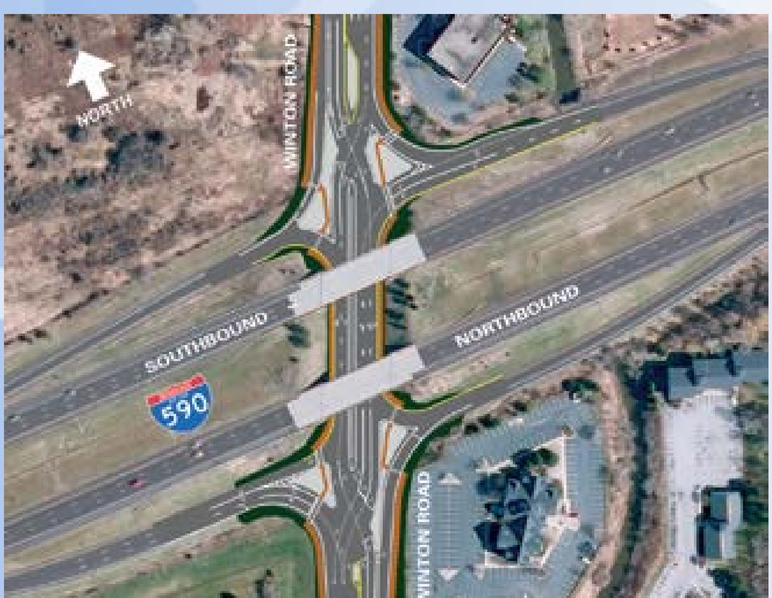
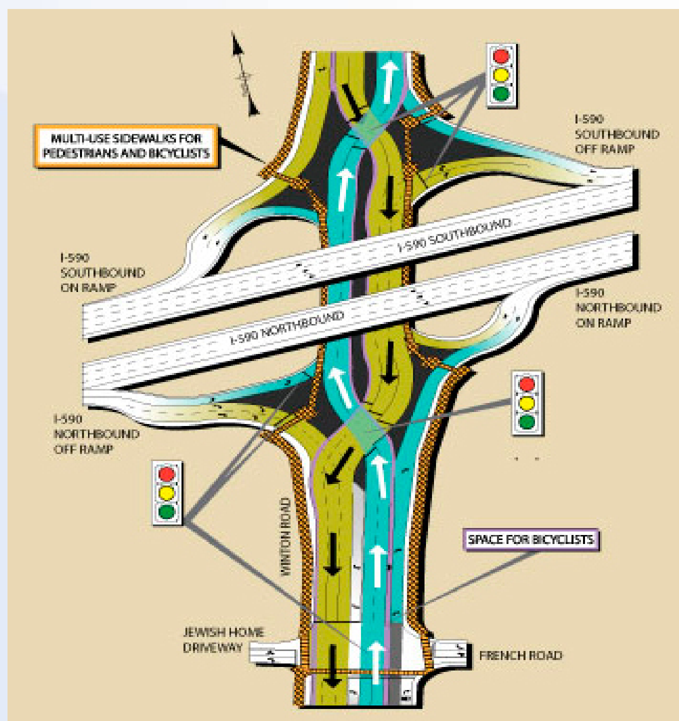
New York Demonstration Project: Improvements to the Winton Road/I-590 Interchange in Rochester

Final Report
June 2013

HIGHWAYS FOR LIFE
Accelerating Innovation for the American Driving Experience.





U.S. Department of Transportation
Federal Highway Administration

FOREWORD

The purpose of the Highways for LIFE (HfL) pilot program is to accelerate the use of innovations that improve highway safety and quality while reducing congestion caused by construction. **LIFE** is an acronym for **L**onger-lasting highway infrastructure using **I**nnovations to accomplish the **F**ast construction of **E**fficient and safe highways and bridges.

Specifically, HfL focuses on speeding up the widespread adoption of proven innovations in the highway community. "Innovations" is an inclusive term used to encompass technologies, materials, tools, equipment, procedures, specifications, methodologies, processes, and practices used to finance, design, or construct highways. HfL is based on the recognition that innovations are available that, if widely and rapidly implemented, would result in significant benefits to road users and highway agencies.

