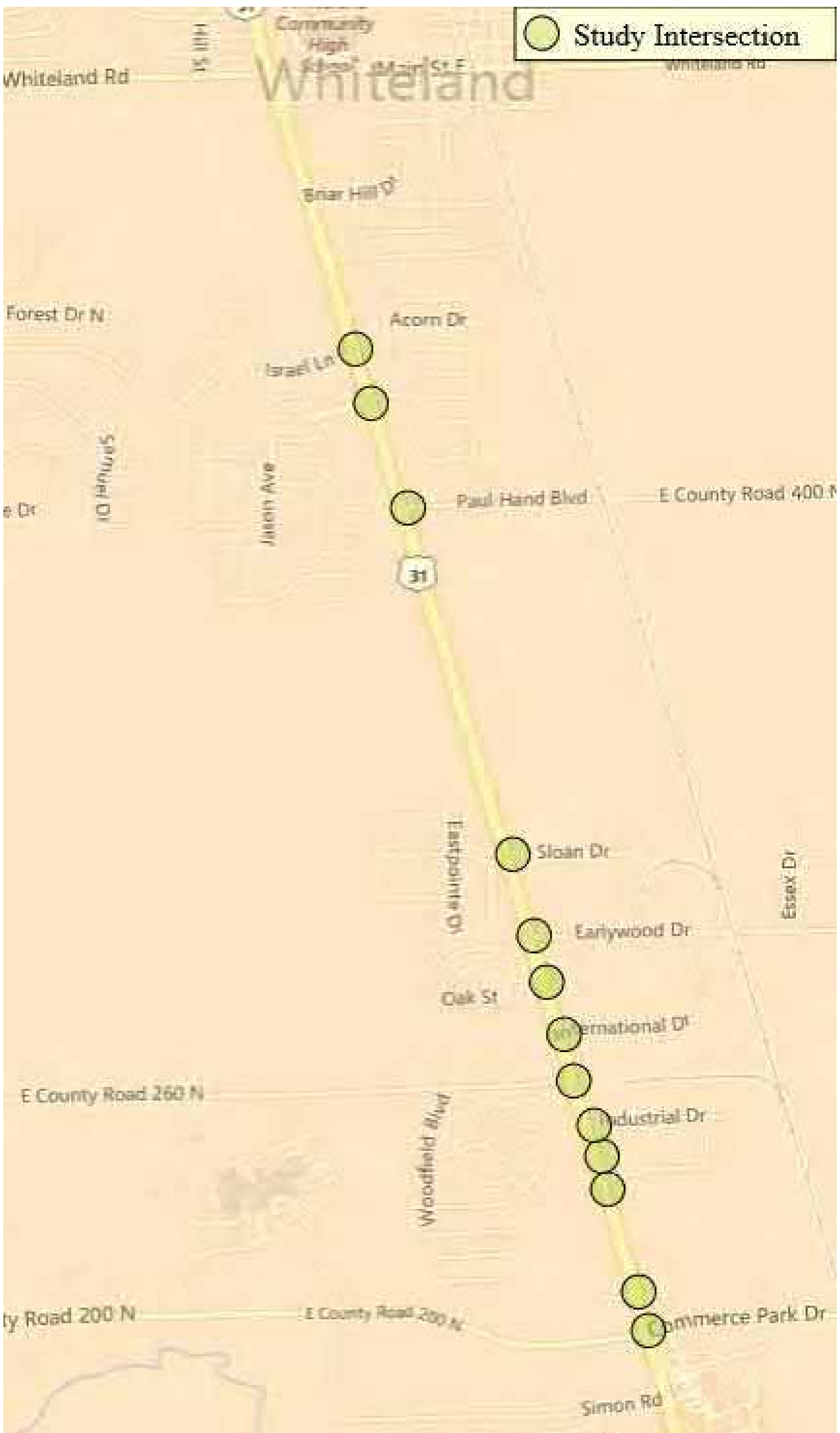
Earlywood Drive - Earlywood Drive (CR E 300 N) is classified as a major collector by Johnson County. This road travels east-west through Franklin, predominantly between US 31 and I-65. Earlywood Drive connects multiple industrial properties to US 31. There is one travel lane in each direction.

1.1.2 Intersections

The impacts of the proposed project to through and local traffic will be studied, including the impacts to a few major intersections. ***Figure 1*** and ***Figure 2*** show all of the intersections studied in this analysis. A brief description and an aerial view of each major intersection is provided after ***Figure 1*** and ***Figure 2***.

Figure 1: Study Area Intersections

Figure 2: Study Area Intersections



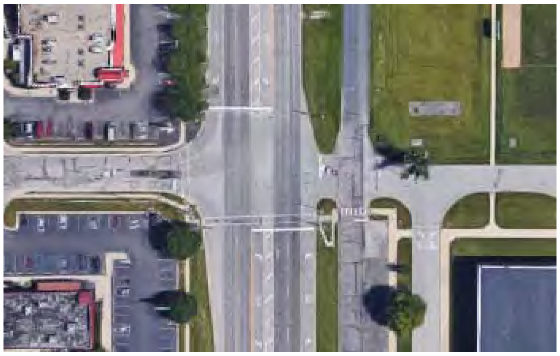
<u>US 31 at Nineveh</u> - This existing four-legged intersection is signal-controlled. The northbound and southbound approaches have 2 lanes in each direction. The eastbound and westbound approaches have one lane in each direction. The northbound and southbound approaches have a left turn lane and right turn lane. There is a significant skew to the intersection of approximately 28^o.

<u>US 31 at South</u> - This existing four-legged intersection is signal-controlled. The northbound and southbound approaches have 2 lanes in each direction. The eastbound and westbound approaches have one lane in each direction. Left turn lanes exist on the southbound, northbound, and eastbound approaches. The southbound approach also has a right turn lane. The westbound approach intersects US 31 at approximately a 22-degree skew.

<u>US 31 at Hospital</u> - This existing intersection is three-legged with stop control on the westbound approach. The north and southbound approaches have 2 lanes in each direction. The eastbound approach has one lane in each direction, and the eastbound lane transitions to one left turn lane and one right turn lane. The southbound approach has a right turn lane and the northbound approach has a left turn lane.

<u>US 31 at Jefferson</u> - This existing intersection is four-legged and signal-controlled. The north and southbound approaches have 2 through lanes in each direction. East and westbound approaches have one through lane in each direction. All approaches have a dedicated left turn lane and the westbound approach also has a dedicated right turn lane (currently under construction).

Pedestrian accommodations are present on each corner. No on street parking is available.



US 31 at Mallory - This existing four-legged intersection is signal-controlled. The northbound and southbound approaches have 2 lanes in each direction. The eastbound and westbound approaches have one lane in each direction. A left-turn lane is present on the eastbound, northbound, and southbound approaches. A right turn lane is present on the northbound and southbound approaches. Crosswalks are present across the northbound and eastbound approaches.

US 31 at Westview - This existing intersection is four-legged and signal-controlled. The north and southbound approaches have 2 lanes in each direction. There is a left turn lane on the southbound, northbound, and eastbound approaches. The northbound and westbound approaches have dedicated right turn lanes. The east approach intersects at approximately a 20-degree skew.

US 31 at Commerce - This existing four-legged intersection is signal-controlled. The north and southbound approaches have 2 lanes in each direction. The eastbound and westbound approaches have one lane in each direction. All four approaches have left turn lanes. The northbound, southbound and eastbound approaches have a dedicated right turn lane.

1.2 Build Alternatives

Through discussion with the City of Franklin and INDOT, a proposed alternative was developed for the corridor that was confirmed through a screening process. Three alternatives were analyzed: the No Build, Build and Enhanced Build scenarios.

The Build alternative recommends a combination of median U-turn (MUT) intersections be implemented along the corridor. Additionally, a raised median would be added from the South

Street intersection north to the Westview Drive / N. Main Street intersection. Figures showing the proposed design may be found in ***Appendix A***. Some minor adjustments were included in the analysis to improve operations and are recommended to be included in the final design. Several U-turn locations were signalized to provide acceptable gaps in oncoming traffic and/or accommodate high U-turn volumes.

Also in ***Appendix A*** is an additional alternative that modified the design of some intersections from the Build scenario that is called the Enhanced Build scenario. Compared to the original design, the proposed design would be modified as noted for the following intersections:

- RCUT at Nineveh Rd.
- Signalized green T at S. Main St.
- Partial RCUT at Hospital Road
- Hybrid Boulevard Left at Jefferson Street
- RCUT at Mallory Parkway
- RCUT at Westview Drive/N. Main Street
- RCUT at Christian Blvd./Oakville Blvd.

This list of modification is not all-inclusive. A few other minor geometric changes were made at some intersections that can be seen in ***Appendix A***. The previously-mentioned adjustments to the proposed are recommended for inclusion in the final design. This will provide a consistent treatment through the entirety of the Franklin city limits along US 31.

2.0 Operational Analysis

2.1 Methodology

This project will use multiple measures of effectiveness (MOEs) to analyze and select the appropriate solution. The MOEs that will be used in the analysis include:

- Level-of-Service (LOS)
- Delay
- Queue Length
- Arterial Speed
- Corridor Travel Time
- Crash Reduction

Through discussion with INDOT and the City of Franklin, a Build scenario was developed. An Enhanced Build scenario was developed that better managed some higher-volume movements in the corridor. A No Build scenario will also be analyzed to serve as a baseline performance level. The proposed designs are shown in ***Appendix A***. The analyses include the existing conditions based on counts conducted in 2017. Future analyses will include the anticipated construction year (2023) and the design year (2043). For each analysis, the morning (AM) and evening (PM) peak hours will be analyzed.

2.2 Traffic Data

The traffic counts used for this analysis were provided by INDOT. MioVision cameras were used to conduct the 24-hour counts within late February to early March. Functional Classifications were collected from the interactive Functional Classification Map. Lane and posted speed limit information were found using Google Maps. Existing signal timing plans were provided by INDOT.

2.3 Operational Analysis

A detailed operational analysis was conducted using multiple traffic modeling software programs. Synchro (Version 10.0.0.181) was used to develop an initial network layout and to develop signal timing parameters. The capacity analysis was conducted using VISSIM microsimulation software (Version 9.00 – 07). The purpose of this model was to analyze the entire study area as a whole and quantify the impacts that each element in the network may have on the rest of the network. The most recent Highway Capacity Manual (HCM), HCM 6, was utilized for minimum gap and headway values for all minor street unsignalized movements and major street unsignalized left and U-turns, as well as LOS thresholds.

2.3.1 Level-Of-Service and Delay

Level-of-service is a common measure of effectiveness for traffic operations at an intersection and is based on intersection delay. The full summary tables for all scenarios may be found in ***Appendix B***. The LOS for each intersection for the No Build, Build and Enhanced Build scenarios are presented in ***Table 2*** and the corresponding intersection delay is presented in ***Table 3***. The LOS and delay for the proposed U-turns are provided in ***Appendix B***.

Table 2: US 31 Intersection Level-of-Service

Intersection Level-Of-Service										
Intersection	2017 Existing		2043 No Build		2043 Build		2043 Enhanced Build		Build Int. Control	Enhanced Build Int. Cntl.
	AM	PM	AM	PM	AM	PM	AM	PM		
S. Main Street	C	F	E	F	D	F*	A	A	Stop Control	Signalized
Nineveh Road/CR S 200 E	B	B	C	B	C	E	A	A	RCUT	Signalized
Ironwood Drive	A	A	A	A	A	A	B	B	Stop Control	Stop Control
Franklin Lakes Blvd./South St.	B	C	D	C	E	F	A	B	Boulevard Left	Signalized
Hospital Road	D	D	F	F	F*	F*	B	B	Stop Control	Signalized
Jefferson Street/SR 44/SR 144	C	C	D	E	D	D	B	C	Boulevard Left	Signalized
Madison Street	B	B	B	E	F*	F*	C	D	Stop Control	Stop Control
King Street	F	F	F	F	D	C	D	F*	J-turn	Stop Control
Adams Street	D	F	F	F	F*	F*	D	F*	Stop Control	Stop Control
Banta Street	E	F	F	F	C	B	A	A	RCUT	Signalized
Kohl's Entrance	C	F	D	F	F*	F*	C	E*	Stop Control	Stop Control
Mallory Parkway	B	B	B	C	B	E	A	B	Boulevard Left	Signalized
Kroger Entrance	B	B	B	C	C	F*	C	D	Stop Control	Stop Control
Lemley Street	B	B	C	D	D	C	E*	C	Stop Control	Stop Control
Tractor Supply/McDonalds	B	C	B	E	C	D	C	D	J-turn	Stop Control
Westview Drive/N. Main Street	C	D	E	F	C	C	B	C	RCUT	Signalized
Schoolhouse Road	A	B	B	F	F*	F*	C	D	Stop Control	Stop Control
Cedar Lane	C	D	C	F	F*	F*	F*	F*	Stop Control	Stop Control
Acorn Road	E	F	F	F	D	F*	E*	F*	Stop Control	Stop Control
Walmart Entrance	A	B	A	F	A	C	B	C	Stop Control	Signalized
Simon Road	C	D	E	F	F*	F*	D	F*	Stop Control	Stop Control
Commerce Drive	C	C	C	E	B	B	A	B	Boulevard Left	Signalized
Utilities Drive	C	B	C	F	C	B	B	C	Stop Control	Stop Control
KYB South	C	D	D	F	C	C	C	F*	Stop Control	Stop Control
KYB North	B	C	B	D	C	D	C	F*	Stop Control	Stop Control
Industrial Drive	C	D	D	F	C	D	B	B	J-Turn	Signalized
Branigin Road	A	A	B	C	F*	F*	A	A	Stop Control	Signalized
International Drive	B	D	C	F	F*	E*	F*	F*	Stop Control	Stop Control
Locust Street	C	C	C	F	C	C	C	C	Stop Control	Stop Control
Earlywood Drive/CR E 300 N	B	B	B	D	A	B	B	B	Boulevard Left	Signalized
Sloan Drive/Lancer Drive	B	C	C	D	C	C	C	D	Stop Control	Stop Control
Paul Hand Boulevard	C	C	C	D	B	C	B	D	Stop Control	Stop Control
Christian Blvd/Oakville Blvd	B	B	B	B	A	A	B	A	Boulevard Left	Signalized
Israel Lane	B	B	B	C	B	B	B	B	Stop Control	Stop Control

*LOS is for stop-controlled side road approaches only. Mainline LOS at these intersections is LOS A.

Table 3: US 31 Average Intersection Delay

Intersection Delay (s/veh)								
Intersection	**2017 Existing**		**2043 No Build**		**2043 Build**		**2043 Enhanced Build**	
	AM	PM	AM	PM	AM	PM	AM	PM
S. Main Street	24.73	53.91	38.60	266.73	33.13	257.84	0.39	1.23
Nineveh Road	12.84	11.78	21.97	15.53	28.24	71.02	8.58	6.77
Ironwood Drive	8.74	8.02	8.30	8.39	7.69	8.43	12.42	11.81
Franklin Lakes Blvd./South St.	19.54	20.09	43.90	34.97	66.03	105.00	9.28	10.16
Hospital Road	25.98	30.04	138.29	250.28	122.58	118.69	13.61	13.49
Jefferson Street	28.05	32.96	49.34	55.36	52.76	51.77	18.71	21.13
Madison Street	11.55	13.79	14.51	38.79	77.13	58.36	17.74	28.61
King Street	196.37	193.71	970.03	722.82	37.31	32.81	34.18	182.15
Adams Street	33.29	82.90	84.96	378.77	957.43	1352.97	29.47	100.60
Banta Street	36.87	367.99	134.93	919.33	20.09	18.88	4.87	5.22
Kohl's Entrance	16.98	78.16	26.47	585.27	122.41	1454.18	17.40	37.93
Mallory Parkway	12.13	12.37	14.72	29.61	13.38	67.95	9.98	13.23
Kroger Entrance	10.06	12.51	11.70	18.43	16.45	471.60	15.27	30.17
Lemley Street	11.87	12.65	20.31	29.79	29.85	16.25	37.20	24.57
Tractor Supply/McDonalds Entrance	12.17	18.42	14.76	47.93	15.18	27.74	22.62	33.73
Westview Drive/N. Main Street	30.26	35.65	61.42	106.36	20.84	28.59	16.69	21.57
Schoolhouse Road	7.03	16.88	10.14	109.11	78.63	1555.07	15.19	25.27
Cedar Lane	17.79	26.08	21.29	4432.24	165.92	61.42	100.52	456.98
Acorn Road	39.70	63.41	117.32	914.87	33.00	267.36	39.03	203.21
Walmart Entrance	5.22	10.17	6.45	93.54	3.92	23.43	14.64	24.22
Simon Road	22.57	26.34	36.67	306.17	446.78	278.80	32.08	163.30
Commerce Drive	25.64	25.68	31.67	67.36	13.68	15.53	9.28	10.59
Utilities Drive	18.03	12.34	22.21	200.84	16.18	13.64	14.44	23.01
KYB South	22.82	29.71	29.37	480.53	15.30	22.40	18.23	51.09
KYB North	11.82	15.19	14.40	30.62	18.92	29.08	23.46	55.58
Industrial Drive	20.76	29.92	28.50	321.56	20.03	25.74	17.79	10.94
Branigin Road	7.66	5.58	14.07	27.70	508.83	300.12	6.80	5.88
International Drive	14.78	25.07	22.92	68.37	72.55	38.86	51.79	151.08
Locust Street	16.23	20.62	19.85	166.71	16.73	23.20	18.58	21.13
Earlywood Drive	11.41	12.97	15.86	40.14	9.13	13.96	10.91	17.52
Sloan Drive/Lancer Drive	13.64	15.97	18.13	32.14	18.79	21.91	24.17	34.11
Paul Hand Boulevard	15.20	20.38	22.02	27.44	10.20	18.63	14.42	30.98
Christian Blvd/Oakville Blvd	10.44	10.57	13.52	13.10	7.87	3.20	13.77	8.94
Israel Lane	10.82	14.79	14.43	18.59	12.06	14.05	13.85	14.59

The results in both ***Table 2*** and ***Table 3*** show degraded traffic operations by the design year for the No Build scenario. Delay, LOS and arterial progression corridor-wide deteriorate by the design year in the No Build scenario. The Enhanced Build scenario does indicate failing LOS at some intersections for the side streets in the design year, but it does show significant reductions in delay at a majority of the side streets with failing LOS in the No Build scenario. To remedy these locations, minor adjustments may be desirable. Minor adjustments may include, but are not limited to, extending median turn lanes and/or adjusting intersection configurations.

2.3.2 Arterial Speed and Corridor Travel Time

Arterial speed and corridor travel time can both be good indicators of how well a corridor's signal system is coordinated. Without any traffic signals or delays from other traffic in the corridor, a vehicle could traverse the US 31 corridor in 7 minutes. Comparatively, as seen in ***Table 4***, the existing northbound and southbound travel times are approximately 9.5 minutes during the AM peak and 10 minutes for the PM peak. Traffic signals and vehicle interactions are currently adding approximately 2.5-3 minutes of travel time for either direction through the corridor.

Table 4: US 31 Travel Time and Speed

	2017 Existing	2023 No Build	2023 Build	2023 Enhanced Build	2043 No Build	2043 Build	2043 Enhanced Build
AM Northbound Avg. Travel Time (min/veh)	9.55	9.7	8.82	9.66	10.65	14.85	10.25
AM Southbound Avg. Travel Time (min/veh)	9.5	9.85	8.43	9.54	10.68	11.8	9.95
PM Northbound Avg. Travel Time (min/veh)	10.01	9.96	19.28	10.38	15.61	17.65	11.51
PM Southbound Avg. Travel Time (min/veh)	10.35	10.35	15.98	9.95	22.45	18.64	11.29
AM Northbound Avg. Travel Speed (mph)	34.6	34.1	37.5	34.2	31	22.3	32.3
AM Southbound Avg. Travel Speed (mph)	34.9	33.6	39.3	34.7	31	28.1	32.5
PM Northbound Avg. Travel Speed (mph)	33.1	33.2	17.1	31.8	21.2	18.7	28.7
PM Southbound Avg. Travel Speed (mph)	32.0	32.0	20.7	33.3	14.8	17.8	29.3

Table 4 shows that the corridor average travel time is less in the Enhanced Build scenario compared to the No Build scenario. Compared to existing travel times, there is an increase between 24 seconds – 1.5 minutes in travel time for the Enhanced Build scenario, but the increase is significantly less than the No Build by the year 2043. As would be expected with a slight increase in travel time, average travel speed slightly decreases in the design year. Evening peak travel speeds are significantly improved over the design year No Build scenario, though. The southbound PM peak average travel speed is nearly twice as fast in the Enhanced Build scenario versus the No Build.

It should be noted that some of the increase in corridor travel time and decrease in average travel speed is attributable to an adjustment to posted speed limits for some sections of US 31. Per INDOT design standards, 45 MPH is the maximum design speed for a curbed facility, and curbs are proposed for the length of the corridor. Therefore, US 31 segments where the existing posted speed limit is greater than 45 MPH were reduced to 45 MPH in the build scenarios. The reduced speed limit is assumed to slightly increase predicted travel time and slightly decrease predicted travel speed for these segments in the build scenarios.

2.3.3 Queue Length

Another measure of effectiveness for the corridor is queue length. Because of the significant amount of delay shown in ***Table 3***, queues will be significant at multiple intersections. Average and maximum queue lengths may be seen in ***Appendix B***. The letters “L”, “T”, “R” and “U” in the queue titles correspond to left, through, right and U-turn movements, respectively. Because of the number of intersections within the study area, there are many queue lengths to report.

Based on the results in ***Appendix B***, the existing average queue lengths are generally less than 200 feet. By the design year, queues in the No Build scenario reflect the increased delay seen in the network. Multiple side streets experience average queues over 500 feet long, indicating vehicles struggle to find adequate gaps in mainline traffic. Mainline queues at some of the signalized intersections, such as Mallory Parkway and Westview Drive/N. Main Street, extend over 800 feet, blocking access to auxiliary lane turn bays.

In the 2043 design year, the Enhanced Build scenario does not have any average queues that extend greater than 500 feet. Some U-turn locations do experience long maximum queues, but they do not degrade mainline operations because they clear within one signal cycle. The U-turn for southbound traffic south of Westview Drive is one example of the queue clearing in a single cycle. Other U-turn locations may require a signal in the future condition to prevent the queue from spilling back into mainline traffic. The U-turn south of Cedar Lane for southbound traffic is one movement that may queue into through traffic in the future. As time passes, these locations would need to be monitored.

There are instances in the Build scenario where 2043 queues are less than 2023 queues. Franklin Lakes Blvd. and Jefferson Street are a couple examples of this occurring. There are a couple reasons for this. The first reason is the stochastic nature of VISSIM, which randomly inserts traffic into the network. Differences in the distribution of vehicles entering the network across the evaluation period could cause queue results to be significantly different. The second reason is the propagation of congestion in the network. Compared to 2023, the congestion in the 2043 Build scenario that brought the network to a standstill likely began further north than in the 2023 simulation, which allowed intersections further south such as Jefferson Street to be able to operate more effectively, resulting in shorter queues. Analyzing the queues against the entire network still shows breakdowns in traffic operations in the Build scenario, which are alleviated in the Enhanced Build scenario.

2.3.4 Crash Reduction

The final measure of effectiveness for the corridor is crash reduction. A *Safety Improvements Memo* was developed to document the expected safety improvements in the corridor based on the proposed design. By the design year, it is estimated that a 24.4% crash reduction will be seen throughout the corridor. For additional details, please see the *Safety Improvements Memo*.

3.0 Summary and Recommendations

3.1 No Build (Not Recommended)

Based on the measure of effectiveness (MOE) results, the No Build scenario is not recommended. Vehicles have trouble finding adequate gaps in traffic to conduct their turning movements and long queues form that extend back to upstream intersections. The congestion propagates throughout the network, causing operations at numerous intersections to break down. The existing US 31 corridor will not provide for efficient movement of traffic and motorists will experience long delays in the design year. This is represented by the number of intersections experiencing LOS F in the No Build scenario.

3.2 Build (Not Recommended)

Based on the MOE results, the initial Build scenario is not recommended. Vehicles have trouble finding adequate gaps in traffic to conduct their turning movements. The relocation of left turns to the proposed U-turn locations creates some high-volume U-turn movements that queue back into through travel lanes. The queueing past the provided turn bay lengths slows through traffic, which causes queues to back up and block other intersections and U-turn movements, breaking down traffic operations in the corridor. While several intersections have improved operations, the corridor still experiences heavy congestion in certain segments.

3.3 Enhanced Build (Recommended)

The Enhanced Build scenario is recommended as it addresses the high U-turn volume locations and some other high-volume movements. This scenario provides significant improvements for all the MOEs over the No Build scenario. As this project focused on improved US 31 operations, minor street performance was a secondary goal, and some did not see significantly improved performance.

A few critical modifications were needed to the Build scenario. One critical location was the intersection of Hospital Road. Projected northbound left turns are over 300 in the peak hour, which in the Build scenario had been relocated to a U-turn at Banta Street along with U-turning traffic for four other intersections. This intersection was converted to a partial RCUT intersection, allowing the heavy US 31 left turn movement to occur at Hospital Road. There was concern that traffic wanting to turn left from northbound US 31 at Jefferson Street would detour to Hospital Road with this configuration. A sensitivity analysis showed the Hospital Road intersection could still operate at an acceptable LOS with all of the US 31 northbound left turns from Jefferson Street relocated to Hospital Road. The Jefferson Street eastbound left turn volume is projected to have approximately 500 vehicles making that movement in the PM peak in the design year, so dual eastbound left turn lanes were implemented for a partial boulevard left configuration. The intersection with Westview drive experiences high left-turn volumes on all approaches, so an RCUT configuration was selected to lessen U-turn volumes and improve safety.

A goal was to not over-signalize the corridor, as that would negatively impact corridor travel times and speeds. Some U-turn locations need to be evaluated in more depth before final design to confirm signal warrants. Removing any of these signals could improve corridor travel times and speeds more, but would penalize U-turn traffic. Overall, the major intersections see improved performance and the corridor will see similar levels of operation out to the design year.

4.0 Future Work/Coordination

A few intersections will require further coordination/discussion to finalize the intersection type or some of the geometric features that are more detailed than the current planning level of the project. Those locations and topics are discussed hereafter to provide documentation of the discussion to-date.

Two existing signalized intersections were analyzed with a MUT configuration that require additional analysis prior to final design. Those intersections were US 31 at South Street/Franklin Lakes Boulevard and US 31 at Christian Boulevard/Oakville Boulevard. The MUT configuration for low minor street through volumes might lead to motorists disregarding the no left turn restriction at the intersection. The RCUT or J-turn configuration would place a physical barrier minimizing the likelihood of disregarding the restriction. Further investigation will be needed during the design phase to confirm the final design. The RCUT or J-turn configuration was not analyzed at the Franklin Lakes/South Street intersection because further coordination with the City and INDOT is needed.

At the intersection of US 31 and Westview Drive/Main Street, a RCUT intersection type is proposed. This configuration will force Westview Dr. and Main St. left and through traffic to utilize a U-turn downstream. A City of Franklin fire station is approximately 350 feet east of the intersection. Further coordination as to how best accommodate fire trucks using US 31 southbound on emergency calls is needed. One suggestion mentioned during the planning meetings was brick pavers in the center directional island that grass could grow between and around. This would allow fire trucks to be able to easily traverse the island while giving the allusion to other motorists that the island was composed of just sod/grass.

The Enhanced Build alternative removed all left turns from the Walmart main entrance, which is signalized currently. It was noted that the INDOT district may prefer to allow left turns into the Walmart entrance. Further coordination is needed to finalize the intersection geometry for this intersection.

Indiana Department of Transportation

100 N Senate Ave, IGCN
Indianapolis, IN 46204

City of Franklin

70 East Monroe Street
Franklin IN 46131

Safety Countermeasures Memo

US 31 Corridor

June 2017

CMT
Engineers and Consultants

8790 Purdue Road
Indianapolis, IN 46268

1.0 Introduction

This project will evaluate potential intersection types and corridor treatments on US Highway 31 (US 31) in Johnson County from South Main Street to Israel Lane. The proposed study area is located in Franklin, Indiana, beginning approximately 1.1 miles south of SR 44/SR 144/Jefferson Street at S. Main Street and extending north to Israel Lane 0.67 miles south of CR E 500 N/Whiteland Road.

The City of Franklin is proposing to reconfigure the US 31 corridor intersections to meet local and regional transportation needs. The design of this new corridor will be completed in a manner that best meets the needs of INDOT, Johnson County, the City of Franklin, and the traveling public. The formal purpose and need for the project will be determined through the NEPA process, but initial components of the purpose and need utilized for this study may include:

- Reduce **congestion** at intersections along US 31.
- Improve **roadway mobility** for the US 31 corridor.
- Improve **safety** throughout the roadway network through a more efficient transportation system.
- Support **non-motorized** modes of transport by developing an accommodation plan to improve non-motorized access to the City of Franklin and Johnson County.

1.1 Existing Conditions

US Highway 31- US Highway 31 is classified as a principle arterial by INDOT. From south to north, the speed limit at the south end of the project is 55 mph. The posted speed switches from 55 mph to 45 mph between S. Main Street and Nineveh Road. The speed limit decreases to 40 mph south of Hospital Road. The speed limit remains 40 through Franklin until it is increased to 50 mph north of the Walmart entrance. The whole corridor has four lanes, two northbound lanes and two southbound lanes. Most of the corridor has a 30 to 40-foot median. The section from South St. to Lemley St. does not have a raised median, but does have a two-way left-turn lane (TWLTL). There are 34 intersections within the study limits. Of these 34 intersections, seven are major collectors, two are minor arterials, and one is a principle arterial. Eleven intersections are signalized, the rest are two-way stop-controlled (TWSC) on the minor street.

Figure 1 – Corridor Through Franklin

2.0 Crash History

Crash history data was obtained from the ARIES database by INDOT. The crash history includes reports from the Franklin Police Department, the Johnson County Sheriff and the Indiana State Police. Crash records were pulled for a three-year time period to average out spikes and/or dips in the number of crashes in the corridor. The crash data provided used in this analysis is from a period between 2014 and 2016. The types of crashes that occurred in the corridor can be found in **Table 1**.

Table 1- Types of Collisions in Corridor

Crash Type	Backing Crash	Head On	Left Turn	Opposite Direction Sideswipe	Other - Explain in Narrative	Rear End	Right Angle	Right Turn	Ran Off Road	Same Direction Sideswipe	Total
Crashes 2014-2016	14	8	75	5	5	379	100	14	25	70	697

As seen in **Table 1**, the most frequent crash type was rear end crashes by a large margin. The high number of rear end crashes may be due to congestion along the US 31 corridor. Safety recommendations will need to focus heavily on reducing the number of rear end crashes occurring in the corridor. The next most frequent crash types were right-angle and left turn crashes. These crashes typically occur in intersections and have a higher probability of causing injury. Implementing intersection alternatives that limit these dangerous impacts is crucial to improving corridor safety for US 31 through Franklin.

Table 2 tallies the different severities of crashes along the US 31 corridor. The levels of severity are fatal, injury, and property damage. Injury crashes are separated into two categories: incapacitating and non-incapacitating. An incapacitating injury is a non-fatal injury that prevents the injured person from walking, driving or normally continuing the activities the person was capable of performing before the injury occurred. Hospitalization is usually required. A non-incapacitating injury is an injury, other than a fatal or incapacitating injury, which is evident to the officer at the scene of the crash and may require medical treatment, but hospitalization is usually not required. Two fatalities occurred in the corridor in recent history, but they are not included in ***Table 2*** because they occurred during 2013, which is outside the analysis period. The first fatality occurred because of a left turn crash between a motor vehicle and a moped at the intersection of Banta Street and US 31. The second fatality resulted from the collision of a motor vehicle with a pedestrian crossing US 31 near the intersection of Acorn Road and US 31. These crashes will be noted so that countermeasures might be considered to help prevent future incidents at these locations.

Table 2- Collision Severity

Intersection	Fatal	Injury	Property Damage	Total
Acorn Rd	0	8	21	29
Adams St	0	6	11	17
Banta St	0	3	10	13
Branigin Rd	0	3	20	23
Cedar Ln	0	2	1	3
Christian Blvd-Oakville Blvd	0	8	18	26
Commerce Dr	0	9	26	35
Earlywood Dr	0	14	31	45
Hospital Rd	0	6	16	22
Industrial Dr	0	1	6	7
International	0	1	12	13
Ironwood Dr	0	0	0	0
Israel Ln	0	2	2	4
Jefferson St	0	6	37	43
King St	0	1	8	9
Kohls Ent	0	0	1	1
Kroger Dr	0	2	2	4
KYB North	0	0	4	4
KYB South	0	0	3	3
Lancer Dr-Sloan Dr	0	2	5	7
Lemley St	0	3	11	14
Locust St	0	0	0	0
Madison St	0	1	4	5
S Main St	0	0	5	5
Mallory Pkwy	0	11	16	27
Nineveh Rd	0	4	7	11
Paul Hand Rd	0	0	1	1
Schoolhouse Rd	0	13	48	61
Simon Rd	0	14	23	37
South St - Franklin Lakes Blvd	0	3	10	13
Tractor Supply - McDonalds	0	0	2	2
Utilities Dr -Blank	0	0	1	1
Walmart Entrance	0	6	40	46
Westview Dr - Main St	0	13	69	82
US 31 Segments	0	14	70	84
Total	**0**	**156**	**541**	**697**

Table 2 lists the severity of the collisions reported within the corridor. These 3 years saw no fatalities, 156 injuries, and 541 crashes involving property damage. The intersections with the most crashes are Commerce Dr., Earlywood Dr., Jefferson St., Schoolhouse Rd., Simon Rd., the main Walmart entrance, and Westview Dr. These intersections have some of the highest intersecting volumes so higher crash frequencies can be expected. These same intersections are where a significant percentage of the injuries occurred. Corridor treatments will be sought that emphasize improvements at these high-risk locations as well as the rest of the corridor.

Many of the intersections experiencing high numbers of crashes have been identified within the past two years by INDOT on the Network Screening lists as having indices of crash costs (Icc) that are above nominal levels for those types of intersections. The intersections within the study limits that have been recently identified in the screening lists include:

- Acorn Road
- Adams Street
- Banta Street
- Earlywood Drive
- Hospital Road
- Schoolhouse Road
- Simon Road
- Westview Drive

The higher crash rates might be due to both operational and human factors. Corridor speeds may be decreasing and resulting in impatient and aggressive drivers, causing them to accept too small of gaps or make risky decisions. Construction outside the corridor could have caused drivers to change routes and utilize US 31, increasing traffic volumes which increases exposure in the corridor. Deficiencies in existing infrastructure could also be contributing to the high crash rates. Many of the traffic signal heads do not have back plates and may be difficult to see at times. Other signals do not have one signal head per lane on all approaches, which may reduce their visibility along with lacking back plates. With failing to yield the right of way and distracted driving being two of the most common cited causes of crashes in this corridor, current driving habits are likely a major factor in the crash history. Electronic device usage during driving has become more prevalent and resulted in more drivers not being focused on traffic while driving.

The proposed project seeks to address several the factors cited in the crash reports. The intersection designs proposed to be implemented in the corridor restrict turning movements at the intersections that should reduce the occurrence of right angle and left turn crashes. Aggressive driving may be tempered through the corridor by improving progression, reducing the urgency felt by motorists. Improved progression should also reduce rear end crashes by reducing queue lengths and keeping traffic moving. Signal head backplates and additional signal heads will be added with the project, improving signal visibility, which should reduce instances of disregarding traffic signals and failing to yield the right of way.

One of the intersections that has been previously identified in INDOT's network screening (Simon Road) has been actively programmed for a safety project. The project will close the median opening at Simon Road on US 31, which is consistent with what is planned for that location within this project. Coordination should occur with the designer of the Simon Road project as the US 31 corridor project is further developed.

3.0 HSM Analysis

The 2010 Highway Safety Manual (HSM) 1st Edition was used to analyze the intersection conditions and crash history using the safety performance function (SPF) for urban and suburban arterials. Models have been developed that utilize the SPFs presented in the HSM to predict fatal, injury, and property damaging crashes. Geometric and site characteristics needed for the analysis were derived from aerial images.

3.1 Model Calibration

After site and geometric conditions were input, the analysis predictions did not closely match observed crash history. Therefore, calibration factors were developed to improve the accuracy of the HSM prediction. These factors were developed for the corridor's segments, signalized intersections, and stop controlled intersections. For each category, the total predicted crash frequency and the total observed crash frequency were summed. The observed crash total was divided by the HSM predicted total to develop calibration factors of 0.8 for segments, 3.4 for signalized intersections, and 1.8 for unsignalized intersections. The data for these calculations can be found in **Table 3**.

Table 3 - Calibration Factor Calculations

	Average Observed Crashes	Predicted Total Crashes	Calibration Factor
Signalized Intersections	137.3	40.8	3.4
Unsignalized Intersections	67.0	36.8	1.8
US 31 Segments	28.0	33.9	0.8

The calibration factors modify the results of the SPFs to better match local conditions. Once calibrated, the HSM model was compared against observed crash history to confirm they present similar results. The frequency of crashes predicted by the HSM and the observed number of crashes for the corridor are displayed in **Table 4**. The difference between the calibrated HSM model and observed crash history is shown in **Table 5**.

Table 4 - HSM Existing Crash History Analysis

Uncalibrated HSM Crashes Predicted (crashes/year)	Calibrated HSM Crashes Predicted (crashes/year)	Crashes Observed (crashes/year)
114.1	236.5	232.3

Table 5 – Calibrated HSM Crash Predictions

	Average Observed Crashes	Calibrated HSM	% Difference
Signalized Intersections	137.3	138.7	1%
Unsignalized Intersections	67.0	66.2	1%
US 31 Segments	28.0	27.1	3%

The calibrated model crash predictions are within 1.8% of the observed crash history. When broken out, both intersection types are modeled within 1.0% of the observed crash data and segments are modeled within 3.0%. Once calibrated, the HSM model was used to extrapolate future crash expectancy.

3.2 Crash Analysis

To improve the safety of the corridor, intersection modifications have been proposed. Those improvements include a large median separating northbound and southbound traffic along the length of the corridor. Throughout the corridor, median U-turn (MUT) intersection variations are proposed to be installed, including J-turns, boulevard lefts, and restricted-crossing U-turns (RCUTs). The proposed corridor configuration may be seen in ***Appendix A***. The J-turn is demonstrated in ***Figure 2***, below. This design eliminates minor street left turn and through movements at the main intersection. Minor street left turns and through movements are accommodated by downstream median cuts that permit U-turns. The main intersection is unsignalized. The RCUT intersection is the signalized version of the J-turn and may be seen in ***Figure 3***.

Figure 2– J-Turn Intersection

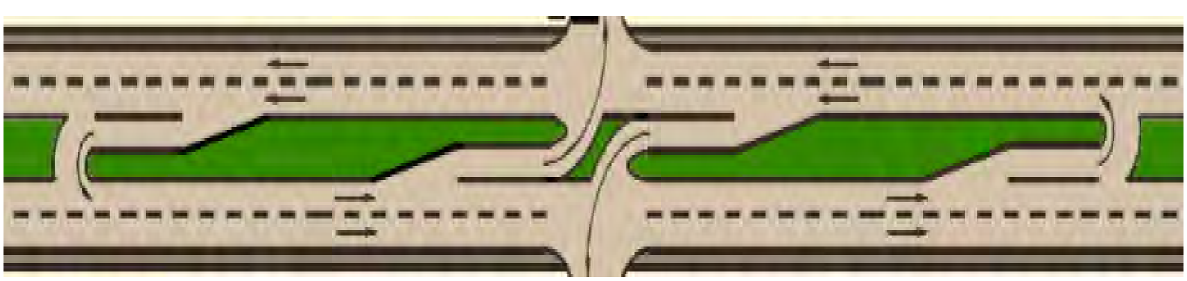
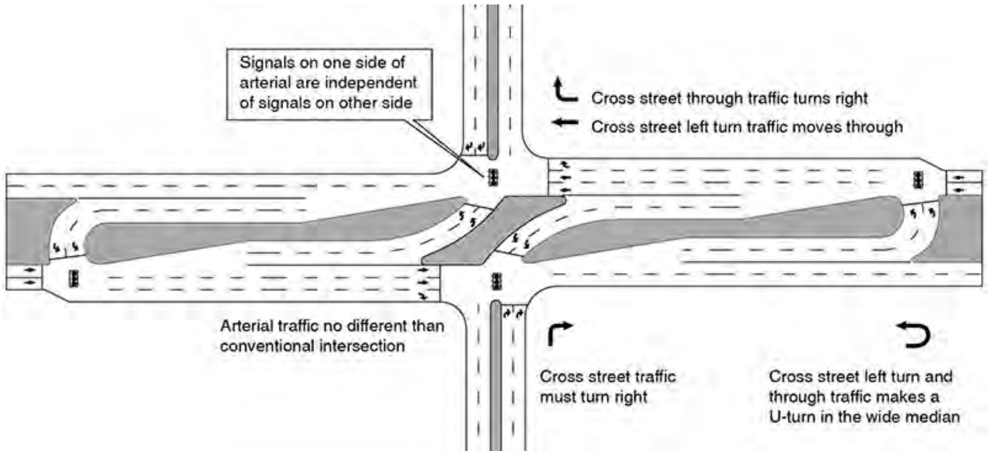


Figure 3– RCUT Intersection



Boulevard left intersections are another MUT variation. Unlike the RCUT and J-turn, the boulevard left prohibits all left turns at the main intersection, but does allow all through movements. Left turns must be conducted using a downstream U-turn, like the RCUT and J-turn intersections. *Figure 4* displays an example of a boulevard left.

Figure 4 – Boulevard Left Intersection

Reduction of left-turns throughout the corridor should eliminate many of the right-angle and turning crashes that occur within the corridor, particularly at minor road approaches where left turning traffic must find a gap in both directions of the major road traffic. To modify the HSM model for build conditions, crash modification factors (CMFs) were researched for conversion to J-turn, RCUT, Green T, and Median U-turn (MUT) intersections. CMFs were found on FHWA's Crash Modification Factor Clearinghouse website or in FHWA study reports and may be found in *Appendix B*. For converting a two-way stop-control (TWSC) intersection to a J-turn, a crash modification factor of 0.652 was found. This CMF indicates a reduction in crashes. This CMF, while developed for rural locations, was selected to be more conservative because the project is in a suburban/urban area. Other CMFs showed significantly more reduction in crashes for rural areas and no highly reliable CMFs were available for installing J-turns in suburban/urban areas.

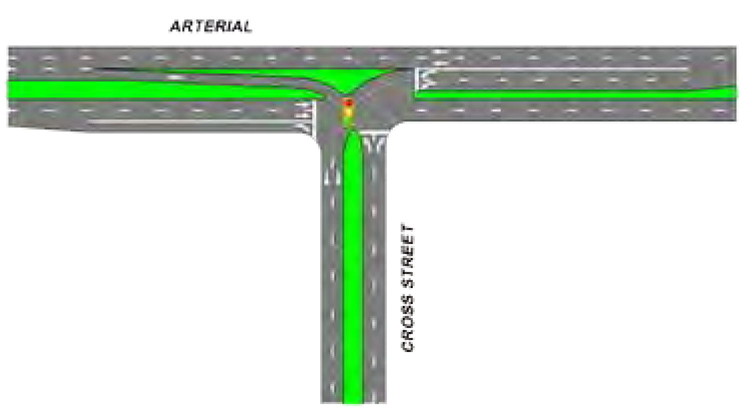
Most of the signalized intersections along the corridor are proposed to be replaced with median U-turn or RCUT intersections. Median U-turns eliminate all left turns in the intersections themselves. Similar to J-turns, left turns for both major and minor streets are accommodated by downstream median cuts that permit U-turns. For converting a signalized intersection to a MUT, a CMF of 0.84 was used. Some signalized intersections were proposed to be converted to RCUT intersections. RCUT intersections permit major street left turns at the main intersection, but minor street left-turn and through movements must make a right-turn and utilize a downstream U-turn median cut. A CMF of 0.78 was selected for converting a signalized intersection to an RCUT.

The addition of a median throughout the corridor would likely cause a reduction in crashes along the US 31 segments; however, the U-turn locations along the segments might negate the benefits of the medians. Medians would reduce the number of conflict points in the corridor, but U-turns dispersed throughout the segments would introduce new opportunities for crashes by adding some conflict points. Because of the uncertainty of the net result of the U-turns and medians, no crash reduction was included along the corridor segments.

A secondary Enhanced Build alternative was developed that modified the treatment at certain intersections based on the capacity analysis of the corridor. Additionally, a MUT intersection was proposed at Nineveh Road and a green T intersection at S. Main Street in this alternative. This would provide a consistent corridor treatment throughout US 31 through the City of Franklin. The revised corridor configuration may be seen in ***Appendix A***.

A green T-intersection, or continuous green T, is a signalized T intersection that channelizes the major street and minor street left turns. The minor street left turn is channelized into an acceleration lane or added lane to provide a free-flow merge or addition to the major road traffic stream. An example of a green T intersection is shown in ***Figure 5***.

Figure 5 – Green T Intersection



The proposed corridor design was used to develop crash predictions for 2023 and 2043 for both the Build and Enhanced Build alternatives. AADT predictions were provided by INDOT for the construction (2023) and design (2043) years. The J-turn, RCUT, Green T, and MUT CMFs were applied based on the proposed corridor design. As previously stated, no reduction factors were applied to the US 31 segments due to the introduction of U-turn movements. The HSM crash predictions are shown in ***Table 6***. Current AADT volumes were extrapolated using a 1.2% growth rate provided by INDOT to develop construction and design year volumes.

Table 6 – HSM Crash Predictions

	Fatal and Injury (crashes/year)	Property Damage (Crashes/year)	Total (crashes/year)
2023 Build	69	136	205
2023 No Build	87	167	254
2023 Enhanced Build	66	130	196
2043 Build	90	173	263
2043 No Build	115	217	332
2043 Enhanced Build	86	165	251
% Reduction Between 2043 Build and No-Build	21.7%	20.3%	20.8%
% Reduction Between 2043 Enhanced Build and No-Build	25.2%	24.0%	24.4%

The HSM was used to extrapolate crash predictions for the construction year (2023) and the design year (2043). **Table 6** displays the crash predictions calculated using the HSM. The Build alternative would see an estimated 20.8% decrease in crashes through the corridor. The Enhanced Build alternative is estimated to reduce total crashes by 24.4%. The injury and fatality rate reductions account for a significant portion of the overall reduction. In the 2043 Enhanced Build, there is predicted to be 29 fewer injury/fatal crashes than the No Build, four fewer than the 2043 Build alternative. The full HSM analysis results may be seen in ***Appendix C***.

4.0 RoadHat

In addition to the HSM safety analysis, a RoadHat safety audit was conducted using the RoadHat 3.0 program. The additional analysis was done to provide safety analysis results in a format that could be used for project ranking when applying for funding. Five intersections along the corridor were analyzed to provide a good representation of the safety improvements along the corridor. Crash modification factors were applied to the crash history for each intersection to develop the design year crashes. ***Table 7*** has the existing, construction and design year No Build, Build, and Enhanced Build Index of Crash Frequency (I_{CF}) and Index of Crash Cost (I_{CC}) values. The I_{CC} values were developed using 2013 dollars.

Table 7 – RoadHat Crash Index Predictions

US 31 Intersection	Index	Hospital Road	Jefferson Street	Westview Drive/N. Main Street	Schoolhouse Road	Commerce Drive
2017 Existing	I_{CF}	3.34	0.67	1.99	1.81	0.42
	I_{CC}	1.95	0.4	3.08	2.51	2.21
2023 No Build	I_{CF}	3.37	0.62	2.02	1.87	0.46
	I_{CC}	1.95	0.35	3.21	2.68	2.39
2023 Build	I_{CF}	2.29	0.34	1.54	0.71	0.17
	I_{CC}	1.52	0.2	2.84	1.8	1.8
2023 Enhanced Build	I_{CF}	0.19	0.34	1.05	0.71	0.17
	I_{CC}	1.02	0.2	2.43	1.8	1.8
2043 No Build	I_{CF}	3.76	0.59	2.07	1.91	0.48
	I_{CC}	2.26	0.3	3.43	2.82	2.51
2043 Build	I_{CF}	2.54	0.31	1.58	0.73	0.18
	I_{CC}	1.74	0.14	3.02	1.88	1.88
2043 Enhanced Build	I_{CF}	0.27	0.31	1.07	0.73	0.18
	I_{CC}	1.23	0.14	2.59	1.88	1.88

The results in ***Table 7*** confirm the results from the HSM analysis. The improvements to the US 31 corridor provide significant reductions in the Index of Crash Frequency at all five intersections. I_{CF} values decreased between 0.28 – 3.49 while I_{CC} values saw a more moderate decrease of 0.16 – 1.13 between the No Build and Enhanced Build alternatives. The Enhanced Build alternative results were the same or better than the Build alternative. The full RoadHat results may be found in ***Appendix D***.

5.0 Summary and Recommendations

Based on the results of the HSM analysis, it is recommended that a combination of median U-turn configurations proposed in the Enhanced Build alternative be implemented along the US 31 corridor in Franklin. The combination of J-turns, RCUTs, boulevard lefts and green T intersections will improve the safety of the corridor significantly based on HSM and RoadHat predictive analyses. The HSM predicts a 24.4% reduction in corridor crashes by 2043, and intersection I_{CF}

values are expected to decrease between 0.16 – 1.13 between the No Build and Enhanced Build alternatives. Additional safety improvements might also be realized with the improved traffic operations from the proposed design.

Compared to the Build alternative, the Enhanced Build alternative should be modified at a few intersections. Due to the positive results of this safety study and the capacity analysis, the following adjustments to the proposed are recommended in the Enhanced Build alternative:

- RCUT at Nineveh Rd.
- signalized green T at S. Main St.
- partial RCUT at Hospital Road
- a hybrid Boulevard Left at Jefferson Street
- RCUT at Mallory Parkway
- RCUT at Westview Drive/N. Main Street
- RCUT at Christian Blvd./Oakville Blvd.

The modifications listed above provide capacity as well as additional safety benefits to the corridor. By 2043, the Enhanced Build alternative will reduce the crash frequency of the corridor by an estimated 71 crashes compared to the No Build according to the HSM. Busy intersections such as Westview Dr. and Schoolhouse Rd. will see significant improvements in I_{CF} values, indicating improved safety at the US 31 intersections in Franklin. The recommended design to provide the analyzed safety benefits may be seen in ***Appendix A***.

Indiana Department of Transportation

100 North Senate Avenue, IGCN
Indianapolis, IN 46204

City of Franklin

70 East Monroe Street
Franklin IN 46131

Intersection Alternatives Memo

US 31 Corridor

June 2017

CMT Engineers and Consultants

8790 Purdue Road
Indianapolis, IN 46268

1.0 Introduction

This project will evaluate potential intersection types and corridor treatments on US Highway 31 (US 31) in Johnson County from South Main Street to Israel Lane. The proposed study area is located in Franklin, Indiana, beginning approximately 1.1 miles south of SR 44/SR 144/Jefferson Street at S. Main Street and extending north to Israel Lane 0.67 miles south of CR E 500 N/Whiteland Road.