Although innovations themselves are important, HfL is as much about changing the highway community's culture from one that considers innovation something that only adds to the workload, delays projects, raises costs, or increases risk to one that sees it as an opportunity to provide better highway transportation service. HfL is also an effort to change the way highway community decisionmakers and participants perceive their jobs and the service they provide.

The HfL pilot program, described in Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) Section 1502, includes funding for demonstration construction projects. By providing incentives for projects, HfL promotes improvements in safety, construction-related congestion, and quality that can be achieved through the use of performance goals and innovations. This report documents one such HfL demonstration project.

Additional information on the HfL program is available at www.fhwa.dot.gov/hfl.

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16. Abstract

As part of a national initiative sponsored by the Federal Highway Administration under the Highways for LIFE program, the New York State Department of Transportation (NYSDOT) was awarded a grant for a demonstration project that involved the construction of a diverging diamond interchange (DDI) at the intersection of Interstate 590 and Winton Road in Brighton. This DDI is the first of its kind in New York, allowing traffic to access the interstate using the concept of "free" or unopposed left turns, minimizing the risk of serious crashes and decreasing travel times. Additional benefits include improved access and safety for bicyclists and pedestrians, shorter construction time, and less real estate acquisition.

Several innovative strategies were used on this project to speed construction, reduce congestion, and increase work zone safety. NYSDOT allowed complete closure of on and off ramps on weekends during periods of high construction activity, providing signed detours to motorists. The agency also required a complete shutdown of Winton Road while the final traffic patterns were developed to eliminate driver confusion. The construction costs for the Winton Road improvement totaled about $8 million, $4.9 million less than the traditional alternative.

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Unclassified	Unclassified	37	

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SI* (MODERN METRIC) CONVERSION FACTORS				
APPROXIMATE CONVERSIONS TO SI UNITS				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		LENGTH		
(none)	mil	25.4	micrometers	µm
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	millimeters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela per square meter	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	Newtons	N
lbf/in^2 (psi)	poundforce per square inch	6.89	kiloPascals	kPa
k/in^2 (ksi)	kips per square inch	6.89	megaPascals	MPa
		DENSITY		
lb/ft^3 (pcf)	pounds per cubic foot	16.02	kilograms per cubic meter	kg/m^3
APPROXIMATE CONVERSIONS FROM SI UNITS				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		LENGTH		
µm	micrometers	0.039	mil	(none)
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela per square meter	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	Newtons	0.225	poundforce	lbf
kPA	kiloPascals	0.145	poundforce per square inch	lbf/in^2 (psi)
MPa	megaPascals	0.145	kips per square inch	k/in^2 (ksi)

ACKNOWLEDGMENTS

The project team would like to acknowledge the invaluable insights and guidance of Federal Highway Administration (FHWA) Highways for LIFE Team Leader Byron Lord and Program Coordinators Mary Huie and Kathleen Bergeron, who served as the technical panel on this demonstration project. Their vast knowledge and experience with the various aspects of construction, technology deployment, and technology transfer helped immensely in developing both the approach and the technical matter for this document. The team also is indebted to Hans Anker of the FHWA New York Division for his effective coordination effort and to New York State Department of Transportation Design Engineer Eric Thompson, Project Manager Wesley Alden, and Construction Engineer Douglas Koenig. The project team was instrumental in making this project a success and provided the information that helped shape this report.

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ABBREVIATIONS AND SYMBOLS

ADT	average daily traffic
dB(A)	A-weighted decibel
DDI	diverging diamond interchange
FHWA	Federal Highway Administration
HfL	Highways for LIFE
IRI	International Roughness Index
LOS	Level of Service
NYSDOT	New York State Department of Transportation
OBSI	onboard sound intensity
OSHA	Occupational Safety and Health Administration
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
vpd	vehicles per day
VOC	vehicle operating cost

INTRODUCTION

HIGHWAYS FOR LIFE DEMONSTRATION PROJECTS

The Highways for LIFE (HfL) pilot program, the Federal Highway Administration (FHWA) initiative to accelerate innovation in the highway community, provides incentive funding for demonstration construction projects. Through these projects, the HfL program promotes and documents improvements in safety, construction-related congestion, and quality that can be achieved by setting performance goals and adopting innovations.

The HfL program—described in the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU)—may provide incentives to a maximum of 15 demonstration projects a year. The funding amount may total up to 20 percent of the project cost, but not more than $5 million. Also, the Federal share for an HfL project may be up to 100 percent, thus waiving the typical State-match portion. At the State's request, a combination of funding and waived match may be applied to a project.

To be considered for HfL funding, a project must involve constructing, reconstructing, or rehabilitating a route or connection on an eligible Federal-aid highway. It must use innovative technologies, manufacturing processes, financing, or contracting methods that improve safety, reduce construction congestion, and enhance quality and user satisfaction. To provide a target for each of these areas, HfL has established demonstration project performance goals.

The performance goals emphasize the needs of highway users and reinforce the importance of addressing safety, congestion, user satisfaction, and quality in every project. The goals define the desired result while encouraging innovative solutions, raising the bar in highway transportation service and safety. User-based performance goals also serve as a new business model for how agencies can manage the highway project delivery process.

HfL project promotion involves showing the highway community and the public how demonstration projects are designed and built and how they perform. Broadly promoting successes encourages more widespread application of performance goals and innovations in the future.

Project Solicitation, Evaluation, and Selection

FHWA has issued open solicitations for HfL project applications annually since fiscal year 2006. State highway agencies submitted applications through FHWA Divisions. The HfL team reviewed each application for completeness and clarity, and contacted applicants to discuss technical issues and obtain commitments on project issues. Documentation of these questions and comments was sent to applicants, who responded in writing.

The project selection panel consisted of representatives of the FHWA offices of Infrastructure, Safety, and Operations; the Resource Center Construction and Project Management team; the Division offices; and the HfL team. After evaluating and rating the applications and supplemental information, panel members convened to reach a consensus on the projects to recommend for approval. The panel gave priority to projects that accomplish the following:

- Address the HfL performance goals for safety, construction congestion, quality, and user satisfaction.
- Use innovative technologies, manufacturing processes, financing, contracting practices, and performance measures that demonstrate substantial improvements in safety, congestion, quality, and cost-effectiveness. An innovation must be one the applicant State has never or rarely used, even if it is standard practice in other States.
- Include innovations that will change administration of the State's highway program to more quickly build long-lasting, high-quality, cost-effective projects that improve safety and reduce congestion.
- Will be ready for construction within 1 year of approval of the project application. For the HfL program, FHWA considers a project ready for construction when the FHWA Division authorizes it.
- Demonstrate the willingness of the applicant department of transportation to participate in technology transfer and information dissemination activities associated with the project.

HfL Project Performance Goals

The HfL performance goals focus on the expressed needs and wants of highway users. They are set at a level that represents the best of what the highway community can do, not just the average of what has been done. States are encouraged to use all applicable goals on a project:

- **Safety**
  - Work zone safety during construction—Work zone crash rate equal to or less than the preconstruction rate at the project location.
  - Worker safety during construction—Incident rate for worker injuries of less than 4.0, based on incidents reported via Occupational Safety and Health Administration (OSHA) Form 300.
  - Facility safety after construction—Twenty percent reduction in fatalities and injuries in 3-year average crash rates, using preconstruction rates as the baseline.

- **Construction Congestion**
  - Faster construction—Fifty percent reduction in the time highway users are impacted, compared to traditional methods.
  - Trip time during construction—Less than 10 percent increase in trip time compared to the average preconstruction speed, using 100 percent sampling.
  - Queue length during construction—A moving queue length of less than 0.5 mile (mi) (0.8 kilometer (km)) in a rural area or less than 1.5 mi (2.4 km) in an urban area (in both cases, at a travel speed 20 percent less than the posted speed).

- **Quality**
  - Smoothness—International Roughness Index (IRI) measurement of less than 48 inches (in) per mile.

- Noise—Tire-pavement noise measurement of less than 96.0 A-weighted decibels (dB(A)), using the onboard sound intensity (OBSI) test method.

- **User Satisfaction**—An assessment of how satisfied users are with the new facility compared to its previous condition and with the approach used to minimize disruption during construction. The goal is a rating of 4 or more points on a 7-point Likert scale.

REPORT SCOPE AND ORGANIZATION

This report documents the New York State Department of Transportation's (NYSDOT) HfL demonstration project, which involved the construction of a diverging diamond interchange (DDI) at the intersection of Interstate 590 and Winton Road in Brighton. The report presents project details relevant to the HfL program, including safety, construction congestion, and user satisfaction. HfL performance metrics, economic analysis, and lessons learned are also discussed, along with innovative methods of public involvement and technology transfer.