The City of Franklin is proposing to reconfigure the US 31 corridor intersections in order to meet local and regional transportation needs. The design of this new corridor will be completed in a manner that best meets the needs of INDOT, Johnson County, the City of Franklin, and the traveling public. The formal purpose and need for the project will be determined through the NEPA process, but initial components of the purpose and need utilized for this study may include:

- Reduce **congestion** at intersections along US 31.
- Improve **roadway mobility** for the US 31 corridor.
- Improve **safety** throughout the roadway network through a more efficient transportation system.
- Support **non-motorized** modes of transport by developing an accommodation plan to improve non-motorized access to the City of Franklin and Johnson County.

1.1 Existing Conditions

US Highway 31- US Highway 31 is classified as a principle arterial by INDOT. From south to north, the speed limit at the south end of the project is 55 mph. The posted speed switches from 55 mph to 45 mph between S. Main Street and Nineveh Road. The speed limit decreases to 40 mph south of Hospital Road. The speed limit remains 40 through Franklin until it is increased to 50 mph north of the Walmart entrance. The whole corridor has 4 lanes, 2 Northbound lanes and two southbound lanes. Most of the corridor has a 30 to 40-foot median. The section from South St. to Lemley St. does not have a raised median, but does have a two-way left-turn lane (TWLTL). There are 34 intersections along the corridor. Of these 34 intersections, seven are major collectors, two are minor arterials, and one is a principle arterial. Eleven intersections are signalized, the rest are two-way stop-controlled (TWSC) on the minor street.

Figure 1 – Corridor Through Franklin

2.0 Intersection Design Methodology

The corridor of US 31 through Franklin, IN consists of signalized and stop-controlled intersections. The purpose of this memo is to analyze alternative intersection designs for implementation into the US 31 corridor to improve mobility and safety. The INDOT Intersection Decision Guide (IDG) and FHWA's Capacity Analysis for the Planning of Junctions (CAP-X) software were used for the decision-making process.

FHWA's CAP-X software is a spreadsheet-based tool to assist with intersection configuration development during early planning stages of a project. The software requires minimal inputs to determine which intersections should be further analyzed.

The alternative intersection types analyzed are as follows:

- Conventional Intersection
- Median U-turn Intersection
- Roundabout Intersection
- Displaced Left-Turn Intersection
- Jug-Handle Intersection
- Offset "T" Intersection
- Green "T" Intersection
- Quadrant Roadway Intersection
- Grade Separation Intersection
- No Build

For more information on each intersection type, please see the INDOT IDG. The initial screening in the IDG is done via four yes/no questions in a flowchart. The intersection type must pass all four questions for that alternative to be considered viable. The intersection would then go on to a secondary assessment. This memo will focus on the initial screening.

The first assessment question, "Is it feasible and reasonable given site and geometric characteristics, notably right of way constraints, sheer nature of the junction (3 vs. 4 legs), and presence or absence of median potential?". The analysis for this criterion was done using aerial images and engineering judgment. The need for some right-of-way acquisition did not eliminate an alternative, but significant right-of-way needs in developed areas did.

The second question asks, "Is there a reasonable expectation that it will address essential project intent (remedy the core problem, be it traffic safety or traffic mobility), and does it do so in a manner in balance with the scale of the problem?". Determining the effectiveness of the alternative solution was done by CAP-X software. Major and minor road information were entered into the software. The effectiveness of the alternatives is displayed in ***Appendix A***.

The third question is, "Does it likely improve or preserve existing state of performance relative to traffic safety (for all modes, including pedestrians), irrespective of essential project intent, be it mobility or safety?" The analysis for this criterion was done using information in the INDOT IDG.

The final question is written as, "Is it feasible and reasonable with respect to all other factors:

- Initial capital and recurring costs
- Stakeholders, customers
- Project development time
- Continuity, uniformity
- Environmental impacts
- Utility impacts"

The Question Four analysis was done using a subjective, high-level analysis. Information derived from aerial images and past project experiences were used as the basis for most of the decision making. A high-level Red Flag Investigation was also done to identify some potential environmental concerns. Some of the results of the red flag investigation are described below. Additional information may be found in ***Appendix B***.

NWI-Wetlands – Eighteen wetlands are located within 0.5 miles of the project. One of these wetlands crosses the project and may be impacted.

Floodplain-FIRM – Two floodplains are located within 0.5 miles of the project. One of the identified floodplains crosses the project at two locations. Both floodplains may be impacted by the project.

Rivers and Streams – Three rivers/streams are located within 0.5 miles of the project. Two of these streams cross the project. These streams may be impacted.

Underground Storage Tanks (UST) – Thirty-five underground storage tanks are located within 0.5 miles of the project. Eighteen of the underground storage tanks are located near the limits of the project. Of the tanks within the project limits, ten are leaking. The project may impact some of the USTs.

3.0 Intersection Design Analysis

For the analysis, the four questions were applied one at a time for each intersection type at each intersection in the project corridor. For each question, if the design met the question criteria, it was given a "yes" and proceeded to the next question. If the design received a "no", the analysis for that design at the particular intersection ended. At the fourth question, if a design received a yes, it was deemed a feasible design for that intersection. The full results of the analysis are presented in ***Table 1***.

Table 1- Results of Initial Screening

Intersection	Conventional Intersection (signilized or unsignilized)				Median U-turn Intersction (Boulevard/ Michigan Left, J-turn, RCUT)				Roundabout Intersection				Displaced Left-Turn Intersection (Continuous Flow)				Jug-Handle Intersection (near- or far-sided)				Offset "T" Intersection				Green "T" Intersection (Florida "T")				Quadrant Roadway Intersection				Grade Seperation (Overpass)				Other Alternative			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Acorn Rd	Yes	No			Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No			No				No				Yes	Yes	Yes	Yes	No				No							
Adams St	Yes	No			Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No				No				No				No				No				No							
Banta St	Yes	No			Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No				No				No				No				No				No							
Branigin Rd	Yes	No			Yes	Yes	Yes	Yes	No				No				No				No				No				No				No							
Cedar Ln	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No				No				Yes	Yes	Yes	Yes	No				No							
Christian Blvd-Oakville Blvd	Yes	No			Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No				No				No				Yes	Yes	Yes	No				
Commerce Dr	Yes	No			Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No				No				No				No				Yes	No						
Earlywood Dr	Yes	No			Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No				No				No				Yes	No						
Hospital Rd	Yes	No			Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No				No				No				Yes	Yes	Yes	Yes	Yes	No			No							
Industrial Dr	Yes	No			Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No				No				No				Yes	Yes	Yes	Yes	No				No							
International Dr	Yes	No			Yes	Yes	Yes	Yes	No				Yes	Yes	Yes	No	No				No				Yes	Yes	Yes	Yes	No				No							
Ironwood Dr	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No			No				No				No				No				No							
Israel Ln	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No			No				No				Yes	Yes	Yes	Yes	No				No							
Jefferson St	Yes	No			Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No				No				No				No				No				No							
King St	Yes	No			Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No				No				No				No				No				No							
Kohls Ent	Yes	No			Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No				No				Yes	Yes	Yes	Yes	No				No							
Kroger Dr	Yes	No			Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No				No				No				Yes	Yes	Yes	Yes	No				No							
KYB North	Yes	No			Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No				No				No				No				No				No							
KYB South	Yes	No			Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No				No				Yes	Yes	Yes	Yes	No				No							
Lancer Dr-Sloan Dr	Yes	No			Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No				Yes	Yes	Yes	No	Yes	Yes	Yes	No				
Lemley St	Yes	No			Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No				No				No				Yes	Yes	Yes	Yes	No				No							
Locust St	Yes	No			Yes	Yes	Yes	Yes	Yes	No			No				No				No				No				No				No							
Madison St	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No				No				No				No				No				No							
South Main St	Yes	No			Yes	Yes	Yes	Yes	Yes	No			Yes	No			No				No				Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No				
Mallory Pkwy	Yes	No			Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No				No				No				No				No				No							
Nineveh Rd	Yes	No			Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No				Yes	No			Yes	No			No				Yes	Yes	Yes	No	Yes	Yes	Yes	No				
Paul Hand Rd	Yes	No			Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No				Yes	Yes	Yes	No	No				Yes	Yes	Yes	Yes	Yes	No			No							
Schoolhouse Rd	Yes	No			Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No				No				No				No				No							
Simon Rd	Yes	No			Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No			Yes	Yes	Yes	No	No				No				Yes	Yes	Yes	No	No							
South St - Franklin Lakes Blvd	Yes	No			Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No				No				Yes	Yes	Yes	No	No							
Tractor Supply - McDonalds	Yes	No			Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No				No				No				No				No				No							
Utilities Dr	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No				No				No				No				No				No							
Walmart Entrance	Yes	No			Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No				No				No				No				No							
Westview Dr - Main St	Yes	No			Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No				No				No				No				No				No							

The alternatives screening in ***Table 1*** confirms the feasibility of the proposed design that would install median U-turns throughout the corridor. Median U-turns pass the initial screening in all but one intersection. Roundabout intersections were also found to be feasible at many corridor intersections. Roundabouts may require more right of way acquisition than the MUTs because the U-turn locations can be moved along the corridor to lessen impacts. Green "T" intersections were also deemed feasible at several three-legged intersections. All three intersection types need or accommodate medians, which would be present in this corridor. These intersection designs could be incorporated into the same corridor.

4.0 Summary and Recommendations

The intersection design analysis confirms the feasibility of the proposed corridor design. Median U-turns are feasible throughout a majority of the entire corridor and would provide a continuous intersection treatment throughout. Green T intersections could be implemented with the MUTs at T-intersections but could not be implemented corridor-wide. Roundabouts could also provide a consistent corridor treatment. While roundabouts are feasible, they are not recommended for this corridor for the following reasons:

1. A main goal of this project is improved progression on the US 31 corridor through Franklin. Traffic would be forced to slow at each roundabout, slowing corridor progression and increasing corridor travel time.

2. Roundabouts interspersed with MUTs would prevent the progression of platoons along the US 31 corridor and would break up platoons arriving at downstream signals, lowering the signal efficiency.
3. US 31 is an alternate route for I-65 when events on I-65 require lane or full closures of the interstate. Providing quicker progression through the corridor would lessen the impact of interstate traffic detouring to US 31 when I-65 is congested or impassable.

Median U-Turn configurations are recommended for the US 31 corridor. Nineveh Road is recommended for inclusion in the study as a median U-turn design, similar to the proposed design for the rest of the corridor. This may provide additional travel time improvements and would provide a consistent treatment on US 31 through the Franklin city limits. A green T intersection is recommended for analysis at S. Main Street where there is a significant minor street left turn volume. Safety and capacity analyses were conducted, and the results may be found in the US 31 *Capacity Analysis Memo* and the US 31 *Safety Countermeasures Memo*. The memos confirmed MUTs to be an effective corridor design. Refer to those reports for the recommended design at each intersection.

PROVEN SAFETY COUNTERMEASURE:

Reduced Left-Turn Conflict Intersections

FHWA Safety Program

U.S. Department of Transportation
Federal Highway Administration

Safe Roads for a Safer Future
Investment in roadway safety saves lives

http://safety.fhwa.dot.gov

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Cover photo sources: Left - Bolton & Menk, Inc., Top right - FHWA, Right bottom - FHWA

Reduced Left-Turn Conflict Intersections

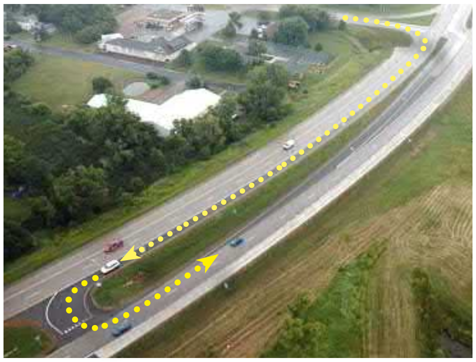
What is it?

Generally, reduced left-turn conflict intersections are geometric designs that lessen the number or severity of potential vehicle-to-vehicle conflicts associated with left-turn movements. Two of these highly effective intersection designs are included in this FHWA Proven Safety Countermeasure—the **restricted crossing U-turn (RCUT)** and the **median U-turn (MUT)**. In addition to modifying conflict points, these designs simplify driver decisions, reduce intersection congestion and delay, and minimize the potential for related crashes. For the RCUT and the MUT, the main intersection and the designated U-turn locations may be signalized or unsignalized.

Restricted Crossing U-turn

(Also known as: J-Turn, Synchronized Street, Superstreet)

The RCUT intersection design modifies the direct left-turn and through movements that drivers make from cross-street approaches. In an RCUT design, cross-street vehicles make a right turn followed by a U-turn at a designated location before continuing in the desired direction.



Source: Bolton & Menk, Inc.

Median U-turn

(Also known as: Michigan Left, Express Left, ThrU-Turn, Boulevard Left)

Source: FHWA

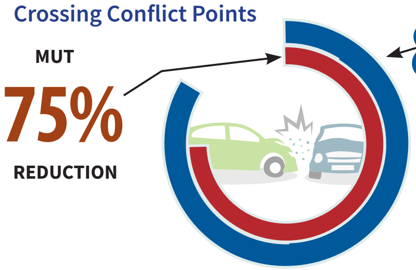
The MUT intersection design modifies direct left turns from either (or both) the major and minor approaches. Vehicles proceed through the targeted main intersection, make a U-turn a short distance down the road, then make a right turn at the targeted main intersection. Left-turning traffic on the minor approach can also be directed to make a right turn at the main intersection followed by a U-turn at a designated location.

"It is estimated that **10 to 20** *reduced-conflict intersections can be* **built for the cost of ONE interchange.** *We are treating as many intersections as possible, being effective with taxpayer dollars and, most important,* **saving lives with every installation.**"
Minnesota DOT

What are the Benefits?

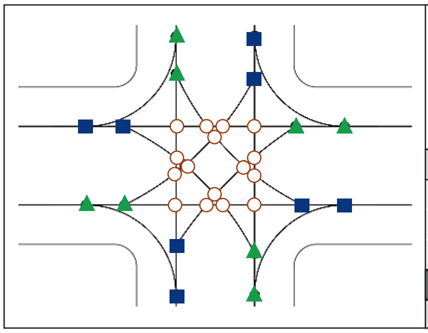
Safety

The underlying reason for the proven safety of the RCUT and MUT intersection designs is the reduction of conflict points—in particular, crossing conflict points. Each *crossing* conflict point increases the opportunity for right-angle crashes (also called T-bone crashes) to occur, which often result in severe injuries or fatalities. Compared to traditional intersection designs, the RCUT and MUT intersection designs reduce the number of *crossing* conflict points by 87 percent and 75 percent, respectively.



With this dramatic lessening in potential conflict points, the reduced left-turn conflict intersection strategy is proving its worth as States are increasingly implementing—and realizing the safety benefits of—RCUT and MUT designs.

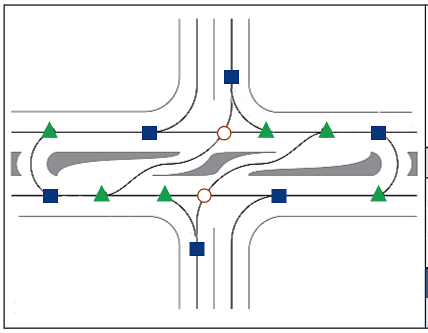
Conventional Intersection: Conflict Points



Legend
○ = Crossing
■ = Merging
▲ = Diverging

Conflict Type	Count
Crossing	16
Merging	8
Diverging	8
Total:	32 Conflicts

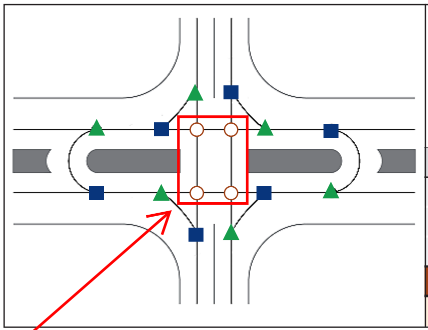
RCUT Intersection: Conflict Points



Legend
○ = Crossing
■ = Merging
▲ = Diverging

Conflict Type	Count
Crossing	2
Merging	6
Diverging	6
Total:	14 Conflicts

MUT Intersection: Conflict Points



Legend
○ = Crossing
■ = Merging
▲ = Diverging

Conflict Type	Count
Crossing	4
Merging	6
Diverging	6
Total:	16 Conflicts

In Des 1800082, the MUT intersections where all left turns are restricted will not have these conflict points.

The following table highlights several RCUT implementations and study results.

MARYLAND	MINNESOTA	MISSOURI	NORTH CAROLINA
9 RCUT intersections along US 15 and US 201[1]	**8 RCUT intersections**[3]	**5 RCUT intersections along US 63**[4]	**93 RCUT intersections**[5,6]
■ 44% reduction in total crashes **RCUT at US 301 and MD-313**[2] ■ 92% crash reduction over a 10-year period ■ 100% reduction in right-angle collisions and fatal and injury crashes	■ 100% reduction in fatal and serious injury right-angle crashes ■ 77% reduction in all severity right-angle crashes ■ 50% reduction in injury crashes	■ 35% reduction in total crashes ■ 54% reduction in fatal and injury crashes	■ 59% reduction in total crashes ■ 71% reduction in fatal and injury crashes ■ The study also showed that these crash reductions remained consistent over a range of intersection volumes

1 USDOT, FHWA, Field Evaluation of a Restricted Crossing U-Turn Intersection, FHWA-HRT-11-067 (June 2012). Available at: https://www.fhwa.dot.gov/publications/research/safety/hsis/11067/11067.pdf.

2 Hochstein, J., T. Maze, T. Welch, "The J-turn Intersection Design Concept Basics," September, 2008. Available at: https://transportation.ky.gov/Congestion-Toolbox/Documents/J-Turn%20101.pdf.

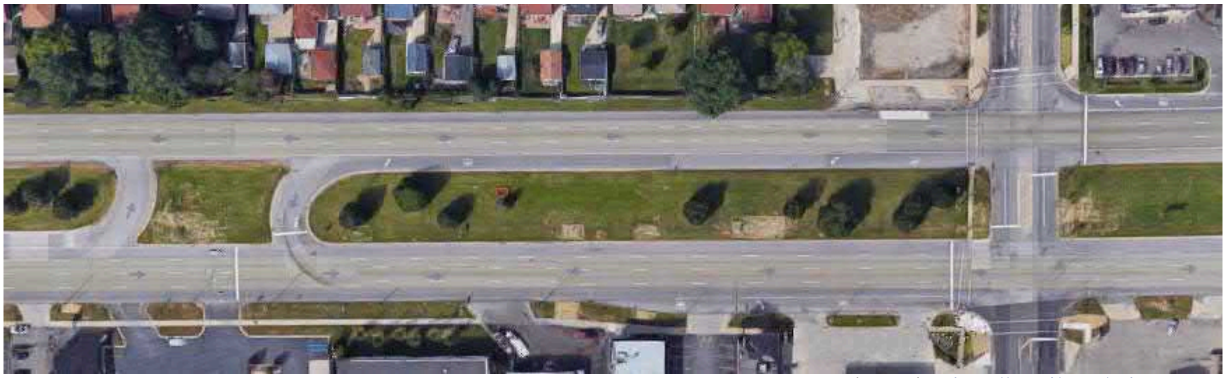
3 Minnesota Department of Transportation, A Study of the Traffic Safety at Reduced Conflict Intersections in Minnesota (May 2017). Available at: http://www.dot.state.mn.us/roadwork/rci/docs/trafficsafetyatrcistudy.pdf.

4 Edara, P., C. Sun, and S. Breslow. "Evaluation of J-turn Intersection Design Performance in Missouri." Missouri Department of Transportation, December 2013.

5 Simpson, C., Safety Effectiveness of Un-Signalized Synchronized Street Intersections. North Carolina: North Carolina Department of Transportation, July 2016. Available at: https://connect.ncdot.gov/resources/safety/Safety%20Evaluation%20Completed%20Projects/Unsignalized%20Synchronized%20Street%20Presentation%202016.pdf.

6 North Carolina Department of Transportation, NCDOT Traffic Safety Unit Programs, Synchronized Streets Evaluation. Available at: https://connect.ncdot.gov/resources/safety/TrafficSafetyResources/Unsignalized%20Synchronized%20Streets.pdf.

Michigan Department of Transportation (MDOT) is a pioneer on MUT installations. The MDOT website reports that, on roadways where Michigan Lefts were implemented, overall crashes were reduced by 30 to 60 percent. The greatest reductions are rear-end and head-on crashes during left turns (a 60 to 90 percent reduction), and in right-angle crashes (60 percent reduction).[1]



Source: @2018 Google Map data, https://goo.gl/maps/DnhC4PJpu4L2

MUT intersection at US 24 and W. Warren Avenue in Dearborn Heights, Michigan.

1 Michigan Department of Transportation, "Michigan Lefts." last modified n.d., Available at https://www.michigan.gov/mdot/0,4616,7-151-9615_44557-161777—,00.html. Last accessed October 2, 2018.

Traffic Flow

The RCUT and MUT designs can reduce travel times and congestion as well as improve overall traffic flow.

Implementation of an MUT design can improve intersection throughput by 20 to 50 percent compared to direct left-turn configurations.*

Source: FHWA

*FHWA, Median U-turn Intersection, FHWA-SA-14-042, (Washington, DC: 2014)

Texas used the RCUT design (called Superstreet in Texas) on US 281 North and Loop 1604 West. Each corridor has yielded travel time reductions in both the morning and evening peak times.[2]

Travel Time Savings

	Morning Rush Hour	Evening Rush Hour
US 281	**19%**	**34%**
Loop 1604	**14%**	**35%**

According to the US 281 traffic study completed for the Alamo Regional Mobility Authority, **the RCUT design can reduce fuel consumption by 1.1 million gallons annually for the corridor**.[3]

1.1

million gallons annually

[2] Texas A&M Transportation Institute, Mobility Investment Priorities, Strategies, Superstreets. Available at: https://mobility.tamu.edu/mip/strategies-pdfs/system-modification/technical-summary/superstreets-4-pg.pdf.

[3] Alamo Regional Mobility Authority, Proposed U.S. Highway 281 Superstreet Traffic Study (June 2009).

Many agencies use the unsignalized RCUT design for their rural four-lane divided highways to improve safety. But in areas with higher volumes, signalized RCUTs and MUTs can also increase capacity and improve traffic efficiency.

- A signalized RCUT provides great flexibility in traffic signal timing to accommodate unbalanced traffic flow, because it allows for unique cycle lengths in each major street direction.
- A signalized MUT intersection can particularly improve traffic flow for the through movements on the major street by reducing the number of signal phases (from four to two) and shortening the overall signal cycle length. This can provide more “walk” time for pedestrians to cross the intersection, as well as more frequent crossing opportunities on an hourly basis.

Overall, reduced left-turn conflict intersections are often comparable in cost to an equivalent conventional design. When compared to a full, grade-separated interchange, RCUTs and MUTs cost much less while still meeting traffic demand, having fewer right-of-way impacts, and being faster to construct.

Signalized RCUT

3:1 When considering safety only

4:1 When considering both safety and operations

Source: Safety Evaluation of Signalized Restricted Crossing U-Turn Intersections, FHWA-HRT-17-082.

Source: @2018 Google Map Data, https://goo.gl/maps/8sML3WGT3v12

RCUT intersection at US 169 and Dodd Road in Traverse Township, Minnesota.

What Do I Need To Know To Implement RCUTs and MUTs?

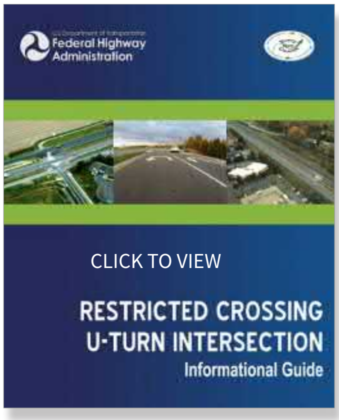
Design and User Considerations

Some of the basic elements agencies will need to consider when implementing RCUT and MUT intersections include acceleration/auxiliary lanes, crossover spacing, median width, signing and pavement marking, and accommodations for large trucks, pedestrians, bicycles, emergency vehicles, and transit.

Signing, pavement marking, and geometric design are especially important for the success of RCUTs and MUTs. Providing sufficient guidance and direction to motorists reduces the chance of driver error and discourages prohibited turns.

The RCUT and MUT designs are adaptable and useful not only as a corridor treatment, but also as a treatment for single intersections. In addition, the designs can support community mobility and safety goals for both pedestrians and bicyclists.

FHWA has developed comprehensive informational guides for both RCUTs and MUTs. The guides provide multiple design options for accommodating pedestrians, bicyclists, and transit. Transportation practitioners looking to learn more about detailed design elements and overall guidance should refer to these publications.



Source: FHWA.

FHWA Informational Guides for RCUT and MUT Intersections.

Source: MoDOT, https://flic.kr/p/8YT2t5.

Extra pavement or loons may be necessary at the U-turn location to accommodate large vehicles where narrow medians are present.

Source: North Carolina DOT.

Providing sufficient guidance and direction to motorists reduces the chance of driver error.

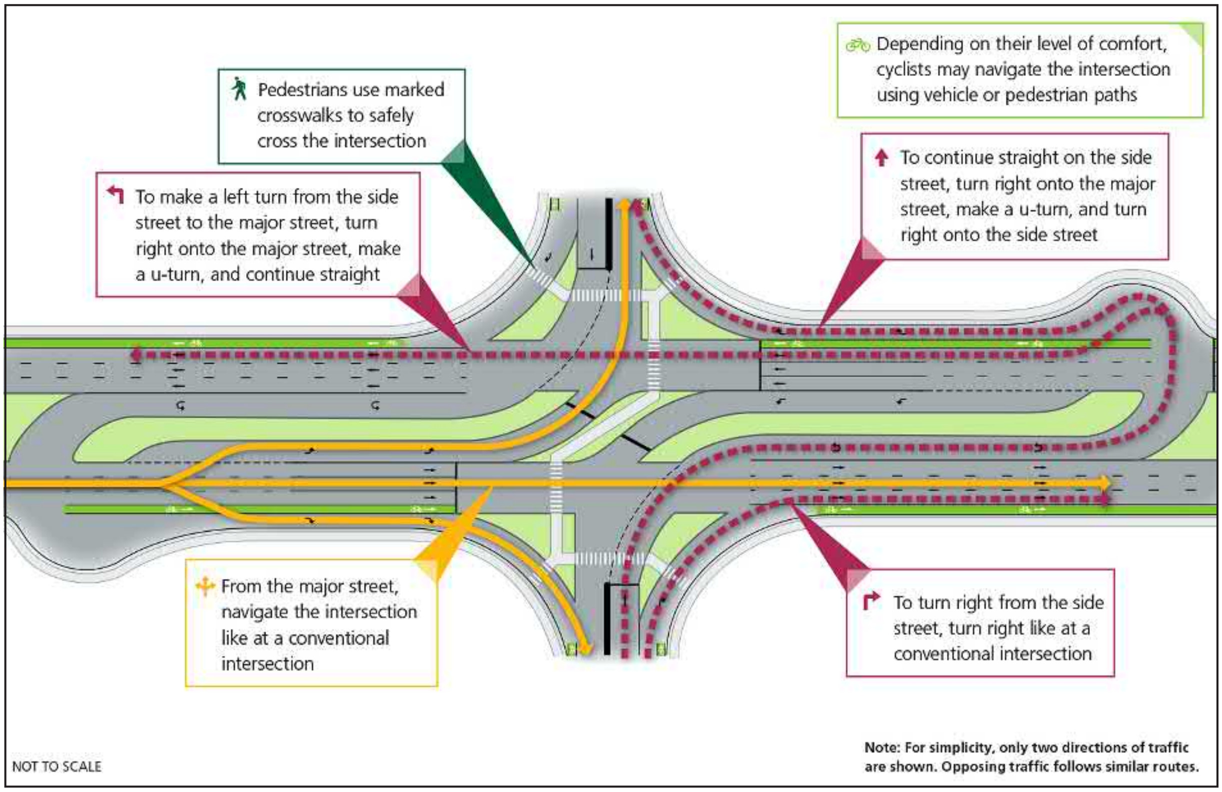
Public Outreach and Education

Public meetings are now commonplace for most transportation projects, but outreach becomes more important when implementing an unconventional intersection, especially in an area that has not experienced an RCUT or MUT design.

> *"In Missouri, converting from two-way stop-controlled intersections to RCUT intersections **cut the average wait time in half**."*
>
> Source: Evaluation of J-turn Intersection Design Performance in Missouri

One common concern from the public is often related to the "perceived" extra travel time they think will occur by using the u-turn designs. Most implementations have demonstrated that travel time actually improves, and the resulting safety benefits that the RCUT and MUT intersections offer are substantial.

To help address public concerns and explain the benefits of the designs, FHWA provides multiple case studies, fact sheets, brochures, and videos to help support State and local transportation agencies in their communication and education efforts. Many State DOTs have also developed their own materials; for example, Virginia DOT developed an Innovative Intersections and Interchanges website that features valuable information for the public on RCUTs and MUTs, as well as other designs.



Source: Virginia DOT.

Graphic that shows how to navigate an RCUT (available on Virginia DOT's website): http://www.virginiadot.org/info/innovative_intersections_and_interchanges/rcut.asp.

What Else Can I Learn from Others?

Exceptional Outreach and Education in Utah

Source: UDOT

When Utah DOT (UDOT) decided to implement the ThrU Turn—the first MUT in the western United States—the agency knew that public education and outreach needed to be a priority. UDOT developed numerous materials to help stakeholders understand the reduced left-turn conflict concept and how it will improve safety, reduce congestion, and support the economy. UDOT representatives visited businesses along the targeted corridors multiple times to explain the new design, provide information, and answer questions. The agency also hosted public meetings to provide opportunities to learn about the project, express concerns, and ask questions. To reach even more people, UDOT arranged for the ThrU Turn design informational videos to show at local theaters prior to the main feature. UDOT's ThrU Turn Intersection videos are available on UDOT's YouTube channel.

Reducing Left Turns in Orange Beach, Alabama

From 2012 to 2014, Highway 182 in Orange Beach experienced 227 total crashes, 49 injury crashes, and 4 fatalities – 50 percent of the fatalities were pedestrians. Alabama DOT (ALDOT) found that more than 70 percent of the crashes in this area involved left-turning traffic. To address these safety concerns, in 2016, ALDOT started a phased-construction roadway project on Highway 182 that included adding signalized median u-turns, redesigning intersections to restrict left-turn movements, and installing additional pedestrian crosswalks. With this reduced left-turn conflict intersection project, ALDOT sought to balance the needs of pedestrians, bicyclists, and motorists. While safety is the primary benefit, the project also allowed the City of Orange Beach to add landscaping to the medians, improving the overall aesthetics of the corridor, which is important for this vacation-destination city.

Source: Alabama DOT

Reduced left-turn conflict intersections can be designed to safely accommodate pedestrians and bicyclists, as shown in this preliminary concept graphic from Alabama DOT.

For More Information:

- FHWA's Office of Safety U-Turn-based Intersections Website

For More Information:

https://safety.fhwa.dot.gov/provencountermeasures/

FHWA Office of Safety

U.S. Department of Transportation
Federal Highway Administration

Safe Roads for a Safer Future
Investment in roadway safety saves lives

Updated July 2020

FHWA-SA-18-048

Bridge Inspection Report

031-41-07875

US 31

over

YOUNGS CREEK

Inspection Date: 10/21/2020

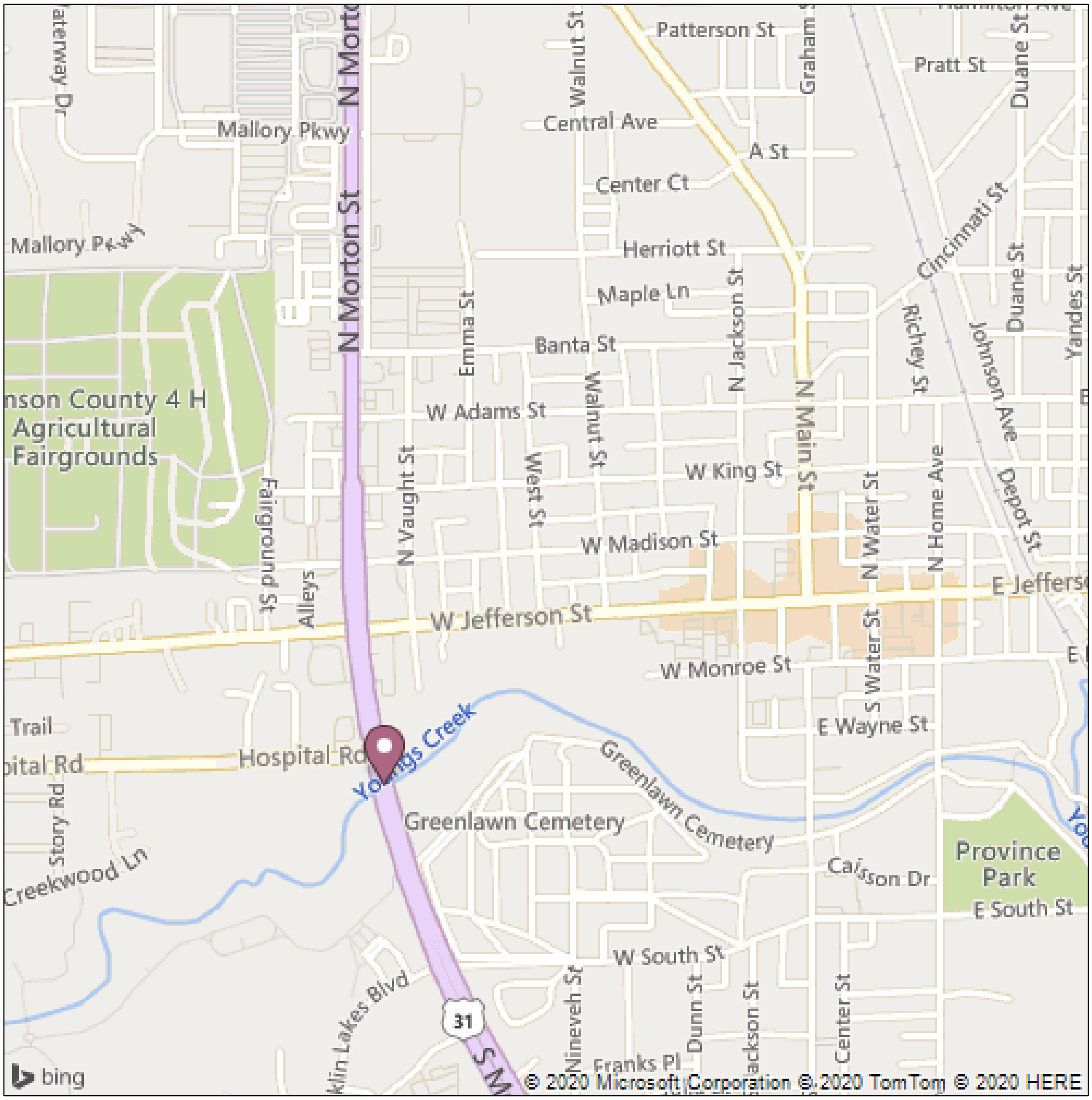
Inspected By: Jessica Waggoner

Inspection Type(s): Routine

TABLE OF CONTENTS

Latitude: 39.47773

Longitude: -86.06361



Latitude: 39.47773

Longitude: -86.06361

The bridge was built in 1998 under Contract R-22852, Des # 9247461.

The bridge is to receive a thin deck overlay under Contract B-42083, Des # 1900702, due to let on 9/15/2021.

Overall the structure is in good condition.

There is a deficiency for drain cleaning.

Changed Item 104 HIGHWAY SYSTEM OF THE INVENTORY ROUTE from 1 - Structure/Route is on NHS to 0 - Structure/Route is NOT on NHS and deleted the elements from the asset values due to updates to the NHS map. The elements and quantities can be found in previous reports. (Chris Everman 5/11/2018)

IDENTIFICATION

(1) STATE CODE:	**185 - Indiana**
(8) STRUCTURE:	**009390**
(5 A-B-C-D-E) INV. ROUTE:	**1 - 2 - 1 - 00031 - 0**
(2) HIGHWAY AGENCY DISTRICT:	**05 - Seymour**
(3) COUNTY CODE:	**041 - JOHNSON**
(4) PLACE CODE:	**25450 - FRANKLIN**
(6) FEATURES INTERSECTED:	**YOUNGS CREEK**
(7) FACILITY CARRIED:	**US 31**
(9) LOCATION:	**00.15 S SR 44**
(11) MILEPOINT:	**0010.640**

(12) BASE HIGHWAY NETWORK:	**0**
(13A) INVENTORY ROUTE:	
(13B) SUBROUTE NUMBER:	
(16) LATITUDE:	**39.47773**
(17) LONGITUDE:	**-86.06361**
(98) BORDER	
A) STATE NAME:	
B) PERCENT	**%**
(99) BORDER BRIDGE STRUCT. NO:	

STRUCTURE TYPE AND MATERIAL

(43) STRUCTURE TYPE, MAIN:	
A) KIND OF MATERIAL/DESIGN:	**6 - Prestressed concrete continuous**
B) TYPE OF DESIGN/CONSTR:	**02 - Stringer/Multi-beam or Girder**
(44) STRUCTURE TYPE, APPROACH SPANS:	
A) KIND OF MATERIAL/DESIGN:	**0 - Other**
B) TYPE OF DESIGN/CONSTR:	**00 - Other**

(45) NUMBER OF SPANS IN MAIN UNIT:	**003**
(46) NUMBER OF APPROACH SPANS:	**0000**
(107) DECK STRUCTURE TYPE:	**1 - Concrete Cast-in-Place**
(108) WEARING SURFACE/PROT SYS:	
A) WEARING SURFACE:	**1 - Monolithic Concrete (concurrently placed with structural deck)**
B) DECK MEMBRANE:	**0 - None**
C) DECK PROTECTION:	**1 - Epoxy Coated Reinforcing**

AGE OF SERVICE

(27) YEAR BUILT:	**1998**
(106) YEAR RECONSTRUCTED:	**0000**
(42) TYPE OF SERVICE:	
A) ON BRIDGE:	**1 - Highway**
B) UNDER BRIDGE:	**5 - Waterway**

(28) LANES:	
A) ON BRIDGE:	**05**
B) UNDER BRIDGE:	**00**
(29) AVERAGE DAILY TRAFFIC:	**013625**
(30) YEAR OF AVERAGE DAILY TRAFFIC:	**2004**
(109) AVERAGE DAILY TRUCK TRAFFIC:	**05 %**
(19) BYPASS DETOUR LENGTH:	**001 MI**

GEOMETRIC DATA

(48) LENGTH OF MAX SPAN:	**0049.2**	**FT**
(49) STRUCTURE LENGTH:	**00143.0**	**FT**
(50) CURB/SIDEWALK WIDTHS:		
A) LEFT	**00.0**	**FT**
B) RIGHT:	**00.0**	**FT**
(51) BRDG RDWY WIDTH CURB-TO-CURB:	**080.3**	**FT**
(52) DECK WIDTH, OUT-TO-OUT:	**086.2**	**FT**
(32) APPROACH ROADWAY	**080.0**	**FT**
(33) BRIDGE MEDIAN:	**2 - Closed median (no barrier)**	
(34) SKEW:	**15**	**DEG**

(35) STRUCTURE FLARED:	**0 - No flare**	
(10) INV RTE, MIN VERT CLEARANCE:	**99.99**	**FT**
(47) TOT HORIZ CLEARANCE:	**045.5**	**FT**
(53) VERT CLEAR OVER BR RDWY:	**99.99**	**FT**
(54) MIN VERTICAL UNDERCLEARANCE:		
A) REFERENCE FEATURE:	**N**	
B) MIN VERT UNDERCLEAR:	**0**	**FT**
(55) LATERAL UNDERCLEARANCE RIGHT:		
A) REFERENCE FEATURE:	**N**	
B) MIN LATERAL UNDERCLEAR:	**000.0**	**FT**
(56) MIN LATERAL UNDERCLEAR ON LEFT:	**00.0**	**FT**

INSPECTIONS

(90) INSPECTION DATE:	**10/21/2020**
(92) CRITICAL FEATURE INSPECTION:	
A) FRACTURE CRITICAL REQUIRED/FREQUENCY:	**N**
B) UNDERWATER INSPECTION REQUIRED/FREQUENCY:	**N**
C) OTHER SPECIAL INSPECTION REQUIRED/FREQUENCY:	**N**

(91) DESIGNATED INSPECTION FREQUENCY:	**24 MONTHS**
(93) CRITICAL FEATURE INSPECTION DATE:	
A) FRACTURE CRITICAL DATE:	
B) UNDERWATER INSP DATE:	
C) OTHER SPECIAL INSP DATE:	

CONDITION

(58) DECK:	**7 - Good Condition (some minor problems)**
(58.01) WEARING SURFACE:	**7 - Good Condition**
(59) SUPERSTRUCTURE:	**8 - Very Good Condition (no problems noted)**

(60) SUBSTRUCTURE:	**7 - Good Condition (some minor problems)**
(61) CHANNEL/CHANNEL PROTECTION:	**8 - Banks are protected**
(62) CULVERTS:	**N - Not Applicable**

CONDITION COMMENTS

(58) DECK: **7 - Good Condition (some minor problems)**

Comments:
Light cracking in parapet walls with 8' spacing.
There is a minor amount of chipping at the joints.

(58.01) WEARING SURFACE: **7 - Good Condition**

Comments:
The wearing surface is monolithic with the deck.
There is some minor cracking in the wearing surface. There is a minor amount of chipping at the joints.

(59) SUPERSTRUCTURE: **8 - Very Good Condition (no problems noted)**

Comments:
The superstructure is in good condition.

(60) SUBSTRUCTURE: **7 - Good Condition (some minor problems)**

Comments:
Rip rap missing on the east side of Abutment #1, between beams #6 and 7 at Abutment #1, and between beams #3 and 4 of Abutment #4 (possibly due to being moved). There are minor cracks in the wing walls.

(61) CHANNEL/CHANNEL PROTECTION **8 - Banks are protected**

Comments:
The channel protection is in good condition. There is minor drift on the west side of Span C.

(62) CULVERTS: **N - Not Applicable**

Comments:

LOAD RATING AND POSTING

(31) DESIGN LOAD:	**5 - HS 20**	(66) INVENTORY RATING:	**33**
(70) BRIDGE POSTING	**5 - Equal to or above legal loads**	(65) INVENTORY RATING METHOD:	**1 - Load Factor (LF)**
		(66B) INVENTORY RATING (H):	**24**
(41) STRUCTURE OPEN/POSTED/CLOSED:	**A - Open**	(66C) TONS POSTED :	
		(66D) DATE POSTED/CLOSED:	
(64) OPERATING RATING:	**55**		
(63) OPERATING RATING METHOD:	**1 - Load Factor (LF)**		

APPRAISAL

SUFFICIENCY RATING:	**97.4**	(36) TRAFFIC SAFETY FEATURE:	
STATUS:	**0**	36A) BRIDGE RAILINGS:	**1**
(67) STRUCTURAL EVALUATION:	**7**	36B) TRANSITIONS:	**1**
(68) DECK GEOMETRY:	**9**	36C) APPROACH GUARDRAIL:	**1**
(69) UNDERCLEARANCES, VERTICAL & HORIZONTAL:	**N**	36D) APPROACH GUARDRAIL ENDS:	**1**

(71) WATERWAY ADEQUACY: **8 - Bridge Above Approaches**
Comments:

(72) APPROACH ROADWAY ALIGNMENT: **8 - Equal to present desirable criteria**
Comments:

(113) SCOUR CRITICAL BRIDGES: **8 - Stable for scour conditions**
Comments:

CLASSIFICATION

(20) TOLL:	**3 - On Free Road**
(22) OWNER:	**01 - State Highway Agency**
(37) HISTORICAL SIGNIFICANCE:	**5 - Not eligible**
(101) PARALLEL STRUCTURE:	**N - No parallel structure**
(103) TEMPORARY STRUCTURE:	
(105) FEDERAL LANDS HIGHWAYS:	**0-Not Applicable**
(112) NBIS BRIDGE LENGTH:	**Yes**
(21) MAINT. RESPONSIBILITY:	**01 - State Highway Agency**
(26) FUNCTIONAL CLASS OF INVENTORY RTE:	**14 - Urban - Other Principal Arterial**
(100) STRAHNET HIGHWAY:	**Not a STRAHNET route**
(102) DIRECTION OF TRAFFIC:	**2-way traffic**
(104) HIGHWAY SYSTEM OF INVENTORY ROUTE:	**0 - Structure/Route is NOT on NHS**
(110) DESIGNATED NATIONAL NETWORK:	**Inventory route on National Truck Network**

NAVIGATION DATA

(38) NAVIGATION CONTROL:	**0 - No navigation control on waterway (bridge permit not required)**
(111) PIER OR ABUTMENT PROTECTION:	
(39) NAVIGATION VERTICAL CLEAR:	**000.0 FT**
(116) MINIMUM NAVIGATION VERT. CLEARANCE, VERT. LIFT BRIDGE:	**FT**
(40) NAV HORIZONTAL CLEARANCE:	**0000.0 FT**

PROPOSED IMPROVEMENTS

(75A) TYPE OF WORK:	
(75B) WORK DONE BY:	
(76) LENGTH OF IMPROVEMENT:	**00000.0 FT**
(94) BRIDGE IMPROVEMENT COST:	**$ 000000**
(95) ROADWAY IMPROVEMENT COST:	**$ 000000**
(96) TOTAL PROJECT COST:	**$ 000000**
(97) YR OF IMPROVEMENT COST EST:	
(114) FUTURE AVG DAILY TRAFFIC:	**019535**
(115) YR OF FUTURE ADT:	**2033**

Miscellaneous Asset Data

Asset Management

Load Rating 2:

Has the dead load or the structural condition of the primary load carrying members changed since the last inspection? No

Extended Frequency: Submittal Date:

Inspector:

INDOT Reviewer:

This bridge has been accepted into the Extended Frequency Program. Approval Date:

Joints: ** Indicate location, type, and rating of lowest rated joint.*

Mid-Section B 6

Comments:

Terminal Joints: **Rating of lowest rated terminal joint.* 7

Comments:

Concrete Slopewall: **Rating of lowest rated slopewall.* N

Comments:

Bearings: ** Indicate type, and rating of lowest rated bearing.*

2 - Elastmeric 8

Comments:

Approach Slabs: ** Indicate if present & condition rating.*

1 - Approach Slabs 7 - Good condition, minor cracking, wide spacing

Comments:

North and south approaches have angular, transverse and longitudinal cracks.

Paint: ** Indicate if paint present , year painted & condition rating.*

N - No Paint Not Rated

Comments:

Endangered Species: ** If yes, add one photo to the dropdown field*

Bats: seen or heard under structure? * N - No evidence of bats

Birds/swallows/nests seen? Empty nests present? * N - No Birds and/or Nests Visi

BRIDGE Culvert Geometry:

Barrel Length:

Height:

Width:

LOAD RATING - BRADIN

Load Rating Date: 22-OCT-07

National Bridge Inventory (NBI):

(66B) INVENTORY RATING (H):	24	(31) DESIGN LOAD:	5
(65) INVENTORY RATING METHOD:	1	(70) BRIDGE POSTING:	5
(66) INVENTORY RATING:	33	(41) STRUCTURE OPEN/POSTED/CLOSED:	A
(63) OPERATING RATING METHOD:	1	(66C) TONS POSTED:	
(64) OPERATING RATING:	55	(66D) DATE POSTED/CLOSED:	

Posting Configurations:

Emergency Vehicles:

EV2: LEGAL RF:	2.26
EV3: LEGAL RF:	1.528

2-Axles:

H20-44: LEGAL RF:	2.064
ALTERNATE MILITARY: LEGAL RF:	1.923

3-Axles:

HS20: LEGAL RF:	1.536
AASHTO TYPE 3: LEGAL RF:	2.101

4-Axles:

SU4: LEGAL RF:	1.822
TOLL ROAD LOADING NO. 2: ROUTINE PERMIT RF:	

5-Axles:

AASHTO TYPE 3S2: LEGAL RF:	2.086
SU5: LEGAL RF:	1.712
TOLL ROAD LOADING NO. 1: ROUTINE PERMIT RF:	

6+-Axles:

AASHTO TYPE 3-3: LEGAL RF:	2.221
LANE TYPE: LEGAL RF:	
SU6: LEGAL RF:	1.629
SPECIAL TOLL ROAD TRUCK: ROUTINE PERMIT RF:	
SU7: LEGAL RF:	1.569
MICHIGAN TRAIN TRUCK NO. 5: ROUTINE PERMIT RF:	
MICHIGAN TRAIN TRUCK NO. 8: ROUTINE PERMIT RF:	

Other Configurations:

H20-44: DESIGN RF:	1.236
NRL: LEGAL RF:	1.549
SUPERLOAD-11 AXLES: SPECIAL PERMIT RF:	.988
SUPERLOAD-13 AXLES: SPECIAL PERMIT RF:	1.058
SUPERLOAD-14 AXLES: SPECIAL PERMIT RF:	.777
SUPERLOAD-19 AXLES (152.5T): SPECIAL PERMIT RF:	1.044
SUPERLOAD-19 AXLES (240.045T): SPECIAL PERMIT RF:	.805

Bridge Inspection Report

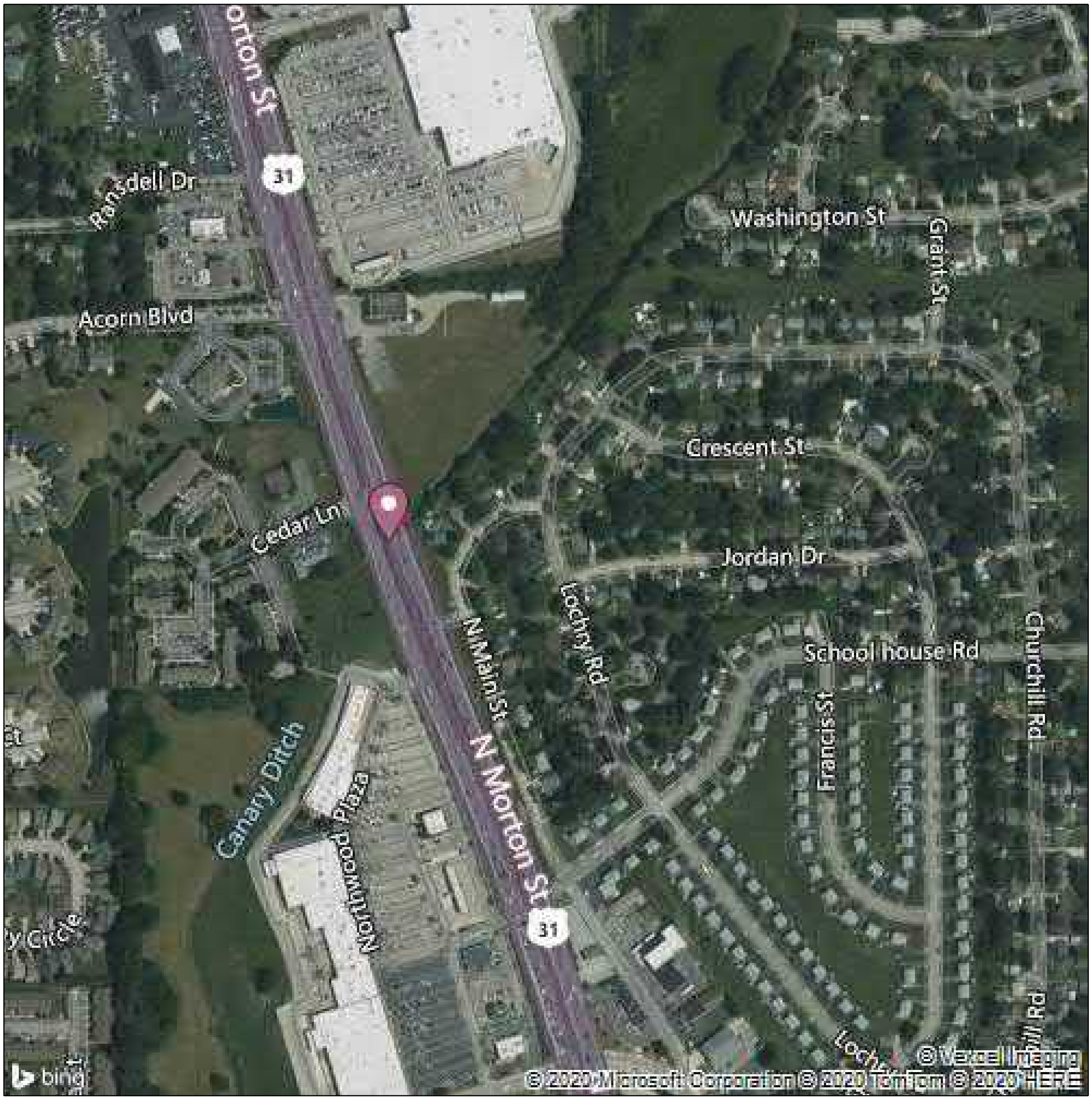
031-41-03534
US 31
over
CANARY DITCH

Inspection Date: 10/21/2020

Inspected By: Jessica Waggoner

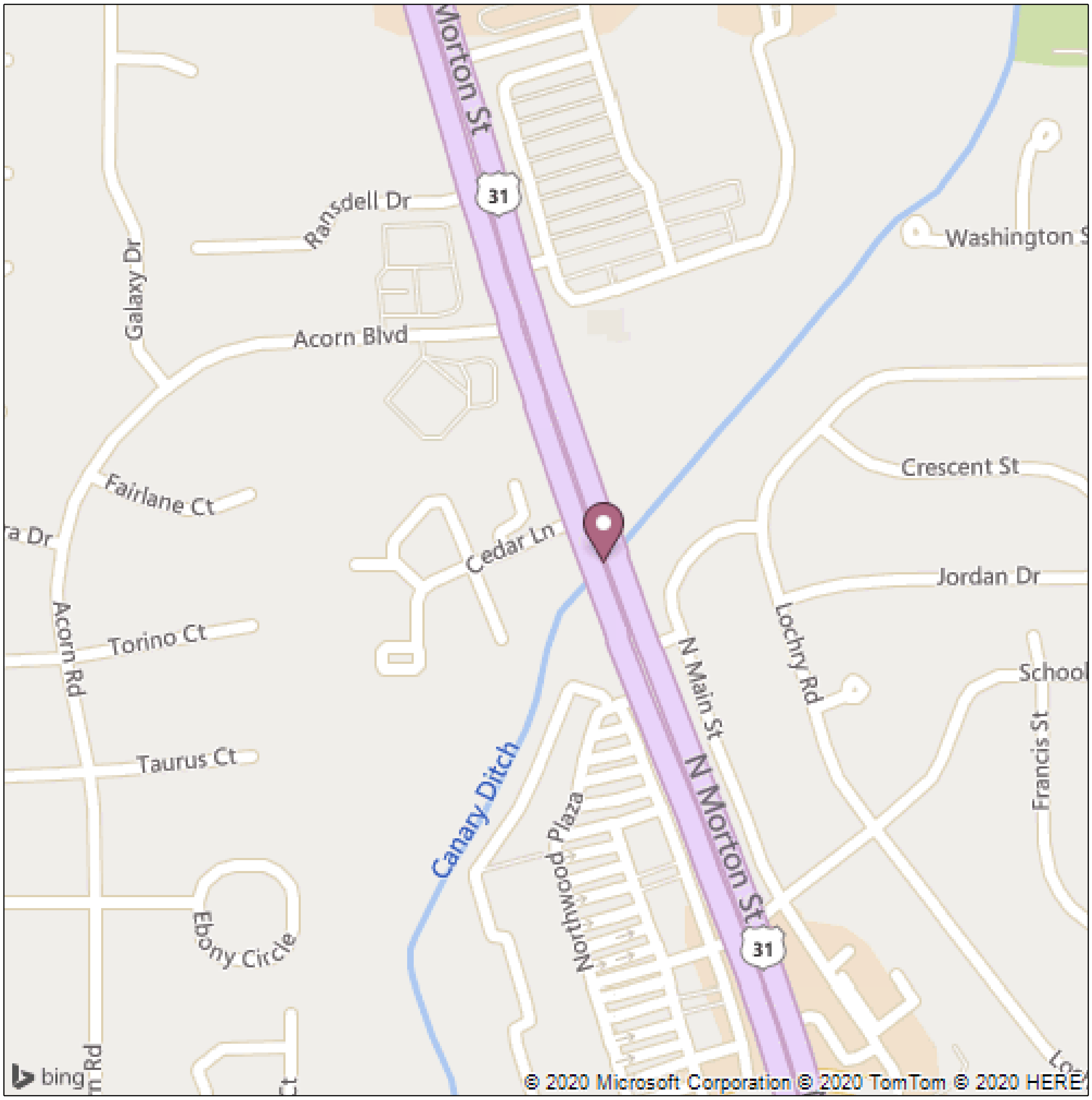
Inspection Type(s): Routine

TABLE OF CONTENTS



Latitude: 39.49877

Longitude: -86.06703



Latitude: 39.49877

Longitude: -86.06703

The bridge was built in 1946 under Contract R-2686.
The bridge is in SPMS for replacement under Contract B-41480, Des # 1800272, due to let on 10/13/2022.
The bridge is in fair condition.

IDENTIFICATION

(1) STATE CODE:	**185 - Indiana**
(8) STRUCTURE:	**009400**
(5 A-B-C-D-E) INV. ROUTE:	**1 - 2 - 1 - 00031 - 0**
(2) HIGHWAY AGENCY DISTRICT:	**05 - Seymour**
(3) COUNTY CODE:	**041 - JOHNSON**
(4) PLACE CODE:	**25450 - FRANKLIN**
(6) FEATURES INTERSECTED:	**CANARY DITCH**
(7) FACILITY CARRIED:	**US 31**
(9) LOCATION:	**01.30 N SR 44**
(11) MILEPOINT:	**0012.090**

(12) BASE HIGHWAY NETWORK:	**0**
(13A) INVENTORY ROUTE:	
(13B) SUBROUTE NUMBER:	
(16) LATITUDE:	**39.49877**
(17) LONGITUDE:	**-86.06703**
(98) BORDER	
A) STATE NAME:	
B) PERCENT	%
(99) BORDER BRIDGE STRUCT. NO:	

STRUCTURE TYPE AND MATERIAL

(43) STRUCTURE TYPE, MAIN:	
A) KIND OF MATERIAL/DESIGN:	**1 - Concrete**
B) TYPE OF DESIGN/CONSTR:	**19 - Culvert (includes frame culverts)**
(44) STRUCTURE TYPE, APPROACH SPANS:	
A) KIND OF MATERIAL/DESIGN:	**0 - Other**
B) TYPE OF DESIGN/CONSTR:	**00 - Other**

(45) NUMBER OF SPANS IN MAIN UNIT:	**001**
(46) NUMBER OF APPROACH SPANS:	**0000**
(107) DECK STRUCTURE TYPE:	**N - Not Applicable**
(108) WEARING SURFACE/PROT SYS:	
A) WEARING SURFACE:	**N - NA**
B) DECK MEMBRANE:	**N - NA**
C) DECK PROTECTION:	**N - NA**

AGE OF SERVICE

(27) YEAR BUILT:	**1946**
(106) YEAR RECONSTRUCTED:	**0000**
(42) TYPE OF SERVICE:	
A) ON BRIDGE:	**1 - Highway**
B) UNDER BRIDGE:	**5 - Waterway**

(28) LANES:		
A) ON BRIDGE:	**04**	
B) UNDER BRIDGE:	**00**	
(29) AVERAGE DAILY TRAFFIC:	**026617**	
(30) YEAR OF AVERAGE DAILY TRAFFIC:	**2004**	
(109) AVERAGE DAILY TRUCK TRAFFIC:	**05**	**%**
(19) BYPASS DETOUR LENGTH:	**007**	**MI**

GEOMETRIC DATA

(48) LENGTH OF MAX SPAN:	**0025.0**	**FT**
(49) STRUCTURE LENGTH:	**00028.0**	**FT**
(50) CURB/SIDEWALK WIDTHS:		
A) LEFT	**00.0**	**FT**
B) RIGHT:	**00.0**	**FT**
(51) BRDG RDWY WIDTH CURB-TO-CURB:	**068.0**	**FT**
(52) DECK WIDTH, OUT-TO-OUT:	**123.0**	**FT**
(32) APPROACH ROADWAY	**116.0**	**FT**
(33) BRIDGE MEDIAN:	**2 - Closed median (no barrier)**	
(34) SKEW:	**25**	**DEG**

(35) STRUCTURE FLARED:	**0 - No flare**	
(10) INV RTE, MIN VERT CLEARANCE:	**99.99**	**FT**
(47) TOT HORIZ CLEARANCE:	**040.0**	**FT**
(53) VERT CLEAR OVER BR RDWY:	**99.99**	**FT**
(54) MIN VERTICAL UNDERCLEARANCE:		
A) REFERENCE FEATURE:	**N**	
B) MIN VERT UNDERCLEAR:	**0**	**FT**
(55) LATERAL UNDERCLEARANCE RIGHT:		
A) REFERENCE FEATURE:	**N**	
B) MIN LATERAL UNDERCLEAR:	**000.0**	**FT**
(56) MIN LATERAL UNDERCLEAR ON LEFT:	**00.0**	**FT**

INSPECTIONS

(90) INSPECTION DATE:	**10/21/2020**
(92) CRITICAL FEATURE INSPECTION:	
A) FRACTURE CRITICAL REQUIRED/FREQUENCY:	**N**
B) UNDERWATER INSPECTION REQUIRED/FREQUENCY:	**N**
C) OTHER SPECIAL INSPECTION REQUIRED/FREQUENCY:	**N**

(91) DESIGNATED INSPECTION FREQUENCY:	**24 MONTHS**
(93) CRITICAL FEATURE INSPECTION DATE:	
A) FRACTURE CRITICAL DATE:	
B) UNDERWATER INSP DATE:	
C) OTHER SPECIAL INSP DATE:	

CONDITION

(58) DECK:	**N - Not Applicable**
(58.01) WEARING SURFACE:	**N - Not Applicable**
(59) SUPERSTRUCTURE:	**N - Not Applicable**

(60) SUBSTRUCTURE:	**N - Not Applicable**
(61) CHANNEL/CHANNEL PROTECTION:	**7 - Bank protection needs minor repairs**
(62) CULVERTS:	**5 - Moderate to major deterioration**

CONDITION COMMENTS

(58) DECK: **N - Not Applicable**

Comments:

(58.01) WEARING SURFACE: **N - Not Applicable**

Comments:
The wearing surface is in good condition.

(59) SUPERSTRUCTURE: **N - Not Applicable**

Comments:

(60) SUBSTRUCTURE: **N - Not Applicable**

Comments:
Spread footings, NO piles, set clay

(61) CHANNEL/CHANNEL PROTECTION **7 - Bank protection needs minor repairs**

Comments:
The banks are steep but well vegetated.
There was no drift at the time of inspection.
The channel bottom is soft.
There is erosion in the northwest ditch around the telephone pole.

(62) CULVERTS: **5 - Moderate to major deterioration**

Comments:
The barrel appears to have been repaired in the past. These repairs are holding.
Several cracks with efflorescence on lower portion of the barrel. Staining at the weep holes.
There is a 1' X 3" spall at the south spring line about 20' from the east arch ring. There is spalling with an area of approximately 2' X 25' at the north spring line half way through the structure. There is a 2' X 3' spall with exposed rebar in the top of the arch 50' from the west end of the structure. There is a 3' X 5' area of spalling at the north spring line 20' from the west end of the structure.
Headwalls are spalling, cracking, and have efflorescence. Wingwalls have cracking with efflorescence and staining. There is scaling along the west headwall and spandrel wall and 10' of scaling and spalling on the east headwall. There is some cracking and spalling with exposed rebar at the construction joints.

LOAD RATING AND POSTING

(31) DESIGN LOAD:	**5 - HS 20**
(70) BRIDGE POSTING	**5 - Equal to or above legal loads**
(41) STRUCTURE OPEN/POSTED/CLOSED:	**A - Open**
(64) OPERATING RATING:	**65**
(63) OPERATING RATING METHOD:	**1 - Load Factor (LF)**

(66) INVENTORY RATING:	**38**
(65) INVENTORY RATING METHOD:	**1 - Load Factor (LF)**
(66B) INVENTORY RATING (H):	**22**
(66C) TONS POSTED :	
(66D) DATE POSTED/CLOSED:	

APPRAISAL

SUFFICIENCY RATING:	**73.0**
STATUS:	**0**
(67) STRUCTURAL EVALUATION:	**5**
(68) DECK GEOMETRY:	**9**
(69) UNDERCLEARANCES, VERTICAL & HORIZONTAL:	**N**

(36) TRAFFIC SAFETY FEATURE:	
36A) BRIDGE RAILINGS:	**N**
36B) TRANSITIONS:	**N**
36C) APPROACH GUARDRAIL:	**0**
36D) APPROACH GUARDRAIL ENDS:	**0**

(71) WATERWAY ADEQUACY: **6 - Occasional Overtopping of Approaches - Insignificant Delays**
Comments:

(72) APPROACH ROADWAY ALIGNMENT: **8 - Equal to present desirable criteria**
Comments:

(113) SCOUR CRITICAL BRIDGES: **5 - Scour within limits of footing or piles**
Comments:

CLASSIFICATION

(20) TOLL:	**3 - On Free Road**
(22) OWNER:	**01 - State Highway Agency**
(37) HISTORICAL SIGNIFICANCE:	**5 - Not eligible**
(101) PARALLEL STRUCTURE:	**N - No parallel structure**
(103) TEMPORARY STRUCTURE:	
(105) FEDERAL LANDS HIGHWAYS:	**0-Not Applicable**
(112) NBIS BRIDGE LENGTH:	**Yes**
(21) MAINT. RESPONSIBILITY:	**01 - State Highway Agency**
(26) FUNCTIONAL CLASS OF INVENTORY RTE:	**14 - Urban - Other Principal Arterial**
(100) STRAHNET HIGHWAY:	**Not a STRAHNET route**
(102) DIRECTION OF TRAFFIC:	**2-way traffic**
(104) HIGHWAY SYSTEM OF INVENTORY ROUTE:	**0 - Structure/Route is NOT on NHS**
(110) DESIGNATED NATIONAL NETWORK:	**Inventory route not on network**

NAVIGATION DATA

(38) NAVIGATION CONTROL:	**0 - No navigation control on waterway (bridge permit not required)**
(111) PIER OR ABUTMENT PROTECTION:	
(39) NAVIGATION VERTICAL CLEAR:	**000.0 FT**
(116) MINIMUM NAVIGATION VERT. CLEARANCE, VERT. LIFT BRIDGE:	**FT**
(40) NAV HORIZONTAL CLEARANCE:	**0000.0 FT**

PROPOSED IMPROVEMENTS

(75A) TYPE OF WORK:	
(75B) WORK DONE BY:	
(76) LENGTH OF IMPROVEMENT:	**00000.0 FT**
(94) BRIDGE IMPROVEMENT COST:	**$ 000000**
(95) ROADWAY IMPROVEMENT COST:	**$ 000000**
(96) TOTAL PROJECT COST:	**$ 000000**
(97) YR OF IMPROVEMENT COST EST:	
(114) FUTURE AVG DAILY TRAFFIC:	**039614**
(115) YR OF FUTURE ADT:	**2031**

Load Rating 2:

Has the dead load or the structural condition of the primary load carrying members changed since the last inspection? No

Extended Frequency: Submittal Date:

Inspector:

INDOT Reviewer:

This bridge has been accepted into the Extended Frequency Program. Approval Date:

Joints: ** Indicate location, type, and rating of lowest rated joint.*

No Joints Present

N - ONLY to remove other value that is no longer present.

N - ONLY to remove other value that is no longer present.

Comments:

Terminal Joints: **Rating of lowest rated terminal joint.* N

Comments:

Concrete Slopewall: **Rating of lowest rated slopewall.* N

Comments:

Bearings: ** Indicate type, and rating of lowest rated bearing.*

N - No Bearing(s)

Comments:

Approach Slabs: ** Indicate if present & condition rating.*

N - No Approach Slabs

Comments:

Paint: ** Indicate if paint present , year painted & condition rating.*

N - No Paint	Not Rated

Comments:

Endangered Species: ** If yes, add one photo to the dropdown field*

Bats: seen or heard under structure? *	N
Birds/swallows/nests seen? Empty nests present? *	N

BRIDGE Culvert Geometry:

Barrel Length:	134.7
Height:	9
Width:	25

LOAD RATING - BRADIN

Load Rating Date: 13-OCT-11

National Bridge Inventory (NBI):

(66B) INVENTORY RATING (H):	22	(31) DESIGN LOAD:	5
(65) INVENTORY RATING METHOD:	1	(70) BRIDGE POSTING:	5
(66) INVENTORY RATING:	38	(41) STRUCTURE OPEN/POSTED/CLOSED:	A
(63) OPERATING RATING METHOD:	1	(66C) TONS POSTED:	
(64) OPERATING RATING:	65	(66D) DATE POSTED/CLOSED:	

Posting Configurations:

Emergency Vehicles:

EV2: LEGAL RF:

EV3: LEGAL RF:

2-Axles:

H20-44: LEGAL RF:

ALTERNATE MILITARY: LEGAL RF:

3-Axles:

HS20: LEGAL RF: 1.833

AASHTO TYPE 3: LEGAL RF: 2.055

4-Axles:

SU4: LEGAL RF: 4.037

TOLL ROAD LOADING NO. 2:
ROUTINE PERMIT RF:

Other Configurations:

H20-44: DESIGN RF: 1.1

NRL: LEGAL RF: 6.657

5-Axles:

AASHTO TYPE 3S2: LEGAL RF: 3.543

SU5: LEGAL RF: 5.653

TOLL ROAD LOADING NO. 1: ROUTINE PERMIT RF:

6+-Axles:

AASHTO TYPE 3-3: LEGAL RF: 2.717

LANE TYPE: LEGAL RF:

SU6: LEGAL RF: 6.081

SPECIAL TOLL ROAD TRUCK: ROUTINE PERMIT RF:

SU7: LEGAL RF: 6.081

MICHIGAN TRAIN TRUCK NO. 5: ROUTINE PERMIT RF:

MICHIGAN TRAIN TRUCK NO. 8: ROUTINE PERMIT RF:

SUPERLOAD-11 AXLES: SPECIAL PERMIT RF:

SUPERLOAD-13 AXLES: SPECIAL PERMIT RF:

SUPERLOAD-14 AXLES: SPECIAL PERMIT RF:

SUPERLOAD-19 AXLES (152.5T): SPECIAL PERMIT RF:

SUPERLOAD-19 AXLES (240.045T): SPECIAL PERMIT RF:

Culvert Inspection Report

CV 031-041-094.74

US 31

over

Inspection Date: 09/23/2021

Inspected By: Jessica Waggoner

Inspection Type(s): Culvert

Executive Summary

Unable to access at time of insepction.

Structure Number: *CV 031-041-094.74* **Inspector:** Waggoner,Jessica

Large Culvert Inspection Report

(8) Asset Code:	*93006677*	(27) Year Built:	*0000*
Asset Name:	*CV 031-041-094.74*	(90) Inspection Date:	*09/23/2021*
OLD Culvert ID:	*31-41-94.74*	(91) Inspection Frequency:	*36*
Team Assignment:	*05*	■ Additional Treatment Exists	

Identification

(2) Highway Agency District: *05*

(3) County Code: *041*

Sub District: *5300*

Ramp ID:

(42B) Type of Service (Under): *5*

■ Adjacent to Roadway

(7) Facility Carried: *US 31*

(6) Features Intersected:

(9) Location: *N Barth. Co*

(9.01) Location Additional Description:

(11) Milepoint: *14.29*

(16) Latitude: *39.527702*

(17) Longitude: *-86.078468*

Classification:

(104) Highway System of the Inventory Route: *1*

(26) Functional Classification of Inventory Route: *02*

Geometric Data

Culvert: Kind of Material: *1. Concrete*

Culvert: Type of Structure: *19. 4 Sided Box Culvert*

Min Est Fill Cover (ft): *1.00*

Culvert: Max. Horizontal Opening (ft.): *4.00*

Culvert: Max. Vertical Opening (ft.): *3.00*

(34) Skew:

Barrel Length (ft.): *120.0*

Original Culvert Shape: *Box*

Measurement Remarks:

Structure Additional Description: *Reinforced Concrete Box*

Openings:

Direction	Opening Latitude	Opening Longitude	Direction	Opening Latitude	Opening Longitude
1.			3.		
2.			4.		

Openings Comments:

■ **Follow Up Required:**

**If checked, please describe for follow up: *Water*

<u>Endangered Species</u>

Bats: seen or heard under structure? *	*N - No evidence of bats*
Birds/swallows/nests seen? Empty nests present?	*N - No Birds and/or Nests Visi*

* If yes, add one photo to the dropdown field

General Condition Ratings

(36A) Bridge Railings:	*N*	(36C) Approach Guardrail:	*N*
(36B) Transitions:	*N*	(36D) Approach Guardrail Ends:	*N*

Culvert:

(62) Culvert - Rating: *6*

(62) Culvert Rating Comments: *There is spalling with exposed rebar on the east headwall. There is a bend in the box under the northbound lanes.*

Deck:

(58) Deck: *N*

(58a) Deck Comments:

Superstructure:

(59) Superstructure: *N*

(59.01) Superstructure Comments:

Substructure:

(60) Substructure: *N*

(60.01) Substructure Comments: *Spalling on east headwall with exposed rebar.*

CV-Headwall/Anchor Rating *5*

CV-Wingwalls Rating *N*

Channel:

(61) Channel and Channel Protection: *7*

(61.01) Channel and Channel Protection Comments: *Water in channels.*

Bank Erosion Rating: *8*

Drift/Sediment Rating *7*

Channel Alignment Rating *8*

■ **Check this box if culvert has OBSTRUCTED flow**

Describe Obstruction:

Overtopping Frequency:

Overtopping Frequency Comments:

INDIANA DEPARTMENT OF TRANSPORTATION

100 North Senate Avenue
Room N758-ES
Indianapolis, Indiana 46204

PHONE: (855) 463-6848
(855) INDOT4U

Eric Holcomb, Governor
Joe McGuinness, Commissioner

February 4, 2022

Chip Orner
City of Franklin Parks & Recreation Dept.
396 Branigan Blvd
Franklin, IN 46131

Re: United States (US) 31 Roadway Improvement (Des. No. 1800082- lead) and Bridge Rehabilitation (Des. No. 2001610) in the City of Franklin, IN.

Mr. Orner,

The Indiana Department of Transportation (INDOT), the Federal Highway Administration (FHWA), and the City of Franklin are developing plans for a roadway improvement, culvert replacement, and bridge rehabilitation project. The proposed undertaking is on US 31, beginning approximately 1.05 miles south of SR 44/SR 144, near the US 31/Main Street intersection, and extending north to Israel Lane, approximately 4.35 miles north of SR 44/SR 144 in the City of Franklin, Johnson County, Indiana. It is within Pleasant and Franklin townships, Greenwood and Franklin United States Geological Survey (USGS) Topographic Quadrangles, Sections 3, 11, 12, 14, 23, 27, 28, and 34, Township 12 North, Range 4 East.

Project Description

INDOT has identified the need to address traffic congestion at intersections along US 31 within the identified project area. Also, the need for improved non-motorized transportation and pedestrian access arises due to limited amounts of existing infrastructure throughout the project corridor and the need to meet the City of Franklin's goal of improving and expanding its sidewalk and recreational trail system. The roadway improvement project (Des. No. 1800082) proposes construction of a combination of reduced conflict intersections (RCIs), median U-turn, green T, restricted crossing U-turn, and boulevard left intersection styles throughout the project corridor. Also, the project proposes to install traffic loons in conjunction with median U-turns at various points throughout the project corridor (a traffic loon is pavement that is constructed outside of normal traffic lanes to allow for larger vehicles to safely make a U-turn on a divided roadway). Improvements to non-motorized transportation access will occur by updating and extending sidewalks, installing 10-foot-wide paved trails parallel to both sides of US 31, and installing pedestrian crossing infrastructure at some intersections. The rehabilitation of the existing bridge over Youngs Creek (Bridge No. 031-41-07875 northbound and southbound, Des. No. 2001610) proposes widening the bridge to accommodate new multi-use trails on both sides of US 31.

Section 4(f) Definition of Use of Section 4(f) Property

Section 4(f) of the U.S. Department of Transportation Act of 1966, 49 USC 303 (c) was established to protect publicly owned parks, recreational areas (including recreational trails), wildlife and waterfowl refuges, or public and private historical sites against transportation conversions. A use of Section 4(f) property occurs when land is permanently incorporated into a transportation facility; there is a temporary occupancy of land that is adverse in terms of the Section 4(f) statute's preservationist purpose; or there is a constructive use of Section 4(f) property.

Section 4(f) Resources
The project area of the roadway improvement project (Des. No. 1800082) intersects with four existing trails: the Simon Road Trail along the north side of Simon Road; Franklin Community High School Trail along Commerce Drive; the Historic Franklin Greenway Trail Phase 4 along State Road (SR) 44/Jefferson Street; and the Historic Franklin Greenway Trail Phase 3 along Main Street. The Historic Franklin Greenway Trail Phase 2 crosses under the bridge rehabilitation project over Youngs Creek (Bridge No. 031-41-07875 northbound and southbound, Des. No. 2001610). All four existing trails are considered Section 4(f) resources.

Temporary closures of the Simon Road Trail; Franklin Community High School Trail; the Historic Franklin Greenway Trail Phase 4; and the Historic Franklin Greenway Trail Phase 3 will be necessary to construct the connections of the proposed trails along the east and west sides of US 31 that are part of the roadway project (Des. No. 1800082). These four existing trails will not be affected by the bridge rehabilitation project (Des. No. 2001610). The Historic Franklin Greenway Trail Phase 2 that travels under the bridge carrying US 31 over Young's Creek will also be temporarily closed to rehabilitate the bridge but will not be affected by the roadway project (Des. No. 1800082).

There are two proposed shared use paths (trails) shown in the February 2020 Bicycle and Pedestrian Way Master Plan (found at: https://www.franklin.in.gov/department/division.php?structureid=63) along Branigan Road and Paul Hand Boulevard that will likely be managed by the City of Franklin Parks and Recreation Department. The current design of the roadway project (Des. No. 1800082) will not prevent the future construction of these two planned trails, and no impacts will occur as a result of the proposed bridge rehabilitation project (Des. No. 2001610).

There is also one planned trail, the Nineveh Road Corridor Trail, which is planned along Nineveh Road (County Road (CR) 200 E.), on the west side of US 31 approximately 0.37 mile north of the US 31/Main Street intersection and adjacent to the project area. This planned trail is under the ownership and management of the Johnson County Plan Commission. The current design of the roadway project (Des. No. 1800082) will not prevent the future construction of the planned Nineveh Road Corridor trail, and no impacts will occur as a result of the proposed bridge rehabilitation project (Des. No. 2001610).

The proposed trails along US 31 in this project, the proposed trails along Branigan Road and Paul Hand Boulevard, the five existing trails discussed in this letter, and the planned Nineveh Road Corridor Trail are all identified as proposed pedestrian and bicycle facilities in the February 2020 Bicycle and Pedestrian Way Master Plan.

Exceptions to Use of a Section 4(f) Resource
Section 4(f) of the U.S. Department of Transportation Act of 1966 defines use of a Section 4(f) resource as:

1) Land is permanently incorporated into a transportation facility such as through permanent acquisition of property or a permanent easement on a property protected by Section 4(f) for maintenance or other transportation related purposes;
2) Temporary occupancy of a property for a construction related purpose. The property is not permanently incorporated into a transportation facility but the activity is considered to be adverse in terms of the preservation purpose of Section 4(f); and/or
3) Constructive use. A constructive use involves no actual physical use of the Section 4(f) property via permanent incorporation of land or a temporary occupancy of land into a transportation facility. A constructive use occurs when the proximity impacts of a proposed project adjacent to, or nearby, a

Section 4(f) property result in substantial impairment to the property's activities, features, or attributes that qualify the property for protection under Section 4(f).

23 Code of Federal Regulations (CFR) 774.13 of the U.S. Dept of Transportation Act refers to exceptions to the requirements for Section 4(f) approval. These exceptions include 23 CFR 774.13(g), which are transportation enhancement activities, transportation alternatives projects, and mitigation activities, where:

1) The use of the Section 4(f) property is solely for the purpose of preserving or enhancing an activity, feature, or attribute that qualifies the property for Section 4(f) protection; and
2) The official(s) with jurisdiction over the Section 4(f) resource agrees in writing to paragraph (g)(1) of this section (above)

The proposed roadway project (Des. No. 1800082) will enhance the activities, features, and attributes of the Simon Road Trail; the Franklin Community High School Trail; the Historic Franklin Greenway Trail Phase 4; and the Historic Franklin Greenway Trail Phase 3, by constructing connections between the proposed trails and the existing trails as well as construction of Americans with Disabilities Act (ADA) compliant ramps and new marked street crossings, thus improving the overall connectivity of the Franklin's bicycle and pedestrian system (Condition #1 above). The US 31 bridge rehabilitation project over Youngs Creek (Des. No. 2001610) will widen the bridge to accommodate the proposed trails on the east and west sides of US 31. The bridge project will enhance the Historic Greenway Trail Phase 2 by providing the City of Franklin with opportunities to provide future connections between the Historic Greenway Trail Phase 2 and the proposed trails in the project, thus providing additional improvements to overall City of Franklin trail connectivity.

INDOT believes the proposed roadway and bridge rehabilitation projects along US 31 meet the above criteria for Exceptions for transportation enhancement activities as outlined above in 23 CFR 774.13(g).

By signing below, the City of Franklin concurs that the projects meet the criteria for Exceptions as outlined above.

Please return the signed concurrence to us. With this concurrence, we can conclude the Section 4(f) review for the project. We appreciate your help.

If you have any questions regarding this matter, please feel free to contact INDOT Project Manager Terry Summers at (812) 524-3749.

Note: The Historic Greenway Trail, Phase 2 passing under the US 31 over Youngs Creek bridge will remain open during construction. At the time this letter was drafted, it was believed that the trail would be closed temporarily during construction.

Sincerely,

Erin Mulryan

Erin Mulryan, SJCA Inc.
Project Consultant

I/We concur with each of the stated findings above regarding the 4(f) Franklin Community High School Trail; the Historic Franklin Greenway Trail Phase 4; the Historic Franklin Greenway Trail Phase 3; and the Historic Franklin Greenway Trail Phase 2. I/We are officials with jurisdiction over the trails.

Chip Orner, Director- City of Franklin Parks & Recreation Dept. Date 2/11/2022


GREENWAY TRAILS
FRANKLIN | INDIANA
MULTI-USE TRAILS
1. Historic Greenway Trail
2. Franklin Community High School Trail
3. Branigin Creek
4. Heritage Neighborhood
ROADSIDE ROUTES & TRAILS
5. King Street
6. Eastside Bypass
7. Upper Shelbyville Road
8. Hurricane Road
9. Brookhaven Drive
10. Simon Road
11. Branigin Road
12. Cumberland
13. Westview Drive
14. West Jefferson Street
15. Hospital Road
CONSTRUCTION
16. Construction in 2020
West Jefferson Street
BIKE LANE
17. East King Street
PARK FACILITIES
A. Blue Heron Park
B. Blue Heron Disc Golf
C. Greenlawn Cemetery
D. Action Skate Park
E. Dog Park
F. Province Park
G. Cultural Arts & Recreation Center
Franklin Family Aquatic Center
H. Palmer Park
Palmer Park Community Center
I. Payne Park
Active Adult Center
J. Depot Park
K. Community Park
L. Morgan Park
M. Schmidt Park
N. Temple Park
O. Scott Park
P. Branigin Park

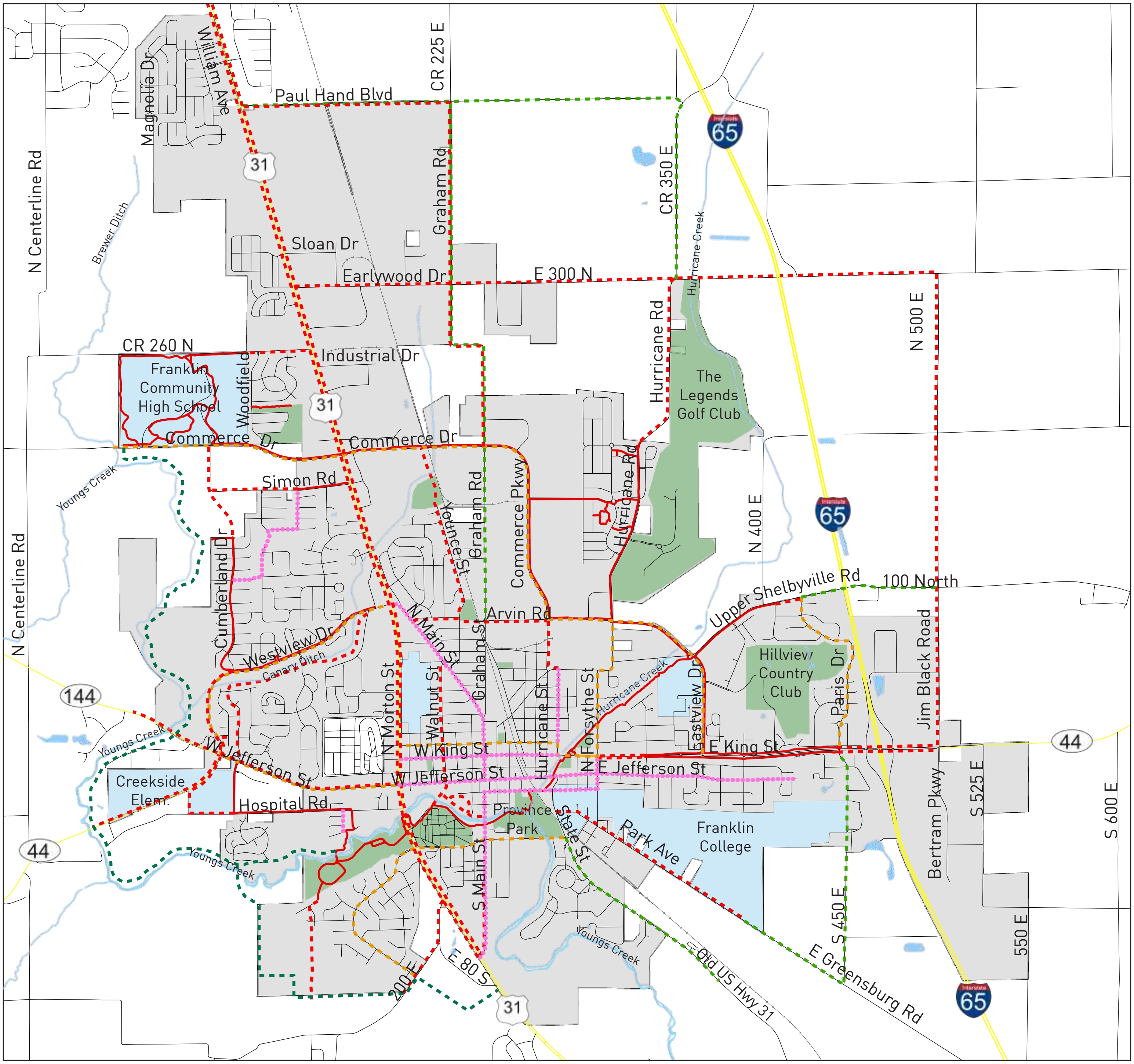


FIGURE 15 PROPOSED BICYCLE FACILITIES (CITYWIDE)

PROPOSED

- Proposed Shared-Use Path
- Proposed Bicycle Lane
- Proposed Greenway
- Proposed Shared Lane
- Proposed Bike Route

EXISTING

- Existing Shared-Use Path
- Existing Bicycle Lane

DESTINATIONS & BOUNDARIES

- City Limits
- Project Limits
- School
- Park

Land and Water Conservation Fund (LWCF) County Property List for Indiana (Last Updated July 2020)

ProjectNumber	SubProjectCode	County	Property
1800148	1800148	Johnson	Tot Park, New Whiteland Park
1800369	1800369B.10	Johnson	Independence Park
1800369	1800369B	Johnson	Johnson Co. Park/Hoosier Horse Park

*Park names may have changed. If acquisition of publically owned land or impacts to publically owned land is anticipated, coordination with IDNR, Division of Outdoor Recreation, should occur.

US 31 Roadway Improvement (Des. No. 1800082- lead), Culvert Replacement (Des. No. 1800272), and Bridge Rehabilitation (Des. No. 2001610)
City of Franklin, Pleasant and Franklin Townships, Johnson Co.
December 9, 2021

Project Description
Under Des. No. 1800082 (lead), the proposed project encompasses the roadway improvement for the entire length of the project, which begins approximately 800 feet south of South Main Street and extends north approximately 5.59 miles to Israel Lane. The proposed project will use a combination of reduced conflict intersections (RCIs), median U-turn, green T, restricted crossing U-turn, and boulevard left intersection styles throughout the project corridor. Also, the project proposes to install traffic loons in conjunction with median U-turns at various points throughout the project corridor. (A traffic loon is pavement that is constructed outside of normal traffic lanes to allow for larger vehicles to safely make a U-turn on a divided roadway.) Improvements to non-motorized transportation access will occur by updating and extending sidewalks, installing 10-foot-wide paved trails parallel to both sides of US 31, and installing pedestrian crossing infrastructure at some intersections.

Under Des. No. 1800272, the project proposes to replace the culvert (Structure Number 031-41-03534) that carries Canary Creek under US 31. Under Des. No. 2001610, the project proposes to rehabilitate the bridge that carries US 31 over Youngs Creek (Structure Numbers 031-41-07875 NBL & SBL) in order to accommodate the proposed trails on the outside.

At this time, the maintenance of traffic (MOT) plan will involve a combination of detours and phased construction to allow access to all businesses, residences, and facilities on US 31. At this time, the MOT plan proposes five phases of construction from Fall of 2022 to Fall of 2024 to minimize the impacts to access as well as impacts to travel to and through the City of Franklin.

EJ Analysis
Under FHWA Order 6640.23A, FHWA and the project sponsor, as a recipient of funding from FHWA, are responsible to ensure that their programs, policies, and activities do not have a disproportionately high and adverse effect on minority or low-income populations. Per the current INDOT Categorical Exclusion Manual, an Environmental Justice (EJ) Analysis is required for any project that has two or more relocations or 0.5 acre of additional permanent right-of-way. Both temporary and permanent right-of-way are anticipated for the undertaking: 10.3 acres temporary and 3.3 acres permanent. No business or residential relocations will occur. Therefore, an EJ Analysis is required.

Potential EJ impacts are detected by locating minority and low-income populations relative to a reference population to determine if populations of EJ concern exists and whether there could be disproportionately high and adverse impacts to them. The reference population may be a county, city or town and is called the community of comparison (COC). In this project, the COC is Johnson County. The community that overlaps the project area is called the affected community (AC). In this project, the AC is the City of Franklin. An AC has a population of concern for EJ if the population is more than 50% minority or low-income or if the low-income or minority population is 125% of the COC. Data from the 2019 American Community Survey (ACS) 5-year estimates was obtained from the US Census Bureau Website https://data.census.gov/cedsci/advanced on November 8, 2021 by SJCA Inc. The data collected for minority and low-income populations within the AC are summarized in the below table:

	COC – Johnson County, Indiana	AC – City of Franklin, Indiana
Percent Low-Income	7.4 %	10.0 %
125% of COC	9.3 %	AC > 125% COC
EJ Population of Concern		Yes
Percent Minority	11.0 %	6.6 %
125% of COC	13.8 %	AC < 125% COC
EJ Population of Concern		No

The AC, the City of Franklin, has a percent low-income of 10.0% which is below 50% and is above the 125% COC threshold of 9.3%. Therefore, the AC contains low-income populations of EJ concern.

The AC, the City of Franklin, has a percent minority of 6.6% which is below 50% and is below the 125% COC threshold of 13.8%. Therefore, the AC does not contain minority populations of EJ concern.

The project will result in positive community-wide impacts in the form of improved traffic flow and pedestrian/bicycle connectivity to existing trails and sidewalk networks, regardless of minority or income status. The maintenance of traffic will impact all travelers regardless of income or ethnicity and will not impact EJ populations more than any other population. Once complete, the project will maintain access to all businesses and residences on both sides of the US 31 roadway using a combination of RCIs, median U-turn, green T, restricted crossing U-turn, and boulevard left intersection styles. Traffic turning into businesses will use the proposed turning configurations, which are different from existing conditions, but access to businesses and residences will not be denied. The EJ analysis conducted for this project was forwarded to INDOT ESD on November 8, 2021. INDOT ESD responded on December 10, 2021, stating that "with the information provided, INDOT-ESD would not consider the impacts associated with this project as causing a disproportionately high and adverse effect on minority and/or low-income populations of EJ concern relative to non-EJ populations in accordance with the provisions of Executive Order 12898 and FHWA Order 6640.23a."

Note: The anticipated ROW amounts changed following the completion of the EJ Analysis. The current anticipated ROW amounts are 6.37 acres temporary and 6.8 acres permanent. The change in the total amount of ROW was not substantial; therefore, the impacts to low-income and minority populations remains the same.

Environmental Justice Analysis for US 31 Roadway, Culvert, & Bridge Improvements (Des 1800082- lead; Des. 1800272; Des. 2001610)

		COC	AC1
		Johnson County, Indiana	City of Franklin, Johnson County, Indiana
	LOW-INCOME		
B 17001001	Population for whom poverty status is determined: Total	150,832	23,851
B 17001002	Population for whom poverty status is determined:Income in past 12 months below poverty	11,196	2,396
	Percent Low-Income	**7.4%**	**10.0%**
	125 Percent of COC	**9.3%**	**AC>125% COC**
	Potential Low-Income EJ Impact?		**Yes**
	MINORITY		
B 03002001	Total population: Total	153,716	25,106
B 03002002	Total population: Not Hispanic or Latino	148,218	24,388
B 03002003	Total population: Not Hispanic or Latino; White alone	136,803	23,447
B 03002004	Total population: Not Hispanic or Latino; Black or African American alone	3,664	266
B 03002005	Total population: Not Hispanic or Latino; American Indian and Alaska Native alone	178	0
B 03002006	Total population: Not Hispanic or Latino; Asian alone	5,192	193
B 03002007	Total population: Not Hispanic or Latino; Native Hawaiian and Other Pacific Islander alone	27	0
B 03002008	Total population: Not Hispanic or Latino; Some other race alone	375	67
B 03002009	Total population: Not Hispanic or Latino; Two or more races	1,979	415
B 03002010	Total population: Hispanic or Latino	5,498	718
B 03002011	Total population: Hispanic or Latino; White alone	3,119	499
B 03002012	Total population: Hispanic or Latino; Black or African American alone	137	0
B 03002013	Total population: Hispanic or Latino; American Indian and Alaska Native alone	28	0
B 03002014	Total population: Hispanic or Latino; Asian alone	0	0
B 03002015	Total population: Hispanic or Latino; Native Hawaiian and Other Pacific Islander alone	18	0
B 03002016	Total population: Hispanic or Latino; Some other race alone	1,662	181
B 03002017	Total population: Hispanic or Latino; Two or more races	534	38
	Number Non-White/Minority (P007001-P007003)	**16,913**	**1,659**
	Percent Non-White/Minority	**11.0%**	**6.6%**
	125 Percent of COC	**13.8%**	**AC<125% COC**
	Potential Minority EJ Impact?		**No**

HISPANIC OR LATINO ORIGIN BY RACE

Survey/Program: American Community Survey

Product: 2019: ACS 5-Year Estimates Detailed Tables

TableID: B03002

Universe: Total population

	Johnson County, Indiana		Franklin city, Indiana	
Label	**Estimate**	**Margin of Error**	**Estimate**	**Margin of Error**
Total:	153,716	*****	25,106	±527
Not Hispanic or Latino:	148,218	*****	24,388	±653
White alone	136,803	±199	23,447	±685
Black or African American alone	3,664	±327	266	±124
American Indian and Alaska Native alone	178	±189	0	±22
Asian alone	5,192	±232	193	±152
Native Hawaiian and Other Pacific Islander alone	27	±32	0	±22
Some other race alone	375	±211	67	±46
Two or more races:	1,979	±517	415	±286
Two races including Some other race	49	±64	0	±22
Two races excluding Some other race, and three or more races	1,930	±512	415	±286
Hispanic or Latino:	5,498	*****	718	±335
White alone	3,119	±762	499	±284
Black or African American alone	137	±173	0	±22
American Indian and Alaska Native alone	28	±33	0	±22
Asian alone	0	±28	0	±22
Native Hawaiian and Other Pacific Islander alone	18	±29	0	±22
Some other race alone	1,662	±683	181	±138
Two or more races:	534	±282	38	±62
Two races including Some other race	438	±271	38	±62
Two races excluding Some other race, and three or more races	96	±87	0	±22

POVERTY STATUS IN THE PAST 12 MONTHS BY SEX BY AGE

Survey/Program: American Community Survey

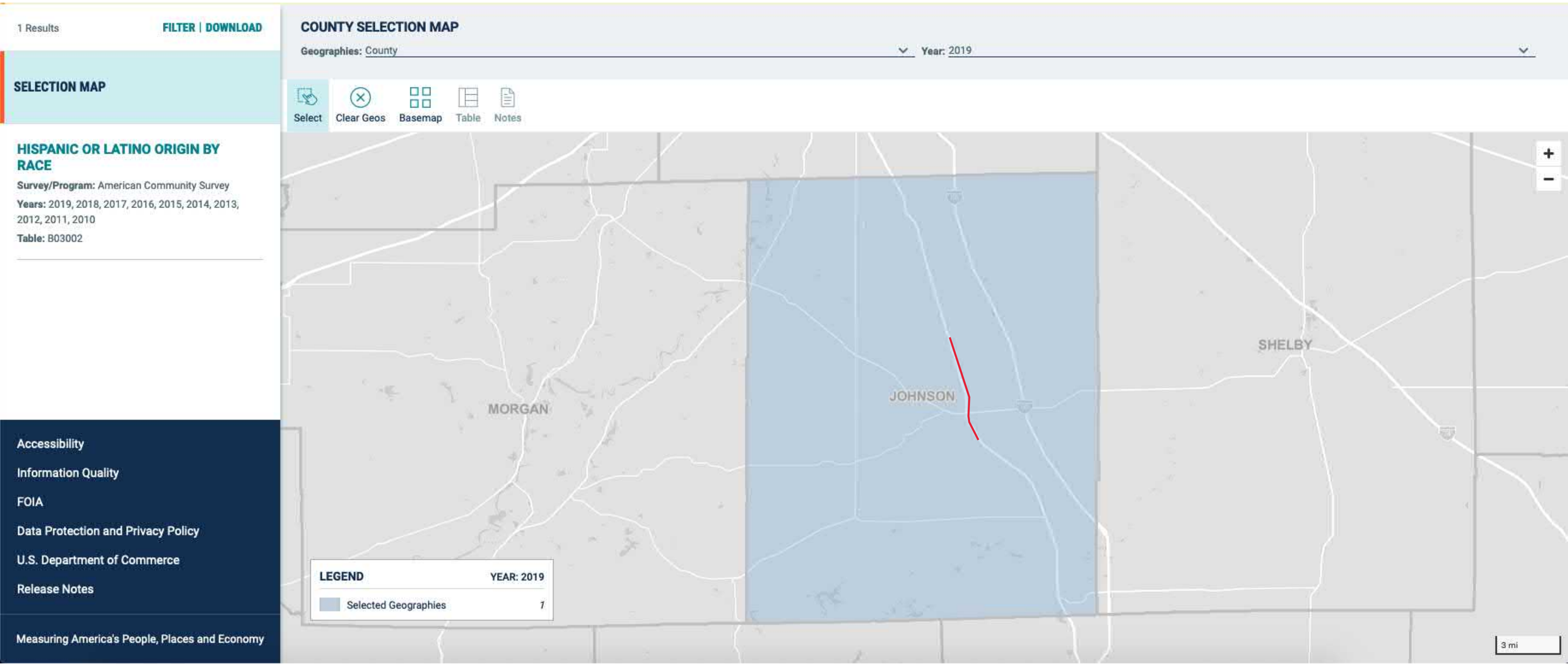
TableID: B17001

Product: 2019: ACS 5-Year Estimates Detailed Tables

Universe: Population for whom poverty status is determined

	Johnson County, Indiana		Franklin city, Indiana	
Label	**Estimate**	**Margin of Error**	**Estimate**	**Margin of Error**
Total:	150,832	±377	23,851	±596
Income in the past 12 months below poverty level:	11,196	±1,355	2,396	±668
Male:	5,139	±722	1,128	±365
Under 5 years	570	±203	103	±61
5 years	119	±88	57	±58
6 to 11 years	862	±306	366	±232
12 to 14 years	183	±91	43	±42
15 years	124	±94	65	±72
16 and 17 years	150	±92	76	±70
18 to 24 years	654	±185	120	±80
25 to 34 years	587	±230	50	±43
35 to 44 years	446	±182	67	±46
45 to 54 years	448	±150	32	±35
55 to 64 years	631	±236	91	±73
65 to 74 years	248	±106	38	±31
75 years and over	117	±54	20	±25
Female:	6,057	±878	1,268	±352
Under 5 years	332	±165	18	±28
5 years	152	±97	44	±53
6 to 11 years	635	±225	154	±98
12 to 14 years	364	±133	44	±41
15 years	85	±88	48	±37
16 and 17 years	227	±124	89	±72

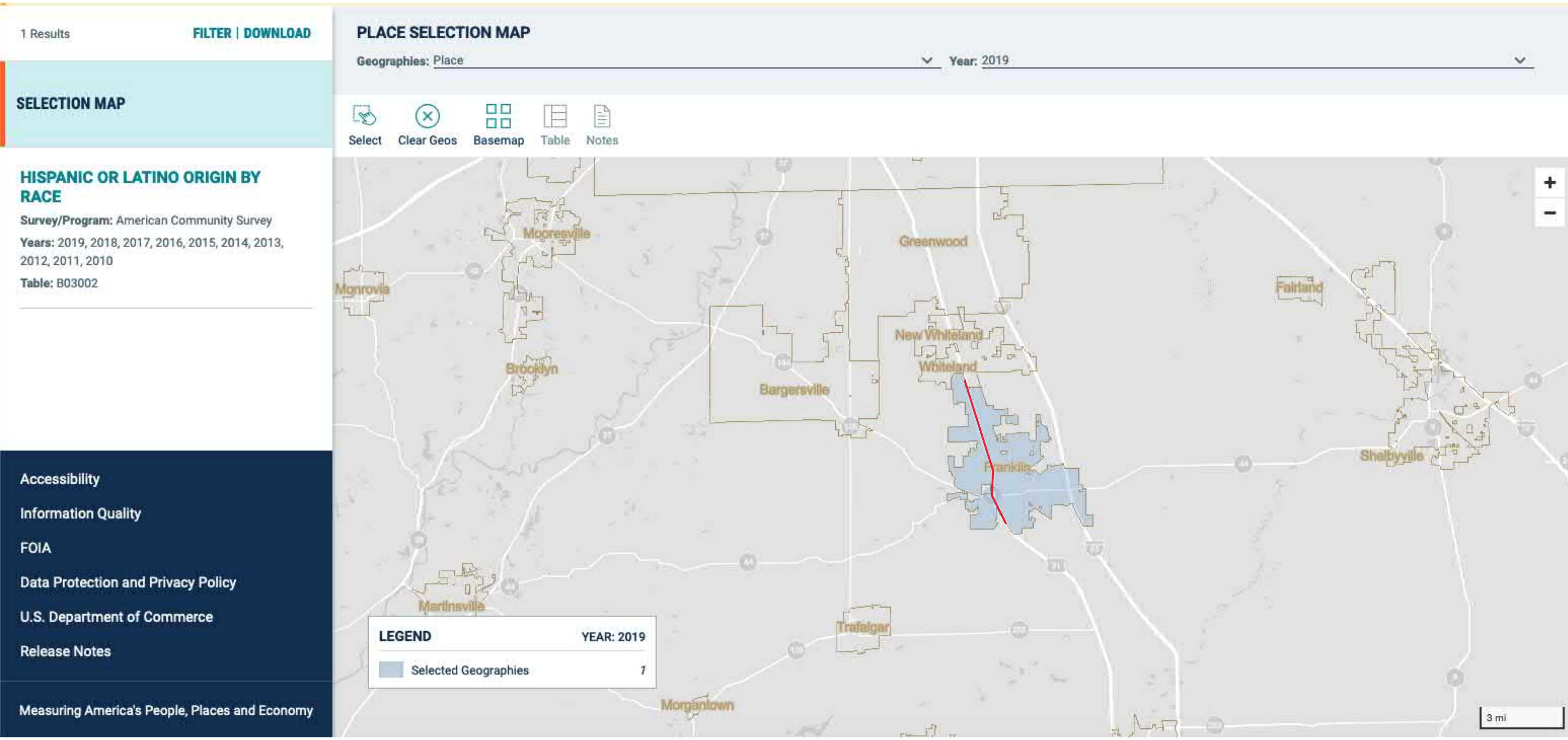
US 31 Roadway Improvement, Culvert Replacement, & Bridge Rehabilitation Project, Des. 1800082, 1800272, 2001610
City of Franklin, Johnson Co., IN



Project Alignment

US 31 Roadway Improvement, Culvert Replacement, & Bridge Rehabilitation Project, Des. 1800082, 1800272, 2001610

City of Franklin, Johnson Co., IN



Project alignment

Louisiana Transportation Research Center

Final Report 617

Economic Effect of Restricted Crossing U-Turn Intersections in Louisiana

by

Helmut Schneider
Stephen Barnes
Emily Pfetzer
Cory Hutchinson

Highway Safety Research Group
Economics & Policy Research Group
LSU

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TECHNICAL REPORT STANDARD PAGE

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4. Title and Subtitle **Economic Effect of Restricted Crossing U-Turn Intersections in Louisiana**	5. Report Date November 2019 6. Performing Organization Code LTRC Project Number: 18-1SA SIO Number: DOTLT1000213	
7. Author(s) Helmut Schneider, Stephen Barnes, Emily Pfetzer, Cory Hutchinson	8. Performing Organization Report No.	
9. Performing Organization Name and Address Highways Safety Research Group Louisiana State University Baton Rouge, LA 70803	10. Work Unit No. 11. Contract or Grant No.	
12. Sponsoring Agency Name and Address Louisiana Department of Transportation and Development P.O. Box 94245 Baton Rouge, LA 70804-9245	13. Type of Report and Period Covered **Final Report** **July 2017-April 2019** 14. Sponsoring Agency Code	
15. Supplementary Notes **Conducted in Cooperation with the U.S. Department of Transportation, Federal Highway Administration**		

16. Abstract

The RCUT, aka J-turn intersection, is an innovative alternative intersection design that displaces left-turn and through movements from the minor street. There is sufficient evidence that these designs reduce severe injury crashes and the FHWA hence added them to their list of "Proven Safety Countermeasures." However, there is often resistance from businesses located near planned J-turns because of potential loss of business due to a perceived reduced ease of access of customers to their business. This report analyzes sales data surrounding ten completed J-turn projects in four study locations in Louisiana for a time period of two years before and two years after the completion of the projects. Analysis of aggregated sales data show an overall increase in sales after the completion of the projects. A parish-by-parish analysis of sales data also shows that there is no evidence of a decline in sales, but rather an increase. One parish that has been undergoing considerable growth in the state appeared to have mixed findings: looking at only businesses that existed before and after the J-turns were completed, some showed a slight decline in sales while the overall sales volume of all businesses around the J-turns increased. The decline at some isolated locations was likely due to increased competition from a number of new businesses near the J-turns. Overall, these findings suggest the construction of J-turns is associated with an increase in sales among businesses in their vicinity. Results from the business and patron surveys provide some insight into perceptions of access in these locations. Perceptions of access appear to coincide with primary concerns about congestion, traffic/backups, and perceptions of ongoing construction impacts.