PROJECT OVERVIEW AND LESSONS LEARNED

PROJECT OVERVIEW

The project is located at the intersection of I-590 and Winton Road in Brighton, a suburb of Rochester New York. The existing facility consisted of a traditional diamond interchange with a four-lane highway (Winton Road) passing under two structures that carry I-590 traffic between I-390 and I-490 just outside Rochester. I-590 is a six-lane (three in each direction) interstate route carrying more than 75,000 vehicles per day (vpd).

At this location, Winton Road consists of two 12-foot through lanes in each direction with left and right turn lanes at various locations within the limits of the project. At this location, Winton Road carries traffic approaching 25,000 vpd south of I-590 and nearly 11,000 vpd north of the interchange.

Three major intersections with Winton Road, all controlled by traffic signals, are within the project limits: Meridian Centre Boulevard, French Road, and Cambridge Place. Existing sidewalks were located on both sides of Winton Road, but no signalized crosswalks. Ramp intersections were not signalized, but had refuge islands.

A 1999 corridor study identified this location as a problem area with safety and congestion issues during peak travel periods. NYSDOT has worked since 2003 to develop a plan that improves the situation while minimizing the impact on the surrounding area. Several issues complicated the selection of a solution at this location, including a wetland and flood plain area associated with Allen's Creek, the bridges over Winton Road on I-590, and a historic 1830s farmhouse in the northwest quadrant of the existing interchange.

Several configurations were considered before the DDI design was selected, including the replacement of the intersections on Winton Road with roundabouts, a single-point urban interchange, and triple left-turn bays from I-590 south to southbound Winton Road and the construction of a partial cloverleaf in the northwest quadrant of the interchange. All of these configurations would have involved acquiring significant additional right-of-way (ROW) and most would have involved replacing the bridge structures on I-590 with longer or wider structures. The selected alternative, a DDI, minimized the right-of-way acquisition and eliminated the need to replace or modify the structures on I-590, greatly reducing construction time, disruption to the public, and initial cost. It also eliminated the need to disturb the historic structure.

The DDI is the first of its kind in New York, allowing traffic to access the interstate using the concept of "free" or unopposed left turns, minimizing the risk of serious crashes and decreasing travel times. Additional benefits include improved access and safety for bicyclists and pedestrians, as well as the shortest construction time and the least real estate acquisition of the alternatives considered.

Building most of the other alternatives considered as a solution at this location would have spanned at least two construction seasons. While the total contract time for the project exceeded

2 years, more than 18 months of that time were devoted to utility relocations with limited traffic impacts. The ability to fit the DDI in the existing right-of-way footprint and use the interstate bridges without modification allowed the completion of all roadway work in a single construction season.

Several innovative strategies were also used to speed construction, reduce congestion, and increase work zone safety. NYSDOT allowed complete closure of on and off ramps on weekends during periods of high construction activity, providing signed detours to motorists. The agency also required a complete shutdown of Winton Road while the final traffic patterns were developed to eliminate driver confusion.

The NYSDOT Regional Traffic Operations Center was used to ensure coordination with other construction activities in the area and keep the public informed of delays, detours, and general driving conditions with dynamic message signs on I-590 and I-390.

HIGHWAY PERFORMANCE GOALS

Safety, construction congestion, quality, and user satisfaction data were collected before, during, and after construction to demonstrate that innovations can be deployed while simultaneously meeting the HfL performance goals in these areas.

Safety

The safety goals for the project included both worker safety and motorist measures.

The worker safety goal was an incident rate of 4.0 or less based on the OSHA 300 form. No worker injuries were reported during the construction of this project, achieving the worker safety goal.

The motorist safety goal during construction was a crash rate equal to or less than the preconstruction crash rate. Thirty traffic incidents were reported during the construction period, which corresponds to a crash rate of 495, 192 less than the 3-year average crash rate reported for this location, thus achieving the HfL goal.

Construction Congestion

NYSDOT considered several alternatives before selecting the DDI configuration. Most of the other alternatives would have required substantially more construction time, resulting in multiyear construction contracts and major traffic impacts. Also, most would have included traffic disruption on I-590 because of the modification of bridge structures not required under the DDI alternative.