17. Key Words J-Turn, Access management, RCUT		18. Distribution Statement **Unrestricted. This document is available through the National Technical Information Service, Springfield, VA 21161.**	
19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price

TABLE OF CONTENTS

Some pages and all Appendices have been removed to reduce the overall size of the document, but they can be made available upon request.

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The goal of "Destination Zero Deaths," as envisioned in the 2017 Louisiana Strategic Highway Safety Plan (SHSP), is to achieve a significant reduction of vehicle-related fatalities and serious injuries on all public roads statewide. The SHSP establishes statewide safety priorities and outlines the strategies and actions needed to address Louisiana's most severe traffic safety problems [*1*]. The SHSP mission is "to reduce the human and economic toll on Louisiana's surface transportation system due to traffic crashes through widespread collaboration and an integrated 4E (i.e., engineering, enforcement, emergency medical services, and education) approach" [*1*]. Under the leadership of the Louisiana Department of Transportation and Development (DOTD), the Louisiana State Police (LSP), and the Louisiana Highway Safety Commission (LHSC), and in partnership with safety stakeholders, the SHSP is a coordinated, comprehensive, multidisciplinary approach to identifying and addressing the most pressing safety priorities (i.e., emphasis areas). Priorities are determined based on analysis of available data and involvement from safety stakeholders [*2*]. One of Louisiana's SHSP goals focuses specifically on Infrastructure and Operations. As stated in the 2017 SHSP, "Louisiana experiences high incidences of roadway departure and intersection-related crashes" as well as crashes involving non-motorized users [*1*]. In 2016, roadway departure accounted for 57.8% of fatalities and 40.3% of all severe injuries, while intersection-related crashes accounted for 19.1% of fatalities and 39.9% of severe injuries [*1*].

DOTD has made progress toward reducing crashes and increasing capacity along strategic highway corridors throughout the state. One method has been the deployment of access management in locations with considerable potential for total and/or targeted crash reduction, particularly fatal and serious injury crash reductions. Access management formally refers to the "systematic control of the location, spacing, design, and operation of driveways, median openings, interchanges, and street connections to a roadway" [*3*]. Examples include raised non-traversable medians and reduced-conflict intersections (RCIs) specifically designed to reduce traffic congestion, crashes, and injuries associated with making left turns, such as the Restricted Crossing U-Turn (RCUT) intersection. The RCUT, aka J-turn intersection, superstreet, or synchronized street, is an innovative alternative intersection design that displaces left-turn and through movements from the minor street [*4*]. Sufficient evidence regarding the effectiveness of infrastructure-focused treatments such as RCIs exists, prompting the FHWA to add them to their list of "Proven Safety Countermeasures" [*5*].

Since 2011, DOTD has deployed about a dozen J-turn intersections at strategic locations and along major corridors throughout the state. Ample research shows these treatments greatly improve road safety and increase mobility for a reasonable cost; however, projects such as this can be controversial at the local level, particularly among businesses. While J-turns are associated with a significant decline in crashes and injuries along the corridors in states where they have been implemented, businesses are predominantly concerned that modifying or limiting direct access to their properties will have a negative economic impact on their business. State DOTs that have implemented unconventional intersection designs like the RCUT have faced opposition from business located near project sites. Though research examining the economic impact of access management techniques is limited, findings have generally indicated effects to businesses are positive or neutral. Specifically, DOTD has received negative comments from businesses near locations where J-turns are planned.

This research will provide insight into the economic impact (real and perceived) of J-turns on local businesses and will assess the extent to which (if at all) J-turns have had a negative (quantifiable) impact on business. In the end, this research will help clarify the impact of J-turns on traffic safety and the economic priorities of local businesses, which DOTD and other SHSP stakeholders can use for more effective deployment of access management in Louisiana.

OBJECTIVE

The overall goal of this research is to assess the economic impact J-turns have had on businesses in the corridors where these treatments have already been implemented in Louisiana. A secondary goal is to assess the perception of businesses near these J-turns. The analysis in this study can be used by DOTD for more effective access management in Louisiana.

SCOPE

The scope of the project includes 10 projects/locations where J-turns have been constructed in Louisiana and a limited survey of businesses and customers at these 10 locations. Sales taxes for two years before and after construction of the J-turns were analyzed.

METHODOLOGY

Before reviewing the research documenting safety and economic impacts of specific access management techniques, it is important to provide a basic overview of access management. This overview provides a practical foundation for the research presented in this report and covers the fundamental concepts underlying the definition and development of access management in the United States as well as the traffic engineering concepts underlying highway operations. In many respects, the practice of access management cannot be sufficiently understood without acknowledging the dynamic relationship between transportation and land use in context. Therefore, some background discussion of the transportation-land use relation is provided.

A Basic Overview of Access Management

State DOTs are responsible for managing and maintaining the vast multimodal transportation infrastructure system on which all members of society depend. A significant component of this responsibility comes down to preserving the public investment in roads and streets, maintaining these facilities, and ensuring connectivity within a safe and reliable travel network. The functional integrity of the network ultimately comes down to how efficiently traffic flows through the transportation system, which depends on balancing the need for mobility against the need for access.

In the United States, all DOTs employ access management in some capacity. The primary goal of access management is to satisfy access to land development in a way that maintains the safety and efficiency of the transportation system [*3*]. In practice, "access management" refers to *a coordinated process* and *a set of techniques*. As a coordinated process, particularly in the earliest stages of economic development, access management includes "policy, planning, design, and highway system operations" [*6*]. As a set of techniques, access management incorporates both strategic (i.e., policy/management) and/or tactical (i.e., design/operations) treatments designed to reduce crashes, congestion, and travel delays while simultaneously improving road user safety and traffic flow. These techniques can be deployed at specific sites or retrofit to existing facilities that have become functionally inefficient and/or present safety concerns. An NCHRP research synthesis sponsored by the FHWA determined that, as of 2010, about two-thirds of states have adopted formal access management programs and policies, while the remaining one-third practice access management informally as part of normal operations [*7*].

Background: Transportation & Land Use

The relationship between transportation infrastructure and land use/development is mutually dependent, dynamic, and complex. This section provides a basic outline of the most essential concepts and terms underlying access management. These concepts are directly pertinent to access management approaches, in theory and in practice. While transportation professionals such as engineers and planners are no doubt well aware of the complex relationship between transportation and land use, it would not be reasonable to assume that stakeholders with less specialized knowledge would possess such an understanding. For the uninitiated, this section provides a sufficient foundation for the research presented in this report.

The relationship between transportation and land use is difficult to isolate, much like the classic "chicken-or-egg" paradox. Given the highly complex and interdependent nature of the relationship, impacts are largely dynamic and become evident over time. Transportation systems are spatial networks subject to physical constraints [*8*]. While full discussion of transportation networks is beyond the scope of this research, Appendix A provides a diagram illustrating the structural components of transportation networks, the properties of which resemble networks such as the Internet. Ultimately, the transportation system infrastructure affects the pattern of urban development in what Stover and Koepke termed the "transportation-land use cycle" [*9*]. The main way in which transportation impacts land use is through provision of *access*. Access (i.e., accessibility) refers to the capacity or opportunity to get to some particular location relative to another. Without access to land, development could not occur. Since land is developed with specific uses in mind (e.g., agricultural, commercial, residential, etc.), changes in land use affects activity patterns, influencing travel patterns which can impact the transportation network in critical—often irreversible—ways. Figure 1 illustrates a general diagram of transportation-land use cycle, which is essentially a "retroactive feedback system" of mutual influence [*8*].

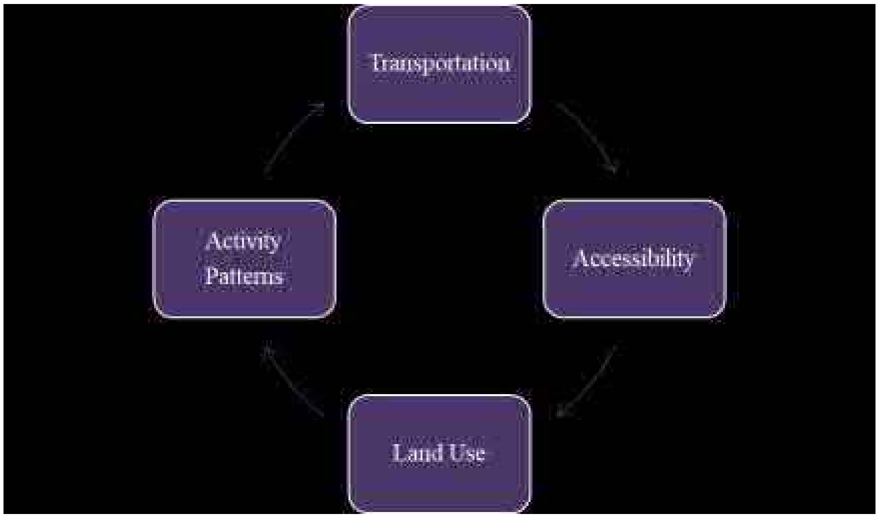

Figure 1
Transportation-land use cycle (conceptual diagram)

State DOTs impact land development primarily through providing infrastructure (i.e., roads, bridges) and secondarily through transportation-related regulations [*10*]. Land-use patterns reflect zoning practices as well (e.g., single-use vs. mixed-use) largely due to the effect that particular uses have on the road network and the potential interactions that arise as a result [*11*]. Because land-use management practices and area planning implementation occurs at the local level, there is considerable variation in how decisions and policies related to comprehensive planning play out. Moreover, the political incentives of local actors or special interests rather than community preferences may drive such comprehensive planning efforts [*12*]. Spatial and temporal interactions occur at multiple scales (e.g., local, regional, etc.) and the potential complexity of emergent patterns are a challenge, if not impossible, to predict. Land uses for particular locations along an arterial can change numerous times, and zoning changes tend to occur without a consistent consideration of long-term consequences [*9*]. One way impacts can be seen is in travel patterns. Thus, the impact of land use on transportation can occur in many ways. Operationally, this has obvious implications for the functional integrity of the road network.

Functional Classification. Roadways serve two primary purposes: access to/egress from particular properties/locations and travel mobility [*13*]. Most travel involves the use of multiple interdependent roadways to reach a specific destination. While roads can and do serve multiple purposes, the functional classification of a roadway determines the primary function a given roadway provides within the road hierarchy and how the road interacts with other roads to allow traffic to flow through the network. The functional integrity of the network ultimately comes down to how efficiently traffic flows through the transportation system. Generally, freeways are designed to move traffic over long distances at high speeds with fully-controlled access. Arterials offer a high degree of mobility for longer distances; many are partially-limited-access, serving as intermediaries between freeways and collector roads. Collectors are lower-moderate speed roads designed to circulate traffic to arterials and local streets and provide access to properties. Local roads feed into collector roads and tend to have low-traffic volume at lower speeds, providing the highest levels of accessibility to property. Figure 2 illustrates the functional classification of roads relative to the degree to which their primary function is one of mobility or access. Maintaining the functional integrity of the road system ultimately depends on preserving the functional classification of roadways.

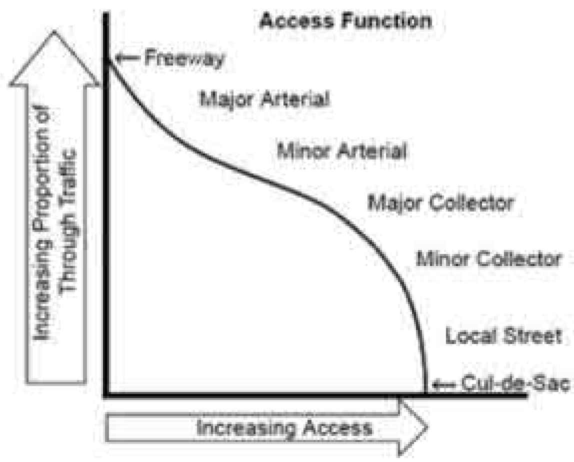

Figure 2
Functional classification of roadways [TRB Access Management Manual]

Capacity and Level of Service. Problems arise when roads originally intended to provide a high degree of mobility no longer function as intended. Many factors can affect a road's "ability" to serve its intended function whether on a temporary or situational basis, such as heavy traffic associated with a major sporting event or backups from a crash, many mobility or access problems emerge over time in response to land-use changes, road use patterns, and travel demands. Roads have fixed properties, such as capacity. The FHWA defines road capacity as "the maximum sustainable flow rate at which vehicles can pass through a given point in an hour under prevailing conditions" [*14*]. Estimating capacity is frequently "based on assumed values for saturation flow," the number and width of lanes, grades, and lane use allocations, in addition to signalization conditions [*14*, *15*]. Thus, a road's capacity is finite. In general, higher-speed roads designed to move traffic over longer distances tend to have higher capacity and more travel lanes than roads that function primarily to provide access to properties. It is important to note that increasing capacity by adding more lanes may alleviate congestion and improve safety, but effects are only temporary since crash rates generally increase with the addition of more lanes [*16*]. Since capacity is a probabilistic measure, it varies in terms of time and location, traffic conditions, road design, traffic composition and environmental conditions [*17*]. When travel demand exceeds available capacity, such as in peak travel times, congestion ensues and the road's operational performance, i.e., "level of service," declines.

The term "level of service" (LOS) is a qualitative measure of effectiveness, involving performance measures such as speed and travel time, density, and delay. LOS depends on the flow of traffic under varying operational conditions and anything that impairs a road's ability to serve its intended function can decrease LOS. For instance, operational "decision points" along specific segments of the roadway, like merge areas, on and off ramps, and traffic signals, or design constraints such as curves, shoulder presence and/or width can impact performance.

Land Use and Road Operations. A road's functional classification is subject to change over time if routine conditions result in degraded LOS. This can occur whenever, e.g., a regional corridor undergoes significant population growth and/or development and a major arterial starts to experience considerably higher traffic volume, leading to increased travel time, lower speeds, and recurring congestion [*18*]. In this way, congestion is substantially more complex than that of traffic volume merely exceeding road capacity; rather, the capacity problems interact with a host of other "traffic-influencing events" such as crashes, construction, poorly timed signals, and environmental conditions [*15*].

In many instances, LOS issues arise in areas that undergo land-use changes, such as when commercial development takes place in a linear fashion along a busy arterial. Because the arterial's primary function is to move traffic over distance, an increasing number of access points has a negative effect on mobility and can impair the road's LOS. Often, land adjacent to arterials is zoned for commercial purposes [*19*]. The high traffic volume is appealing to businesses and property owners due to increased property values. Given the investment in strategic location, it is natural for businesses to seek as direct-access as possible to their property; however, when access is provided from the arterial, the road's LOS declines. When an existing arterial begins to experience degraded LOS following development and increased commercial activity, improvements become necessary to address congestion and safety problems. Arterial improvements typically increase/improve access to an area and land values, attract new business to the area, which spurs further development. Eventually, the "new" developed area experiences increased traffic and consequently, traffic conflicts and congestion, which will require further road improvements to mitigate.

According to Stover and Koepke, changes in a major arterial's LOS can result in "unstable land-use patterns as the relative accessibility of other locations changes" [*9*]. The transition happens over time as commercial strip and low-density residential developments situate along the arterial, often in an uncoordinated or seemingly "haphazard" way [*19*]. This type of "unplanned" linear development, commonly referred to as "sprawl," is vehicle-dependent, has varying (and often inadequate) spacing between driveways and side-streets, permits direct access and unrestricted left-turns from the roadway. Ewing finds that the primary factor that distinguishes sprawl from other development patterns is the degree of "poor accessibility among related land uses," which may result from "a failure to concentrate development and/or to mix land uses" [*20*].

Evolution of Access Management

The concept of access management has existed since the late 1800s/early 1900s; however, it has only been within the past several decades that it has gained widespread acceptance and application [*21*]. One of the earliest state statutes concerning access control was enacted in New Jersey in 1902 [*22*]. While the interstate system was built with full access control, the majority of public roads and highways were not. From the early 1910s to 1940s, automobile ownership grew rapidly and with it, so did the demand for improved highways. As automobile use and travel demand continued to increase, commercial and residential land development proliferated, spreading outside of major city-centers. Development along non-freeway principal arterials took place with relatively little oversight as to the frequency and placement of driveways. By the 1950s, a majority of the existing state highway road network (completed in the 1930s) was considered functionally obsolete "due to poor route locations, poor traffic capacity, and a lack of modern highway design features" [*22*].

Another major outcome of the land-use changes was that owning an automobile became ever more important. Traffic volume, congestion, and crashes increased while the functional integrity of roadways continued to decrease [*22*]. Along the same lines, the increase in traffic-related deaths brought about additional safety-related concerns. In the 1950s, research began to examine the impact of driveway frequency on road safety and found a significant relationship between frequent access points and road crashes [*22*]. Access point density (i.e., the number of driveways per mile) has been examined on roads of varying geometry, operating speeds, and traffic volumes for over five decades, with findings consistently showing that the greater the number of access points, the greater the crash rates [*22-25*]. This knowledge led to the development of national standards for driveway placement, spacing and design beginning in the 1960s.

According to Williams and Levinson, "the *formal* development of access management begins around 1980" [*21*]. At this time, it became clear that "operational techniques alone do not offset the adverse effects of poorly located or poorly planned access to neighboring land, [and] that excessive signals reduce travel speeds…" [*21*]. It also became clear that in order to mitigate these issues in the future, systematic planning of access is critical, particularly in areas undergoing rapid growth [*21*]. The first state to enact a system-wide access management program was Colorado in 1981, followed soon after by states like New Jersey, Florida, and Oregon, among others [*21*]. As of 2010, 33 states have formal access management programs, though the scope and content of these programs vary widely [*7*].

Contemporary access management "extends the concept of access design and location control to all roadways—not just limited-access highways or freeways" [*7*]. This includes traffic signals, driveways, intersections, interchanges, and median openings. The basic principles of access management are as follows [*26, 27*]:

1. Provide a specialized roadway (circulation) system
2. Promote intersection hierarchy
3. Locate signals to favor through movements
4. Preserve the functional area of intersections and interchanges
5. Limit the number of conflict points
6. Separate conflict areas
7. Remove turning vehicles from through traffic lanes
8. Use non-traversable medians on major roadways
9. Provide a supporting street network along arterials and other major travel routes
10. Provide unified site access and circulation systems within and between development sites along major travel routes

Principles 1, 2, 9, and 10 are necessary for coordinating the systemic impact land use has on transportation and traffic operations, but states without formal access management programs can apply any of the techniques to improve road conditions. Because effective access management varies according to roadway function and traffic circulation, land use context, and the sociocultural and/or institutional characteristics of immediate and surrounding areas, there are no "one-size-fits-all" solutions or processes [*26*]. Access management is important in urban, suburban, and rural environments. The more developed an area becomes, the greater need to manage and plan access.

Impacts of Access Management

Research has examined the impacts of access management techniques on traffic safety, traffic operations and mobility, the economy, and the environment. Impacts of access management techniques are largely interrelated [*28*]. For instance, safety and operations benefits tend to go hand-in-hand: Improving traffic operations and mobility tends to result in better safety and fewer crashes, which has a positive effect on mobility. The role mobility plays in economic development and business activities is so essential, it is undisputed. It makes sense that improved mobility along major corridors would have a positive economic impact. While research has generally found this to be the case, states often face challenges from businesses whenever access management projects are proposed. Given the objectives behind access management principles, and the specific goals stated in the LA SHSP, any discussion of economic impacts [of access management] must be contextualized by safety and operational impacts. Therefore, the first subsection provides an overview of access management impacts on safety and operations, while the second subsection focuses on research examining the economic impacts associated with access management treatments.

Safety and Operational Impacts

Research has shown that access-managed roads are safer, move traffic more effectively and have shorter, more reliable, travel times than roads without [*23*]. This generally has positive implications for business and the environment (e.g., via lower emissions). Moreover, access management prolongs the life of roadways, and by extension, the public investment in highway infrastructure [*24*]. Access management is important in urban, suburban, and rural environments. The more developed an area becomes, the greater need to manage and plan access.

Driveway/Signal Placement & Density. The relationship between crash rates and the frequency, density, and spacing of access points and signals is well-documented: greater frequencies of intersections and driveways generally leads to increased crash rates [*25, 29*]. According to AASHTO, a disproportionate number of crashes occur at driveways rather than at other intersections [*7, 30*]. In general, history has shown that increasing numbers of driveways have "cumulative adverse impacts" on safety and operations [*7*]. Crash rates increase as the density of unsignalized access connections per mile increases, and these patterns are largely consistent among states [*28, 29*]. For example, one study conducted in South Carolina analyzed the potential safety and operational consequences of individual driveways and their characteristics in order to provide the state with decision-making support with respect to driveway permitting [*31*]. The study found increasing distance between driveways, increasing entry lanes and the presence of raised medians are associated with a decrease in crashes, while wider driveways, corridor volume and higher speeds, as well as high-turnover land use and full access are associated with an increase in crashes [*31*].

Likewise, signal density is associated with higher crash rates [*28, 32, 33*]. Signal density is also related to travel speeds and is one of the most important factors in estimating average speeds on arterial streets [*34*]. The spacing of traffic signals affects the operational performance of urban and suburban highways [*7*]. According to Stover and Williams, the traffic signal spacing has a "direct effect on roadway efficiency" [*26*]. Poorly timed and close, frequent, or non-uniformly placed signals constrain traffic flow, contribute to delays and increase travel times. Gluck, Levinson, and Stover find that increased signal frequency results in reduced progression efficiency with a corresponding increase in delays [*28*]. Short traffic signal spacing is associated with problems like high crash rates, less flexibility in signal timing, greater variability in traffic speeds, as well as environmental consequences i.e., reduced fuel economy and increased emissions [*35*]. It is important to note that the consistency of findings across states holds even as precise relationships vary due to differences in the geometry of roads, intersections, driveways, etc., operating speeds and traffic volumes [*28*, *29*].

Conflict Points at Intersections & Medians. The primary goal of access management is to limit the frequency and impact of conflict points (or driver decision points as they are sometimes called) on through-traffic [*36*]. All access points have at least one or more conflict points, i.e., any point where the paths of two road users cross, diverge, or merge. About half of the basic principles underlying access management explicitly pertain to limiting and reducing the impact of conflict points at driveways, intersections, and median openings. These are:

- Preserve the functional area of intersections and interchanges
- Limit the number of conflict points
- Separate conflict areas
- Remove turning vehicles from through traffic lanes
- Use non-traversable medians on major roadways

Any access point (e.g., driveway) that intersects with the road is a potential point of conflict, however, public road intersections are of particular interest [*23*]. By design, intersections are planned locations of friction where road users may come into conflict with one another [*28, 37*]. Because access management techniques are used to control the location of merging, diverging and crossing traffic, they are especially advantageous at intersections [*38*].

The range of potential safety and operational concerns that may arise at a given intersection is related to the surrounding environment. Table 1 provides a basic overview of the operational and safety concerns at intersections in rural, suburban, and urban environments. In urban and suburban areas, for example, congestion at intersections during peak travel periods has a detrimental impact on overall arterial efficiency. According to Reid, “in the vast majority of cases, the single, most limiting capacity factor in overall arterial performance is signalized intersection operations” [*39*].

Table 1
Operational and safety concerns at intersections, by environment-type

	Rural	Suburban	Urban
Operational Concerns	Maintenance of high speeds for through movements Navigation for unfamiliar drivers Provision for comfortable turning movements	Maintenance of flexibility to accommodate traffic growth Control of access along major routes Capacity of major signalized intersections	Intersection capacity Accommodation of parking, deliveries Maintenance of signal progression schemes and network considerations
Safety Concerns	Mitigating rear-end conflicts caused by turning vehicles Providing adequate geometry and sight distance for safe gap acceptance Avoiding ‘surprise’ situation (e.g., hidden intersections, unusual channelization)	Angle and rear-end conflicts at congested intersections Localized pedestrian-related problems (e.g., schools, shopping) Driveway access conflicts	Pedestrian conflicts Angle and rear-end conflicts at congested intersections

Source: 2004 NCHRP Report 279, p. 40 [14]

Concerns are different in rural areas. First, median-separated (i.e., divided) multi-lane highways or expressways typically have speeds greater than or equal to 50 mph and partial access control in that they allow at-grade intersections and limited driveway access [*40*]. Research shows that increasing minor road traffic is associated with greater crash frequency and severity [*40*]. One major safety concern at rural intersections is right-angle crashes due to the inability of the driver entering or crossing from the minor road to gage the speed and distance of oncoming vehicles on the major road [*40*].

Intersections vary in complexity by the number of legs (i.e., lanes), entering vehicle volume, as well as the presence of bicyclists and/or pedestrians [*26*]. Intersection complexity generally increases as the number of approach legs increases; as the number of legs increase, so do the number of conflict points. The geometric design or crossing angle contribute to intersection complexity as well. Figure 3 illustrates a conventional four-leg signalized intersection, which has a total of 32 conflict points. Compared to conventional four-leg intersections, a typical rural four-leg divided highway intersection has 42 conflict points, as shown in Figure 3. The presence of many conflict points becomes a greater concern under increasing traffic volumes as the probability of two users coming into contact increases [*26*].

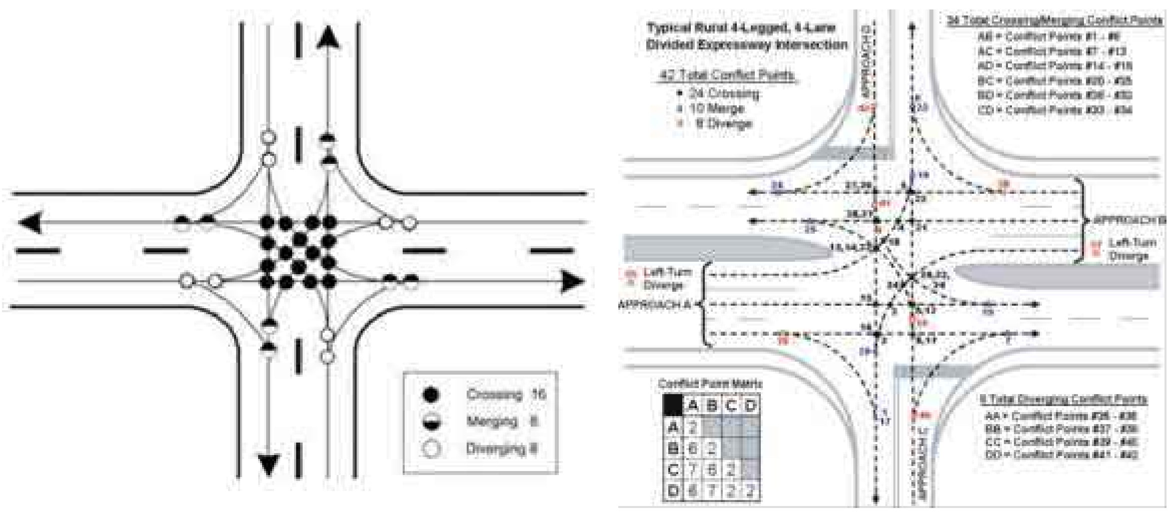

Figure 3
Left: Conflict diagram of conventional four-leg at-grade intersection [*14*]
Right: Conflict diagram of typical rural four-leg divided highway intersection [*19*]

Left-Turn Treatments & Unconventional Intersections. Left-turning vehicles present operational and safety challenges due to conflicts arising from opposing through traffic, same direction through traffic, and crossing traffic with other road users [*41*]. Intersection capacity and operations depend on how left turns are treated [*42*]. Left turn treatments that separate turning vehicles from through movements have been shown to improve intersection performance, maintain travel speed, preserve roadway capacity and reduce the risk of crashes [*39*]. Separating and limiting conflict points associated with left-turning vehicles can be achieved through various access management techniques, ranging from more conventional options, such as adding protected turn lanes and channelization, installing non-traversable raised medians, to the unconventional, such as re-routing/reconfiguring the intersection by design.

The term "unconventional intersection" refers to any intersection design that does not allow direct movement in all directions. Throughout the literature, there are a number of terms used describe the unconventional intersections with apparent interchangeability, i.e. reduced conflict intersections (RCI), innovative intersections, alternative intersections and non-traditional intersections. There are three main principles behind unconventional intersection design, operations, and management:

1. Design and operational emphasis on through movements (preserve functional classification of arterials, minimize stopped delay for through movements)
2. Reduction in the number of signal phases (reduce cycle length)
3. Reduction of conflict points at intersections and separation of remaining [*39, 43*].

Considering these principles in the context of access management, unconventional intersections are ultimately "conflict-point management" treatments. Conflict-point management treatments are those that, by design, strategically reduce, relocate or otherwise control the number and/or the potential severity of conflicts at intersections [*40*]. The effectiveness of such treatments comes down to the elimination of the high-risk conflict points, which varies according to intersection complexity and traffic volume [*40*]. For example, on rural high-speed roads, the highest-risk conflict points are those on the far-side intersection associated with left turns and crossing maneuvers from the minor street. Case studies on several different unconventional intersection designs have shown that they are capable of improving both operational efficiency and safety [*40*].

The unconventional intersection design most suited for a particular location depends on a multitude of factors, including whether or not the design will be implemented at a single location or at multiple intersections successively along a corridor [*39*]. Compared to conventional intersections, unconventional designs are capable of mitigating the growing congestion problems experienced on high-volume roads because they operate more efficiently and with less signal phases, which can be especially beneficial when implemented systemically [*39*]. They can also be very effective at isolated locations, particularly as a safety countermeasure.

While there are at least a dozen unconventional designs and a number of variations associated with each, states are increasingly considering designs that do away with direct left turns (i.e., unconventional median U-turn crossover, RCUT, roundabouts) as a means of access management. The unconventional intersection design of interest in this study is the Restricted Crossing U-turn (RCUT), otherwise referred to as a J-turn, superstreet, or synchronized street intersection [*44*]. The RCUT is a variation of the median U-turn (MUT) intersection design, also called "Michigan left" due to its frequent use along roads and highways in the state of Michigan [*45*]. In the state of Utah, this design is called a "ThrU-Turn," while in other states, the terms U-turn Crossover, Express Left, or Boulevard Turnaround are used.

There are differences between the MUT and RCUT worth noting; however, before describing how the designs differ, it is important to first clarify how alternative intersection designs such as these compare with conventional designs to reduce the number of conflict points. Table 2 displays the number of conflict points these designs have compared to conventional intersections. Both the MUT and the RCUT eliminate 50% or more of the total conflict points associated with conventional intersections and well over 75% of the crossing conflict points, which are considered far more severe than those left remaining. Obviously, more lanes will increase the number of conflict points, but the number will still be fewer than a conventional intersection with the same number of legs.

Table 2
Intersection design and number of conflict points

Type of Intersection	No. of Legs	Crossing	Diverging	Merging	Total
Conventional	4	16	8	8	32
Conventional Divided Hwy	4	24	8	10	42
Conventional T	3	3	3	3	9
Offset T (two T intersections)	3	22	2	2	26
Median U-Turn (MUT)	3 or 4	4	6	6	16
RCUT/J-Turn/Superstreet	3 or 4	2	6	6	14

Median U-Turn. The MUT and RCUT are closely related but differ in important ways [*45*]. First, the MUT intersection eliminates direct left turns from major and/or minor approaches, often both, and requires drivers to travel through the main intersection and then make a U-turn downstream at a median opening followed by a right turn. In most cases, the main MUT intersection is signalized, while a crossover may or may not be signalized [*45*]. Due to its design, signalized MUT intersections have only two signal phases and operate more efficiently than conventional intersections. As previously mentioned, the MUT is heavily used in Michigan and has been since the 1960s [*46*].

A FHWA research synthesis of 25 studies published between 1974 and 2005 reviewed findings concerning the safety and operational performance of MUT intersections [*47*]. In general, reduction of signal phases leads to about 20-50% increased capacity for the intersection, while the reduction in conflict points has been shown to reduce the number of crashes from about 20-50% as well, with a dramatic reduction in the most severe conflict points [*47*]. Reid et al. examined a combination of comparative simulation and field studies with publication dates ranging from 1997-2002 and 1974-2010, respectively, and concluded that MUT intersections have the following operational advantages over conventional intersections:

- Added 14-18% capacity
- Increase total throughout from 15-40%
- Lower number of stopped vehicles in network, 20-40% lower
- Critical lane volumes reduced by 17%
- MUT corridors reduce travel times by about 17% and increase average speed by 25% (compared to conventional corridors with TWLTLs) [*48*].

Restricted Crossing U-Turn. An RCUT intersection redirects left turns and through movements from minor/side street approaches, requiring all left-turning vehicles approaching the major road to turn right onto the major road and make a U-turn at a directional median opening 400-1000 ft. downstream [*45*]. Drivers who need to continue through on the side street follow the same path, only they would turn right from the major road to the side road. A basic illustration of the RCUT design appears in Figure 4. The primary difference between the two designs is that the RCUT reroutes through movements whereas the MUT does not. This difference suggests that in places with high through demand, the MUT may be a better option [*46*].

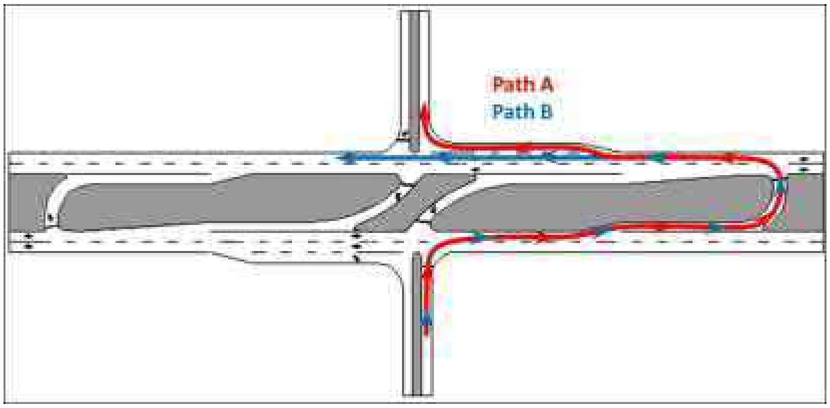

Figure 4
RCUT intersection diagram, from FHWA

The purpose of RCUT intersections is to serve through traffic on the major road. By design, they have the capability to provide a relatively high LOS to major road through traffic over a wide range of demands. The RCUT intersection is known by alternative terms such as a “superstreet,” J-turn, or “synchronized street” intersection. The terms are used with apparent interchangeably throughout the literature; however, the term “J-turn” was first applied to unsignalized RCUT intersections on high-speed rural highways [*45*].

The RCUT was first presented in the late 1980s by Richard Kramer, a traffic engineer in Huntsville, AL, but the design was also independently developed in Maryland and North Carolina in the late 1980s-early 1990s [*44, 49*]. Kramer, who was primarily concerned with congestion on suburban arterials carrying high volumes of through traffic, called the design a “superstreet” advancing the idea that signal-controlled intersections along arterials should have a “high percentage of green time… to promote high quality-progression” [*45*]. In Maryland, the RCUT primarily developed out of the need to maintain adequate traffic flow at some minor road intersections on high-speed four-lane rural roads [*44*]. Specifically, operational issues were beginning to emerge under growing traffic volumes and conflicts, increasing the potential for signalization. The state was concerned that signals ultimately would decrease arterial mobility, attract more development, and increase minor street traffic. Maryland was the first state to install an unsignalized RCUT intersection, which they called a “J-turn.” In North Carolina, a series of RCUT intersections, were installed on a “narrow, high-speed, four-lane highway through the mountains” to address conflicts associated with left-turning vehicles from the minor street without signals [*44*]. North Carolina adopted Kramer’s term “superstreets” for these intersections.

RCUT intersections may be signalized, stop-controlled, or merge/yield-controlled. As with any geometric treatment, the suitability of a particular treatment at a given location depends on a constellation of factors (i.e., access/land use, operational, safety, etc.) as well as an assessment of the relative impact the treatment would have on the overall road network. According to Hummer et al., "stop-controlled RCUT intersections are typically used as a safety countermeasure, RCUT intersections with merges are often used as an interim measure instead of implementing an interchange, and RCUT intersections with signals are an arterial corridor treatment" [*44*]. When signalization is warranted, the RCUT requires only two phases (as opposed to four phases at conventional intersections) [*45*]. This improves signal progression and offers important operational benefits. The RCUT can be implemented as a "safety measure" or as a "collision countermeasure" [*45*].

As of 2014, RCUT intersections have been installed in Texas, Tennessee, Alabama, Louisiana, Ohio, Maryland, Missouri, Michigan, and Minnesota [*44*]. Because of the relative newness of RCUT implementation; however, there have only been a handful of comprehensive impact studies, conducted in North Carolina, Maryland, and Missouri, which are reviewed here. The focus is predominantly on unsignalized RCUTs and safety impacts, but some studies also include signalized RCUTs and examine operational impacts. Several studies published after 2016 provide further insight into the safety and operational impacts. One particularly relevant 2018 study examined the safety impacts of RCUTs (in addition to three other countermeasures) on Louisiana highways [*50*]. These studies are reviewed here as well. While more research is undoubtedly needed, findings consistently support the claim that RCUTs perform better than conventional intersections (with respect to travel time/delay, signal progression, pedestrian crossing and transit service) [*51*].

North Carolina. One of the first major studies to examine safety and operational impacts was conducted in North Carolina [*52, 53*]. Hummer et al examined the safety impacts of 13 unsignalized superstreets on four-lane divided highways in North Carolina using traffic flow adjustment, comparison-group, and Empirical Bayes (EB) analyses [*53*]. Findings indicate significant reductions in total, angle and right turn, and left turn crashes overall and at 10-12 of the 13 individual sites [*52, 53*]. Overall, the researchers recommend unsignalized superstreets for rural and suburban arterials, particularly where high-volume, divided arterials with four or more lanes intersect with two-lane minor roads [*52, 53*].
The study also compared the travel times of three signalized superstreets, two of which are at isolated locations and the other, a five-intersection corridor, which they compared to comparable conventional intersections [*53*]. In all three cases, the superstreets out-performed conventional intersections in reducing overall travel times during peak periods. As a corridor

treatment, superstreets allow for "perfect progression in both directions at any speed and signal spacing" [*53*]. Additionally, the researchers recommend building superstreets along developing corridors as a "preventative measure" to reduce congestion and increase capacity before it truly becomes a problem. Arterial traffic will eventually outgrow the capacity of a conventional design before it will the superstreet, which is ultimately a cost-saving measure in the end [*53*].

Maryland. Inman and Haas evaluated the safety and operations of an RCUT (i.e., J-turn) intersection on a rural four-lane divided highway from a human factors perspective [*54*]. The researchers compared several observations at the RCUT intersection to a nearby conventional intersection located on the same corridor [*54*]. Observations included: conflict between vehicles, merging behavior, lag acceptance, weaving, and travel time differences between the RCUT and the conventional intersection [*54*]. They also examined the impact of converting conventional intersections along two rural high-speed divided highways to RCUTs in Maryland by conducting a before-and-after analysis of crash data using three approaches. In total, they considered nine RCUT intersections, installed between 1998 and 2003. Findings indicated that while travel times at the RCUT took about a minute longer than the conventional intersection, there were clear safety impacts that make the RCUT safer than conventional designs. The before-and-after crash analysis showed between 28 and 44% crash reduction following the conversion to RCUT and suggested a decrease in crash severity. In their conclusions, the researchers recommend the RCUT design for minor road intersections of sufficient volume where they meet four-lane divided highways, noting that with increased volume on the major road, the increased travel time at the RCUT is likely to decrease [*54*].

Subsequent case study research conducted by the Applied Technology and Traffic Analysis Program, a partnership between Maryland State Highway Administration and the University of Maryland, provides additional support for earlier findings. In a presentation for the 2014 TRB Alternative Intersections & Interchanges Symposium, Rahwanji, and Kim present the state of the practice, case studies, and analysis tools on unconventional designs in Maryland [*55*]. Specifically, results of a before-and-after (i.e., 3 years before, 1.25 years after) comparison of crash data at the signalized RCUT intersection in Maryland. In general, the superstreet saw the most impactful crash reductions in angle crashes, which went from 12 (2008-2010) to 1 (2012-2013).

Missouri. Edara, Sun, and Breslow evaluated the effectiveness of J-turns in Missouri by conducting field studies, a public survey, crash analysis, and conflict analysis [*56*]. The researchers report that in the sample of five intersections the J-turn design resulted in approximately 35% reduction in crash frequency for all crashes and about a 54% reduction in crash frequency for all injury and fatal crashes. Among injury crashes, serious injury crashes decreased by 86% while minor injury crashes decreased by 50%. There were zero fatal crashes following J-turn implementation. Of all of the potential safety benefits associated with the J-turn design, decreasing the frequency of angle crashes is perhaps one of the most important safety impacts. In this study, the researchers reported that annual right angle crashes decreased by 80% for all five sites. They also report that the J-turns "completely eliminated" left-turn right-angle crashes. Another safety finding involved a comparison between a J-turn site and a TWSC site on US 63 on "time to collision," a measure of conflict defined as "the time after which a vehicle will collide with another vehicle if both vehicles were to maintain their current speed and path" [*56*]. With this measure, smaller values indicate greater crash likelihood if no evasive actions are made, while higher values suggest lower crash likelihood. Time to collision was significantly higher at the J-turn site than at the TWSC site, which was an average of 41.28 second and 10.40 seconds respectively. See also [*57, 58*].

Other States. The studies on unsignalized RCUTs indicate generally positive impacts, particularly in regards to safety but also in operations. In general, when states install signalized RCUT intersections they typically do so as a corridor treatment to improve traffic operations [*44*]. Hummer and Rao collected and analyzed crash data at 11 intersections in four states (i.e., Alabama, North Carolina, Ohio, and Texas) to examine before-and-after conversion from conventional to RCUT design [*51*]. All of the intersections were in suburban areas along four-lane or six-lane arterials. All four states reported the predominant reason they chose the RCUT design was for operational reasons rather than safety. The researchers were able to determine high-quality comparison sites. In general, they find that support for the assumption that signalized RCUT intersections reduce crashes. At 8 of the 11 sites, they observed reduction in overall and injury crashes. Among the three sites that did not show a reduction in crashes, the researchers observed each had three-lane approaches from at least one of the minor streets. This finding suggests RCUTs may be safer when the minor streets are narrower and/or have lower traffic volumes [*51*].

In their 2018 study particularly relevant to this research, Sun and Rahman investigated the safety impact of several crash countermeasures recently installed in Louisiana, one being the RCUT [*50*]. In total, all of the countermeasures examined achieved a reduction in crashes and all were deemed cost-effective, but this review focuses only on the RCUT findings. For 10 RCUTs in Louisiana (one rural, nine urban) Sun and Rahman performed a before-and-after crash characteristics analysis, developed the crash modification factor (CMF) of RCUT intersections (using two methods), and estimated the overall safety benefit-cost ratio of RCUT installations [*50*]. The researchers classified crashes occurring within 150 ft. of the intersection as "intersection only" crashes, while crashes taking place between the two U-turns were classified as "RCUT crashes." Despite some variation in crash changes, the before-and-after crash characteristics analysis showed significant reductions in RCUT crashes (by 13%, 11%, and 100% for total, injury and fatal crashes, respectively) and Intersection only crashes (by 31.1%, 41.8%, and 100%, respectively).

The researchers estimated the CMFs using the Improved Prediction method (for both RCUT and intersection only) and the Empirical Bayes (EB) method (for intersections only). For the Improved Prediction method, the expected crash reduction is 85 (14%) for RCUTs, which translates to a CMF of 0.86 (95% confidence) with the intersection only CMF estimated to be 0.69. The EB method estimates the CMF of intersection only crashes is 0.80, indicating a 20% reduction in the total number of crashes at RCUT intersections. The safety benefit-cost analysis provides insight into how the decreased number of crashes translates into economic savings. Using an average construction cost estimate of $300,000 (provided by a DOTD district representative), the researchers estimate the overall safety benefit cost ratio is 2.72. Even if the average RCUT construction cost estimate was $500,000, the researchers estimate the ratio would be 1.63 [*50*].

Summary. The impact of access management on safety and operations is well documented. While there are many techniques to reducing, separating, relocating, and minimizing the impact of conflict points, unconventional intersection designs such as the RCUT provide simultaneous benefits to roadway operations and safety. Any potential limitations associated with the unconventional designs (such as potential driver confusion or increased travel time for minor street access) are out-weighed by the safety and operational benefits, which significantly impact all road users.

Barriers to Implementation

State DOTs often face serious challenges and opposition to access management projects, which require the coordination of state/local resources and policy as well as the cooperation and support from property owners and developers to be successful. Consistent throughout the literature, access management strategies and treatments go a long way in improving roadway operations and safety. Despite the documented benefits, there continue to be a number of barriers to implementation. *NCHRP Report 548: A Guidebook for Including Access Management in Transportation Planning* lists some of the more common barriers states face to addressing access management concerns in the planning process [*6*]. These include insufficient funding, a lack of standardized procedures and/or an inability to apply standards consistently, as well as a lack of understanding among local elected officials and small property owners [*6*]. Other barriers include attitudes and perceptions of access management techniques among local elected officials, property owners and the public overall. For instance, Rose notes the persistent "erroneous public belief that U-turns are dangerous" and the longstanding "preconceived notion of the negative impact of access management techniques" [*6*]. This is especially the case among businesses, as there is a tendency to perceive any proposed access changes negatively due to the overriding perception that the changes to access will be harmful to their bottom lines.

In a 2012 publication, Shumaker, Hummer, and Huntsinger examined the barriers to implementing unconventional intersection designs (UIDs) by conducting a national survey of 1,073 randomly selected members of the Institute for Transportation Engineers (ITE) [*59*]. The response rate was 23% (N=245). When asked to provide their level of familiarity with and their opinion on UIDs, respondents who reported being very familiar with UIDs were most likely to report the opinion that they offer much potential for improvement over the conventional designs [*59*]. Respondents were asked to rank barriers in the order of importance, which were divided into three separate categories: Public acceptance barriers (n=6), Professional barriers (n=8), and Political barriers (n=8). Of the public acceptance barriers, respondents ranked "potential for driver confusion" at the top, followed by "fear of the unknown." Respondents ranked public opinion the highest among political barriers, followed by "Lack of proof of design function," which also ranked first among professional barriers. When asked which factors are most important to increasing the use of UIDs, all of the respondents indicated some degree of importance in "proof of benefits" and "education."

Controversy. The barriers to implementation tend to be similar regardless of the access management technique proposed. One of the most controversial issues in access management, for example, is the construction of raised/nontraversable medians (i.e., left-turn restrictions) in areas with extensive development and heavy traffic volume. In general, research finds that crash rates on multi-lane undivided highway decline when any median treatment is implemented [*28, 30, 60-62*]. Compared to two-way left turn lanes (TWLTs), which are the least access-restrictive median treatment, nontraversable medians physically separate opposing traffic and directly reduce the number of left-turn conflict points, in addition to a host of other safety benefits, such as providing a pedestrian refuge and reducing driver workload [*63*].

Research published since the 1980s has tended to arrive at the same conclusion: that four- and six-lane divided highways with nontraversable medians have lower crash rates than similar capacity roads with TWLTLs [*28*]. On average, the crash rate is approximately 30% lower [*18*]. Despite the clear implications for safety, which are well-documented, these projects are generally perceived negatively by citizens and businesses likely to be affected.

Dixon, Hibbard, and Mroczka examined the public perception of median treatments for three median improvement projects on developed urban roads in Cobb County, GA, located in the greater Atlanta area [*64*]. Dixon et al, reviewed public hearing comments and found comments tended to reflect five basic areas of concern, specifically: (1) Total project opposition, (2) design based on abutting land use, (3) access constraints, (4) safety, and (5) cost. One thing that was apparent to the researchers was that in many cases, the features of the treatment that were perceived as strengths to one group of citizens was perceived as a weakness to others. Some citizens took the public hearing as an opportunity to communicate their dissatisfaction with local government. In general, citizens appeared primarily concern with the potential impacts the median improvement would have on them personally, rather than the impact on road operations. Dixon et al. suggest agencies preparing for public hearings set up the meeting in such a way as to more directly communicate the potential impacts on individual citizens [*64*].

Ott, Feilder et al., recommend a proactive approach to communicating the safety and operational benefits of proposed projects to members of the public as well as to businesses [*65*]. They emphasize the importance of pinpointing what is “of value” to various stakeholders in the public (i.e., residents, businesses, commuters) in their education and awareness outreach efforts [*65*]. A study on public involvement in median projects in Florida found that some of the FDOT district offices handled public concerns more proactively than others, which led to better success. For example, involving the public in earlier phases of the project development process (such as the design phase) can head off public opposition to median decisions [*66*]. Williams notes “agencies that rely on public hearings for median projects report they tend to be adversarial and have not been effective in resolving public concerns for several reasons,” such as the point in the process when they are typically held, the fact that the hearing must focus on a broad range of issues as opposed to access issues, and a lack of time spent explaining the project necessity. [*66*]. To improve success, Williams recommends holding open house-style public meetings as well as one-on-one meetings with civic groups and officials as needed to “diffuse conflict and promote a more personal atmosphere” [*66*].

Business Opposition. According to the FHWA, "access management has no impact on the demand for goods and services;" therefore, it is improbable that access changes will be a primary cause of a business' success or failure [*67*]. Still, research has tended to show businesses often perceive access changes negatively. As one part of a large study evaluating operational and economic impacts of access management along corridors in South Carolina, researchers conducted an online survey of state DOTs as well as phone interviews (18 participants) to gain more in-depth insight into state DOTs access management practices. Thirty-two DOTs responded to the online survey and 18 of them participated in phone interviews. In both samples, approximately 80% of state DOTs reported that opposition from business owners is a primary challenge [*68*].

Business & Economic Impacts

There are a number of difficulties associated with measuring and assessing economic impacts of access management treatments [*28*]. Some of this difficulty is attributed to obstacles obtaining reliable business income and property value data [*24, 69*]. According to Gluck et al., economic impacts not only depend on the extent to which access to adjacent property increases or decreases following the change, but also on the type of business activity affected and the "background economic conditions." [*28*]. These effects are also contingent on changes in business conditions, traffic volume, population shifts as well as shifts in purchasing power, and developing sites of business competition [*28*]. Moreover, other confounding factors that influence business activity and traffic patterns, etc. could mediate and/or moderate the relationship. For example, several studies conducted in the late 2000s coincided with the global economic recession, making it difficult to determine exact impacts from access management on business sales [*70*].

Several studies conducted in the 1990s and 2000s examined the economic impact of median treatments/left turn restrictions. Research since the 2010s has expanded to include other types of access management treatments; however, only a few studies primarily focus on economic impacts and none of them specifically considers J-turns or RCUT intersections. Existing studies look at the impacts of specific techniques (such as raised medians) on business perceptions while also examining sales data, property values, employment and other metrics before-and-after construction. The most common methods of analysis include perception-based surveys at retrofit project sites, before-and-after survey studies, and empirical analysis of quantitative data when available, with the former two being far more prevalent than the latter [*69, 71*]. The majority of economic impact studies tend to be "desired in a short time frame" and post-construction, thus "no true before-and-after studies [have been] completed to date" [*69*]. Almost all use survey methods to measure business perception following the treatment.

From a transportation/access perspective, businesses are primarily considered one of two types: "Destination" or "Drive-by." Destination businesses are those that customers typically plan to patronize before their trip begins. Examples of these include professional services, major retailers, specialty retailers, most professional offices, sit-down restaurants, etc. Drive-by businesses are those that customers tend to stop at on impulse or for convenience, as they are "passing by." These include convenience stores, gas stations and fast-food restaurants. Economic impact studies conducted in Texas, Minnesota, Washington, Utah, and others generally conclude that most businesses (regardless of type) tend to perform the same or better once access projects have been implemented [*19, 67, 70, 72-74*]. These studies are reviewed below.

Business Perceptions. Eisle and Frawley conducted a four-year research effort to develop and test a methodology for determining the economic impact of raised medians [*72, 75*]. In the first year of the project, the methodology was developed and tested at one case study location in College Station, TX before and during construction of a raised median. The second year, 10 additional case study locations were identified and data collected in the cities of McKinney, Longview, Wichita Falls, Odessa, Houston, and Port Arthur, TX. These cities reflect a range of development mixes and a variety of population sizes, ranging from approximately 35,000 in McKinney to about 1.8 million in Houston. Data were collected using survey research methods among business owners and managers along corridors where raised medians were installed. The survey questions were focused on gathering insights into perceptions of business performance over time (i.e., better/worse/same). Some of the key findings include:

- Perceptions of median impact prior to installation were slightly more pessimistic than what actually occurred. Businesses interviewed before construction had more negative perceptions.
- When asked to rank the relative importance that their customers placed on "accessibility to business," "distance to travel," "hours of operation," "customer service," "product quality," and "product price," businesses ranked "accessibility" as fourth or lower, while "customer service," "product quality," and "product price" were ranked within the top three.

- Based on self-reported number of customers per day and gross sales, most business types experienced increases once the installation was complete. The exceptions were auto-repair shops and gas stations.
- Among business owners present before, during, and after construction, property values increased by 6.7% while business owners anticipating access changes perceived property values would decrease.
- The most impactful phase of the process was the construction phase in which businesses reported a reduction in the number of customers per day and gross sales. Most businesses (with the exception of auto-repair shops and gas stations) reported increases following median installation [*72, 75*].

Another Texas study considered effects of access management projects on operations, safety, and economic performance of businesses in the greater Houston, TX, area [*70*]. The economic assessment entailed an analysis of taxable sales data before, during, and after completion of access management improvements for various classes of business along three corridor study areas. All three corridors consisted of principal arterials with retail and residential urban development. Businesses were classified according to North American Industry Classification System (NAICS) as pass-by, destination, or combination (i.e., 50% pass-by/50% destination). Economic tax data were received in aggregate form for each corridor section and business category, which they analyzed by zip code. Taxable sales receipts were adjusted to 2012 U.S. dollars with consumer price index data for normalization purposes and local control zones were created from the zip codes for comparison purposes.

For the most part, results of the analysis indicate mostly positive findings across the three corridors. Two corridors in particular saw taxable sales increases for all three business types after access management improvements had been completed. The results for the third corridor were mixed, with some sections of the corridor showing significant decreases, and others showing large increases. In general, the trends model the taxable sales growth trends observed in the zip code control zones. This suggests that business sales along the corridors after access management improvements were completed increased at a rate greater than businesses in the adjacent control zone [*70*]. The researchers note that during the study period, two major hurricanes (i.e., Rita in 2005, Ike in 2008) along with the global economic recession may have been confounding factors; however, there is no way to determine their impact [*70*].

In Utah, Riffkin, et al. examined the economic impact (i.e., retail sales) before and after the completion of raised median projects along three study and three comparison corridors [*76*]. The study corridors included the construction of a raised median, while the comparison corridors consisted of nearby roads on which other construction projects (i.e., not raised medians) were completed within the same period. Taxable sales data were analyzed one full year before and after the projects were completed. Findings showed that along all of the raised median corridors, corridor-area retail sales and sales per square feet increased, with no evidence of any negative sales impacts. They did not analyze impacts on individual business, so it is possible that not all businesses experienced positive impacts. Riffkin et al. also conducted a business perception survey and found, in general, those businesses who were located along a corridor where raised medians were added, had more negative perceptions of the raised median impact before and after the project completion than businesses along the comparison corridor that did not add raised medians. Overall, business owners had neutral-positive perceptions of the raised medians' impact on traffic safety and operations while also reporting neutral-negative perceptions of the raised medians' impact on sales. Despite the relatively negative perception, sales data analysis indicated that there was a 32% increase in sales along the raised median corridors. This finding suggests perceptions of individual businesses may not reflect reality [*76*].

Several studies have been conducted in North Carolina. Cunningham et al. studied the perceptions and attitudes toward access management held by business owners and managers [*69, 71*]. In order to conduct a before–after study, the researchers identified seven treatment sites where medians were installed and seven comparison sites (as a surrogate for the "before period"). The purpose of using the comparison sites was to control for "the same general macroeconomic conditions, similar traffic patterns, and roadway geometry." [*69, 71*]. The researchers worded the questions differently so that the business comparison group was asked how they think potential access modifications *would* impact them, which served as a proxy before-group. Results indicated that there were no significant differences in revenue changes according to the self-reported responses. There were no significant differences in business turnover. There were differences in perceptions of safety between the comparison group and the after-treatment group in that the after group tended to express positive or neutral attitudes. Additionally, perceived impact on the number of customers-per-day was worse in the comparison group than it was for after-treatment group, suggesting the impact of the median was far less negative than first perceived [*69, 71*].

Vu, Shankar, and Ulfarsson examined business perceptions of access management impacts on accessibility and patronage in Western Washington State (King County) along six major commercial corridors [*74, 77*]. The purpose of the study was to develop explanatory models that provide insight into factors contributing to business perceptions of access management. Data were collected using survey research methods, which asked businesses about current access control, existing traffic conditions, perceptions of patronage impact and preferences for different access management treatments. The researchers assumed (and confirmed) a correlation between perceptions of access management impacts on perceptions of accessibility and perceptions of patronage impact as well as simultaneity in the relationship between perceptions of each (i.e., they influence one another). To examine the relationship, the researchers constructed a "discrete choice model of business perceptions" using a simultaneous logit model approach. Controlling for business use, operation, and street environment variables, the following hypotheses were tested:

- Available access (via driveway controls) could have "significant marginal effects on patronage perceptions;" and,
- "Access management should not directly affect businesses perceptions of accessibility, i.e., the measure of ease of entry or exit at driveways" since the effect of current accessibility should be captured by "street environment" variables [*77*].

One general finding from analysis of the survey data is that businesses tended to have similar perceptions of traffic concerns at their location as well as the corridor. The street environment variables include level of congestion on corridor as well as the presence of right-in-right-out (RIRO) driveways and traffic signals. Results show that perceptions of current accessibility had a significant impact on perceptions of patronage. Specifically, businesses with shared driveways or traffic signal access control had a more positive perception of the impact, while businesses with more restrictive access (e.g., RIRO) had a more negative perception of the impact on patronage. The perceptions of impacts on patronage are closely related to perceptions of access impacts on revenue, with businesses reporting substantially similar perceptions of access impacts on revenue. This suggests that it is reasonable to view perceptions of patronage impacts as a proxy for perceptions of revenue impacts. Additionally, perceptions of traffic concerns, namely high traffic volume/ congestion and high speeds at business driveways, are very similar to the perceptions of traffic concerns along the corridor. Consistent with the second hypothesis, none of the access management variables had a significant impact on perceptions of accessibility; controlling for business operation variables, high traffic volume/congestion was significantly related to perceptions of accessibility, in that the more congestion, the greater the accessibility concerns and less congestion with lower accessibility concerns [*74, 77*].

A study of long-term impacts of access management on business and land development was conducted in Minnesota, following the systematic comprehensive conversion of US Hwy 12 to Interstate 394 in the Twin Cities metro area between 1985 and 1993 [*73*]. Secondary data analysis to assess economic, transportation, land use and demographic trends from 1980 to the early 2000s provided insight across the corridor as a whole, while interviews with 14 business owners and managers representing a cross-section of business-types located in the corridor provided insight into how individual businesses managed during the transition [*73*]. At the corridor level, the impact of the conversion was very positive: traffic volumes increased to nearly double the traffic volume carried on Hwy 12; peak hour speeds increased between 2-25 miles per hour (despite greater volume) and travel time for typical trips generally decreased (despite greater indirect access to retailers). Traffic safety-wise, the rate of fatal and injury crashes (normalized by traffic volume) declined significantly. Land use trend analysis showed land use growing more intensive overtime, with commercial and industrial land use increasing and vacant land decreasing. Post-conversion, gross retail sales (which include taxable services) increased considerably; employment increased and the business turnover-rate in the area was less than typical annual rates for Minnesota (and the country overall) and commercial land values increased greatly. The interviews with business owners yielded findings consistent with other studies: while the experience of individual businesses varied, most businesses were doing well and for the most part, the impact of the conversion was positive. The researchers note that prior to the conversion, some business owners raised concerns about the expected impact to their business. The actual impact turned out to be much less (and generally in the opposite direction) than anticipated and no business suffered as a direct result. Most of the businesses interviewed reported positive experiences [*73*].

Methods

This section describes the data sources, collection, processes, and methodologies used in analysis for this project.

Economic Impact Analysis

The primary data used in the analysis came from the Louisiana Department of Revenue, who provided sales tax data for individual business locations surrounding the J-turns. J-turn location data was provided by DOTD. In some cases, businesses may have experienced turnover, such as a change in ownership or even business type, or become established for the first time during the study period. These transitions were included in the revenue data by a marker to provide a more comprehensive dataset while making clearer potential causes for changes in business activity over time. These sales tax series are transformed into total sales using the tax rates in each time period, and these total sales figures are the primary subject of our analysis. The statewide sales tax rate increased from 4% to 5% on May 1, 2016. To provide a more consistent measure of economic activity over time, the sales tax collections in each period were divided by the relevant sales tax rate to produce a more consistent measures of taxable sales in each period. In some of the analyses, parish level data were used to provide comparisons to local level economic trends. Total wages, employees, and establishments were acquired from the Quarterly Census of Employment and Wages for each parish where a J-turn was installed. Parish-wide sales tax revenue was acquired from each parish's tax collection agency.

Survey Methods

To gather insight into the perceived impact of access changes on business activity in areas where J-turns were previously installed, both local businesses and their patrons were surveyed. Questionnaires were created and programmed using Qualtrics data collection software: one specifically tailored to business managers and employees and the other was developed for a general population. The primary objective is to survey businesses within a half-mile of existing J-turns constructed between 2011-2013. Given the amount of time since the J-turns were constructed, it is possible that participants may lack a clear recall before or after construction. It was also acknowledged that current employees or managers may not have been present before or after construction and may not recall a time before it was there. The same can also be said for patrons. To avoid introducing memory/recall bias by priming the respondent to think about the J-turn specifically, the questionnaires focus on identifying any access-related issues businesses in the area and their patrons were *currently* experiencing. Copies of both questionnaires are in Appendix B but they are described generally below. For specific question wording or other details, please refer to Appendix B. Both questionnaires were approved for exemption from institutional oversight by LSU IRB.

Businesses. The business survey was open to the highest-level employee available at the time of request who had to be at least 18 years of age as well as have worked at the location or in the immediate area for at least one month. The questionnaire includes a set of questions about the business and its daily operations such as number of employees, number of customers/clients per day on average, etc.; a set of items assessing perceptions of their customers and their perceptions of traffic congestion at their busiest times of day. Several items ask about access-related and safety concerns and asked for elaboration if any concern was mentioned. Finally, for analysis purposes, basic demographic information (e.g., gender, age, etc.) was requested.

Patrons. All participants in the patron intercept survey had to be at least 18 years of age and had to have resided in Louisiana for at least the past month. Patrons were asked if they had planned to stop as well as how frequently they tend to visit that business or others in the area, among other items regarding their preferences and concerns. Like the business survey, there are several items about access-related and safety concerns, as well as basic demographic items.

Recruitment and Data Collection. Recruitment for participation in this study took place on-site, with interviewers spending one day at each of the four general locations to collect data for both surveys. With the exception of a handful of businesses who participated at a later date by telephone interview, all data were collected electronically on iPads, facilitated in-person by the research team who were trained in survey interviewing specifically for this study. Interviewers were accompanied by field supervisors with prior experience to monitor effort, manage the distribution of interviewers across businesses and to answer any questions throughout the day. All participants in this study were assured that their responses would remain anonymous and their answers could not be traced back to them statistically or otherwise.

Survey Sites. Though at least 10 J-turns in the state were constructed between 2011-2013, not all locations were suitable for on-site survey data collection (due to less traffic volume, less commercial development, etc.). One J-turn is located in a rural area and on US 90 for instance, where five of the 10 J-turns were constructed as a corridor treatment, not all of these intersections had enough businesses to generate sufficient patron traffic. Table 3 describes the primary survey site locations. Figure 5 provides a general idea of where these locations are in relation to each other and within the state.

Table 3
Survey sites

Location of J-turn	City	Parish	DOTD District	Year	Setting
US 61 & LA 42	Baton Rouge	East Baton Rouge	61	2013	Urban 4-lane divided
US 90 Corridor (mult. intersections)	Broussard	Lafayette	3	2012	Urban 6-lane divided
LA 21 & Zinnia Dr.	Covington	St. Tammany	62	2012	Urban 4-lane divided
LA 45 & 10th Street	Marrero	Jefferson	2	2013	Urban 4-lane divided

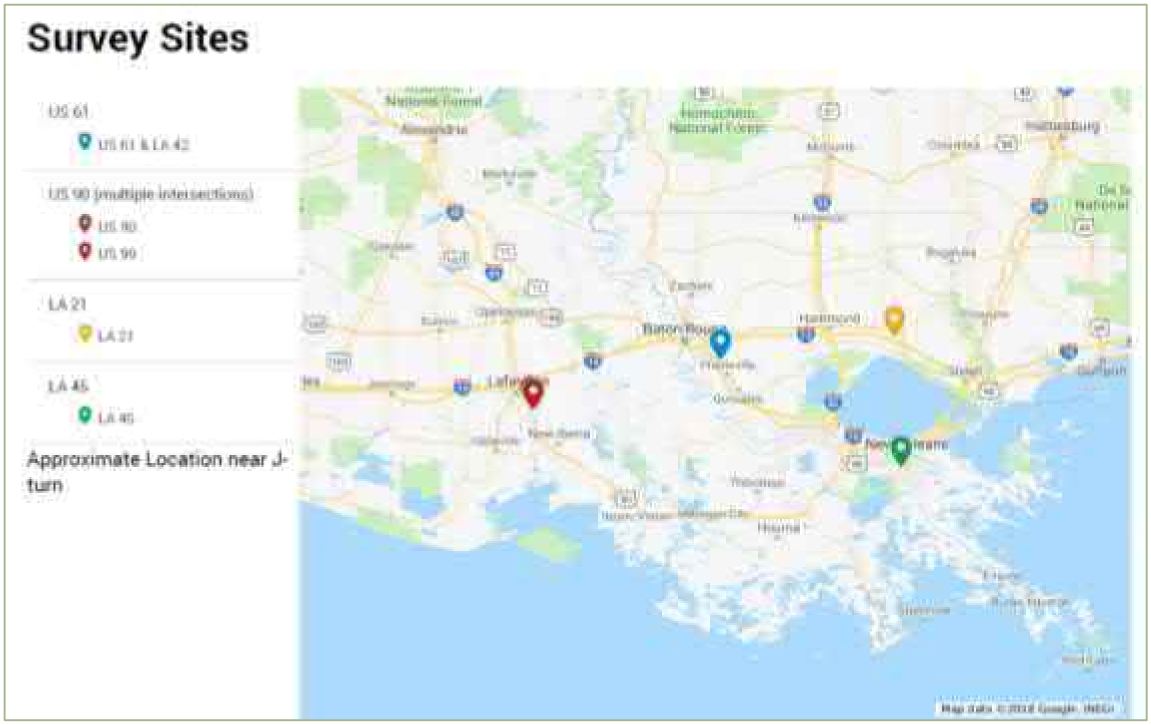

Figure 5
Survey sites, approximate location of existing J-turns

DISCUSSION OF RESULTS

Economic Impact Analysis

Analysis of the economic effects of J-turns follows a top-down approach, which starts by looking at the data broadly and becomes progressively more granular in subject matter. In particular, this analysis focuses on whether J-turns may impact the level of sales at nearby businesses. The first, broadest level of analysis is the aggregate, which includes sales of all businesses within a half-mile of any J-turns matched to the Louisiana Department of Revenue tax database in all years and parishes combined. Second, the data are split by the years that the J-turns were installed, so that different year effects can be observed. The third section splits the data by parish in order to compare business sales to local trends. The final section looks at two specific businesses types, gas stations and restaurants, which were considered most susceptible to impacts from changes in access in the area due to the higher focus on convenience among customers.

Within each of these four sections, two categories of businesses will be analyzed. Businesses within a half mile of the new J-turns were reviewed and categorized as either "affected" or "unaffected" based on whether or not there was a change in travel distance after J-turn installation. An affected business is one that a customer would have to go further out of their way to patronize after installation of the J-turn. Each section compares how affected and unaffected businesses changed after installation of the J-turn. The unaffected businesses act as a local control group to determine the J-turn effect. These comparisons will be done for all matched businesses in the area and also for a more limited set of businesses active 12 months before and 12 months after the installation to ensure a more direct comparison of site-level sales over time. In these data, frequent turnover in storefronts and the establishment of new businesses after infrastructure improvements could lead to trends in sales data that should be attributed to changes in business type or number of businesses. Isolating the analysis to just these existing, constant businesses may clarify the impact of the J-turns, but also in some cases limits the data to too few businesses to draw robust conclusions.

In some cases, it might be preferred to separate the data into affected and unaffected existing businesses to examine the differences between these two groups at every level of detail. However, in some locations, or for certain subgroups, there are not enough businesses in the data to produce reliable results. Moreover, results based on small samples sizes cannot be published due to confidentiality limitations of the data. In addition, an analyst's assessment of whether a business is affected or not by a J-turn requires making certain simplifying assumptions about typical routes taken by drivers in the area and such a determination may not account for unexpected routes and thereby misclassify some businesses as unaffected when they are in fact affected in some cases, or vice versa. By analyzing all businesses as a group as well as businesses active throughout the study period, the effects of j-turns can be examined at varying levels of detail.

Aggregate

The first seven graphs begin at the macro level by aggregating sales across all matched Louisiana businesses near J-turn installations in all parishes and years. A necessary step in viewing all sales on a single graph is to reference the time frame by which they are examined to be relative to the period in which the J-turn is installed. The J-turns were not all installed in the same year so timing of the data must be adjusted to combine into one graph. After adjustment, zero is the first month of the year of installation. Included in all of the graphs are vertical red lines depicting the period of construction, horizontal lines showing the average before and after the installation period, and monthly sales of businesses surrounding J-turns. The time frame stretches two years before the installation to two years after.

To help control for external factors that may influence sales, monthly sales surrounding each J-turn were divided by monthly sales in the parish. During the study period, a number of economic trends can be expected to influence sales. For example, flooding in August 2016 directly impacted businesses in the Baton Rouge and Lafayette areas with sharp negative consequences followed by a boost driven by rebuilding activity in subsequent months. In addition, a slowdown in oil and gas activity that began in late 2014 cost the Lafayette region thousands of jobs leading to worsening economic conditions in 2015 and 2016. By dividing sales at businesses surrounding J-turns by parish-wide sales figures, broad economic trends can be taken out of the analysis to better assess the impact of J-turns on business activity. However, J-turns are often located in areas that have seen nearby construction of new commercial developments and sales at surrounding businesses may be influenced by more localized factors than parish-level economic trends. These considerations will be discussed when relevant.

Figure 6 depicts the percentage of parish sales that the J-turns are responsible for over time. The percentage is calculated by summing all the sales around the J-turns and dividing them by the sum of all the parish sales within a year. The average before the J-turn is 0.22% and the average after is 0.28%. A hypothesis test of mean equality yields a p-value of less than .05, and rejects the null at this level of significance that the two means are equal. Thus, the aggregate share of parish sales can be said to increase on average after the J-turn's installations. (Note that Vernon Parish did not disclose their sales taxes so Vernon Parish businesses have not been included in this graph.)

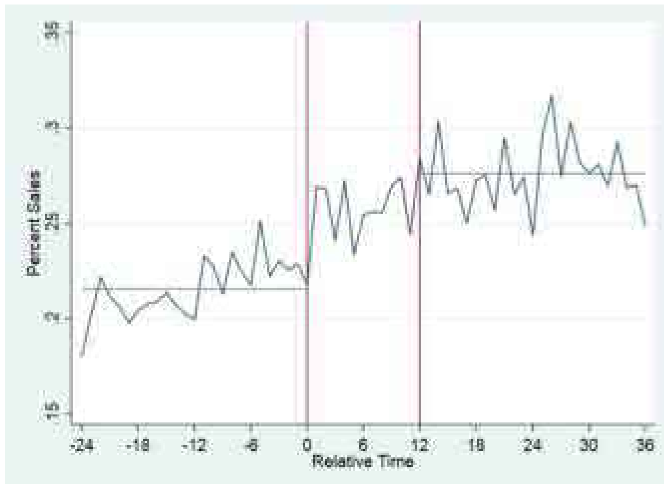

Figure 6
Sales of businesses surrounding J-turns as a percentage of all parish sales

Figure 7 displays nominal sales across all J-turns in millions of dollars. The average before J-turn is \$9.6 million and the average after is \$13.1 million. A hypothesis test that the two means are equal yields a p-value of less than .05, rejecting the null hypothesis at this significance level, indicating the higher sales after the J-turn are statistically significant.

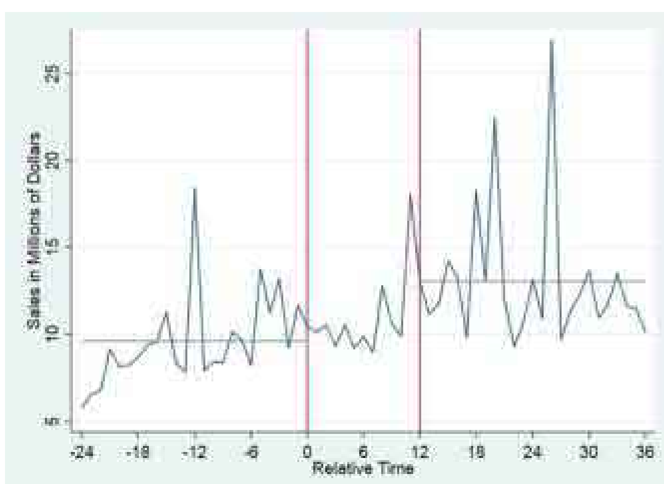

Figure 7
Sales of all businesses surrounding J-turns

Figure 8 shows the same aggregate sales before and after installation but with one key difference: the eight most volatile firms, with standard deviations of over $150,000, have been removed. These were largely oil and gas related firms that might have large sales of equipment or other goods and services in one quarter, and nothing in the next. They have also been removed from all further analysis. The average before installation is 4.4 and after is 6.3. The null hypothesis of the equality of these two means being equal is less than .05, indicating that the mean sales after is significantly more than the mean before.

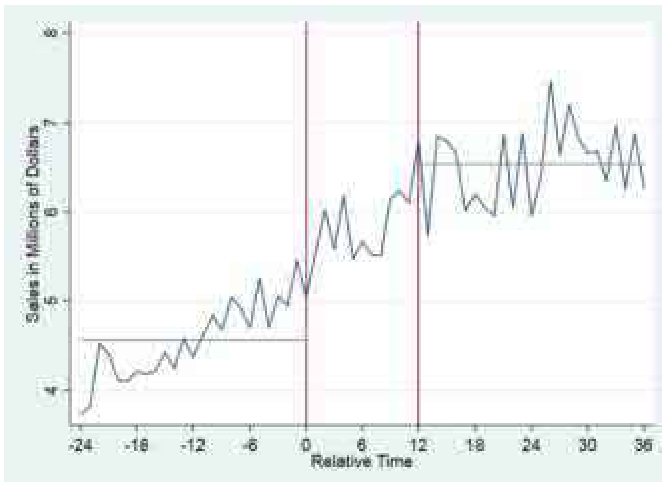

Figure 8
Sales of all businesses surrounding J-turns with volatile industry firms removed

The next two graphs divide businesses by whether their access is affected or unaffected by the J-turn, as determined by travel distance and typical travel in the area (i.e., a mapped route from one point to another not accounting for potential missed turns or temporary disruptions caused by accidents, construction, or other obstructions). Figure 9 portrays the series and averages of the unaffected businesses and Figure 10 portrays those of the affected. The mean of unaffected business sales before the J-turn installation is 3.0, and the mean after is 3.9. The null hypothesis that these two means are equal is rejected at the .05 significance level, indicating that the mean sales after is greater than the mean before.

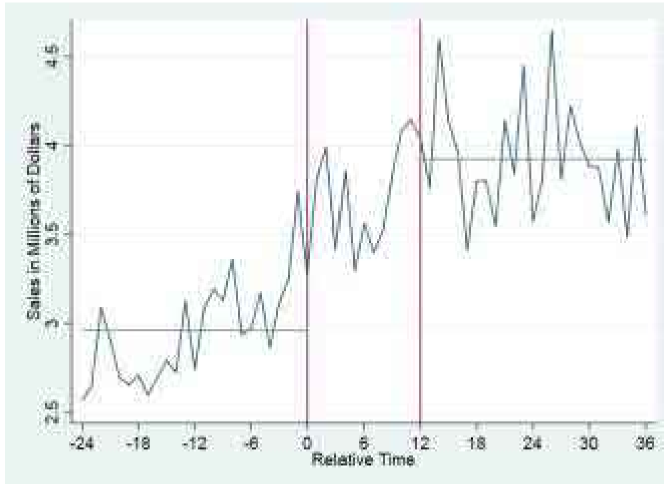

Figure 9
Sales of businesses unaffected by J-turns

Figure 10 depicts the sales of those businesses that were affected by the installation of J-turns. The mean before the installation period is 1.6 and the mean after is 2.6. The equality of the means can be rejected at the .05 level of significance. In both unaffected and affected cases, the mean sales after the J-turns have increased and do not seem to be negatively affected by the J-turn.

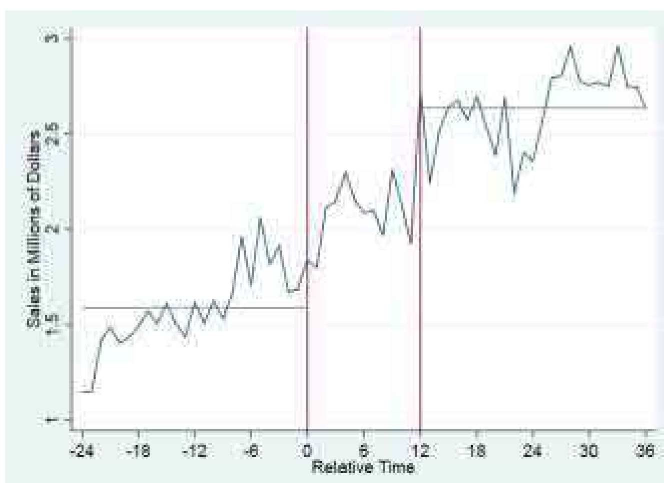

Figure 10
Sales of businesses affected by J-turns

Figures 11 and 12 show the same categories of affected and unaffected businesses, but are restricted to those businesses that were active from a year before the J-turn installation to a year after. This comparison is useful to examine because it eliminates many conflicting explanations of sales trends due to business turnover and focuses on individual business effects. Figure 11 depicts the sales of unaffected businesses that were active throughout the period of analysis. The mean before the installation period began was 2.9 and the mean after was 3.2. The null hypothesis of equality of means is rejected at the .05 significance level. Thus, sales were higher after the J-turn installation in businesses unaffected by J-turns active throughout the period.

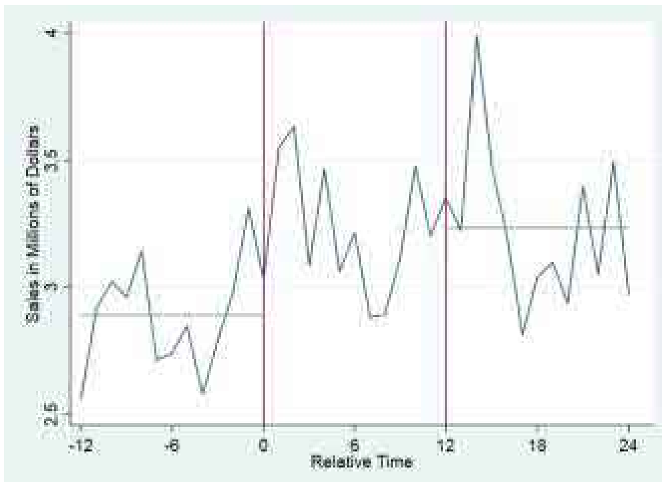

Figure 11
Sales of businesses unaffected by J-turns active throughout period

Figure 12 is the counterpart of Figure 11 and illustrates only those businesses whose access is affected by the installation of a J-turn that were also active throughout the period of analysis. Average sales before the installation was 1.0 and the mean after is 1.2. The null hypothesis of mean equality is again rejected at the .05 level of significance. Sales among this set of businesses were also higher after the J-turn among affected businesses.

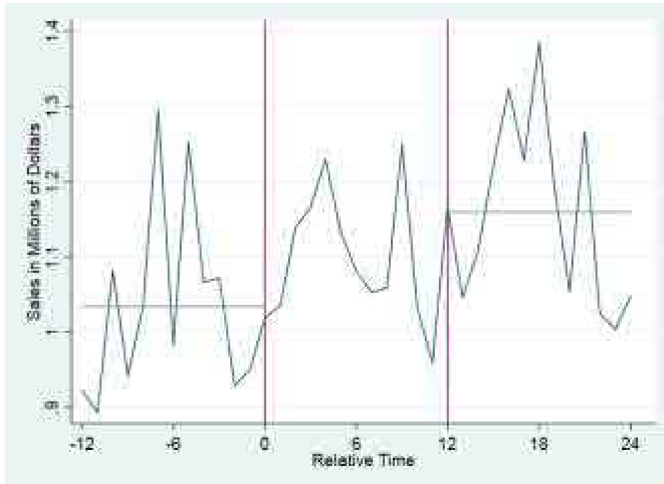

Figure 12
Sales of businesses affected by J-turns active throughout period

Summary. There is no evidence at the aggregate level that J-turns have a negative effect on business sales in the areas where they are installed. On the contrary, they appear to be correlated with growth wherever they are installed. This correlation should not necessarily be taken to mean that J-turns improve business sales; even in the last comparison of businesses active throughout the entire period, there are other factors that may affect business sales, such as the business climate in the parish and the neighborhoods in which they are installed, and potentially growing population and development necessitating J-turn traffic controls in the first place. The fact both affected and unaffected [by travel distance due to the J-turn] businesses experienced increased sales seems to indicate factors besides the J-turn alone may explain the increased sales. These caveats aside, the evidence shows that in aggregate, J-turns do not appear to harm business sales in a significant way.

Summary statistics are shown in Table 4, which displays the means (M), the standard errors (SE) of the means before and after installation, the difference between the means, and indicators representing the level of significance at which the two means are different from one another. To indicate the degree of statistical significance, one, two, or three asterisks indicates rejection of the hypothesis that means are equal at the .10, .05, or .01 level, respectively. A dash in the significance column indicates that the null hypothesis that the means were equal could not be rejected. In every case in this section, the mean after the installation was above the mean before the installation began. Also, every case rejected the null hypothesis that the two means were equal, indicating that within each group analyzed in this section, the mean after J-turn installation is greater than the mean before.

Table 4
Aggregate summary statistics

List of Figures	Mean Before (Std. Err)	Mean After (Std. Err)	Difference Between Means
Figure 6: Sales of businesses surrounding J-turns as a percentage of all parish sales	0.2156 (-0.0149)	0.2759 (-0.0178)	0.0603***
Figure 7: Sales of all businesses surrounding J-turns	9.603 (-2.6499)	13.0523 (-4.0065)	3.4493***
Figure 8: Sales of all businesses surrounding J-turns with volatile industry firms removed	4.408 (-0.4205)	6.3123 (-0.4253)	1.9043***
Figure 9: Sales of businesses unaffected by J-turns	2.9609 (-0.2877)	3.9226 (-0.3238)	0.9617***
Figure 10: Sales of businesses affected by J-turns	1.5909 (-0.22)	2.6357 (-0.1994)	1.0448***
Figure 11: Sales of businesses unaffected by J-turns active throughout period	2.893 (-0.2151)	3.2333 (-0.3109)	0.3403***
Figure 12: Sales of businesses affected by J-turns active throughout period	1.0339 (-0.1231)	1.1595 (-0.1228)	0.1256**

Note ** p=.05; *** p=.01

Installation Years

This section divides the J-turns into the years that they were built. The J-turns in this study were installed between 2011 and 2013. As with the aggregate sales, businesses are first pooled and then categorized as affected and unaffected businesses first with all businesses in the area and then with only those businesses active 12 months before and 12 months after the installation period. These divisions are only included when the number of businesses are sufficiently large to protect confidentiality of sales figures, so 2011 is left out of the detailed analysis. While detailed results cannot be published, the general pattern for businesses surrounding the 2011 J-turn is consistent with other findings that sales increased after installation and the mean was significantly higher in the period following the J-turn than in the period before the J-turn.

The sales of businesses surrounding J-turns built in 2012 are shown in Figure 13. The mean before the installation period for these businesses is 2.9 and the mean after is 4.5. The two means are significantly different at the .05 significance level.

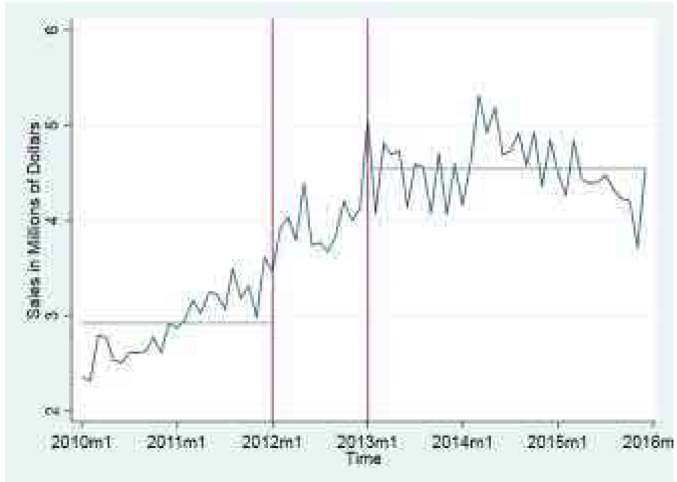

Figure 13
Sales of businesses surrounding J-turns built in 2012

Businesses nearby J-turns built in 2012 were further subdivided into those expected to be unaffected and affected by changes in access due to the installation of the J-turn. Unaffected business sales of J-turns built in 2012 are shown in Figure 14. The mean after installation (2.4) is greater than the mean before (1.7) at the .05 level of significance.

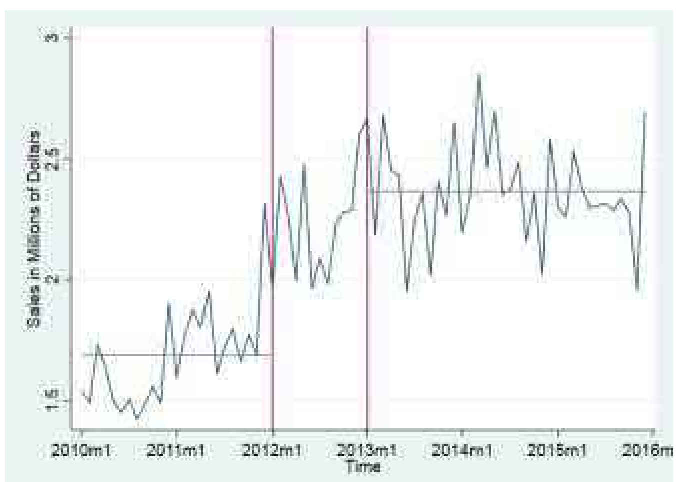

Figure 14
Sales of businesses unaffected by J-turns built in 2012

Affected business sales of J-turns built in 2012 are shown in Figure 15. The mean before the installation period is 1.2 and the mean after is 2.2. The mean after installation is concluded to be significantly greater than the mean before at the .05 level of significance.

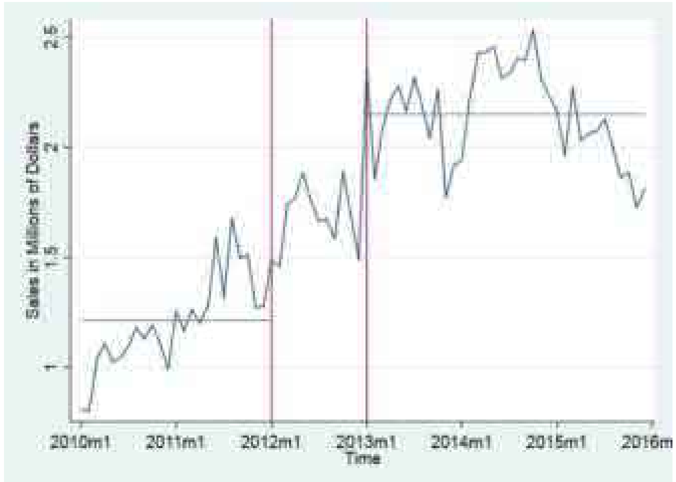

Figure 15
Sales of businesses affected by J-turns built in 2012

Figure 16 divides the 2012 year of installation into affected and unaffected businesses and displays these categories on the same graph. The affected and unaffected business sales exhibit very similar trends around the time that the J-turn is built, which would indicate that there is no or little effect on business sales from the J-turns installed in 2012.

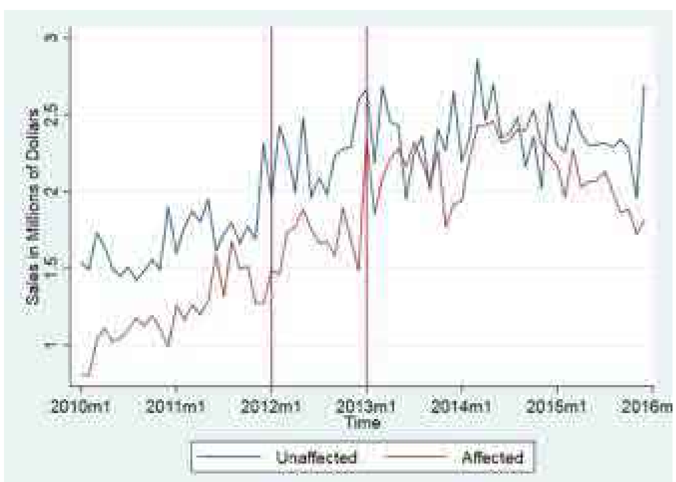

Figure 16
Sales of unaffected and affected businesses built in 2012

Figure 17 further limits the analysis to include only those businesses that were active throughout the period of analysis (i.e. excludes any new businesses or businesses that closed during this period). These businesses had average sales of 2.7 before the installation period began and average sales of 3.0 after. The difference in means is significant at the .05 level of significance.

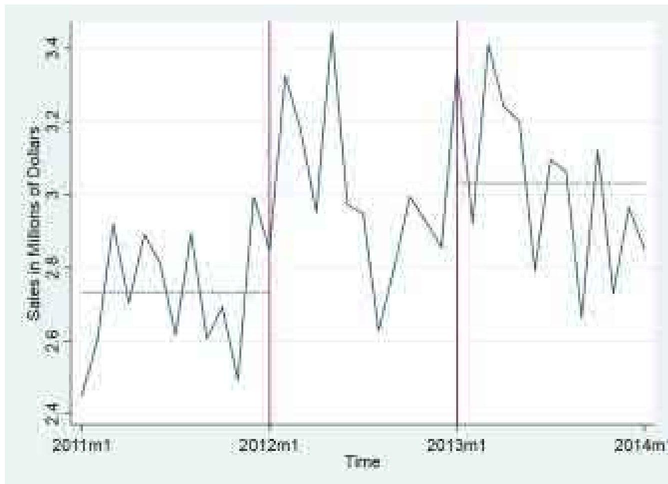

Figure 17
Sales of businesses surrounding J-turns built in 2012 and active throughout period

Next, Figure 18 further limits the analysis to include only those businesses that were active throughout the period of analysis and that were unaffected by the J-turns (i.e. excludes any new businesses or businesses that closed during this period). These businesses had average sales of 1.7 before the installation period began and average sales of 1.9 after. The difference in means is significant at the .05 level of significance.

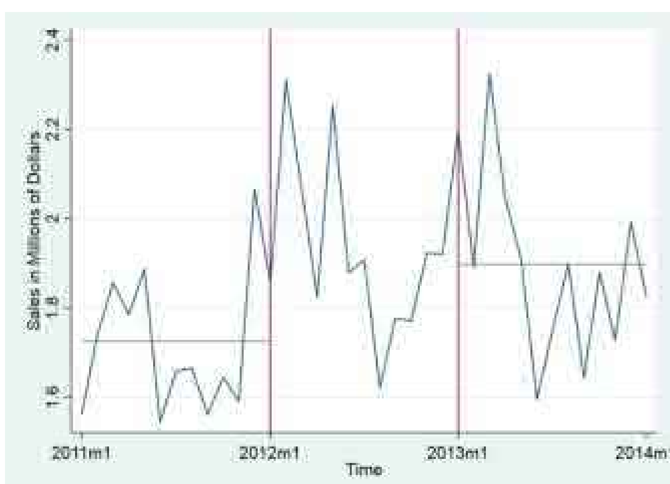

Figure 18
Sales of businesses unaffected by J-turns built in 2012 and active throughout period

Figure 19 depicts only those sales of affected businesses surrounding J-turns built in 2012 that were also active for a year before and a year after the completion of the installation. The mean before and the mean after are 1.0 and 1.1, respectively. The null hypothesis that the two means are equal is rejected at the .05 level. Next, Figure 20 shows both the affected and unaffected businesses surrounding J-turns built in 2012 that began at least a year before installation and existed to at least a year after on the same graph to allow for easier comparison. After omitting disturbances from new businesses opening or closing, the trends for both affected and unaffected are stable and similar. No negative effect is detectable on the businesses that were flagged as affected by changes in traffic due to the 2012 J-turns.

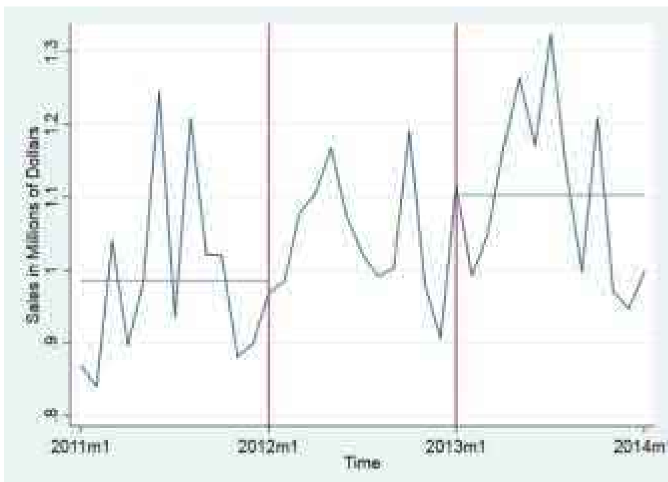

Figure 19
Sales of businesses affected by J-turns built in 2012 and active throughout period

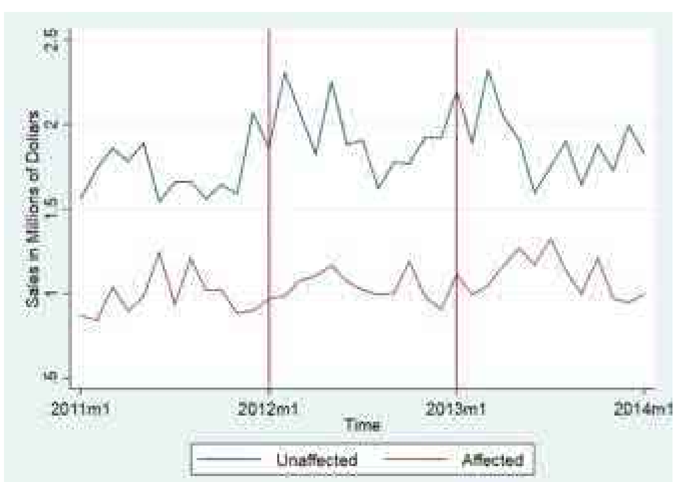

Figure 20
Sales of unaffected and affected businesses built in 2012 and active throughout period

The last year of J-turn installation included in the study is 2013 and the sales surrounding these J-turns are shown in Figure 21. The mean before and the mean after are 1.6 and 1.8, respectively. The two means are significantly different at the .05 significance level.

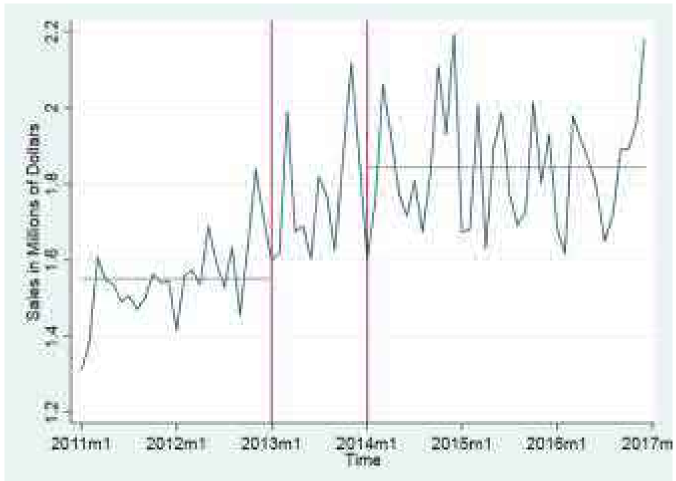

Figure 21
Sales of businesses surrounding J-turns built in 2013

Figure 22 further limits the dataset to businesses surrounding J-turns built in 2013 that also were active for one year before and for one year after. The mean before the installation period began was 1.1 while the mean after was 1.2. The null hypothesis of the equality of these two means is rejected at the .05 significance level.