The most likely traditional alternative to the DDI would have been construction of a partial cloverleaf interchange. It is estimated that this would have required two full construction seasons. Implementation of the DDI alternative resulted in no disruption to I-590 traffic and limited the impact on Winton Road to about 180 days, including about 90 hours during which the contractor completely closed the facility to traffic.

The use of partial-width construction resulted in minimal impacts on travel on Winton Road. The greatest impact was a 12 mile-per-hour (mi/h) reduction in average speed in the southbound direction during the afternoon peak period and a 9 mi/h reduction during the a.m. peak period northbound. This corresponds to a travel time increase of about 2 minutes. During other times of the day, the average travel time increase was less than 1 minute.

NYSDOT identified and signed seven potential detour routes available during periods of complete closure. Detailed origin-destination studies, not done as part of this project, would have been required to determine the percentage of traffic that chose any particular detour leg. However, the effects of weekend closures of the interchange are discussed in this report.

The selection of the baseline alternative would have resulted in an additional 180 days of construction. Selection of the DDI project achieved a 50 percent reduction in the time highway users were impacted compared to traditional methods, meeting the HfL goal.

Quality

Measurements of smoothness (IRI) and noise (OBSI) were taken before and after construction.

The smoothness, or IRI, measurement was initially 91 inches per mile in the northbound direction and 113 southbound. Postconstruction IRI measured 77 inches per mile northbound and 86 inches per mile southbound, compared to the HfL goal of 48 inches per mile. Although the HfL goal was not met, this is an urban setting with relatively low operating speeds and several traffic signals, so the measured IRI should provide adequate smoothness for the traveling public.

Noise was measured using onboard sound intensity methods (OBSI). The initial measurements of noise before construction averaged 95.9 dB(A) in both directions of travel. The postconstruction measurement averaged 94.6 dB(A), a reduction of 1.3 dB(A) and remaining below the HfL goal of 96 dB(A). In an urban setting with a relatively low operating speed of around 40 mi/h, the pavement noise component is considered acceptable.

No user satisfaction survey had been conducted at the time of this report. However, an extensive campaign was conducted to educate the public about the project schedule, available detour routes, and the theory and operation of the DDI.

Economic Analysis

An economic analysis showed that constructing a DDI instead of the next most likely alternative, the partial cloverleaf design, resulted in a savings of about $4.9 million in initial construction costs. The majority of this cost was from reduced right-of-way acquisition. While not a direct capital cost saving, reduced user costs resulting from the decreased construction time added $1.9 million in benefits.

LESSONS LEARNED

NYSDOT considered the experience it gained from building a DDI on Winton Road extremely valuable. Using this new technology provided several insights on design, construction, contracting, and public outreach that will be useful on future projects.

- Design—NYSDOT noted that the number, location, and orientation of signs was critical to the operation of the completed project. Several changes in the striping layout, distance from stop bars to signal heads, and wording of signs were required to increase public awareness of the new technology. Almost daily contact between the resident engineer and design staff was essential to address issues that arose.
- Contract issues—Once traffic was switched to the new configuration, more restrictions on lane closures should have been imposed on the contractor to avoid confusing the public. Although the option to completely close the facility was available, the contractor seldom used it because of the costs associated with weekend and night work.
- Public outreach—Public hearings and media attention alerted the public to the concept and operation of the facility far in advance of implementation. Design staff supplemented construction staff to monitor morning and afternoon peak periods for operational issues and police were on the scene to help if necessary, but they stayed off the roadway to avoid distracting drivers.
- Operational issues—The project was opened to traffic before sunrise. Visibility issues caused confusion until daylight.
- No advance notice was provided that turning right on red lights was no longer allowed, causing early confusion.
- NYSDOT should have coordinated with local agencies on signal timing on roads off the State system.
- The contractor closed lanes after rush hour on opening day, confusing the public. Restrictions on closures after the initial opening should have been in place to prevent additional confusion.
- It took several days for drivers to become comfortable with the operation and begin to use all lanes, allowing higher volume traffic flow.

CONCLUSIONS

NYSDOT gained valuable experience with the construction of its first DDI project on Winton Road. Success measured in terms of construction time, cost savings, and user satisfaction with the completed project will encourage future use of this technology where appropriate.