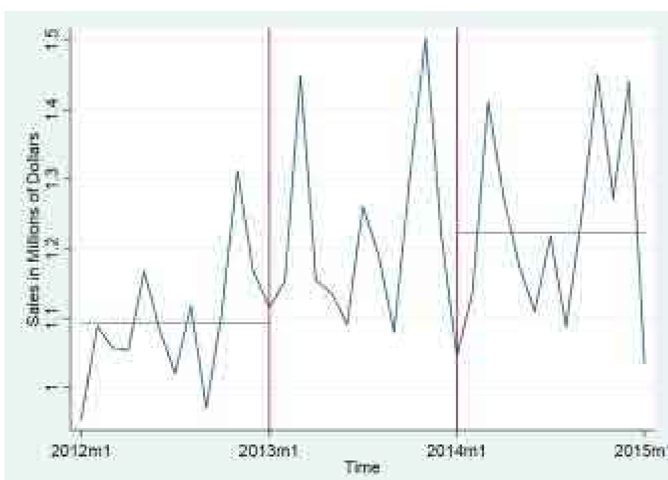

Figure 22
Sales of businesses surrounding J-turns built in 2013 and active throughout period

Summary. The analyses summarized above produces no evidence that J-turns have a negative significant effect on business sales in any year. Sales were either stable or increasing over the study period in 2011, 2012, and 2013 installations. Table 5 displays the summary statistics for this section. No years displayed mean sales after J-turn installation as being significantly below mean sales before. On the contrary, in every case in this section the mean after was indicated to be greater and significantly different at the .05 or higher level of significance.

Table 5
Installation year summary statistics

List of Figures	Mean Before (Std. Err)	Mean After (Std. Err)	Difference Between Means
Figure 13: Sales of businesses surrounding J-turns built in 2012	2.9227 (0.3565)	4.5471 (0.3456)	1.6244***
Figure 14: Sales of businesses unaffected by J-turns built in 2012	1.6893 (0.2073)	2.3658 (0.2130)	0.6765***
Figure 15: Sales of businesses affected by J-turns Built in 2012	1.2123 (0.2194)	2.1509 (0.2155)	0.9386***
Figure 17: Sales of businesses surrounding J-turns built in 2012 and active throughout period	2.7325 (0.1730)	3.0300 (0.2343)	0.2976***
Figure 18: Sales of businesses unaffected by J-turns built in 2012 and active throughout period	1.7247 (0.1581)	1.8984 (0.2073)	0.1737**
Figure 19: Sales of businesses affected by J-turns built in 2012 and active throughout period	0.9852 (0.1246)	1.1028 (0.1207)	0.1176**
Figure 21: Sales of businesses surrounding J-turns Built in 2013	1.5513 (0.1074)	1.8426 (0.1593)	0.2913***
Figure 22: Sales of businesses surrounding J-turns built in 2013 and active throughout period	1.093793 (0.0926)	1.223308 (0.1439)	0.1295**

Note ** p=.05; *** p=.01

Parishes

This section separates J-turn sales by parish. Throughout this section, sales are represented as a percentage of total sales in the parish to capture local trends in the data. Using the percent of total sales in the parish helps to isolate changes in sales attributable to J-turns as opposed to larger economic trends like increasing development in certain parishes. It shows how the sales in the businesses near J-turns fare relative to the entire parish. The following parishes will be shown: Lafayette, East Baton Rouge, Jefferson, and St. Tammany.

For each parish, first, an analysis of all businesses surrounding J-turns will be shown; second the affected and unaffected businesses displayed separately when a sufficient number of businesses are present; third, all businesses active throughout the period; finally, only those businesses active throughout the entire period of study are studied when a sufficient number of businesses exist. While each successive level of analysis provides more detailed and relevant analysis, the number of existing businesses in some cases is quite small, which limits the generalizability of some inferences. For an overview of all summary statistics presented in each of the figures of this section, please refer to Appendix C.

Lafayette Parish. The sales from Lafayette Parish J-turns are exhibited in Figure 23. One notable difference between this graph and previous graphs is that sales have actually declined after the J-turn installation. The means before and after are 0.52 and 0.51, respectively. The p-value of the test that the means are equal is 0.37 and cannot be rejected under any reasonable significance level. Thus, the null hypothesis that the means are equal cannot be rejected, indicating no significant difference between percentages of sales before and after the J-turn installation. Thus, no conclusion can be made as to whether the businesses were negatively affected.

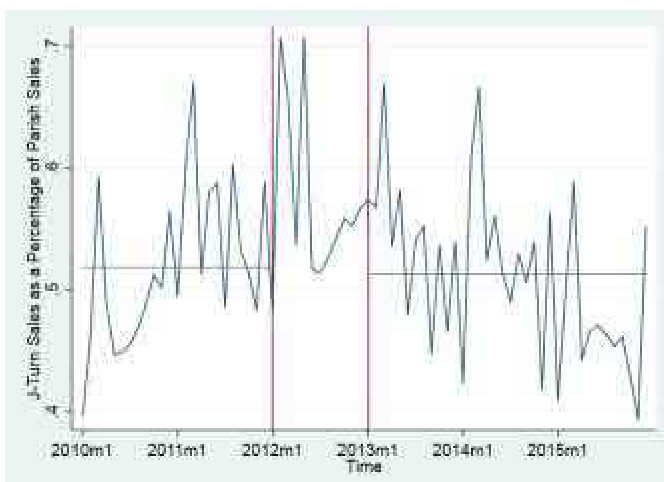

Figure 23
Lafayette Parish: Sales of businesses surrounding J-turns as percentage of parish sales

Next, Figure 24 includes sales of unaffected businesses from Lafayette Parish J-turns. The mean before the installation is 0.28 and the mean after is 0.28. Just as in the last graph, the null hypothesis that the means are equal cannot be rejected in this scenario. In other words, there does not appear to be a significant effect of the J-turn on sales.

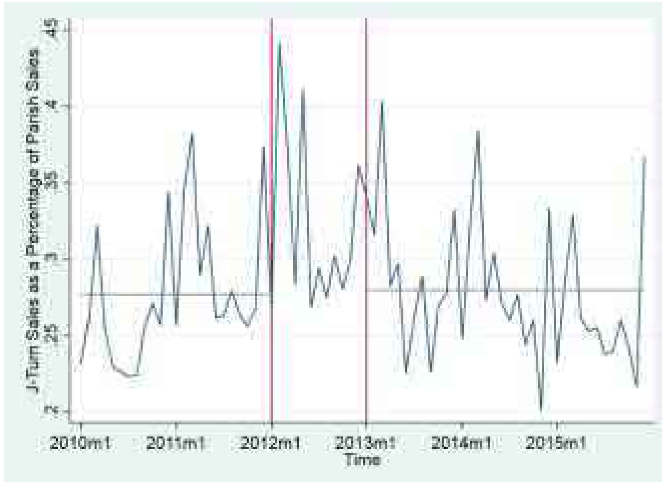

Figure 24
Lafayette Parish: Sales of businesses unaffected by J-turns as percentage of parish sales

In the same way that Figure 24 showed unaffected sales, Figure 25 exhibits the sales of affected businesses around Lafayette Parish J-turns as a percentage of parish sales. The mean before the installation is 0.24 and the mean after is 0.23. The null hypothesis cannot be rejected at the .05 level of significance.

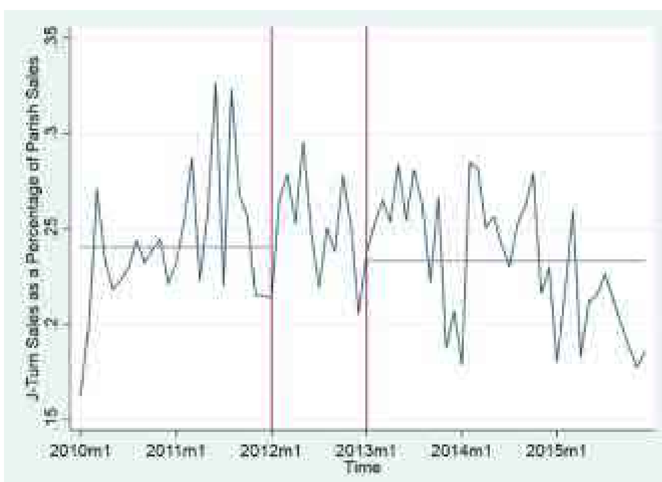

Figure 25
Lafayette Parish: Sales of businesses affected by J-turns as a percentage of parish sales

Figure 26 shows sales as a percentage of parish sales at Lafayette J-turns from a subset of businesses that were open for a full year before and a full year after the installation was complete. The mean before is 0.47 and the mean after is 0.45; however, the difference between means is not statistically significant.

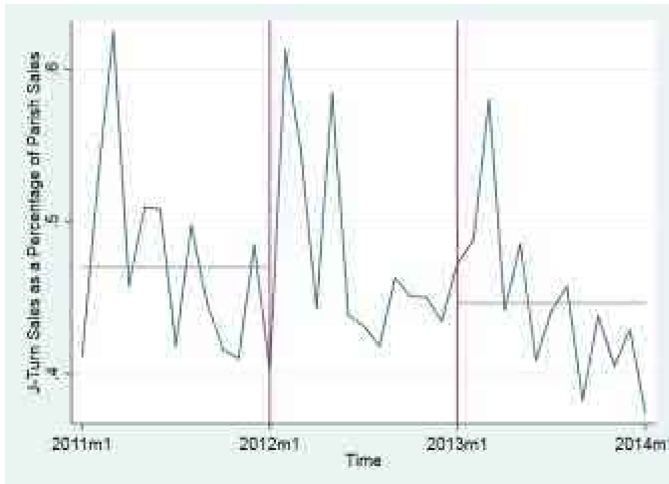

Figure 26
Lafayette Parish: Sales of businesses surrounding J-turns active throughout period as a percentage of parish sales

Next, Figure 27 shows only those businesses active throughout the period that were expected to be unaffected by changes in access caused by the J-turn. The mean before is 0.28 and the mean after is 0.26; however, the difference between means is not statistically significant. No statistically significant conclusions can be drawn about sales impacts.

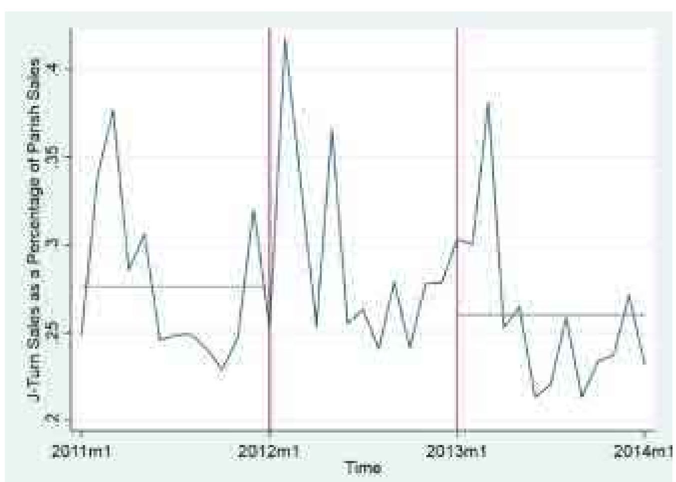

Figure 27
Sales of businesses unaffected by J-turns active throughout period in Lafayette Parish as a percentage of parish sales

Figure 28 shows only those businesses active throughout the period that were expected to be affected by changes in access due to the J-turn. The mean before is 0.19 and the mean after is 0.19, but the difference is not statistically significant.

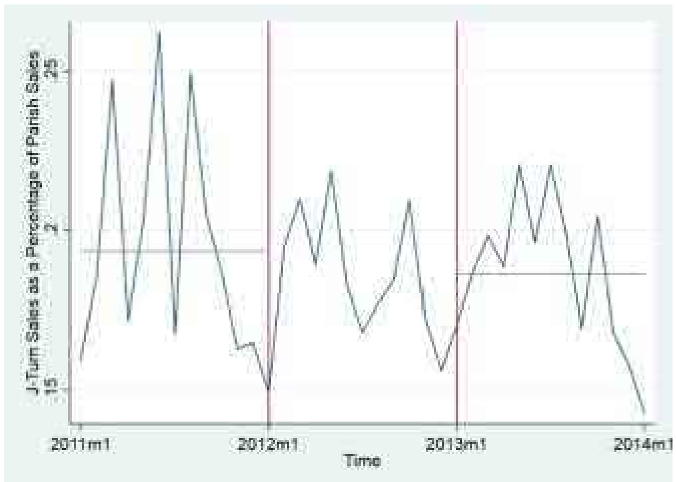

Figure 28
Sales of businesses affected by J-turns active throughout period in Lafayette Parish as a percentage of parish sales

Summary. Although in all but one of these graphs from Lafayette Parish, the mean sales as a percentage of parish sales appears to be decreasing, the small sample size and small change leads to a finding that the differences are not significant.

East Baton Rouge Parish. The following graphs show the analysis of J-turn installations in East Baton Rouge Parish. Figure 29 shows the aggregated East Baton Rouge J-turn sales as a percentage of East Baton Rouge Parish sales. The mean before the installation began was 0.16 and after was 0.17, but the difference is not significant. Due to small sample sizes, separate results for affected and unaffected businesses cannot be displayed, but the pattern is similar with no significant differences before and after J-turn installation.

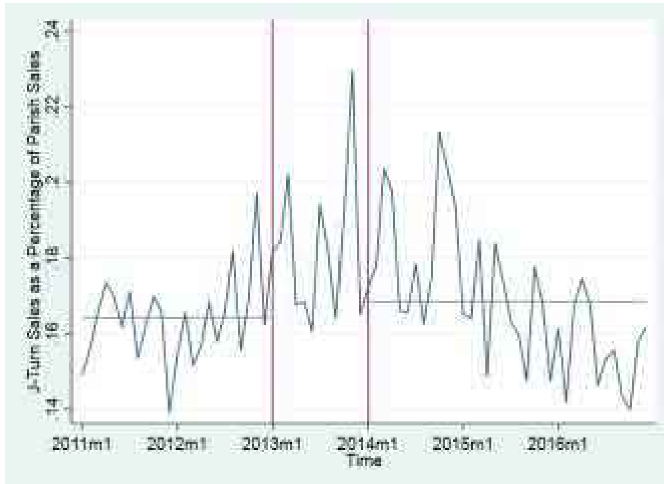

Figure 29
East Baton Rouge Parish sales of businesses surrounding J-turns as a percentage of parish sales

Figure 30 shows sales at those businesses near the J-turn and active a year before and a year after the installation as a percentage of East Baton Rouge Parish sales. The mean before is 0.11 and the mean after is 0.12 and the difference is statistically significant suggesting that among existing businesses, sales actually went up in the period after the J-turn was installed.

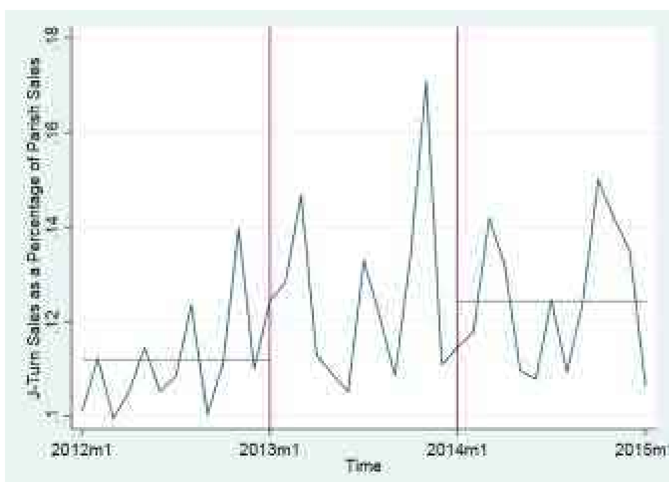

Figure 30
East Baton Rouge Parish sales of businesses surrounding J-turns active throughout period as a percentage of parish sales

Due to small sample sizes, separate results for affected and unaffected businesses cannot be displayed, but the pattern for affected and unaffected businesses continuously operating is similar to the overall pattern for continuously operating businesses with statistically significant increases in sales relative to the parish after the J-turn was installed.

Summary. In East Baton Rouge Parish, there is no evidence that J-turns harm businesses, and there is in fact a statistically significant increase in sales after installation. As discussed in the aggregate section, this correlation does not mean that J-turns cause an increase in business sales. There are a number of other factors that may affect business sales. Even with parish sales to benchmark against and control for some local conditions, neighborhood-level economic conditions like new developments may contribute to the difference.

Jefferson Parish. This subsection looks at business sales in Jefferson Parish. Figure 31 shows the sales of businesses surrounding J-turns in Jefferson Parish as a percentage of sales of the entire parish. The mean before is 0.07 and the mean after is 0.09 and the difference is significant at the .05 level. Due to small sample sizes, separate results for affected and unaffected businesses cannot be displayed, but the pattern is similar for both groups with sales as a percentage of parish sales increasing significantly after the J-turn was installed.

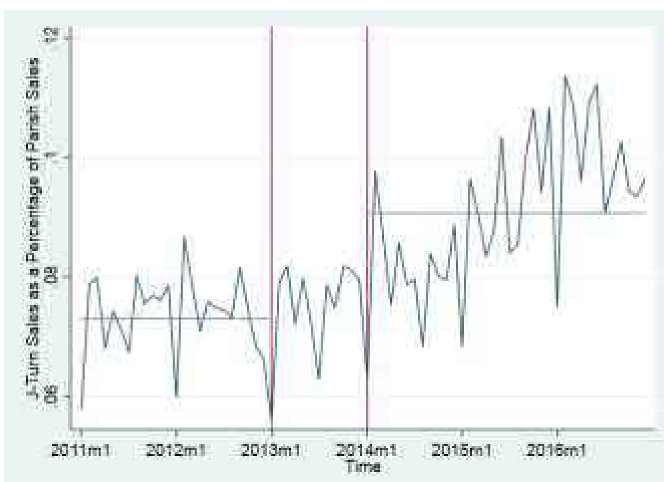

Figure 31
Sales of businesses surrounding J-turns in Jefferson Parish (percentage of parish sales)

Next, Figure 32 shows sales as a percentage of parish sales at Jefferson J-turns from businesses that were there a year before and a year after the installation was complete. The mean before is 0.05 and the mean after is 0.05, but the difference is not significant. Due to small sample sizes, separate results for affected and unaffected businesses cannot be displayed, but the pattern is similar unaffected businesses with no significant difference. On the other hand, businesses that would be expected to be affected exhibited a significant increase in sales relative to the parish after the J-turn was installed.

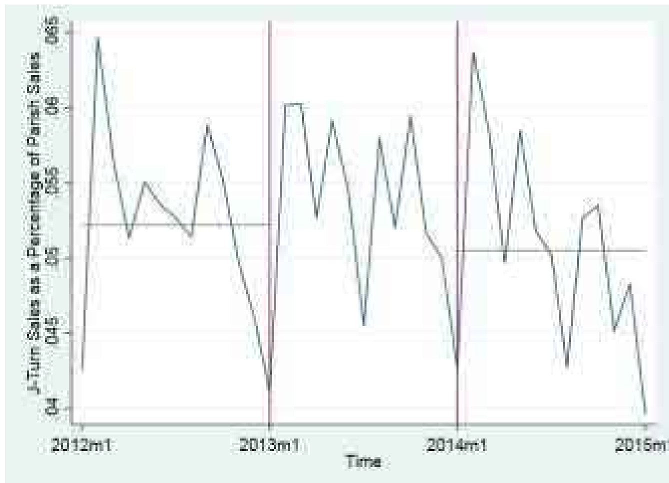

Figure 32
Sales of businesses surrounding J-turns active throughout period in Jefferson Parish as a percentage of parish sales

Summary. While some comparisons discussed above showed no statistically significant change, the general pattern was an increased level of sales after the J-turn was installed. In total, businesses in areas where J-turns were installed were shown to outpace the rest of the parish.

St. Tammany Parish. This final parish subsection shows the analysis of J-turn installations in Covington, LA, located in St. Tammany Parish. There has been considerable population growth in Covington, and the area of study is conveniently situated next to the interstate, which has attracted many new businesses. One of the J-turns in Covington was put in as part of a larger road widening. In response to the improvement of the flow of traffic and the increasing population of Covington, many new businesses opened around the time of the installation of this J-turn. The other J-turn installed in Covington was constructed principally for the development of a new general merchandise retailer. Large retailers often draw other companies to capitalize on the new traffic attracted by the anchor tenant. In both cases the J-turns, like other infrastructure improvements, are associated with increasing traffic (i.e., the transportation-land use cycle). New businesses are built as companies take advantage of the increased throughput of a road, often increasing the aggregate sales of businesses in the area.

Figure 33 shows the sales of businesses surrounding J-turns in St. Tammany Parish as a percentage of sales of the entire parish. The mean before is 0.23 and the mean after is 0.48. The change is significantly different at the .05 level. Due to small sample sizes, separate results for affected and unaffected businesses cannot be displayed, but the pattern is similar for both groups with sales as a percentage of parish sales increasing significantly after the J-turn was installed.

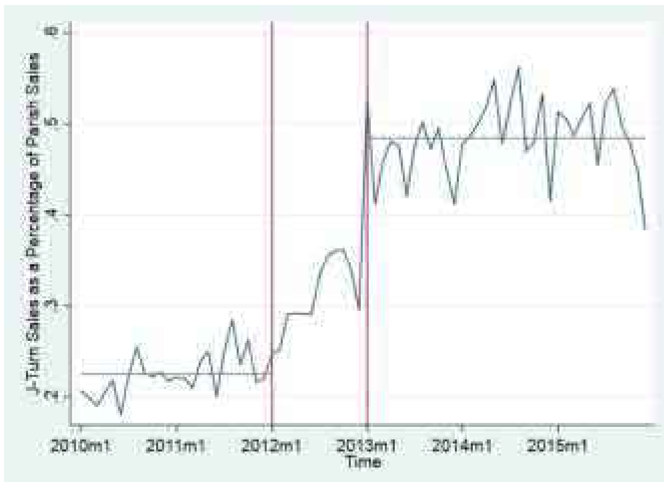

Figure 33
Sales of businesses surrounding J-turns in St. Tammany Parish as a percentage of parish sales

Figure 34 shows sales as a percentage of parish sales at St. Tammany J-turns from businesses that were continuously operating a year before and a year after the installation was complete. The mean before is 0.22 and the mean after is 0.21, but the difference is not significant. Due to small sample sizes, separate results for affected and unaffected businesses cannot be displayed, but the pattern is similar unaffected businesses with no significant difference. On the other hand, businesses that would be expected to be affected based on typical traffic flow exhibited a significant decrease in sales relative to the parish after the J-turn was installed.

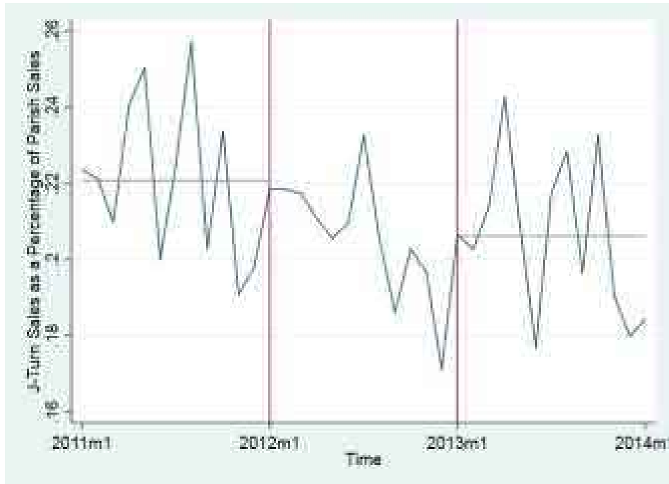

Figure 34
Sales of businesses surrounding J-turns active throughout period in St. Tammany Parish as a percentage of parish sales

Summary. In this section on St. Tammany, J-turns are shown to significantly increase total sales as a percentage of total parish sales in the area, but there are some indications of a decrease in sales among existing businesses that are affected by changes in access. These two observations seem to lie counter to one another, but the likely explanation is that new development is causing increased sales in the area and significantly outpacing the rest of the parish. The area has attracted many new businesses, which would increase competition. The decline in sales among affected businesses active before and after the J-turn was driven largely by one business that saw a relatively large number of competitors enter the area around the same time, it seems more likely that economic factors rather than the J-turn were the underlying cause. However, additional research may be needed to draw conclusive results.

Gas Stations and Restaurants

This final section of graphs isolates the sales of two types of businesses that might be most susceptible to access-related concerns: gas stations and restaurants. These business types often have many nearby substitutes so ease of access may play an important role in patronage; that is, any inconvenience caused by a J-turn or some other obstacle may cause someone to pass one up in favor of another nearby alternative. This section will first explore overall sales before and after J-turn installation in gas stations and restaurants then compare sales in affected and unaffected businesses. Figure 35 contains the sales in millions of dollars of all gas stations and restaurants across all J-turns. The mean before the installation is 1.7 and the mean after is 2.8, a significant difference.

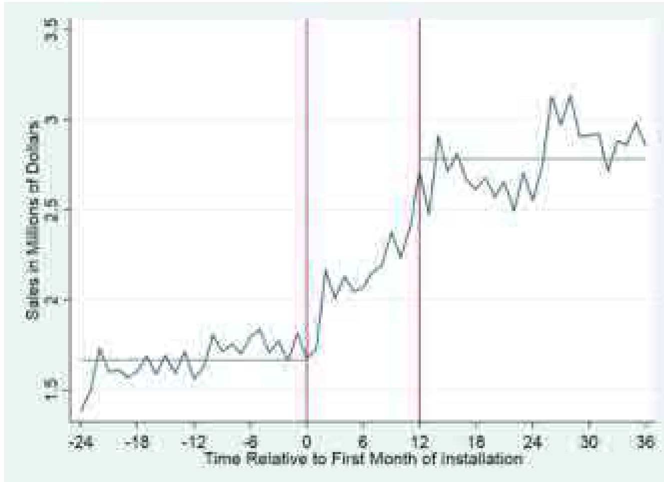

Figure 35
Sales of gas stations and restaurants surrounding J-turns

Figure 36 limits the sample to only those businesses that would be expected to be unaffected based on typical traffic flow and routes. The mean before the installation was 1.1 and the mean after was 1.5, a significant difference.

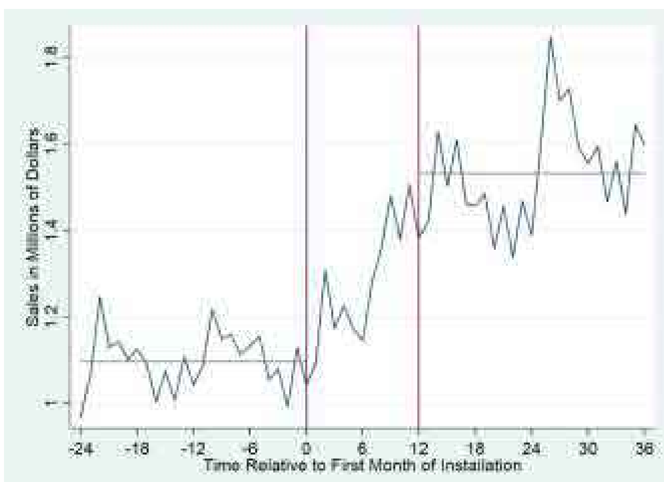

Figure 36
Sales of gas stations and restaurants unaffected by J-turns

Figure 37 includes those businesses that would be expected to be affected by the J-turns. The mean before the installation was 0.6 and the mean after was 1.3, a significant difference.

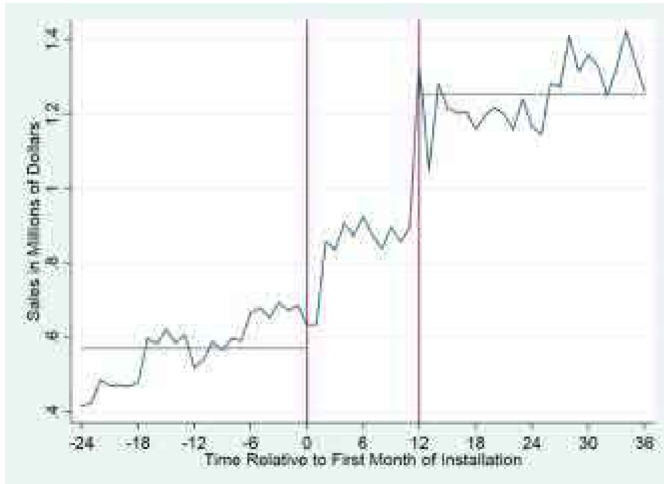

Figure 37
Sales of gas stations and restaurants affected by J-turns

Figure 38 contains only those businesses that were active from a year before the installation period to a year after the installation. The mean before the installation period begins is 1.2 and the mean after it concludes is also 1.2, not a significant difference.

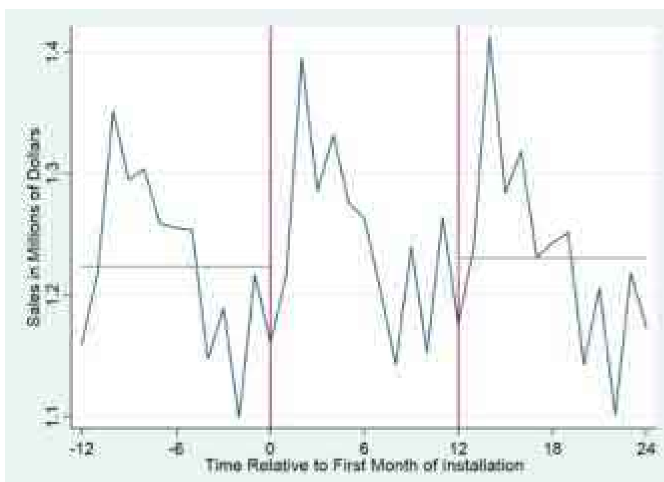

Figure 38
Sales of gas stations and restaurants active throughout period surrounding J-turns

Similarly, Figure 39 contains only businesses that were unaffected. The mean before the installation period begins is 1.0 and the mean after is 1.1, but the difference is not significant.

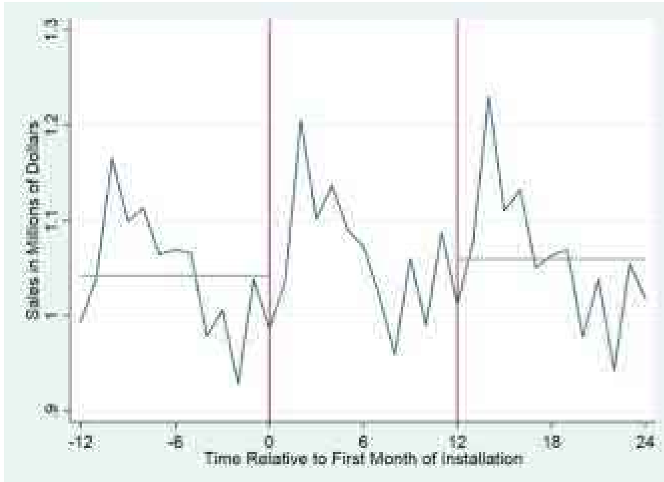

Figure 39
Sales of gas stations and restaurants unaffected by J-turns and active throughout period

Figure 40 contains only businesses that were affected and active throughout the period. The mean before the installation period begins is 0.18 and the mean after it concludes is 0.17. The difference of about $10,000 is significant at the .05 level. However, as discussed in the context of St. Tammany, given the broader trend of increasing sales among gas stations and restaurants, it is likely that the decrease within this group is driven heavily by increased competition from new businesses in the area. In particular, new dining establishments in Covington now compete with what was once one of very few places to dine in a developing area. During the installation period, several new businesses opened.

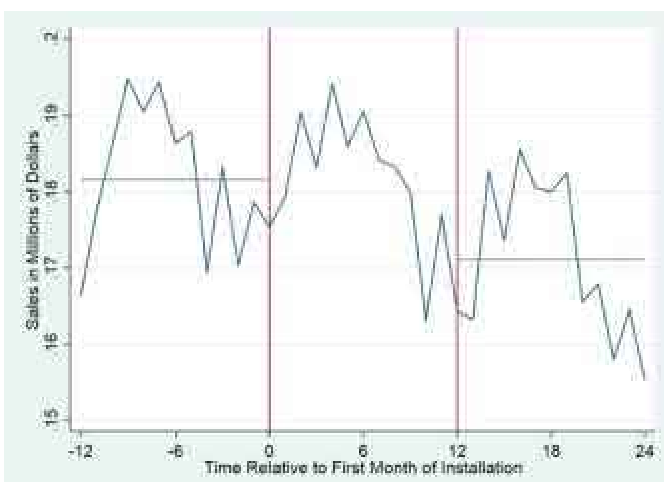

Figure 40
Sales of gas stations and restaurants affected by J-turns and active throughout period

Summary. Most of the graphs in this section show statistically significant increases in sales among gas stations and restaurants, indicating that any access limitations caused by J-turns do not negatively harm these types of businesses. The exception is among existing businesses, which saw a decrease in sales among affected businesses after the J-turn. However, because the series for all gas stations and restaurants, including new and competing dining options, shows a dramatic increase in sales after the J-turn, this is likely due to competition with new establishments rather than any negative affect caused by one element of infrastructure changes in the area. The results of this final section are summarized in Table 6. There were six graphs in this section and of these, three means after were significantly greater than the means before, one mean after was significantly less than the means before, and two were insignificant.

Table 6
Gas stations & restaurants summary statistics

List of Figures	Mean Before (Std. Err)	Mean After (Std. Err)	Difference Between Means
Figure 35: Sales of gas stations and restaurants surrounding J-turns	1.6684 (0.1071)	2.7843 (0.1798)	1.1159***
Figure 36: Sales of gas stations and restaurants unaffected by J-turns	1.0963 (0.0671)	1.5310 (0.1245)	0.4347***
Figure 37: Sales of gas stations and restaurants affected by J-turns	0.5721 (0.0844)	1.2534 (0.0886)	0.6812***
Figure 38: Sales of gas stations and restaurants active throughout period surrounding J-turns	1.2237 (0.0716)	1.2306 (0.0795)	0.0070
Figure 39: Sales of gas stations and restaurants unaffected by J-turns and active throughout period	1.0421 (0.0640)	1.0596 (0.0720)	0.0175
Figure 40: Sales of gas stations and restaurants affected by J-turns and active throughout period	0.1816 (0.0095)	0.1710 (0.0102)	(0.0105)**

Note ** p=.05; *** p=.01

Survey Data Analysis

The following sections report the results of the survey data analysis. Given the centrality of location to this study, it is important to understand the perceptions of businesses and their patrons on access in the vicinity of the J-turns. After first providing an overview of achieved sample statistics for both surveys (all locations), the survey findings are presented by location, beginning with business results followed by patron results. Because these are convenience samples, it is not possible to make inferences to the general population or to the broader local population in these locations. These findings provide qualitative insight into individuals' preferences and opinions about access to businesses in a particular location where traffic conditions as well as land use patterns are highly contextualized.

Sample Overview

Table 7 provides an overview of the number of completed surveys for the business sample and the patron sample, across the four locations. Efforts were made to achieve business and patron participation for each distinct business visited, but participation in the survey was strictly voluntary so this was not always possible. The first row shows the number of business completes per location. All businesses participating have an N=1, meaning that only one interview was completed per business per location. The second row shows the number of patron completes for each location, which ranged from 0-52 completes per location. The next row, "Distinct Business N" refers to the number of *distinct* businesses represented in both survey samples. In total, 70 distinct businesses are represented in the data. This includes businesses that declined participation in the survey with at least one patron participating (n=28) and businesses that participated with zero corresponding patron responses (n=20).

Table 7
Total sample overview (patron and business respondents) by parish location

	East Baton Rouge	Lafayette	St. Tammany	Jefferson	Total
Business N	8	28	4	3	43
Patron N	54	124	84	52	314
Distinct Business N	13	34	17	6	70
Patrons only (no business n)	5	7	13	3	28
Business only (no patron n)	4	14	1	1	20

The number of patron completes per business varied a great deal. Some businesses, specifically very large retail stores (e.g., grocery stores) had a very high number of patron responses at single locations, while many smaller businesses have less than a few. To illustrate variance, measures of central tendency by parish location appear in Table 8.

Table 8
Patron sample N by parish location: Measures of central tendency/dispersion

	East Baton Rouge	Lafayette	St. Tammany	Jefferson
N	54	124	84	52
Mean	4.15	3.65	4.94	8.67
Median	1	1	1	5.5
Mode	1	0	1	1
SD	5.98	8.95	12.29	9.69
R	0-17	0-44	0-52	0-23

Business Types/Characteristics. The next several tables provide an overview of the types of businesses represented in both survey samples. To ensure anonymity of participants is protected, no individual businesses will be named specifically in this report. Instead, businesses are described by their characteristics and analyzed in context of location.

Table 9 provides a general overview of the types of businesses participating in the study for the business sample only (N=43). While there are a variety of business types represented, the two most common are retail sales (N=13) and fast food restaurants (N=12). Many of the properties (N=30) are well-established regional or national chains (e.g., Subway, Walmart, etc.) while the remaining business are specifically local in prominence, having just one location (N=7) or multiple locations (N=6) in the state. Please note that the number of businesses participating in the survey varies considerably across locations, ranging from three businesses in Jefferson Parish to 28 businesses in Lafayette Parish. The total sample size achieved for each of the four locations appears in the last row of Table 9.

Table 9
Participating business types (N) by parish location

	East Baton Rouge	Lafayette	St. Tammany	Jefferson	Total (Row)
Retail Sales	4	6	1	2	13
Retail Service	0	6	0	0	6
Restaurant/fast food	2	7	3	0	12
Restaurant/sit down	0	4	0	1	5
Professional Office	0	1	0	0	1
Convenience Store/gas station	1	3	0	0	4
Other	1	1	0	0	2
Total (Column)	8	28	4	3	43

Table 10 provides an overview of the types of businesses the patrons participating in the study visited. The overall patron sample was much larger than the business sample (N=314).

Like with the business sample, the two most common business types are retail sales (N=180) which constitute about 57% of the patron sample, followed by fast food restaurants (N=63), accounting for about 20% of the patron sample. The vast majority of patron respondents were visiting chain businesses with a regional or national presence (N=296). Across all locations, 18 patrons were visiting local businesses with either one (N=10) or multiple (N=8) locations. The total sample size achieved for each location appears in the last row of Table 10.

Table 10
Patron sample representation of business types by parish location

	E. Baton Rouge	Lafayette	St. Tammany	Jefferson	Total (Row)
Retail Sales	12	89	55	24	180
Retail Service	0	3	1	0	4
Restaurant/fast food	19	26	18	0	63
Restaurant/sit down	1	1	10	1	13
Professional Office	0	0	0	0	0
Convenience Store/Gas station	22	4	0	27	53
Other	0	1	0	0	1
Total (Column)	54	124	84	52	314

As presented earlier in Table 7, the patron sample includes patrons of businesses participating in the business survey as well as patrons of businesses who declined participation. The patron sample includes respondents from an additional 28 businesses not included in the business sample. The location with the greatest discrepancy between businesses participating and the number of patrons from non-participating businesses is Covington/St. Tammany Parish (Business N=4, Patrons/non-participating businesses N=71).

Patron Respondent Characteristics. The samples appear relatively balanced across locations in terms of some demographic characteristics (i.e., gender and age). Samples differed by location in terms of racial composition and residential environment characteristics. Table 11 provides an overview of patron sample demographics (i.e., residential environment, gender, race and age) by location. Note that business sample respondent characteristics are reported by location along with business location details. The next four sections report the remaining findings by location, first presenting analysis of the business sample results followed the patron sample.

Table 11
Patron demographics by parish location

	E. Baton Rouge		Lafayette		St. Tammany		Jefferson	
Residential Environment	N=54		N=124		N=84*		N=52	
Rural	8	14.81%	42	33.87%	18	21.43%	3	5.77%
Somewhat Rural	7	12.96%	32	25.81%	21	25.00%	4	7.69%
Suburban	35	64.81%	38	30.65%	37	44.05%	24	46.15%
Urban	4	7.41%	12	9.68%	8	9.52%	21	40.38%
Gender								
Male	25	46.30%	60	48.39%	33	39.29%	32	61.54%
Female	29	53.70%	64	51.61%	50	59.52%	20	38.46%
Race								
Black	9	16.67%	35	28.23%	4	4.76%	20	38.46%
White	40	74.07%	84	67.74%	73	86.90%	28	53.85%
Hispanic	3	5.56%	2	1.61%	2	2.38%	2	3.85%
Mixed/Other	2	3.70%	3	2.42%	4	4.76%	2	3.85%
Age (years)								
M (SD)	43.45 (17.21)		46.41 (16.52)		49.14 (16.95)		48.35(16.98)	
Min-Max (n)	18-78 (53)		18-90 (122)		18-87 (83)		18-75 (52)	

**note:* respondents were not forced to answer these questions; frequency count totals vary slightly from location sample N for one of more variables due to individual item non-response. The percentages are calculated using the full sample size for each location and therefore may not add perfectly to 100%.

East Baton Rouge Parish

The location of the J-turn in East Baton Rouge Parish is at US 61 and LA-42. Eight businesses participated in the survey and of these, one business is classified as local (single location) while the remaining seven businesses are classified as regional or national chains.

Baton Rouge Business Sample Details & Respondent Characteristics.

Respondents provided additional details about their business location, such as how long their respective business has been in operation at that location, an estimate for the number of employees and an estimate for the number of patrons per day, as well as additional information about their employment at this location such as title, length of employment, etc. The results to these items for the Baton Rouge business sample appear in Table 12. All cells display count data.

Table 12
Business location and employment details: Baton Rouge business sample (n=8)

Business Location Details		Respondent Employment Details	
Time in Location	N	**Job Title**	N
5 years or less	3	Owner/Proprietor	1
more than 5, less than 10	0	Manager (non-owner)	5
more than 10	5	Assistant Manager/Supervisor	1
unknown	0	Employee	1
Number of Employees (estimate)		**Years Employed at Location**	
less than 10	3	Mean	1.91
11-25	2	Min	0.17
26-40	1	Max	5
41-60	0	**Work Commute (days per week)**	
61-74	1	6-7 days	3
more than 75	1	4-5 days	5
unknown	0	3 or less	0
Patrons Per Day (estimate)		**Basic Demographics**	
less than 50	0	Mean Age Years (SD)	30.76 (12.21)
50-99	2	Age Years Min-Max (N)	18-52 (8)
100-200	1	% White (n)	63% (5)
more than 200	5	% Female (n)	63% (5)

Business Respondent Access-Related Items. Business respondents answered a series of closed and open-ended questions designed to gain insight into their perceptions of patron access. When asked to estimate what percentage of patrons plan to stop at their business location (as opposed to the percentage of patrons who might stop out of convenience as they are passing by), respondent estimates (n=8) varied from 25% to 90% (M=62.5%, SD=19.6%). All eight businesses reported that most patrons access their parking lot from the major street, while two businesses indicated an additional access option (one reported from minor street, the other from neighboring business lot). To obtain a sense of how business respondents view the degree of congestion on the roadway during their busiest hours, respondents were asked to indicate the blocks of time in which their business is typically the busiest (i.e., Before 9am, Between 9a-11a, Between 11a-1pm, Between 1pm-4pm, Between 4pm-7pm, After 7pm, Other). Next, for each block of time selected, respondents were asked to describe the degree of congestion in the area immediately surrounding their business on a four-point scale.

Table 13 shows the frequencies for the busiest times as well as the respondent-reported degree of congestion represented in colors (i.e., green=not congested, yellow=slightly congested, bright red=congested, deep red=very congested). The numbers displayed in cells are frequencies for businesses near the J-turn located in Baton Rouge. Since respondents were encouraged to select all applicable busiest times, some businesses indicated degree of congestion for multiple times, which is also clarified in the table (under "No. of times selected"). As shown, five respondents reported just one busiest time while three respondents reported two times.

Table 13
Degree of congestion surrounding business during busiest times: Baton Rouge

	N	S	C	V	No. of Times Selected	N
Before 9am			1		One busiest time	5
B/t 9am-11am		1			Two busiest times	3
B/t 11am-1pm			2			
B/t 1pm-4pm		1	1	1		
B/t 4pm-7pm			3	1		
After 7pm						

All respondents were asked to rank six general factors that people typically consider when deciding whether or not to patron a particular business. Specifically, they were asked to consider where they (personally) would rank each factor when selecting a business of the same type on a scale of 1-6, with 1 being most important and 6 being least important:

- Distance to travel
- Hours of operation
- Customer service
- Quality of products/services
- Pricing of products/services
- Accessibility to location/Ease of access

This ranking item has been used in several other access management business perception studies and provides insight into the relative position of importance access tends to rank. Figure 41 illustrates the mean rank position for each of the items, ordered in importance from most (lowest mean rank) to least important (highest mean rank). Additional descriptive statistics such as detailed rank information, range, standard deviation, and count data are provided in Appendix D.

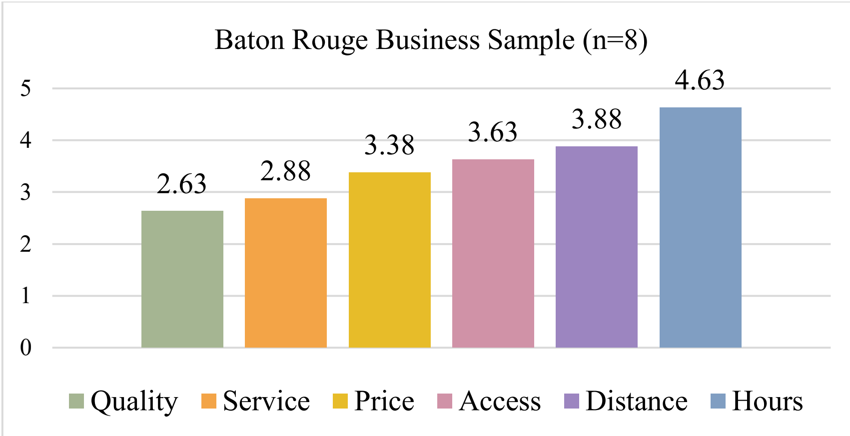

Figure 41
Baton Rouge businesses (n=8) ranked considerations (mean)

Business Respondent Access-Related and Traffic Safety Concerns. The end of the business survey asks a series of four yes/no questions regarding access-related and other traffic safety concerns. All "yes" responses were followed up with an open-ended question for additional details. The first question asks business respondents if any of their customers reported any difficulty accessing their business (at any time)? Among Baton Rouge businesses participating in the survey, about 50% reported "yes," with three mentioning problems with traffic in general (e.g., backups at major road intersection) and one mentioned left turn restrictions on Highland Rd. (i.e., LA 42). The next question asks, "Thinking about the area immediately surrounding your business, do you currently have any access-related concerns?" All eight participants indicated "no" to this item. When asked about any traffic safety concerns in the area immediately surrounding his/her business, three respondents reported "yes" and 5 reported "no." Two of the "yes" responses involved concern with the amount of crashes taking place at the Airline Hwy/Highland Rd. intersection. The other "yes" mentioned that removing the median on Highland Rd. created a higher crash risk turning out of the parking lot (adding that cars speed to make it through the green light) at this location. When asked if respondents had any further comments or concerns about access management in the vicinity of their business they would like to add, all eight respondents reported "no."

Baton Rouge Patron Sample: Business Visit and Prior Patronage. Upon meeting the age and residency criteria, the first question patron respondents were asked was, "Thinking about your visit today, were you specifically planning to come to this business, or did you stop because it is convenient on the way to somewhere else?" Among patrons visiting Baton Rouge businesses (n=54), 57.41% (n=31) reported that they had planned to stop while the remaining 42.59% (n=23) reported that they stopped as they were passing by.

It is worth noting that 22 patrons in the Baton Rouge sample visited convenience store/gas station business types (refer to Table 10 for details). Next, patrons were asked how long they have personally been a patron to the business they just visited; how often they visit the business and how often they visit other area businesses. Response frequencies to these items for the Baton Rouge Patron sample appear in Table 14.

Table 14
Baton Rouge patron sample: reported business patronage and frequency

Reported Length of Patronage		
First time was today	3	5.56%
1-12 mos.	8	14.81%
1-3 years	14	25.93%
3-6 years	7	12.96%
Over 6 years	22	40.74%
Total n	54	100%
Reported Frequency of Patronage (excl. first-time patrons)		
Less than once per month	7	13.73%
Once a month	7	13.73%
Several times a month	15	29.41%
Once a week	10	19.61%
Several times a week or more	12	23.53%
Total n	51	100%
Frequency of Visiting Other Area Businesses		
Regularly	41	75.93%
Sometimes/ Not Regularly	10	18.52%
Rarely	2	3.70%
No	1	1.85%
Total n	54	100%

Patron Respondent Access-Related Items and Traffic Safety Concerns. The remaining patron survey items include the same six-factor ranking item asked of the business respondents, as well as a series of simple yes/no questions with open-ended question follow-up whenever the respondent answered "yes." One item includes an additional "maybe" response option, with the follow-up question also being asked of those responding "maybe." These questions varied somewhat from the questions included in the business survey and are stated as follows:

- Have you ever experienced any difficulties accessing this business? (yes/no)
  - What were the circumstances or could you describe the nature of the difficulties?

- Relative to other similar locations, have you ever experienced any issues navigating streets or accessing property in the surrounding area? (yes/no)
    - What sorts of issues or specific problems have you encountered navigating streets or accessing other properties in the area?
- Are you aware of any recent road improvements that may have improved traffic conditions in this area? (yes/maybe/no)
    - What if anything can you recall about the improvements?
- Do you have any comments or other traffic-related concerns in this area that you would like to share?
    - (add comment)

Figure 42 illustrates the mean rank position for each of the items, ordered in importance from most (lowest mean rank) to least important (highest mean rank) among patron respondents in Baton Rouge (N=54). Similar to Baton Rouge business respondents, Access ranked fourth while Hours ranked sixth. Additional descriptive statistics such as detailed rank information, range, standard deviation, and count data are provided in Appendix D.

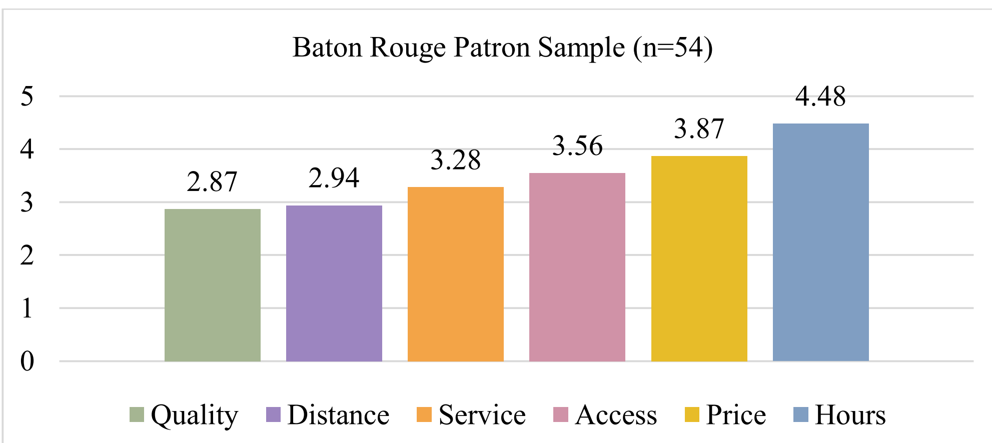

Figure 42
Baton Rouge patrons (n=54) ranked considerations (mean)

When asked if they have ever experienced difficulties accessing the business they just visited, 27.78% (n=15) of Baton Rouge patron respondents reported “yes” while 72.22% reported “no.” When asked to tell the circumstances or describe the nature of the difficulties, all 15 provided open-ended responses. Six individuals mentioned more than one aspect. Almost all (n=9) mentioned “traffic” and traffic-related problems, while an additional three mentioned congestion. One patron mentioned traffic as well as left turn restrictions, stating difficulty leaving the business because of traffic, and they cannot turn left onto Airline Hwy.

The next question asked patrons if they have ever experienced issues navigating streets or accessing other businesses in the surrounding area. Two patrons did not supply a response to this item. Of those who did (n=52), about 40% (n=21) reported "yes." All patrons who said yes provided further details. Four patrons mentioned more than one problem. Again, congestion and traffic (n=11) were mentioned most frequently. Two mentioned construction and six described problems with navigating the area either because of the traffic or difficulty crossing the street. Two respondents specifically mentioned the J-turn/left-turn restrictions due to access management treatment, while one described having to go out of their way to access businesses on either side of the street:

- "That terrible no-left-turn intersection where you have to take a right, go a block then make a U-turn"
- "You cannot go across the median after visiting Chic fil a"
- "Further down by Ruffinos and Healing Place you have to make a loop going in either direction to reach businesses on either side of the street"

The next question asked respondents if they are aware of any recent road improvements that may have improved traffic conditions in the area, to which 18 replied "yes." Reviewing all 18 open-ended responses, almost all (n=17) of the mentions include access-related and operational improvements (e.g., road and intersection widening, improved access, adding extension roads, turn lanes, roundabouts, etc.), while one patron recalled a recently installed stoplight. When asked if they have any comments or traffic related concerns in the area that they would like to share, 21 reported yes. Eleven respondents commented on the traffic/congestion, two reported a lack of synchronization among traffic lights, three mentioned road/pavement quality (e.g., potholes). Four comments involved access-related issues such as a blocked off cut-through, issues with backups due to turning vehicles, and two expressed a need for adding or widening turn lanes. One person gave positive comment: "It's been great. Light put in is great." Finally, one commented, "Baton Rouge all bad," which cannot be easily interpreted for obvious reasons.

Lafayette Parish

The stretch of US 90 of interest in this study is located in Broussard, a small city in Lafayette Parish, where a series of J-turns were constructed in 2012. The approximate location of the J-turns in Broussard is shown in Figure 43. Since that time, US 90 (specifically the 1.6 mile section from Albertson Parkway to Ambassador Caffery Parkway) has been undergoing multiple major construction/improvement projects. Projects include widening US 90 to six lanes and a new overpass, adding frontage roads, as well as the construction of a brand new interchange on US 90 at Albertson Parkway. The site is part of the future I-49 corridor and improvements are necessary to upgrade US 90 to interstate standards [*78-80*]. As of September 2018, the interchange project is behind schedule and is not expected to be completed until early 2019 [*80*]. For context, Albertson Parkway intersects with US 90, which is about 1 mile from the J-turn at Hwy 90 and Girouard Rd.

Figure 43
Approximate location of J-turns in Broussard/Lafayette

US 90/Broussard Business Sample Details & Respondent Characteristics. The business survey sample includes a total of 28 businesses: 19 are national or regional chains, five are local businesses with one location and four are local businesses with multiple locations. Respondents provided additional details about their business location, such as how long their respective business has been in operation at that location, an estimate for the number of employees and an estimate for the number of patrons per day, as well as additional information about their employment at this location such as title, length of employment, etc. The results to these items for the US 90 business sample appear in Table 15. All cells display count data.

Table 15
Business location and employment details: US 90 business sample (n=28)

Business Location Details		Respondent Employment Details	
Time in Location	N	**Job Title**	N
5 years or less	5	Owner/Proprietor	7
more than 5, less than 10	8	Manager (non-owner)	12
more than 10	12	Assistant Manager/Supervisor	5
unknown	3	Employee	4
Number of Employees (estimate)		**Years Employed at Location**	
less than 10	13	Mean	5.73
11-25	8	Min	0.25
26-40	3	Max	25
41-60	0	**Work Commute (days per week)**	
61-74	0	6-7 days	7
more than 75	3	4-5 days	20
unknown	1	3 or less	1
Patrons Per Day (estimate)		**Basic Demographics**	
less than 50	10	Mean Age Years (SD)	37.15 (15.56)
50-99	2	Age Years Min-Max (N)	19-65 (27)
100-200	4	% White (n)	74% (20)
more than 200	10	% Female (n)	63% (17)
unknown	2		

US 90 Business Respondent Access-Related Items. Business respondents answered a series of closed and open-ended questions designed to gain insight into their perceptions of patron access. When asked to estimate what percentage of patrons plan to stop at their business location (as opposed to the percentage of patrons who might stop out of convenience as they are passing by), respondent estimates (n=28) varied from 10% to 100% (M=58.4%, SD=24.1%). When asked to tell how most patrons accessed the parking lot, most (n=21) indicated only one option, while six indicated two (note: one business declined response to this item). The majority of businesses reported access from the major street (n=11) or the minor street/frontage road (n=17). While one business reported no dedicated lot, two businesses reported access from neighboring business lot. One of these also indicated access from a shared driveway.

Of the 28 businesses participating in the survey, 27 provided information about their busiest times and the degree of congestion at those times on a typical day. Table 16 shows the frequencies for the busiest times as well as the reported degree of congestion, indicated by color. Since respondents were encouraged to select all applicable busiest times, some businesses indicated degree of congestion for multiple times, which is also clarified in the table (under column labeled "No. [of times] Selected").

Table 16
Degree of congestion surrounding business at busiest times: US 90/Broussard

	N	S	C	V	Total (row)	No. Selected	N=27
Before 9am		1	2	2	5	one	13
B/t 9am-11am	2		1		3	two	12
B/t 11am-1pm	3	3	5	4	15	three	0
B/t 1pm-4pm	2		4	1	7	four	1
B/t 4pm-7pm	2	3	3	5	13	five	0
After 7pm	1	2	1		4	six	1

Next, respondents were asked to rank six general factors that people typically consider when deciding whether or not to patron a particular business. Figure 44 illustrates the mean rank for each of the items, ordered in importance from most (lowest mean rank) to least important (highest mean rank) among participants providing responses to these items (n=27). In general, service and quality ranked most important, while access and hours ranked least. Additional descriptive statistics such as detailed rank information, range, standard deviation, and count data are provided in Appendix E.

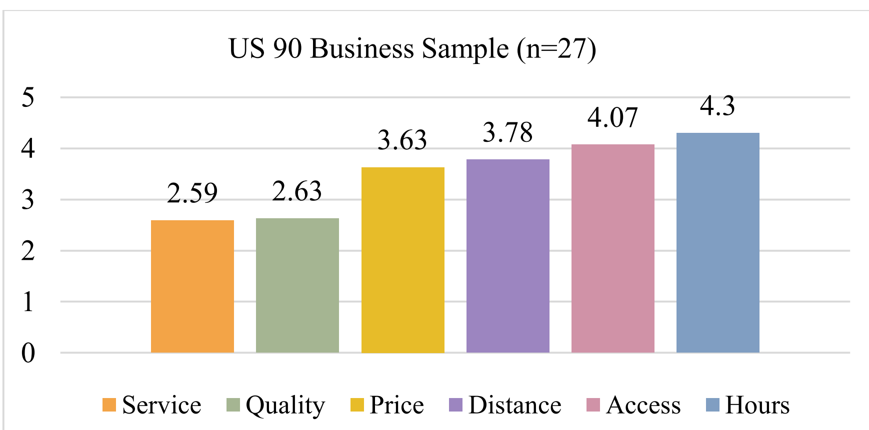

Figure 44
US 90/Broussard businesses (n=27) ranked considerations (mean)

US 90 Business Respondent Access-Related and Traffic Safety Concerns. The end of the business survey asks a series of four yes/no questions regarding access-related and other traffic safety concerns. Respondents were asked if any of their customers had reported difficulty accessing their business (at any time). Just over 55% (n=15) said yes. When asked to describe in general the kinds of difficulties they have reported, a majority mentioned construction-related difficulties (n=10), followed by navigation-related problems (n=4) and high congestion (n=1). Comments concerning navigation and construction appear in Table 17. Comments are shown verbatim with only minor editing to clarify the nature of the comments as well as to point out the similarities among responses, a number of which express more than one concern.

Table 17
Navigation and construction-related comments on patron access difficulties, US 90

Navigation	Difficulty crossing major highway
	Almost every customer has reported problems with lots of confusion navigating streets and getting around all the road work
	Customers worried that they might get hit from behind turning right into the parking lot.
	Can't turn left from 90. Can't turn left to exit.
Construction	Construction on service road
	Construction in area
	Construction and J-turn having to loop around north of business
	Construction (x2)
	Construction and redirection of traffic.
	Construction has caused road closures and delays.
	Construction has obstructed people getting in and out.
	Construction has made getting around confusing.
	Construction has caused several accidents and traffic backups.

The next question asks, “Thinking about the area immediately surrounding your business, do you currently have any access-related concerns?” Thirteen respondents reported “yes” to this question and 15 reported “no.” Respondents explained their current access-related concerns, which are shown verbatim (with minor editing) in Table 18. The next question asks if the respondent has any traffic-safety concerns in the area immediately surrounding their business, to which 14 answered “yes.” When asked to describe these concerns, a number mention specific intersections, some mentioned aggressive driving (related to the construction,) while others described visibility issues or other operational concerns. These comments appear in Table 19 with only minor editing. Similar to prior items, one of the most frequently mentioned issues is construction.

Table 18
Business comments on current access concerns, US 90

Add a U-turn to access business easier
Not being able to turn left at the light on the main road. There are a lot of accidents still even after the J-turn. There needs to be a few more seconds added to the yellow lights as they are too short. More lighting in the area.
Can't go straight under overpass
Intersection and construction make it difficult to drive around
It can be hard to turn onto side street because of traffic
Construction
Traffic and construction.
No left turn allowed causes access and routing issues.
The left turn from the interstate and issues with the intersection.
Getting in and out is difficult due to construction.
Construction has made it to where it takes much longer than before to get around the surrounding area.
Ongoing construction has made it difficult for customers to have a quick trip.
Extremely difficult to access other businesses in the area. Said that access was killing some businesses in the area and some have had to move

Table 19
Business comments on traffic safety concerns near business US 90

Should be a crosswalk and walking lights
A lot of people go straight at the light illegally when they are supposed to turn right which causes accidents
People have a lot of accidents at the corner of south Morgan and east second street
Light next to hwy overpass
Traffic got worse during construction but now better
Main St. and celebrity intersection can get dangerous
Lane merging in construction.
Construction and restricted turns.
Stoplight can't be seen by large trucks.
Construction has led to congestion which has caused people to drive more aggressively.
Traffic lanes near the bridge get clogged and dangerous.
Construction has caused some drivers to drive dangerously which has caused an uptick in traffic accidents.
Construction and lane closings have made accidents more frequent.
Poorly timed lights make people do crazy things and road under overpass not marked well so people cut others off trying to switch lanes

The last question asked the respondent if they have any further comments/concerns about access management in the vicinity of their business. Four respondents provided comments:

- Past year has cost a lot in profits.
- Construction taking too long and as a result revenue is down.
- Seems that construction outside the business has been ongoing/delayed, and has resulted in a significant drop in business activity due to customers not being able to access the business easily.
- Issues crossing road because cars can cross street from one side but not the other.

About half of the 28 businesses participating in the survey along US 90 expressed a great deal of concern about construction and the perceived impact it has on their customers, traffic, driving behavior, and a variety of operational issues, among others. Though left turn restrictions, J-turns, and factors related to them are mentioned a few times, by and large, respondents generally focused on construction and its impact on traffic safety and operations.

US 90/Broussard Patron Sample: Business Visit and Prior Patronage. With the exception of only five local businesses, the majority (n=119) of businesses visited by patron respondents are regional or national chains. Patrons were asked "Thinking about your visit today, were you specifically planning to come to this business, or did you stop because it is convenient on the way to somewhere else?" Among patrons visiting Broussard businesses (n=124), about 71% (n=88) reported that they had planned to stop while the remaining 29% (n=36) reported that they stopped as they were passing by. The vast majority of patrons (n=89) were visiting retail sales business types (refer to Table 10 for business type details). Next, patrons were asked how long they have personally been a patron to the business they just visited; how often they visit the business and how often they visit other area businesses Response frequencies to these items appear in Table 20.

Table 20
US 90/Broussard patron sample: reported business patronage and frequency

Reported Length of Patronage		
First time was today	3	2.44%
1-12 mos.	17	13.82%
1-3 years	33	26.83%
3-6 years	23	18.70%
Over 6 years	47	38.21%
Total n*	123	100%
Reported Frequency of Patronage (excl. first-time patrons)		
Less than once per month	21	17.36%
Once a month	17	14.05%
Several times a month	27	22.31%
Once a week	20	16.53%
Several times a week or more	36	29.75%
Total n	121	100%
Frequency of Visiting Other Area Businesses		
Regularly	81	65.32%
Sometimes/Not Regularly	26	20.97%
Rarely	11	8.87%
No	6	4.84%
Total n	124	100%

*note: 1 participant did not respond to this item

Patron Respondent Access-Related Items and Traffic Safety Concerns. The remaining patron survey items include the same six-factor ranking item asked of the business respondents, as well as a series of simple yes/no questions with open-ended question follow-up whenever the respondent answered "yes" (or "maybe" on the applicable item). Focusing first on the six-factor ranking item, Figure 45 illustrates the mean rank for each of the items, ordered in importance from most (lowest mean rank) to least important (highest mean rank) among participating patrons of businesses located along US 90 in Broussard/Lafayette Parish (N=123; one participant did not supply responses to any of these items).

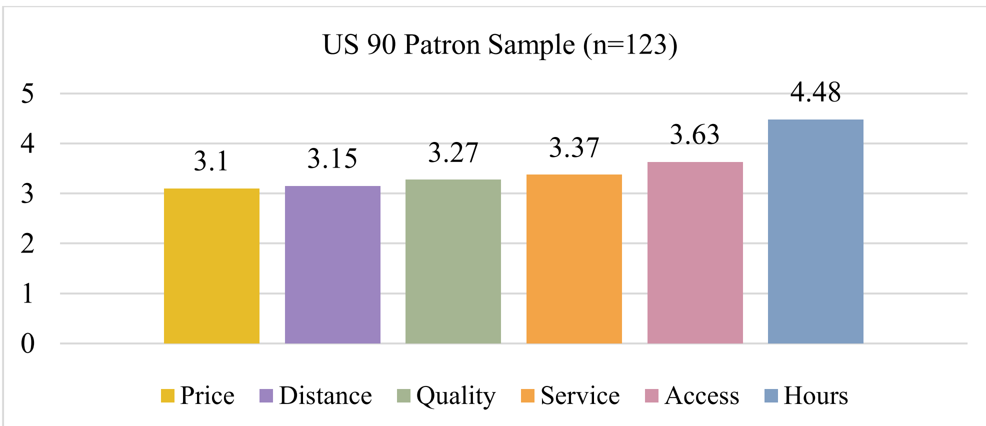

Figure 45
US 90/Broussard patrons (n=123) ranked considerations (mean)

As shown, Access fell fifth on the ranking list of considerations, just above Hours. Distance ranked second, followed by Quality and Service. The mean ranking for the top five considerations ranged from 3.1 (for Price) to 3.63 (for Access) while the mean rank for Hours is 4.48. So while Hours ranks the least important consideration to respondents in this sample, the means for the other five considerations are relatively close in size, which suggests higher degrees of variability relative to rank order. Additional descriptive statistics are displayed Appendix E.

When asked if they have ever experienced difficulties accessing the business they just visited, 29.84% (n=37) of US 90 respondents reported "yes" while 70.16% reported "no." When asked to tell the circumstances or describe the nature of the difficulties, all 37 provided open-ended responses. Eleven mentioned more than one aspect. A majority (n=26) of responses mentioned "construction," which translates to roughly 70% of "yes" responses. Table 21 displays the other comments (that did not only describe construction), which have been minimally edited for punctuation and spelling. As displayed, a number of them mention difficulty accessing the business due to not being permitted to go straight and/or left turn restrictions. Two comments pertain to construction as well as other issues. One comment, which also mentioned construction, specifically takes issue with the J-turns. These two comments are noted with an asterisk.

Table 21
Patron comments other reported prior difficulties accessing other businesses US 90

Comments
US 90 bridge is terrible
Construction in the area - J-TURNS ARE A PROBLEM AND HORRIBLE*
Construction caused congestion which made it difficult to get in and out*
Difficult to take the u turn
No dedicated turning lane to turn into the driveway.
Traffic congestion.
Some hard to cross street
Underpass lights
Can’t go straight at light have to go down and make difficult turn
US 190 bridge intersection can’t go straight
Traffic light is a nightmare doesn’t stay green long enough and can’t go straight
Police had the entrance blocked off
Turning at the light.

*comment included in n=26 (reporting construction), response recorded in all caps

The next question asks respondents if they have experienced issues accessing property in the surrounding area. Nearly half of the US 90 sample (n=55, 44.72%) reported yes, while 55.28% reported no (n=68). Construction was mentioned in 67.3% of respondents’ comments, while access-related issues (e.g., can’t go straight, hard to turn left) and J-turns (n=3) were mentioned in about 29% of responses. The comments specifically mentioning J-turns include: “Traffic backing up at the J-turn,” “J-turns make it hard to cross street,” and simply “J-turns.” When asked if they were aware of any recent road improvements that may have improved traffic conditions in the area, about 52% reported “no,” about 7% reported “maybe” and about 41% reported “yes.” Respondents answering yes or maybe were asked what if anything they can recall about the improvements. Table 22 provides a summary of their comments, which have been categorized and sorted. Seven responses were not able to be categorized because they did not clearly express specific improvements or they were more or less complaints. These appear verbatim at the bottom of the table.

Table 22
US 90 patron sample open-ended responses regarding improvements (categorized)

	Yes	Maybe	Total
Construction	**20**	**2**	**22**
Construction (general)	5		
On US 90	5		
Bridge/underpass/overpass	10	2	
Specific Improvements	**28**	**3**	**31**
Road Improvements/Repairs (e.g., pavement, filled potholes)	6	2	
Installed new light	4		
Reopening/Completed work	3		
Increase capacity/new extension	5		
Specific treatments (roundabout, J-turn)	3		
Congestion/Traffic reduction	1	1	
Improvement- other	6		
Complaint/tentative improvement (verbatim)	**3**	**4**	**7**
J-turn helped at first, but now causes traffic	1		
Turn on Highway 90 is a pain.	1		
They are in progress	1		
Construction has been hectic but there may be improvements		1	
Makes less traffic when construction finishes		1	
No improvement yet for us 190 highway cutting through town		1	
Supposed to get better but not better yet		1	
Total	**51**	**9**	**60**

Thirty-eight respondents had additional comments they wanted to express. While just under 37% could be categorized as construction-weary, there are a number of complaints about other drivers (e.g., running red lights, aggressive actions, etc.) and operational factors (e.g., light time too short/long, need traffic loop, rerouted traffic issues, etc.) as well as miscellaneous comments that could not be categorized (n=8). The summary of comments by category appears in Table 23.

Table 23
Patron sample US 90 additional comment categorical summary

Construction-Weary	14	36.84%
Driver Actions/Complaints	4	10.53%
Operational Factors/Complaints	8	21.05%
Safety Concern	1	2.63%
J-turn-related Comments	3	7.89%
Other	8	21.05%

With the exception of one of them, the comments specifically pertaining to J-turns are not particularly insightful. One indicates impact to travel time, i.e., “Albertsons J-turn is not good because it [is] increasing time spent driving,” but the other two are difficult to meaningfully interpret: “J-turns won't allow for some travel” and “J-turn by movie theater.” All 38 comments are listed verbatim (minimal editing) in Appendix F.

St. Tammany Parish

The area of interest in St. Tammany Parish is the city of Covington, specifically near I-12 and along the Hwy 21 corridor. This area of the state, in particular, has undergone extensive population and economic growth as part of a long-term trend dating back to the 1980s. Prior to 2012 when the J-turns were installed, a 2011 *Times-Picayune* article with the headline “Louisiana 21 traffic nightmare is progress in (constant) motion” provides insight into the emergent traffic problems and the specific growth/development trajectory in this location, which continues to this day [*81*]. More recent news articles published in 2017 provide additional context for the area’s growth trends. According to a 2017 report by the St. Tammany Economic Development Foundation, in 2016, 2,401 new businesses were incorporated in St. Tammany, a 19.8% increase from 2015 [*82*]. The U.S. Census Bureau estimates the population has grown approximately 7.5% from 2010 to 2016, which translates to an addition of about 10 new residents each day [*83*].

Covington Business Sample Details & Respondent Characteristics. The sample of businesses from Covington is very small; only four businesses participated in the survey. Three businesses are fast food restaurants and one is retail sales. Two of the four are local businesses with multiple locations and the other two are regional/national chains.

Respondents provided additional details about their business location, such as how long their respective business has been in operation at that location, an estimate for the number of employees and an estimate for the number of patrons per day, as well as additional information about their employment at this location such as title, length of employment, etc. Respondents provided details about the business location and their employment, which are shown in Table 24.

Table 24
Business location and employment details: Covington business sample (n=4)

Business Location Details		Respondent Employment Details	
Time in Location	N	**Job Title**	N
5 years or less	0	Owner/Proprietor	0
more than 5, less than 10	2	Manager (non-owner)	2
more than 10	2	Assistant Manager/Supervisor	2
unknown	0	Employee	0
Number of Employees (estimate)		**Years Employed at Location**	
less than 10	2	Mean	2.25
11-25	1	Min	0.58
26-40	0	Max	4
41-60	1	**Work Commute (days per week)**	
61-74	0	6-7 days	1
more than 75	0	4-5 days	3
unknown	0	3 or less	0
Patrons Per Day (estimate)		**Basic Demographics**	
less than 50	0	Mean Age Years (SD)	40 (36.06)
50-99	1	Age Years Min-Max (N)	20-94 (4)
100-200	2	% White (n)	75% (3)
more than 200	1	% Female (n)	75% (3)

Covington Business Respondent Access-Related Items. Business respondents answered a series of closed and open-ended questions designed to gain insight into their perceptions of patron access. When asked to estimate what percentage of patrons plan to stop at their business location (as opposed to the percentage of patrons who might stop out of convenience as they are passing by), respondent estimates (n=4) ranged from 30% to 95% (M=68.75%, SD=28.7%). When asked to tell how most patrons accessed the parking lot, two indicated only one option and two indicated two. One respondent reported having "no dedicated lot" and one respondent reported access from the major street. Of the respondents providing more than one option, one reported having no dedicated lot and access from a neighboring business lot and the other reported access from the major street and the minor street or frontage road.

All four business respondents reported their busiest times as well as the reported degree of congestion at those time. One selected two busiest times and the other three each selected one. One respondent reported their busiest time as "before 9am" and described the degree of congestion as "congested." Another reported the area as "congested" during their busiest time, "between 4pm and 7pm." The other two respondents indicated their busiest times were in mid-day (i.e., both indicated "between 1pm and 4pm" and one also indicated "between

11am and 1pm") and both described the surrounding area as "somewhat congested" during these times. Next, respondents were asked to rank six general factors that people typically consider when deciding whether or not to patron a particular business. Figure 46 illustrates the mean rank for each, ordered in importance from most (lowest mean rank) to least important (highest mean rank) among business respondents (n=4). In general, quality ranked most important, followed by service, while access and hours ranked least (respectively). Additional descriptive statistics are provided in Appendix G.

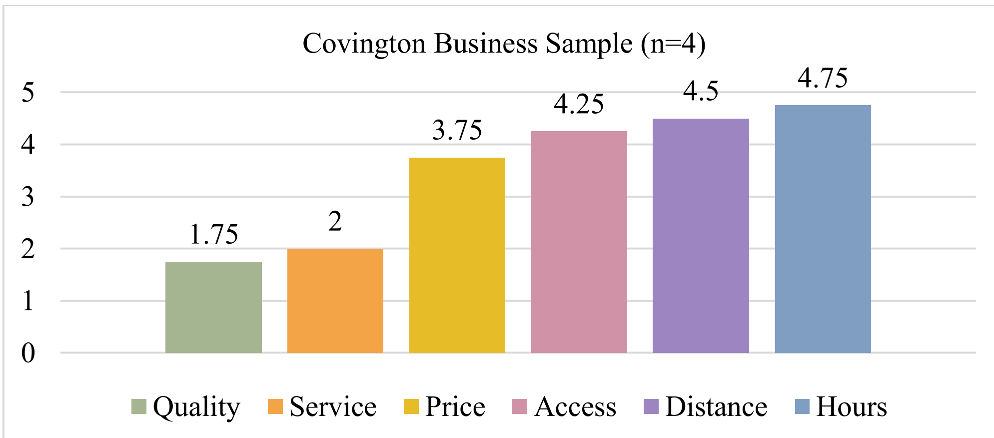

Figure 46
Covington businesses (n=4) ranked considerations (mean)

Covington Business Respondent Access-Related and Traffic Safety Concerns. When asked if customers have reported difficulty accessing their business (at any time), two indicated "yes," but the comments seemed to pertain to factors concerning particular customers or circumstances. Specifically, one comment mentions customers "having to walk too far" and the other indicated that customers have been calling to get directions to the location. None of the respondents reported business-access concerns or traffic safety concerns. One respondent left a final comment, i.e., "Improved streets by adding turning lanes and U-turns with turning lanes" which, while difficult to interpret constructively, doesn't suggest complaint.

Covington Patron Sample: Business Visit and Prior Patronage. While the number of Covington businesses participating in the survey was extremely small, the patron sample size is the second largest in this study by location (n=84). As reported previously in Table 7, the patron sample includes patrons representing 13 additional businesses that did not participate in the business survey. A majority of patrons (n=74) were visiting regional or national chains, while the remaining patrons visited local businesses with either one location (n=4) or multiple locations (n=6). In terms of business types, 65.5% of respondents (n=55) were visiting retail sales businesses; about 21.4% of patrons were visiting fast food restaurants and slightly under 12% were visiting sit-down restaurants. One patron was visiting a retail service.

Patrons were asked "Thinking about your visit today, were you specifically planning to come to this business, or did you stop because it is convenient on the way to somewhere else?" Among patrons visiting Covington businesses (n=84), about 76% (n=64) reported that they had planned to stop while the remaining 24% (n=20) reported that they stopped as they were passing by. Next, patrons were asked how long they have personally been a patron to the business they just visited; how often they visit the business and how often they visit other area businesses Response frequencies to these items appear in Table 25.

Table 25
Covington patron sample: reported business patronage and frequency

Reported Length of Patronage		
First time was today	6	7.14%
1-12 mos.	14	16.67%
1-3 years	19	22.62%
3-6 years	15	17.86%
Over 6 years	30	35.71%
Total n	84	100%
Reported Frequency of Patronage (excl. first-time patrons)		
Less than once per month	10	12.82%
Once a month	10	12.82%
Several times a month	12	15.38%
Once a week	22	28.21%
Several times a week or more	24	30.77%
Total n	78	100%
Frequency of Visiting Other Area Businesses		
Regularly	60	71.43%
Sometimes/Not Regularly	17	20.24%
Rarely	5	5.95%
No	2	2.38%
Total n	84	100%

Patron Respondent Access-Related Items and Traffic Safety Concerns. The remaining patron survey items include the same six-factor ranking item asked of the business respondents, as well the same yes/no questions asked at the other sample locations. Focusing first on the six-factor ranking item, Figure 47 illustrates the mean rank position for each of the items, ordered in importance from most (lowest mean rank) to least important (highest mean rank) among patrons of businesses located in Covington/St. Tammany Parish responding to these items (n=83). As illustrated by mean rank, Quality and Distance (respectively) tended to rank as most important. The mean rankings for Access, Price, and Service ranged from 3.55 for access to 3.69 (for Service) while the mean rank for Hours is 4.49. Additional descriptive statistics are provided in Appendix G.

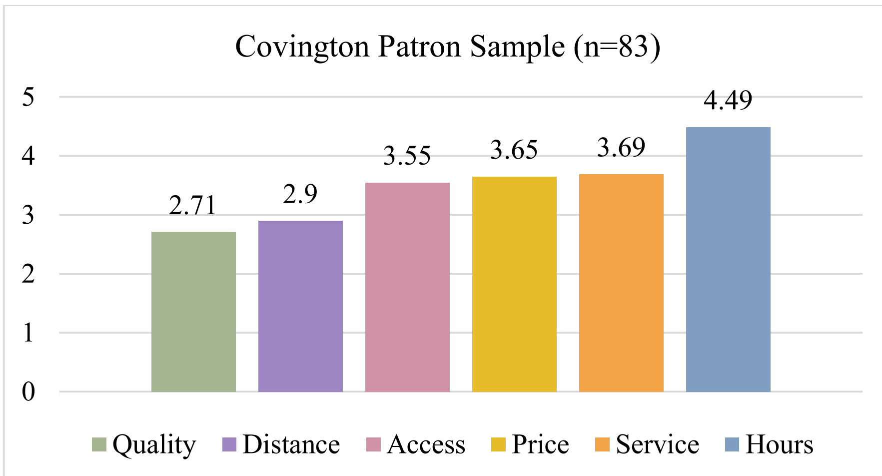

Figure 47
Covington patrons (n=83) ranked considerations (mean)

When asked if they have ever experienced difficulties accessing the business they just visited, 20% (n=17) reported "yes" but one person declined to add comment. Of the 16 comments left, six mentioned traffic and/or backups, three mentioned problems with parking/ parking lots, three mentioned delays at lights, and three indicated they had problems before the construction took place. Finally, one comment did not fall into either of the categories. It states, "the U-turn situation is not ideal" however it is not clear what they mean by that. When asked if they have ever experienced difficulty accessing other property in the area, 38 indicated "yes," 37 of which left comments. Most frequently mentioned (n=23) was difficulty due to traffic/backups, while the remaining comments refer to an array of other concerns, such as parking, construction, etc. Three comments mentioned left turn restrictions and four comments could not be categorized. Table 26 displays an overview of comments categorized by the nature of difficulties expressed.

Table 26
Patron-reported prior difficulties (categorized) accessing other businesses Covington

Comments	N
Traffic/backups	23
Parking	2
Left Turn restrictions	3
Delays (at lights)	1
Construction	4
Other	4
Nothing's ever zoned right	
Walmart down the street is hard to get to	
Difficult regardless of what business	
School traffic needs red light	

When respondents were asked if they were aware of any recent road improvements that may have improved traffic conditions in the area, 51 reported "yes," three reported "maybe," and 30 reported "no." The most frequently mentioned improvement was widening the road/lanes (and adding lanes) along Hwy 21 and the surrounding area (n=40) followed by mentioning of specific treatments such as roundabouts (n=5). Six comments referred to misc. improvements while three declined further comment (two were among the three reporting "maybe," the other "maybe" commented simply "lights"). Finally, when asked if they would like to leave any additional comments, 50% (n=42) reported "yes." All 42 left comments and of these, 27 (64%) specifically mention issues on I-12. Some of these comments specifically referred to exit numbers and/or other roads e.g., Hwy 190, Hwy 21. Though not all explicitly indicate what the issues entail (e.g., "I-12 has to be fixed," "I-12 is bad"), many describe capacity issues like a need to widen I-12 to alleviate traffic and congestion, while some mention safety as their primary concern. In general, patron comments include a range of general and specific complaints. Table 27 provides an overview of the comments, which appear verbatim with minimal editing in Appendix H.

Table 27
Summary of additional patron concerns/comments (categorized) Covington

	N	%
Interstate/I-12	27	64.29%
Hwy 190	3	7.14%
Congestion/Backups	6	14.29%
Other	6	14.29%

Jefferson Parish

The J-turn in Jefferson Parish is located at the intersection of LA 45 and 10th Street in Marrero, a census-designated place (CDP) situated on the Westbank of the Greater New Orleans region.

Marrero Business Sample Details & Respondent Characteristics. Of all four business survey locations, Marrero had the smallest sample size of businesses participating in the study. Two businesses are retail sales and the other is a sit-down restaurant. One is a local business (one location) and the other two are regional or national chains. All three respondents provided details about the business location as well as details about their employment, as shown in Table 28.

Table 28
Business location and employment details: Marrero business sample (n=3)

Business Location Details		Respondent Employment Details	
Time in Location	N	**Job Title**	N
5 years or less	0	Owner/Proprietor	0
more than 5, less than 10	0	Manager (non-owner)	3
more than 10	3	Assistant Manager/Supervisor	0
Number of Employees (estimate)		**Years Employed at Location**	
less than 10	1	Mean	8
11-25	0	Min	4
26-40	0	Max	10
41-60	1	**Work Commute (days per week)**	
61-74	0	6-7 days	0
more than 75	1	4-5 days	3
Patrons Per Day (estimate)		**Basic Demographics**	
less than 50	0	Mean Age Years (SD)	44.67 (21.94)
50-99	0	Age Years Min-Max (N)	20-62 (3)
100-200	1	% White (n)	0% (0)
more than 200	2	% Female (n)	33% (1)

Marrero Business Respondent Access-Related Items. Business respondents answered a series of closed and open-ended questions designed to gain insight into their perceptions of patron access. When asked to estimate what percentage of patrons plan to stop at their business location (as opposed to the percentage of patrons who might stop out of convenience as they are passing by), respondent estimates (n=3) ranged only a slight bit, from 70% to 80% (M=76.67%, SD=5.77%). When asked how most patrons accessed the parking lot, only two of the respondents supplied information. Both reported access from the major street and one also reported access from the minor street/frontage road as well. All three participating businesses indicated just one block of time as being the busiest. While busy times varied by business, all indicated traffic in the surrounding area is typically not congested during their busiest times.

All three respondents ranked the six general factors that people typically consider when deciding whether or not to patron a particular business. Figure 48 shows the mean rank position for each of the items, ordered in importance from most (lowest mean rank) to least important (highest mean rank). One business ranked Access at most important while the remaining respondents ranked Access fourth or fifth. Similar to the business samples in the other three locations, Quality and Service were ranked higher than the other factors (though the particular placement of order varies) and hours ranked least important. Detailed descriptive statistics are provided in Appendix J.

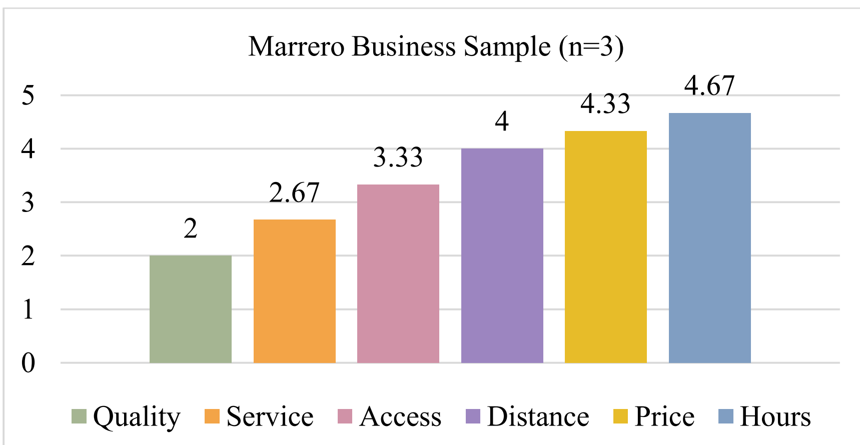

Figure 48
Marrero businesses (n=3) ranked considerations (mean)

Marrero Business Respondent Access-Related and Traffic Safety Concerns. None of the respondents answered “yes” to any of the yes/no concern question items, and so none of the respondents provided any comments to report.

Marrero Patron Sample: Business Visit and Prior Patronage. Compared to the Marrero business survey sample, the patron sample is much larger in size (n=52). As reported previously in Table 7, the patron sample includes patrons representing an additional three businesses that did not participate in the business survey. With the exception of one patron visiting a local business (one location), nearly all of the patrons (n=51) were visiting regional or national chains. Over half of the sample visited convenience store/gas station businesses (n=27) one patron visited a sit-down restaurant and the remaining patrons were visiting retail sales businesses (n=24). About 48% (n=25) reported that they had planned to stop while the remaining 52% (n=27) reported that they stopped as they were passing by. It is worth noting that, of the 27 patrons who reported they did not plan to stop, 20 of them (about 74%) had visited convenience store/gas station businesses. Next, patrons were asked how long they have personally been a patron to the business they just visited; how often they visit the business and how often they visit other area businesses Response frequencies to these items appear in Table 29.

Table 29
Marrero patron sample reported business patronage and frequency

Reported Length of Patronage		
First time was today	5	9.62%
1-12 mos.	9	17.31%
1-3 years	6	11.54%
3-6 years	6	11.54%
Over 6 years	26	50%
Total n	52	100%
Reported Frequency of Patronage (excl. first-time patrons)		
Less than once per month	5	10.64%
Once a month	4	8.51%
Several times a month	16	34.04%
Once a week	10	21.28%
Several times a week or more	12	25.53%
Total n	47	100%
Frequency of Visiting Other Area Businesses		
Regularly	22	42.31%
Sometimes/Not Regularly	15	28.85%
Rarely	8	15.38%
No	7	13.46%
Total n	52	100%

Patron Respondent Access-Related Items and Traffic Safety Concerns. The remaining patron survey items include the same six-factor ranking item asked of the business respondents, as well the same yes/no questions asked at the other sample locations. Focusing first on the six-factor ranking item, Figure 49 illustrates the mean rank position for each of the items, ordered in importance from most (lowest mean rank) to least important (highest mean rank) among patrons of businesses located in Marrero/Jefferson Parish (n=52). Detailed descriptive statistics are provided in Appendix J.

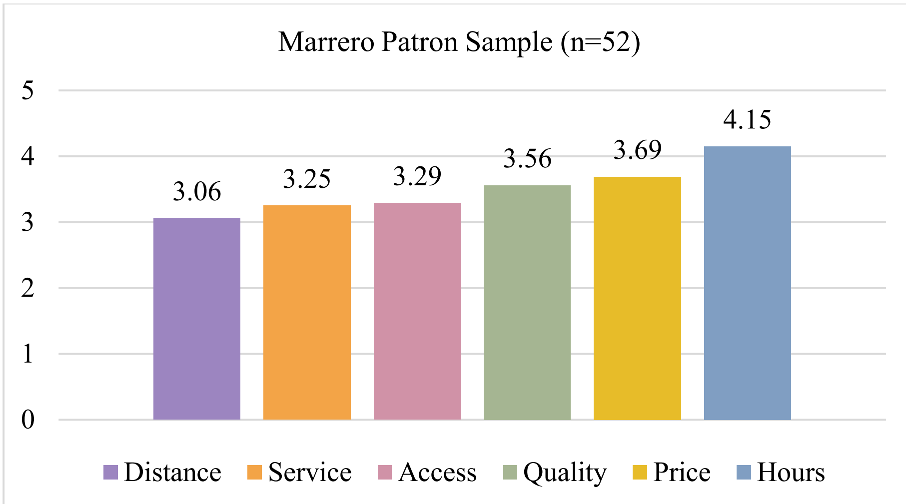

Figure 49
Marrero patrons (n=52) ranked considerations (mean)

When asked if they have ever experienced difficulty accessing the business they just visited, only six (11.54%) reported "yes" and of these, only five provided comments. One respondent reported access-related issues ("lanes blocked"), one mentioned crashes a couple of times a year, and one mentioned traffic around school time. The other two comments are business-specific. One reports the hours of the business while the other refers to crowding (i.e., people staying parked at the gas pumps after filling their gas tanks).

When asked if they have experienced issues accessing property in the surrounding area, eight respondents reported "yes," about 15% of the sample. Seven provided comment in the follow up question. Two respondents reported traffic issues while one indicated "traffic of an accident." Three comments concern navigation or access issues. Two are very general (i.e., Not enough U-turns or turning or access points; Hard to cross) while one is very specific: "Patriot and the corner of Barataria. Heading west on Patriot towards Barataria there should be a third lane for right hand turns only." One comment appears to refer to accessing one of the gas stations at this location, stating: "Truck comes to fill gas and takes too long."

The next question asks respondents if they are aware of any road improvements that may have improved traffic in the area. While eight reported "yes" and two reported "maybe," only six appeared to recall the nature of the improvements, which varied a bit across respondents. These comments appear in Table 30.

Table 30
Marrero patron awareness of recent improvement open-ended response comments

Yes	Opening of the expressway
	Traffic moving better
	Lapalco is now 3 lanes from Westwood to Segette bridge
	The off ramp completed not too long ago. No longer backs up westbound as badly
	Addition of ramp on expressway
Maybe	New light at main intersection

About 19% had additional comments/concerns that they wanted to provide. Similar to the previously reported item, comments varied and with the small size, they are not readily summarized. These comments (verbatim, minimal editing) appear in Table 31. As displayed, several mention concerns with crashes, several mention issues with potholes while others left comment about other drivers/driver actions.

Table 31
Additional patron comments: Marrero

Exit ramps causes traffic and accidents
Greater New Orleans bridge backed up during morning and afternoon
Potholes on service road.
90 business needs to be longer
People should learn how to drive
Red light at corner of Beltaire needs a turning light, accidents frequent
Speeding issue uncontrolled.
Traffic sucks
Potholes need to be filled. Drainage is bad when it rains heavily
Dangerous to cross road to Walgreens.

CONCLUSIONS

The purpose of this study was to assess the economic impact J-turns have had on businesses in the corridors where they have previously been installed in Louisiana. A secondary objective was to provide insight into current existing access-related concerns among businesses and their patrons near the J-turns using survey methods. This section summarizes the findings and conclusions, which have a number of implications for access management in Louisiana.

Economic Impact Findings

First, to assess the extent to which J-turns have had an economic impact on business sales, an economic impact analysis was conducted at multiple levels (i.e., aggregate comparison of affected/not affected business sales within a half mile radius, year effects according to when the J-turn was installed, parish effects at the local trend level and lastly, among businesses of certain types). The economic impact analysis showed that in the aggregate, mean sales are higher after the J-turns were installed and yielded no evidence at the macro level that J-turns had a negative effect on business sales. Rather than harming sales, it appears that the J-turns are positively correlated with growth in areas where they have been installed.

Because sales increased among businesses classified as "affected" and "unaffected" (in terms of travel distance impact from the J-turn), it is unlikely that the sales increase in the half-mile radius is due to the J-turn alone. Rather, the increase in business sales overall suggests other factors are involved (such as the business climate in the parish/neighborhoods, the impact of additional development and/or population growth, etc.). Mean sales increased over the study period (2011-2013) for both unaffected and affected businesses. There is no evidence that the J-turns had a negative impact on business sales in any year. Mean sales remained stable or they increased and in all cases, mean sales one year after installation were higher than the year before installation at statistically significant levels.

At the parish level, sales impacts are analyzed in greater detail, but in some cases, the number of existing businesses is very small, which makes it difficult to draw significant conclusions. Still, by performing analysis on (1) all businesses in close proximity to the J-turn, (2) affected and unaffected businesses separately, (3) all businesses active throughout the period, and (4) only those businesses active throughout the entire study period, it is possible to triangulate findings at the parish level. Focusing first on Lafayette Parish, mean sales as a percentage of parish sales appeared to decline; however, the analysis indicates no substantial differences between affected and unaffected businesses and in all cases, the decrease was not statistically significant. The small sample size and small variance suggests the changes in mean sales before and after the installation can be attributed to randomness or other factors besides the J-turn alone.

In East Baton Rouge Parish, the sales among existing businesses near the J-turn (that were active a year before and a year after installation) as a percentage of parish sales appeared to slightly increase after installation at statistically significant levels for both affected and unaffected businesses. There are numerous other factors that can affect business sales that would be able to account for the difference. That sales increased for both classifications suggests other factors may be involved. In Jefferson Parish, mean sales increased after installation at statistically significant levels over the before-period. While not all comparisons showed statistically significant increases, the sales increased nonetheless and the general conclusion is that businesses in areas where J-turns were installed experienced sales increases relative to the rest of the parish.

Findings for St. Tammany Parish stand out a bit from the other locations. First, Covington, LA, which is located directly next to the interstate, is a high-traffic area that has seen considerable population growth in recent years. It has also been experiencing new development (including a new Walmart) and many new businesses have opened. The analysis indicates a significant increase in total sales as a percentage of total parish sales in the area and a decrease in sales among existing businesses. The most likely explanation for this is the new area development has increased sales at a rate higher than the rest of the parish. Because the decline in sales is observed in both affected and unaffected active businesses before and after the installation, these changes are likely not due to the J-turn itself but rather new business competition.

Taken together, there is no evidence that J-turns have a negative impact on business sales in the areas where they have been constructed. In the aggregate, J-turns appear to have a positive impact on sales and are even correlated with growth. Declines in sales were not restricted to businesses directly affected by the J-turn but were observed in businesses classified as unaffected as well. Analysis at the parish level suggests factors other than the J-turn may explain sales declines, or the changes may be attributed to randomness. These findings are consistent with prior research examining the economic impact associated with access management treatments.

Perception Survey Findings

The findings from the business survey and the patron survey augment the findings of the economic impact analysis by providing insight into location-specific issues that tended to dominate comments in both samples. While these findings cannot be extrapolated to other locations, it is interesting that the specific difficulties/topics mentioned in the open-ended items tended to be similar among business and patron respondents. For instance, construction and construction-related factors are commonly mentioned among respondents in Broussard/ Lafayette, which also had the highest number of businesses participating relative to the other locations. Likewise, traffic-related problems tended to be dominant in the comments from both respondent samples in Baton Rouge.

Among the business sample (all locations) retail sales and fast food restaurants were the most common types and generally, the majority of participating businesses are regional or national chains. Overall, businesses tended to report that most patrons access their parking lot via the major street and/or minor street or frontage road. Only three business selected “no dedicated lot.” Businesses varied in terms of employees, reported average patron counts per day, respondent experience/length of time with the business but no major differences appear to exist between locations. Among the total sample, approximately 23% report the business has been at that location for over five (but less than 10) years, while about 50% report being at their location for over 10 years.

One limitation of the study is the number of businesses participating in the survey differs by location, with two locations having only a handful of respondents (i.e., Covington and Marrero). These businesses tended not to report access or traffic safety concerns and of those who provided comment, none described any issues concerning access management or the J-turn. The patron samples for these two locations, which are much larger than the corresponding business samples, do nonetheless provide some insight into business access issues with respect to location, particularly in Covington where comments concerning access-difficulties were dominated by mentions of traffic/back-ups, especially in relation to I-12. In Marrero, a smaller proportion of respondents reported “yes” to the questions about difficult access/ traffic safety concerns but the comments didn’t particularly coalesce around a specific issue, as they tend to do in the other three locations. Findings for the two locations with larger business sample sizes are discussed further.

In Baton Rouge, Access ranked fourth in importance out of the six considerations among patrons and among businesses. Patrons who reported past difficulties accessing the business they just visited (27.78%) primarily reported the difficulty was due to traffic or congestion.

Only one respondent mentioned left turn restrictions. In subsequent items, left-turn restrictions are mentioned in a minority of responses and in general, across all of the open-ended items, traffic and/or congestion were reported at a greater frequency than access-related issues. Findings are relatively consistent with the business sample for this location, where all respondents reported at least some degree of congestion at their busiest time(s) of day, with congested being the most frequently reported. Additionally, half of the business sample indicated patrons have reported difficulty accessing their business at some prior point in time, with three-quarters indicating that "traffic" was the issue. One mentioned left-turn restrictions. No businesses reported having any access concerns and no businesses had any further comments or concerns about access management in the vicinity of their business.

Along US 90 in Broussard/Lafayette, where a significant portion of the highway has been under construction for the past several years, the concerns are quite different. First, access ranked fifth in importance out of the six considerations among patrons and among businesses. It is also worth noting that among patrons, price and distance were ranked most and second-most important, while business respondents ranked service and quality most and second-most important. Interestingly, the degree of congestion reported by business respondents at their busiest times is higher than in any of the other locations. Of the 27/28 business respondents participating along US 90, 14 indicated more than one busiest time. In general, businesses tended to report at least some degree of congestion during these times. Congestion seemed to be heaviest during the time blocks "between 11am-1pm" and "between 4pm-7pm." In looking at the times/level of congestion reported at these times, approximately 60% (n=9 out of n=15) reported the area is typically congested or very congested around mid-day, while 61.5% of respondents who selected the evening commute hours (i.e., 4pm-7pm) as one of their busiest times also reported congested or very congested. The hours between 1pm and 4pm, which seven businesses indicated was one of their busiest times, about 71% reported the area is typically congested or very congested at that time.

Additional findings from the business sample include when asked if any customers have reported difficulty accessing the business, 10/15 respondents reporting yes indicated the difficultly had to do with construction. When respondents were asked if they have any current access concerns, those reporting yes (n=13) tended to report more than one concern. For instance, while some comments include references to left-turn restrictions, routing of access, or issues with lights/intersections, a number attribute the access issues to the construction or to general traffic. Respondents reporting traffic safety concerns also frequently mention construction and/or driver actions.

Similar to business counterparts, patrons also ranked Access fifth in importance out of the six considerations, though there was a lot of variation with respect to rank order among individual respondents, so there is less difference between rankings. The patron sample also "corroborates" the construction-related problems mentioned by business respondents. Of the 37 comments reporting past difficulties accessing the business they just left, 70% mentioned "construction" and the remaining 30% of comments pertained to various access-related issues such as turning movements, re-routed through traffic or left turn restrictions. The next item, which asks about access to property in the surrounding area, has a similar response pattern, with about 67% reporting construction-related difficulties and about 29% reporting access-related issues. Of the 38 respondents with additional comments/concerns, about one-third (n=14) were construction-related comments and three comments pertained to J-turns specifically, though only one of them elaborated on the issue (i.e., increase to driving time). The remaining comments concerned a variety of other issues such as misc. operational issues, complaints about drivers, etc.

Additional insight may be gleaned from considering the mean rank ordering of the six considerations. While it is not possible to extrapolate these results to the general population, or even the local populations from which the sample was drawn, there do appear to be some general observations worth pointing out. Among the business respondents, across locations, the top ranked considerations are quality (of products/services) and customer service, followed by price, which is consistent with prior research [*72, 75*]. Distance tended to rank just above or just below access and hours was consistently ranked least important. The business sample sizes in Covington and Marrero are very small and having a larger sample size could lead to different results in some way, but it impossible to suggest how.

One of the most interesting observations, particularly in comparing business rankings to the patron rankings, is the placement of distance in terms of its importance to consumers. The business sample tended to rank distance close to the bottom, overall and in individual locations. The patron sample tended to rank distance as the second-most important consideration, or as in Marrero, the most important. Considering the patron comments on traffic and congestion, particularly in Baton Rouge, Covington, and along US 90 where construction work is ongoing, and assuming that a longer travel distance might likely result in a longer total trip time at the least, it is reasonable to expect that distance to travel would be a relatively important consideration. In general, access tended to rank higher in Covington and Marrero than in Baton Rouge and along US 90, where it was ranked fourth and fifth respectively in both survey samples. Consistent with the business sample, across all of the locations, hours was consistently ranked the least important among patrons.

Most of the patrons in the sample reported they have a history visiting the business they just left, with a majority of them reporting they visit once a month or more. While many also had complaints and concerns about traffic, congestion, construction inconveniences, maneuvering areas with heavy congestion, and issues with left turn restrictions, there is little evidence to suggest that these factors have such a deterrent effect that they would stop visiting the business altogether. While these factors are unpleasant, they are largely unavoidable if one intends to go about their routine. Considering that many of the businesses represented in the sample are regional and national chains with multiple locations, it is unlikely that patrons would decide to go out of their way over a longer distance to patron e.g., a different Walmart.

Qualitatively, the survey results provide insight into perceptions of access and mobility in these locations and how the transportation-land use cycle plays out over time. While the purpose of conducting the survey of businesses and their patrons was to gather insight into the perceived impact of access changes (i.e., J-turns) on business activity in areas where they have been previously installed, the access-related difficulties reported in the open-ended comments ultimately describe the impact of traffic, congestion, and/or traffic-impacting factors such as rush hour times, road work, driving behavior, etc. The same issues were reported in comments describing traffic-safety concerns and again when respondents were asked if they wanted to express any additional comments/concerns. There is no doubt that congestion has negative impacts on traffic flow through the road network and results in many negative externalities. Findings from prior research suggest that perceptions of congestion influence perceptions of access [*77*].

RECOMMENDATIONS

The state highway system, an integral component of Louisiana's multimodal transportation system, plays an indispensable role in the state's economy and in the lives of millions of people. While the scope of this study is limited to assessing the extent to which previously installed J-turns have had quantifiable economic impacts on business and perceptions of access, the recommendations provided have a number of implications for highway safety priorities, traffic operations, and for the practice of access management in Louisiana.

Proactive Approach to Addressing Business/Stakeholder Concerns

To the extent that it is possible, proactively addressing the concerns of businesses and other stakeholders in preliminary stages of development/project planning is necessary to foster a more cooperative environment and encourage productive dialog between all parties. The simple justification for regulating access connections from the road system is that it is in the best interest of the state and the general welfare of the public. Businesses may not inherently possess a frame of reference for considering access in these terms. The average person is unlikely to possess an in-depth understanding of traffic engineering concepts, such as roadway functional classification or corner clearance, but they are likely well-aware of the problems of congestion, travel delay, and bottlenecks. Traffic problems such as these are associated with a host of adverse and undesirable impacts. Relating access management to congestion and mobility concerns that impact all road users can provide a meaningful frame of reference.

The results of the analysis of sales tax data should be used in communications and outreach to the public/stakeholders for projects involving the construction of J-turns. There is indication that in locations where J-turns are constructed, there have also been new business developments, which may increase sales overall, but also lead to more competition, which generally benefits the citizens of the state. Though research in this area is still somewhat limited, the findings across studies are fairly consistent.

ACRONYMS, ABBREVIATIONS, AND SYMBOLS

AASHTO	American Association of State Highway and Transportation Officials
CMF	Crash Modification Factors
DOT	Department of Transportation
DOTD	Louisiana Department of Transportation and Development
EB	Empirical Bayes
FDOT	Florida Department of Transportation
FHWA	Federal Highway Administration
ITE	Institute of Transportation Engineers
IRB	Institutional Review Board
LSP	Louisiana State Police
LHSC	Louisiana Highway Safety Commission
LTRC	Louisiana Transportation Research Center
LOS	Level of Service
LSU	Louisiana State University
MUT	Median U-Turn
NAICS	North American Industry Classification System
NCHRP	National Cooperative Highway Research Program
RCI	Reduced Conflict Intersections
RCUT	Restricted Crossing U-Turn
RIRO	Right-In Right-Out
SHSP	Strategic Highway Safety Plan
TRB	Transportation Research Board
TWLTs	Two Way Left Turn Lanes
TWSC	Two Way Stop Control
UIDs	Unconventional Intersection Designs

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Economic Effects of Access Management Techniques in North Carolina

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Abstract

The NCDOT has made significant strides to reduce collisions and increase capacity along strategic highway corridors across the state. Efforts have led to the implementation of many different access management techniques along corridors, such as installing medians versus two-way left turn lanes, using leftovers, closing median openings, and installing superstreets. The Department has continued to receive comments from businesses along these corridors indicating their concern that these new designs will have a negative economic impact because of the lack of direct access to their properties. This study employs a perception based survey technique with the use of comparison sites to create a pseudo before-after study. Owners of businesses along treatment corridors viewed access management techniques in a more positive light than the perceptions of those on comparison sites. Their similar performance in terms of business revenues indicates that there is no direct evidence of negative economic impacts due to access management installations.

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Executive Summary

Access management has evolved over decades and has become a hot topic in recent years as transportation engineers are seeking to provide more sustainable transportation networks. If used correctly, access management techniques can provide significant safety and operational benefits over more traditional roadway designs such as two-way left turn lanes. However, businesses contend that median divided facilities limit the ability of their consumers to reach their establishments. Although research in other states does not suggest this is true, these business owners have been vocal opponents of these techniques in many public meetings throughout the state of North Carolina. In particular, North Carolina businesses are not trusting the results obtained from studies done in other states. Therefore, NCDOT initiated a non-biased research study to determine the effects of access management on surrounding businesses that are specific to this state. These findings, along with previous North Carolina research in the areas of operations and safety along these corridors, should provide important information related to the various trade-offs associated with installing median divided facilities.

The Institute for Transportation Research and Education was tasked with conducting this research effort. A perception based survey was employed by the research team talking to business owners and managers at various treatment installations across the state. Comparison sites were used to account for factors not attributed to the median, such as the recent economic downturn. Sixteen total sites were surveyed: eight treatment sites and eight matched comparison sites. A total of 789 businesses were surveyed.

When analyzing the available survey data, and accounting for external factors such as the economy, the research team determined the following results to be statistically significant at the 95% confidence interval.

Economic Effects

- There was no statistically significant difference in self-reported revenue changes between comparison and treatment sites, even when looking at individual treatment/comparison pairs.
- Based on the data, the perceived effect on the number of customers per day was much worse at comparison sites than treatment sites, indicating that the median did not affect customers as severely as owners originally thought.
- The single-location local business was the only business type that had a statistically significant difference in perceived revenue decreases due to the economy **and** the median, noting that although the economy was the primary reason for decreased revenues, the median was the perceived cause in revenue decreases in many cases also.
- An analysis of the rate of new or vacant businesses (i.e. turnover) showed that treatment corridors typically had more new or vacant locations than their comparison sites. Thus, while the economic comparison of businesses on treatment and comparison sites showed very little differences, there may be evidence that some treatment-site businesses may have left the location prior to the survey date. Conversely, a high occurrence of new businesses points to at least some positive economic activities at the treatment sites.

Surrogate Effects

- Overall, business owners and managers believed that roadway modifications did not improve safety; however, treatment sites were much more likely to indicate positive safety benefits. This is also true when looking at individual site pairs. This finding likely indicates a perception change after the median is actually installed and driver behavior changes.
- Only 15% of business owners and managers at treatment corridors actually ranked accessibility as the number one consideration of customers at their businesses. In fact, 62% of treatment respondents at these sites ranked accessibility as 4^{th}, 5^{th}, or 6^{th}.
- Treatment sites responses said operations had improved or stayed the same 71% of the time, while comparison sites only thought operations would improve or stay the same 57% of the time, indicating that the before business survey population were less likely to agree with that operations would improve than those businesses that had seen the operational improvements following construction.
- Business responses said safety had improved or stayed the same following construction with a response rate of 64%.
- Accessibility to the store was perceived to be much worse between comparison and treatment respondents; however, the perception at treatment sites was much better than

comparison sites indicating again that the median did not affect customers as severely as originally thought.

In summary, it appears that the survey data indicates a significant and positive change in respondent's perceptions between comparison and treatment sites. In spite of the overall negative reactions to a proposed median installation, survey data from the businesses represented here appear to support a more favorable perception once the median is finally installed.

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Introduction

Better highway safety and improved operations are key motivating factors in the majority of improvements made in vehicles and the roads they operate on. Many improvements have been made in the last twenty years on both fronts *(Demosthenes, 1999)*. Vehicles are much safer with improvements in braking, front and side impact airbags, and improved structural support and energy absorption. Other vehicular improvements in safety operation have been made by automating vehicles through initiatives such as the Intelligent Vehicle Initiative and IntelliDrive *(FHWA 1998a-f, Lee et. al 2007, USDOT 2010)*.

In the context of roadway design, access management has evolved over decades and is constantly progressing to encourage sustainable transportation networks *(Williams and Levinson, 2008)*. An array of options exist now that aim to improve the highways we drive on, the majority of which involve access management techniques, defined as "the systematic control of the location, spacing, design and operation of driveways, median openings, interchanges, and street connections" *(TRB 2003)*.

Generally speaking, access management techniques provide significant safety and operational benefits compared to traditional fully directional access designs such as two-way left turn lanes (TWLTL's). However, business owners—in particular those affected by a highway improvement project as opposed to new designs—generally argue that median divided facilities will provide limited access to their storefronts. Therefore, access management projects are oftentimes perceived by business owners as impacting their profits and competitiveness.

Business owner complaints and apparent lack of support for access management projects was the primary motivation for this research effort. The objective was to quantify the economic effects of access management techniques on businesses adjacent to multilane highways in an unbiased manner. This North Carolina (NC) specific research effort supplements research already completed in NC on the operational and safety impacts of access management, all of which should provide great resources to DOTs and municipalities when engaging the public.

Background/Literature

The literature on access management is primarily focused in three areas: economic, safety, and operational effects. The large majority of research has focused on the latter two, and only in the last ten years has work been done on the economic effects. Because this research effort focuses on the economic effects of access management, economic studies will be discussed first, followed by safety studies and then operational studies.

Economic Studies

Economic studies use three primary techniques to examine the economic effects of access management: 1) perception based surveys at retrofit median installation sites, 2) before-after survey based studies, and 3) empirical studies using quantitative data. Previous research utilizing one or more of these techniques is described in this section of the report.

The Florida Department of Transportation constructed medians on five corridors and evaluated median impacts using a perception based survey of drivers and businesses *(Ivey, Harris & Walls, Inc., 1995)*. According to businesses, 57% thought the median changes had affected their volume of business positively or had no effect, while 43% of businesses felt that the median changes had a negative impact on their volume of business.

A study in Iowa examined nine in-state sites for access management impacts on local businesses using a before and after perception-based survey method *(CTRE, 1999)*. The overwhelming majority of surveyed businesses (94%) reported that sales stayed the same or increased after the project was completed. Of the ten businesses reporting sales loss, five involved raised medians and four involved TWLTL's. In addition, the businesses along access-managed corridor projects had a lower rate of failure than other businesses in Iowa, likely due to increased development and revitalization on those corridors.

NCHRP Project 25-4 examined the economic effects of restricting left turns on highways located throughout the US using empirical based sales and revenue data from 9,200 businesses *(TRB, 1998)*. A large comparison group was used to account for increasing or decreasing trends in the case study areas. When left turn access into a gas station, non-durable goods retailer, or service business is restricted, these businesses were the most likely to be negatively affected with decreases in sales and an increase in failure rate. On the contrary, grocery stores and restaurants were most likely to be positively affected with increases in sales and a decrease in failure rate.

Eisele and Frawley studied ten access managed corridors in six cities in Texas using perception based surveys conducted before and after construction of the facilities along each of the ten corridors *(Eisele & Frawley, 2000)*. Overall, businesses reported that regular customer visits were positively affected or had no effect 86% of the time. Surveyed customers reported that the updated roadway median design projects had no effect or a positive effect on their choice of sit-down restaurants (83%), gas stations (50%), and fast food restaurants (69%).

Vu, et al., studied six access managed corridors in King County, Washington by surveying businesses (Vu, et al., 2002). The majority of businesses reported that access management had a negative impact on their revenue and patronage. Perception models were utilized in this study to examine the relationship between the perception of accessibility and customer impacts due to access. The models confirmed the correlation of a business's perception of accessibility and customer impacts due to access.

Other studies have found similar results to those above. An overall look at the economic effects of access management shows a variety of experiences. Some businesses along facilities show negative effects through survey feedback and analysis of sales and property data, while many other areas show either no effect or a positive effect when given surveys. Overall however, the synopsis of existing research indicates that access management strategies have either no effect, a reasonably desirable outcome considering other safety and operational benefits, or a positive effect. The following sections will elaborate on safety and operational effects of access management.

Safety Studies

Safety is often one of the key factors in access management strategies, including median installation. A previous study in NC examined corridor-level safety impacts by comparing 4-lane median divided roads to 5-lane roads with a TWLTL as the center lane (Phillips et al., 2005). The cross-sectional modeling comparison used 143 road segments from across the state and found that median divided segments were generally safer than TWLTL segments.

Potts, et al. (2004), studied the safety impact of U-turns at median openings along urban and suburban arterials. The authors examined 806 unsignalized median openings on 62 corridors in seven states. The results showed that U-turn and left turn crashes were infrequent (0.41 crashes per median opening per year for urban arterials; 0.20 for rural arterials), thus drawing the conclusion that U-turns at unsignalized median openings were not a serious safety problem.

Liu, et al. (2008), examined the safety of right turn plus U-turn maneuvers. They studied 140 roadway segments on urban and suburban arterials where directional median openings forced left-turning drivers to make a right turn and then a U-turn at a downstream median opening or signalized intersection. They concluded that U-turn crashes accounted for only a small percentage of crashes at these sites. For crashes that did occur, they determined that the major street Average Daily Traffic (ADT), the U-turn bay's location, and the separation distances between driveway exits and downstream U-turn locations were major factors in the crash frequency.

NCHRP Report 420 summarized the results of 11 studies that examined the safety impacts of replacing TWLTLs with nontraversable medians (Gluck, Levinson, & Stover, 1999). The studies showed a clear trend of crash reductions after the median was installed. Report 420 found that sideswipe, rear-end, right-angle, left-turn, head-on, and pedestrian crashes were consistently reduced.

Operational Studies

Access management strategies are often implemented to improve operations of the roadway, especially for travel time and delay reduction for the mainline highway. Several studies have examined the operational impact of access management strategies on adjacent locations, such as delay at intersections due to increased U-turns and travel time issues for minor street traffic.

Carter, et al. (2005), examined the effects of increased U-turns at signalized intersections along the median-divided roads in North Carolina. The 16 intersections were selected on the basis of high U-turn percentages. They found that increased amounts of U-turns added a small operational delay for the left turn lane (approximately 2% decrease in saturation flow for every 10% increase in U-turns) but posed no significant safety issue, based on crash history at the intersections.

Liu, et al. (2008), investigated the effects of U-turns on the capacity of unsignalized intersections on four lane divided roads. They found that the capacity of the left turn lane decreases with an increase in U-turn percentage, on the order of 3% capacity decrease for every 10% increase in U-turns for moderately low traffic conditions, slightly larger than their result for left turn capacity at signalized intersections.

Zhou, et al. (2002), studied the operational effects of U-turns as alternatives to direct left turns from driveways. The authors collected data on delay and travel time at eight arterial sites in the Tampa Bay area. Their results detailed the situations where one maneuver or the other (direct left turn vs. right turn plus U-turn) would provide the more efficient traffic flow.

Literature Summary

The body of literature points to overall positive effects from access management. Safety on the road corridor is improved due to decreased conflict points and greater separation of opposing flows. Roadway operations are improved, typically with the greatest benefit going to the main road traffic. However, even minor road traffic has been shown to have improvements in travel time and a minor positive effect on delay at intersections. Economic experiences of businesses on access-managed corridors have been shown to be generally positive or having little to no effect. Concerning methodology, most research on economic effects used some kind of survey method to gather data from businesses, with limited studies using empirical data.

Study Methodology

Based on the literature, three primary study methods exist: empirical, survey based before-after, and perception based surveys at managed facilities. Empirical based studies represent the most quantitative, unbiased studies; however, they are hard to conduct because of the limited availability of accurate, dependable data. The two most prevalent studies were before-after and perception based surveys at median facilities. Before-after survey based studies are the preferred survey method because they provide a method of determining perception changes; however, they are less common because they require data collection prior to the treatment installation. Timing and duration of access management studies typically make a before-after assessment infeasible. Perception based surveys following treatment installation therefore represent the overwhelming majority of access management studies conducted to date.

To provide the most reliable results, the research team initially proposed an empirical study using revenue based data of tenants along access management corridors, as found in the Economic Development Intelligence System at the Department of Commerce. A pilot test was conducted to determine if the data were usable or if other study methods needed to be explored. Similar to conclusions from many prior studies, the revenue data were obtained but found to be unreliable. Of the 31 businesses evaluated along the pilot corridor, 28 used estimates of revenue based on models, while only 3 were based on actual sales data. Because revenue data with modeled estimates provided insufficient accuracy, a perception based survey approach was devised. The selected test (treatment) sites were all existing access managed facilities, so the perception based treatment survey was used over a before-after survey method. In an effort to improve the study design, the team supplemented the data collection effort to include comparison sites, which allows for a pseudo before-after evaluation if the comparison sites are representative of broader economic trends along the access management study sites.

Comparison sites serve two primary purposes for our analysis. First, trends at comparison sites will help account for background economic trends, which are likely to have taken place during a general economic downturn in much of NC and the US in the years preceding this study. Second, business owners on comparison sites were asked questions using a “what-if” scenario, which will represent the pseudo before period for treatment sites. In this way, the team looked at perception changes from the pseudo before period (represented at comparison sites) to the actual perceptions following median installation at treatment sites to determine if perceptions improved following installation. The perceptions from both the treatment and comparison sites, therefore, look to gauge what the opinions of respondents are in a before-after type scenario. The analysis methods used in this report, for the most part, hinge on the assumption that the comparison sites accurately reflect what answers to the survey questions would likely have been prior to median installation. The team believes the assumption is valid based on a comparison of site characteristics, traffic operations, and business types between treatment and comparison sites. The use of comparison sites results in a stronger study design than a mere after study at multiple treatment sites, which would not account for any of the perceived change in opinion of the median. So, while a true before-after survey would have been preferable, the comparison site approach was the best approach available to the research team.

Survey Development

The objective of the survey was to determine the type and magnitude of effect that the access management treatment had on the businesses located along that roadway. This was accomplished by administering the survey to owners or managers of those businesses. Two slightly different versions of the survey were developed and used. One version was used at treatment locations—businesses along a roadway that received an access management installation. The other version was used at comparison locations—businesses along similar roadways that did not receive an access management installation, but that are comparable in site, traffic, and economic attributes to one of the treatment sites. The reason for having two versions was that some questions on the treatment survey would not logically apply to the comparison location (e.g., "what changed after the median was installed?") and therefore needed to be modified or reworded to be appropriate for comparison site businesses.

Using surveys conducted in other prior research efforts as a starting point, the team developed the treatment and comparison surveys. The surveys included questions on economic effects as well as surrogate effects, such as operations and safety, which were important to tie business perceptions to quantitative studies done in past efforts. The survey layout was a two-page design (front and back). The first page of the survey was directed toward more general business-related questions with no mention of the median installation to eliminate any potential bias in the first page answers. The second page of the survey asked questions specifically about the perceived effects of the median on various measures. It is important to emphasize that the interviewees were asked about economic indicators (revenues, daily customers, trends) *before* being asked about their opinions on the median installation on the second page. Table 1 lists the questions used on the treatment and comparison surveys and describes the purpose for asking each question. See Appendices A and B for examples of the comparison and treatment surveys, respectively.

Table 1. Survey Questions

Treatment Survey Question	Comparison Survey Question	Purpose
1. When did this business begin operations at this location?	Same question as treatment survey.	To determine whether the business was open at time of construction. To evaluate turnover rate based on the treatment installation date.
2. How would you classify this business? (Local, Regional, National, etc)	Same question as treatment survey.	To categorize the business type.
3. Please rank the following considerations that customers use when selecting a business of your type. (Accessibility to Store, Customer Service, Distance to travel, Hours of operation, Product price, Product quality)	Same question as treatment survey.	To determine the factors that the business considers to be most important. To determine how accessibility ranks compared to other considerations.
4. What percentage of your customers did not intend to stop at your particular business at the beginning of their trip?	Same question as treatment survey.	To determine how much of the business' customer base relies on pass-by traffic (as opposed to being a destination business).
5. What is your approximate number of sales transactions/patrons per day?	Same question as treatment survey.	To categorize the business size.

Treatment Survey Question	Comparison Survey Question	Purpose
6. Has your expected monthly revenue pattern changed since [date of access management installation]?	6. Has your expected monthly revenue pattern changed since [date of access management installation at matched treatment site]?	(Treatment survey) To ascertain whether the access management installation affected the business revenues. (Comparison survey) To ascertain whether business revenues changed since the date of installation at the treatment site, to account for other factors that may have affected business, such as general economic conditions, changes in overall traffic volumes, or other effects unrelated to the access management installation.
7. Are you familiar with the fact that the median design of the main roadway alongside your business changed in [date of installation]?	No comparable question asked on comparison survey.	To determine whether the survey should continue with specific questions about the effects of the access management treatment.
8. Were you in favor of the roadway modifications before construction? (Yes, No, list reasons)	7. Would you be in favor of roadway modifications to restrict left turns if the result were increased safety and/or operations?	(Treatment survey) To determine the business' opinion before installation. (Comparison survey) To determine public opinion about potential access management treatments.
9. Did your business experience a change in the number of regular customers during construction on the project? (Decrease, No Change, Increase) Following the completion of the project, has your business experienced a change in the number of regular customers? (Decrease, No Change, Increase)	No comparable question asked on comparison survey.	To determine the effect on the business customer traffic during and after the construction period.

Treatment Survey Question	Comparison Survey Question	Purpose
10. Do you feel that the installation of the median has made the following parameters worse, better, or about the same as before the median project was constructed? (Traffic congestion, Traffic safety, Number of customers per day, Gross sales, Property value, Customer satisfaction with access to the store, Delivery convenience)	8. Do you feel that the installation of the raised median would make the following parameters worse, better, or about the same? (same list as treatment survey)	(Treatment survey) To determine the effect of the access management treatment on various aspects of business health and traffic operations and safety. (Comparison survey) To determine public opinion about how access management installations would affect these various aspects. This acts as the "pseudo-before" survey.
11. What was your involvement in the public hearing and public meeting process for this median project? (Attended several meetings, Attended one meeting, No involvement, Not aware of any public meetings)	No comparable question asked on comparison survey.	To determine how many business owners/managers got involved with the public meeting process. To determine if involvement in public meetings correlates to a positive or negative opinion of the project.

To obtain the highest possible sample size and prevent respondent confusion when completing the survey, the decision was made to conduct door-to-door surveys in lieu of a mail-out method. Team members visited businesses along each site and spoke with owners or managers at each business. Most surveys were completed by the team member verbally interviewing the owner or manager. In cases where an owner or manager was not present, the team member would leave a stamped, addressed envelope and a blank survey form and ask for it to be given to the owner or manager for them to complete and mail back.

In addition to the survey, team members collected many types of descriptive data at the site, including where the business was located in relation to median breaks, vacant business locations, and the location and type of nearby traffic control devices.

Site Selection

The selection of appropriate sites was critical for a successful study. For a site to be considered, it had to meet the following criteria:

> *Appropriate access management treatment installed*. For consistency with previous NCDOT research on this topic, the preferred type of treatment was the installation of a raised median.
>
> *Appropriate construction period*. Sites where access management treatments were installed too recently would have a short “after” period on which to base analysis. Sites where treatments were installed too many years in the past would create issues with accurate survey responses (i.e., difficult for respondents to remember that far back) and survey potential (i.e., businesses operating in the current time period may not have been in operation at the time of the treatment). The preferred time window of construction was 2003 to 2008.
>
> *At least 0.25 miles in length*. Longer sections give a larger sample size of businesses and more efficient use of team member time and travel.

Moderately high business density. Higher density of businesses along the site gives a larger sample size. In this context is also important that business density was comparable before and after median installation to be able to evaluate economic impacts. The research team did not consider sites where the median was installed as a part of major redevelopment along the corridor.

Moderately high traffic volume. The team wanted to avoid including sites with low traffic volume from concerns that the effect of the access management treatment would be potentially difficult to determine and the site may be relatively recently developed. Sites with established business development were preferred.

Team members began the process by assembling a list of all potentially eligible sites and then selecting final sites according to the selection criteria. Potentially eligible sites were identified by obtaining input from project panel members, district and division engineers across the state, and personal knowledge among team members. This process yielded a list of 62 potentially eligible sites across NC where access management projects had been installed within the past 15 years. The list of sites is provided in Appendix C. The projects included median installations, median break closings or modifications, and intersection restrictions. From this list, the researchers selected six treatment sites (shown as the top six in the list) for the study based on the above listed criteria. Two other sites were added later with a sister research project.

One comparison site was selected for each treatment site in order to provide a control for possible biases such as general economic conditions, specific local economic issues, and driver demographics. In general, the most appropriate comparison site would be a length of road that matched the treatment site as closely as possible, except for not receiving the access management treatment. Multiple comparison sites were identified for each treatment location, and a ranking was applied to select the best possible corridor for comparison. This selection was based on such factors as proximity, business density, driver population and demographics, and traffic volumes. In some cases, the researchers were simply able to use another section of the same road that was adjacent to the treatment section but that did not receive the access management treatment. In other cases, the comparison site was selected by using a nearby road section that matched the characteristics of the treatment site. It should be noted here that the South Boulevard comparison site was used twice (shown with * in Table 2) because it was the best matching site for the two treatment sites also located along South Boulevard. General matching characteristics when choosing comparison sites included business density, general distribution of business types, traffic volume, road function within the city, and road character. Table 2 shows the treatment and comparison sites, displayed with their matched pairs.

Six of the treatment sites were median installations and two were conversions of signalized intersections to signalized superstreets. Although median installation was the preferred treatment for this study, the two superstreet sites were included because they were being used in a sister research project and collection of data was convenient and efficient.

All sites studied were located on major arterials leading into and out of the respective city. Businesses along the sites were predominantly retail and services (e.g. food, beauty, and auto) along with a minority of financial, technical, and health business types as well. See Appendix D for a listing of characteristics for each site. A total of 535 surveys were successfully completed, comprising 240 surveys from treatment sites and 295 from comparison sites.

Table 2. Descriptive data on treatment and comparison sites chosen for study.

Street Name	Beginning Intx	Ending Intx	City	Segment Length (mi)	AADT	Lanes	Divided	Undivided	TWLTL	Speed Limit	Access Point Density	Surveys Completed	Type of Project
Falls of Neuse Rd.	Spring Forest Rd.	Wake Forest Rd.	Raleigh	0.5	35000	4,5,6		X	X	45	32	16	
Western Blvd	Method Rd.	Gorman St.	Raleigh	0.38	35000	6	X			45	87	35	Median Install
Tryon Rd.	Sugar Creek Rd.	Lambeth Dr.	Charlotte	0.73	15000	5,6		X	X	45	95	58	
Albemarle Rd.	Independence Blvd.	Sharon Amity Rd.	Charlotte	0.55	37000	5	X			45	98	67	Median Install
Market St.	Barclay Hills Dr.	New Centre Dr.	Wilmington	0.98	39000	5			X	45	73	28	
Market St.	New Centre Dr.	MLK Jr. Pkwy	Wilmington	0.89	39000	4,5	X			45	43	24	Median Install
South Blvd.	Scaleybark Rd.	Seneca Pl.	Charlotte	1.38	30000	4		X		35, 40	75	27	
South Blvd.	Hartford Ave.	Scaleybark Rd.	Charlotte	0.44	31900	4	X			45	61	67	Median Install
South Blvd.	Scaleybark Rd.	Seneca Pl.	Charlotte	1.38	30000	4		X		35, 40	75	32	
South Blvd.	Tyvola Rd.	Archdale Dr.	Charlotte	0.82	30000	4	X			45	72	39	Median Install
Jake Alexander Blvd.	Statesville Blvd.	Maupin Ave.	Salisbury	2.2	30000	5			X	45	25	9	
Statesville Blvd.	Holly Ave.	Goodson Rd.	Salisbury	2.5	14000	4	X			45	49	7	Median Install
Sage Road	15-501	15-501	Chapel Hill	0.3	40000	4		X		45	13	51	
15-501	Europa Dr.	Europa Dr.	Chapel Hill	0.3	40000	4	X			45	23	39	Superstreet Conv.
S. College Rd.	Bragg Dr.	Satara Dr.	Wilmington	0.3	39000	6		X		45	17	19	
Carolina Beach Rd.	Julia Dr.	Piner Rd.	Wilmington	0.3	38000	6	X			45	37	17	Superstreet Conv.

Analysis and Results

Analysis Approach

Ultimately, the survey seeks to capture the perceptions and attitudes of business owners and managers regarding the general economic effects that median installation may have had on their business. The survey coincided with a recent economic recessionary period across the state and much of the country, and it was understood that it may not be possible for survey respondents to completely untangle the effects of the median installation and recession in their minds. The comparison sites worked well in accounting for the potential effects of the economy on respondent answers.

It should be noted that treatment site 4 (Albemarle Road in Charlotte, NC), along with its comparison site 3 were deleted from the analysis. Observations from the staff conducting surveys in the field quickly noted that based on respondent feedback this particular site was likely an outlier. This is explained further in Tables 3 and 4. Albemarle Road is an east-west arterial that has fully-controlled access into the site. The issue with this site is that the only signalized intersection, the end of the study corridor on the east end, is also the only U-turn location for businesses at this site, while the western section requires drivers to go almost two miles back to the nearest interchange, an unexpected maneuver for a potential customer. When asked, NCDOT noted that design of the roadway would not allow a median opening at the west end of the corridor. Since the site was so unique, and since it was not representative of the types of access management sites targeted in this project, the team determined that the outlier site should be removed from the remaining analysis.

In summary, after removing sites 3 and 4, there were 566 unique non-vacant records in the final business database along with 101 unique recorded vacancies. As noted earlier, Site 7 (South Boulevard) functions as a comparison site for two treatment sites – sites 8 and 9 – also on

South Boulevard. Data for site 7 is duplicated for any comparison/treatment analyses involving treatment sites 8 and 9. In short, by duplicating site 7 in the database, the database used for the analyses presented here contains 668 non-vacant and 121 vacant business locations for a total of 789 records. Of the 668 non-vacant business locations in the database, 378 (57%) were from comparison sites and 290 (43%) were from treatment sites.

The research team categorized surveyed businesses according to classifications defined by the North American Industry Classification System (NAICS). Although NAICS can provide for high resolution classification, the research team used business classes defined by the first two digits of the six-digit NAICS code for analysis involving business type. This assured a sufficiently-large sample size of observations in each business category needed for analysis.

Table 3 provides a breakdown of NAICS classes represented in this database.

Table 3. Classification of Surveyed Business by NAICS Code

NAICS Code (2-digit)	Comparison	Treatment	Total Sample
23 - Construction	2	1	3
31 – 33 - Manufacturing	8	3	11
42 - Wholesale Trade	2		2
44 – 45 - Retail Trade	114	101	215
48 - Transportation, Warehousing		1	1
51 - Information		4	4
52 - Finance, Insurance	20	15	35
53 - Real Estate, Rental/Leasing	18	11	29
54 – Prof., Scientific, Technical Services	12	7	19
56 – Admin., Support, Waste Mgmt., Rem. Serv’s	12	4	16
61 - Educational Services	3	2	5
62 - Healthcare, Social Assistance	12	15	27
71 - Arts, Entertainment, Recreation	13	4	17
72 - Accommodation, Food Services	91	67	158
81 - Other Services	66	53	119
92 - Public Administration	1	1	2
(blank or n/a)	69	54	123
Totals:	445	344	789

With a wide variety of businesses represented in the database, it is expected that certain classes of business are better represented than others. Businesses corresponding to the (2-digit) NAICS codes 44 and 45 (businesses related to retail trades) constitute the largest class with 215 records. Accommodation and Food Service businesses (NAICS code 72) form the second largest class with 158 records. The remaining NAICS 2-digit classes range in size from 119 records (code 81 - Other Services) down to 1 record.

Survey results are presented through the use of descriptive statistics. In many cases, survey questions asked respondents to classify parameters or rank several parameters in order of importance. These results are usually presented as tables of proportions. When appropriate, tests of significance for these proportions were performed to determine if the results represent a statistically significant change ($p < 0.05$) in perception between the comparison and treatment sites. *Where findings are not significant but warrant showing p-values, the actual p-value will be given to the reader to make inferences.*

Economic Impact

On the first page of the treatment and comparison surveys, business owners were asked if their monthly revenue patterns changed since the year of the median installation. For comparison sites, the year of installation for the corresponding treatment site was used. At the very beginning of the questions, respondents were not told the reason for the survey and thus their responses were not biased based on the median installation.

Out of 484 total business responses to this question, 238 (49%) reported a decrease in monthly revenues, 103 (21%) reported an increase, and 143 (30%) reported no change in monthly revenues since the year of median installation. The breakdown of these results by comparison/treatment, business type, and site number are given in Table 4.

At a 5% level of significance, there is insufficient evidence to conclude that there are differences in the revenue proportions when comparing comparison/treatment and business type breakdown groups shown in Table 4.

Table 4. Survey Results: Monthly Revenue Change. Breakdown by Comparison/Treatment, Business Type, and Site.

(Excluding Sites 3 &4)		Down	No Change	Up
Comparison		50%	30%	20%
Treatment		48%	29%	23%
Business Type		**Down**	**No Change**	**Up**
Local - one location	Comparison	59%	28%	14%
	Treatment	50%	28%	22%
Local - multiple locations	Comparison	64%	18%	18%
	Treatment	56%	22%	22%
Regional	Comparison	39%	35%	26%
	Treatment	46%	21%	32%
National	Comparison	44%	31%	25%
	Treatment	48%	31%	22%
Site (C = Comparison, T = Treatment)		**Down**	**No Change**	**Up**
Site 1 - Falls of the Neuse Rd (C)		40%	26%	34%
Site 2 - Western Blvd (T)		44%	38%	19%
Site 5 - Market St (C)		64%	15%	21%
Site 6 - Market St (T)		55%	22%	24%
Site 7 - South Blvd (C)		50%	29%	21%
Site 8 - South Blvd (T)		43%	26%	31%
Site 7 - South Blvd (C) *		50%	29%	21%
Site 9 - South Blvd (T)		50%	35%	15%
Site 10 - Jake Alexander Blvd (C)		49%	44%	8%
Site 11 - Statesville Blvd (T)		51%	34%	14%
Site 12 - Chapel Hill Blvd (C)		43%	43%	14%
Site 13 - Erwin Rd (T)		20%	40%	40%
Site 14 - South College Rd (C)		41%	47%	12%
Site 15 - Carolina Beach Rd (T)		58%	26%	16%

Significance testing was not appropriate for the site breakdown group due to low survey counts in most cases. Although the significance testing suggests caution when considering similarities between comparison and treatment sites, it is not unreasonable to conjecture that, overall, businesses were generally operating at the same revenue that they would have been operating had the median not been installed. Looking at each category by row, comparison and treatment sites seem to have (roughly) equal proportions of change in revenue versus no change and increase in revenue. This suggests that the median does not appear to have affected the overall stability of the corridor when looking at revenues.

Investigating a little deeper into the perceptions of why a business may have experienced a change in revenue, there are clear indications that most businesses believe the "economy" is the primary factor of a negative change in revenue. As in the previous table, Table 5 shows the breakdown by comparison/treatment, business type, and site.

The results in this table are limited to those respondents that indicated that monthly revenues had decreased (for whatever reason) since the median installation. Reasons for decreased revenues are classified as "Economy," "Median," and "Other". Note that the third portion of the table, "Site," includes the number of survey responses since a few sites have low survey counts in that population.

Table 5. Survey Results: Decrease in Monthly Revenue. Breakdown by Comparison/Treatment, Business Type, and Site.

(Excluding Sites 3 &4)	Economy	Other	Median
Comparison	81%	4%	14%
Treatment	69%	7%	24%

Business Type		Economy	Other	Median
Local - one location	Comparison	87%	7%	5%
	Treatment	65%	12%	24%
Local - multiple locations	Comparison	78%	0%	22%
	Treatment	80%	0%	20%
Regional	Comparison	83%	0%	17%
	Treatment	85%	8%	8%
National	Comparison	76%	4%	20%
	Treatment	64%	5%	31%

Site (C = Comparison, T = Treatment)	Economy	Other	Median	N =
Site 1 - Falls of the Neuse Rd (C)	100%	0%	0%	14
Site 2 - Western Blvd (T)	71%	14%	14%	7
Site 3 – Tryon Road (C)	100%	0%	0%	12
Site 4 – Albemarle Road (T)	33%	20%	47%	15
Site 5 - Market St (C)	72%	16%	12%	25
Site 6 - Market St (T)	68%	4%	29%	28
Site 7 - South Blvd (C)	76%	3%	21%	33
Site 8 - South Blvd (T)	76%	12%	12%	25
Site 7 - South Blvd (C) *	76%	3%	21%	33
Site 9 - South Blvd (T)	54%	8%	38%	13
Site 10 - Jake Alexander Blvd (C)	95%	0%	5%	19
Site 11 - Statesville Blvd (T)	72%	6%	22%	18
Site 12 - Chapel Hill Blvd (C)	67%	0%	33%	3
Site 13 - Erwin Rd (T)	100%	0%	0%	2
Site 14 - South College Rd (C)	100%	0%	0%	7
Site 15 - Carolina Beach Rd (T)	64%	0%	36%	11

Significance testing for the proportions in Table 5 did not reveal a significant difference between comparison and treatment business responses considered as a whole ($p = 0.093$).Tests for the business type breakdown category indicate a significant ($p < 0.05$) difference between comparison and treatment sites for local businesses with one location; 87% of the comparison sites vs. 65% of the treatment sites reporting a decrease in revenue and attributed the decrease to the economy. Although the difference among national chains was technically not significant ($p = 0.055$), it deserves mention that 76% of the comparison sites vs. 64% of the treatment sites reported a decrease in revenue attributed the decrease to the economy with a fairly high level of confidence. Low survey counts prevented reliable significance results for the site breakdown group.

Sites 3 and 4 were provided in the “Site” breakdown to show additional justification for removing the Albemarle Road treatment site from the analysis. Note that the two sites were not included in the overall comparison/treatment site results at the top of the table. When looking at the reason for decreased revenue since the installation of the median, the median (47%) was the reason given by the majority of respondents, even though the economy during the time of the survey was suffering significantly. This finding likely indicates a significant bias against the median based on the design at this site. While it was excluded from the analysis, this site can serve as an interesting case study of the potential effects of “extreme” access management without adequate U-Turn and access opportunities. However, with a sample of only one site, other local characteristics and contributing factors may play into the observed trends.

Although there is a clear indication that the economy was the primary reason for any decrease in revenue, the treatment sites seemed to indicate the median was a larger issue than the comparison sites (24% vs. 14%). In addition, although the comparison sites indicated a median would be problematic, there was no actual median installed (note, respondents were not given information about the reason for the survey when asked this survey question). Although treatment sites were more likely to blame the median for decreased revenue, the economy was still the dominant factor.

As a side note that may support the perceived dominance of the economy as a large factor in business revenue patterns, there was no significant difference between corner and non-corner businesses at signalized median openings with regard to decreased monthly revenues. Both corner locations (47%) and non-corner locations (50%) indicated a decrease in revenues since installation of the median. There was no evidence of a significant difference between comparison and treatment sites.

Table 6. Primary Cause for Decrease in Monthly Revenues using NAICS Codes.

NAICS 2-Digit Code	**Economy**	**Other**	**Median**	**N =**
23 – Construction	100%	0%	0%	2
31 – 33 - Manufacturing	71%	0%	29%	7
42 - Wholesale Trade	100%	0%	0%	2
44 – 45 - Retail Trade	79%	6%	15%	68
48 - Transportation, Warehousing	N/A	N/A	N/A	0
51 – Information	100%	0%	0%	1
52 - Finance, Insurance	50%	0%	50%	18
53 - Real Estate, Rental/Leasing	100%	0%	0%	12
54 – Prof., Scientific, Technical Services	100%	0%	0%	2
56 - Administrative, Support, Waste Mgmt., Remediation Services	75%	0%	25%	8
61 - Educational Services	100%	0%	0%	1
62 - Healthcare, Social Assistance	100%	0%	0%	5
71 - Arts, Entertainment, Recreation	100%	0%	0%	5
72 - Accommodation, Food Services	68%	9%	23%	69
81 - Other Services	78%	8%	14%	37
82 – Indeterminate	100%	0%	0%	1

Survey data were also analyzed by business type using the North American Industry Classification System (NAICS). As shown in Table 6, the majority of business classes indicated the economy as a primary cause of decreased revenues. For instance, 79% of retail trade (those businesses corresponding to two-digit NAICS codes 44 and 45) respondents experienced a decrease in revenues attributed the decline to the economy. Under the two-digit NAICS classification, there were no significant findings for business classes that indicated the median was the primary cause of decreased revenues.

Another possible indicator of economic impact is business turnover rates following median installation. While the survey results could not provide direct historical data on the number of vacancies over time, the research team felt that an analysis of businesses that began operations after the median installation (referred to as "new" businesses) as well as current (at the time of survey) vacancy counts might yield some insight into the general economic conditions of the sites at the time of the survey. For terminology, any business location that is vacant or has a new tenant since the date of median installation is considered "new/vacant," which may be considered as a surrogate measure for actual business "turnover" rate. Excluding the outlier treatment site 4 and its comparison site 3, 121 out of 789 (15%) business locations in the database were actually **vacant** (not new and vacant) at the time of the survey, further separated by comparison (15%) and treatment (16%) corridors. Table 7 breaks down new business/vacancy counts by comparison/treatment and by individual site.

Overall, the rate of new/vacant locations at treatment sites was significantly higher ($p < 0.01$) than comparison sites. When looking at findings by individual sites, site 1 shows a reverse trend from the other pairs. As a potential explanation, the vacancies at this site were focused in an area surrounding a grocery store which relocated to a brand new location up the road. When asked, the grocery store manager said it was a business decision based on surrounding environment and not the road itself. Therefore, the site new/vacancy rate was not affected so much by the median as the movement of its big anchor on the west side of the corridor. Looking at other individual sites (excluding sites 3 and 4), new/vacancy rates appear to be fairly consistent with slightly higher vacancies along treatment corridors than their comparison. So, while the economic comparison of businesses on treatment and comparison sites showed no difference, there may be evidence that some treatment-site businesses may have left the location prior to the survey date. On the other hand, a high occurrence of new businesses speaks to at least some positive economic activities at the treatment sites.

Table 7. Percentage of New/Vacant Business Locations. Breakdown by Comparison/Treatment and Site (* represents very limited sample size).

(Excluding Sites 3 &4)	% New/Vacant
Comparison	24%
Treatment	30%

	% New/Vacant
Site 1 - Falls of the Neuse Rd (C)	44%
Site 2 - Western Blvd (T)	15%
Site 3 - Tryon Rd (C)	14%
Site 4 - Albemarle Rd (T)	47%
Site 5 - Market St (C)	24%
Site 6 - Market St (T)	36%
Site 7 - South Blvd (C)	21%
Site 8 - South Blvd (T)	30%
Site 7 - South Blvd (C) *	21%
Site 9 - South Blvd (T)	34%
Site 10 - Jake Alexander Blvd (C)	22%
Site 11 - Statesville Blvd (T)	35%
Site 12 - Chapel Hill Blvd (C)	0%*
Site 13 - Erwin Rd (T)	20%*
Site 14 - South College Rd (C)	0%
Site 15 - Carolina Beach Rd (T)	0%

Supplemental Findings

Aside from the central question of economic effect, other survey results may yield insight into differences in perception between comparison and treatment sites. Regarding the median installation, survey respondents were asked if they were in favor of the roadway modification to increase safety. Similarly, comparison site businesses were asked if they *would be* in favor of roadway modifications to increase safety. Table 8 shows the results by comparison/treatment, business type, and by site.

The table shows a clear tendency towards more negative perceptions when discussing safety; however, it is important to note the significant change ($p < 0.05$) in attitude between the comparison and the treatment sites. However, testing on the business type breakdown revealed that there is not sufficient evidence (at a 5% level of significance) to conclude that there are differences between comparison and treatment responses when considered in the business type categories local (one or multiple locations), regional, or national.

Table 8. Survey Results: In Favor of Raised Median to Increase Safety. Breakdown by Comparison/Treatment, Business Type, and Site.

(Excluding Sites 3 &4)	Yes	No
Comparison	21%	79%
Treatment	34%	66%

Business Type		Yes	No
Local - one location	Comparison	15%	85%
	Treatment	24%	76%
Local - multiple locations	Comparison	25%	75%
	Treatment	44%	56%
Regional	Comparison	18%	82%
	Treatment	27%	73%
National	Comparison	27%	73%
	Treatment	40%	60%

Site (C = Comparison, T = Treatment)	Yes	No
Site 1 - Falls of the Neuse Rd (C)	29%	71%
Site 2 - Western Blvd (T)	50%	50%
Site 3 - Tryon Rd (C)	25%	75%
Site 4 - Albemarle Rd (T)	18%	82%
Site 5 - Market St (C)	19%	81%
Site 6 - Market St (T)	22%	78%
Site 7 - South Blvd (C)	20%	80%
Site 8 - South Blvd (T)	61%	39%
Site 7 - South Blvd (C) *	20%	80%
Site 9 - South Blvd (T)	50%	50%
Site 10 - Jake Alexander Blvd (C)	19%	81%
Site 11 - Statesville Blvd (T)	19%	81%
Site 12 - Chapel Hill Blvd (C)	50%	50%
Site 13 - Erwin Rd (T)	40%	60%
Site 14 - South College Rd (C)	13%	88%
Site 15 - Carolina Beach Rd (T)	33%	67%

Lastly, excluding sites 3 and 4, every individual comparison/treatment group showed that perceptions of safety increased or stayed the same, which aligns well with quantitative findings noted earlier in the literature which noted that safety did in fact increase after median installation.

While Table 8 would seem to indicate business owners are not sure if a median would improve safety, there is an interesting piece of related survey data that may shed a different light on the matter. One particular survey question asks participants to rank the attributes in order of importance as considered by their customers: accessibility to store, customer service, distance to travel, hours of operation, product price, and product quality. Only 18% of comparison site locations and 15% of treatment site locations ranked accessibility to store as their customers' highest priority. In fact, 59% of comparison site respondents and 62% of treatment site respondents ranked accessibility as 4th, 5th, or 6th. Thus, while businesses may have generally negative opinions on the impact of medians, they do not seem to feel accessibility is a high ranking consideration among their customers. Table 9 summarizes the survey results for this question by comparison and treatment groups.

Table 9. Survey Results: Ranking of Customer Considerations. Breakdown by Comparison/Treatment Sites.

		Ranking					
(Excluding Sites 3 &4)		1	2	3	4	5	6
Accessibility	Comparison	18%	9%	14%	20%	21%	18%
	Treatment	15%	13%	13%	17%	14%	29%
Customer Service	Comparison	48%	19%	16%	8%	5%	4%
	Treatment	33%	26%	22%	11%	5%	3%
Distance to Travel	Comparison	4%	14%	9%	17%	28%	27%
	Treatment	7%	8%	15%	16%	34%	22%
Hours of Operation	Comparison	2%	4%	9%	20%	27%	38%
	Treatment	2%	7%	11%	25%	25%	31%
Product Price	Comparison	14%	22%	29%	19%	10%	7%
	Treatment	16%	26%	21%	22%	10%	6%
Product Quality	Comparison	15%	32%	22%	16%	10%	6%
	Treatment	27%	19%	19%	10%	14%	10%

In further questions about the access management treatment, survey respondents were asked if the installation of the raised median made (or "would make" for comparison sites) the following better, worse, or stay the same: safety, congestion, number of customers per day, property value, accessibility to store, and delivery convenience (Table 10).

Table 10. Survey Results: Impact of Raised Median on Business-Related Attributes. Breakdown by Comparison/Treatment Sites.

(Excluding Sites 3 &4)		Better	Same	Worse
Traffic Congestion	Comparison	16%	41%	43%
	Treatment	30%	41%	29%
Traffic Safety	Comparison	52%	31%	17%
	Treatment	40%	24%	36%
Number of Customers per Day	Comparison	6%	38%	56%
	Treatment	12%	46%	42%
Property Value	Comparison	7%	55%	38%
	Treatment	18%	40%	42%
Store Access	Comparison	8%	21%	71%
	Treatment	10%	37%	53%
Delivery Convenience	Comparison	5%	39%	56%
	Treatment	7%	53%	40%

When examining each comparison/treatment pair response for worse (or better and same combined), the differences between proportions in each set of pairs is significant ($p < 0.05$). Therefore, businesses in comparison sites versus treatment sites have very different perceptions of these attributes.

Looking at congestion, 43% of comparison site respondents felt that a median would worsen traffic congestion, whereas only 29% of treatment site respondents believed that the median actually did worsen congestion. Since comparison sites represent the "what if" condition (or before scenario), this indicates that perceptions of the median on congestion likely improved after installation. In addition, 71% of treatment respondents felt that traffic congestion remained the same or improved after median installation, which is important because these responses indicate that only a small minority of businesses believe that congestion deteriorated. This finding supports previous research on operational impacts of access management techniques provided in the literature.

Even more pronounced is the perceived safety effect. Eighty-three percent (83%) of businesses along comparison corridors believed that safety would improve or stay the same, compared to 64% of businesses on treatment corridors. Although the perception of safety appeared to decrease following installation of the median, the majority of respondents did believe there were significant safety improvements. Like the operational effects, this mirrors prior research findings summarized in the literature.

Similarly, 44% of comparison respondents felt that a median installation would increase or have no change in the number of customers per day, while 58% of treatment site respondents indicated that the number of customers actually increased or stayed the same. These results suggest a shift in perception between comparison and treatment sites and may indicate that some negative preconceptions of median impact on sales may not have been well-founded.

Customer satisfaction with access to the store was also surveyed. Seventy-one percent (71%) of businesses at comparison sites thought that access to the store would get worse, while businesses at treatment sites said 53% of customers indicated access was worse. This is an important question because the perception of business owners in the comparison group represents a population subset similar to that of business owners that go to public meetings. This finding says that business owner's perception of customer accessibility improved. Also, looking at treatment sites only, an equal split of better and no change versus worse access is shown. This generally means that there was basically no perceived change from before to after median installation.

The last surrogate measure was delivery convenience. The perception of delivery convenience improved after installation of the median, shown as comparison site perceptions of better or no change at 44% versus treatment sites at 60%.

Finally, businesses at treatment sites were asked if they had experienced any change in the number of regular customers during construction and then after completion of the installation. Table 11 summarizes these results by business type.

Table 11. Survey Results: Change in Regular Customer Volume, Treatment Sites Only. Breakdown by Business Type.

During Construction	Decrease	No Change	Increase
Local - one location	66%	37%	0%
Local - multiple locations	56%	44%	0%
Regional	69%	31%	0%
National	48%	43%	10%

After Installation	Decrease	No Change	Increase
Local - one location	50%	50%	0%
Local - multiple locations	50%	44%	6%
Regional	40%	53%	7%
National	55%	45%	0%

While it is clear that the majority of business types experienced no increase in regular customer volume during construction, these effects seemed to somewhat normalize after completed installation. It should be noted that the question on customer trends was not asked to comparison sites, and so it is somewhat difficult to isolate these responses from the background economic recession trends. Interestingly, when looking at averages, some local multiple-location and regional business types seemed to benefit from the installation with an increase in regular customer volume, although the sample sizes were small for both of these groups.

Conclusions

This study deals with the perceptions and attitudes of business owners and managers towards access management. The team conducted a pseudo before-after study using businesses at comparison sites as a surrogate for the before period at treatment installations. A large sample of data was collected to determine the overall perceived effect of median installations, and in most cases sample sizes were large enough to do significance testing by individual site pairs. The major findings in this study are summarized below.

Economic Effects

There were no significant differences in self-reported revenue changes when comparing before and after survey responses from all sites. Even when looking at individual site pairs, it is reasonable to assume that businesses were generally operating at the same revenue they would have been operating had the median not been installed.

When looking at responses for decreased revenue after median installation, treatment sites seemed to indicate the median was a larger issue than the comparison sites, though not significant at the 95% confidence interval ($p = 0.093$). When partitioning the data further by business type, single-location local businesses had a significant difference in perceived revenue decrease due to the economy, noting that although the economy was the primary reason for decreased revenues, the median was the perceived cause in revenue decreases in many cases also. In addition, national chains were affected in a similar way, though not significantly different at the 95 percentile confidence interval ($p = 0.055$).

Overall, the rate of vacant or new businesses (a potential surrogate for turnover rate) at treatment sites was significantly higher ($p < 0.01$) than comparison sites.