PROJECT DETAILS

BACKGROUND

The Winton Road/I-590 interchange is located in Brighton, a suburb of Rochester (see Figure 1 and Figure 2) . The existing configuration was a traditional diamond interchange constructed in the 1960's (see Figure 3 and Figure 4). The area has seen a significant increase in traffic because of the development of vacant land, including construction of the Meridian Centre office park and Jewish Community House south of the interchange.

Increased traffic volumes resulted in backups and delay on Winton Road and caused backups on the ramp legs of I-590 during peak periods. At the time of design, traffic was more than 75,000 vpd on I-590 and nearly 25,000 vpd on Winton Road south of I-590. Winton Road traffic to the north of the interchange was about 11,000 vpd. Future traffic volumes are predicted to increase by 0.8 percent per year on Winton Road and 0.73 percent on I-590. Design year traffic using these assumptions jumped to about 87,000 on I-590 and nearly 29,000 on Winton Road south of the interchange. Most of the delay associated with the existing interchange was caused by the southbound movement of traffic from I-590 to Winton Road.

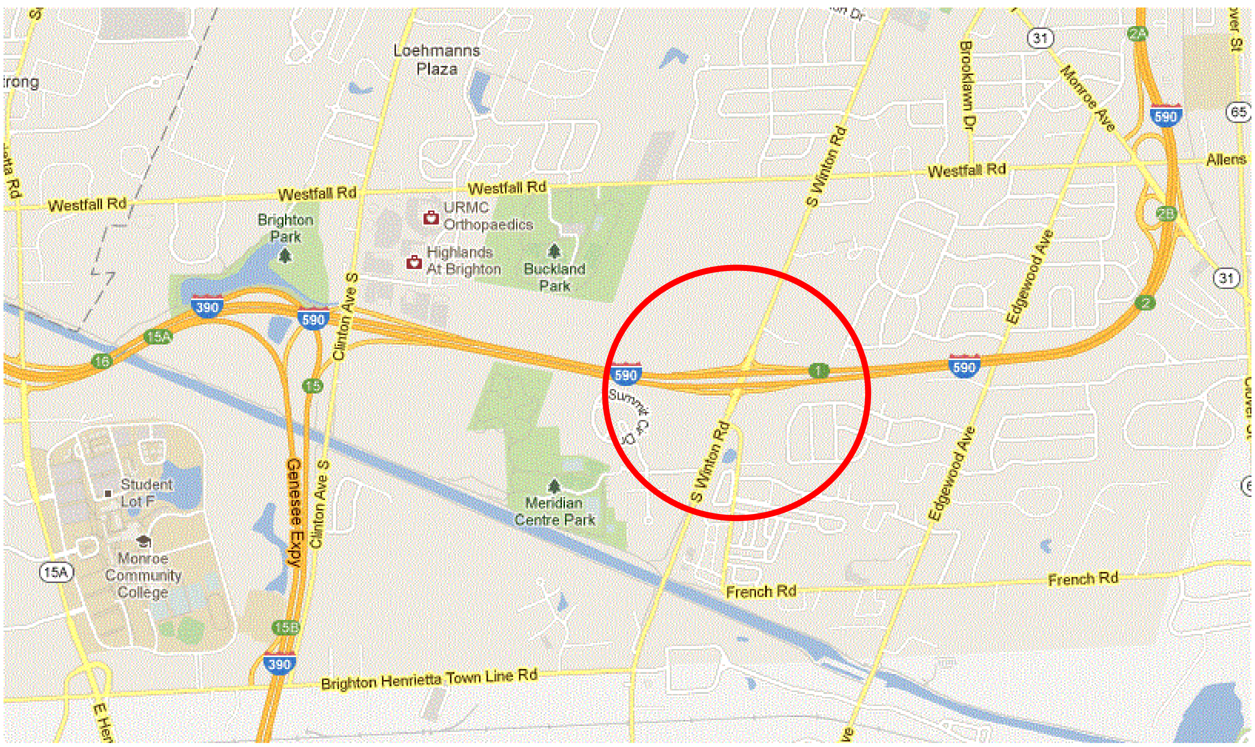

Figure 1. General location of I-590/Winton road interchange project.

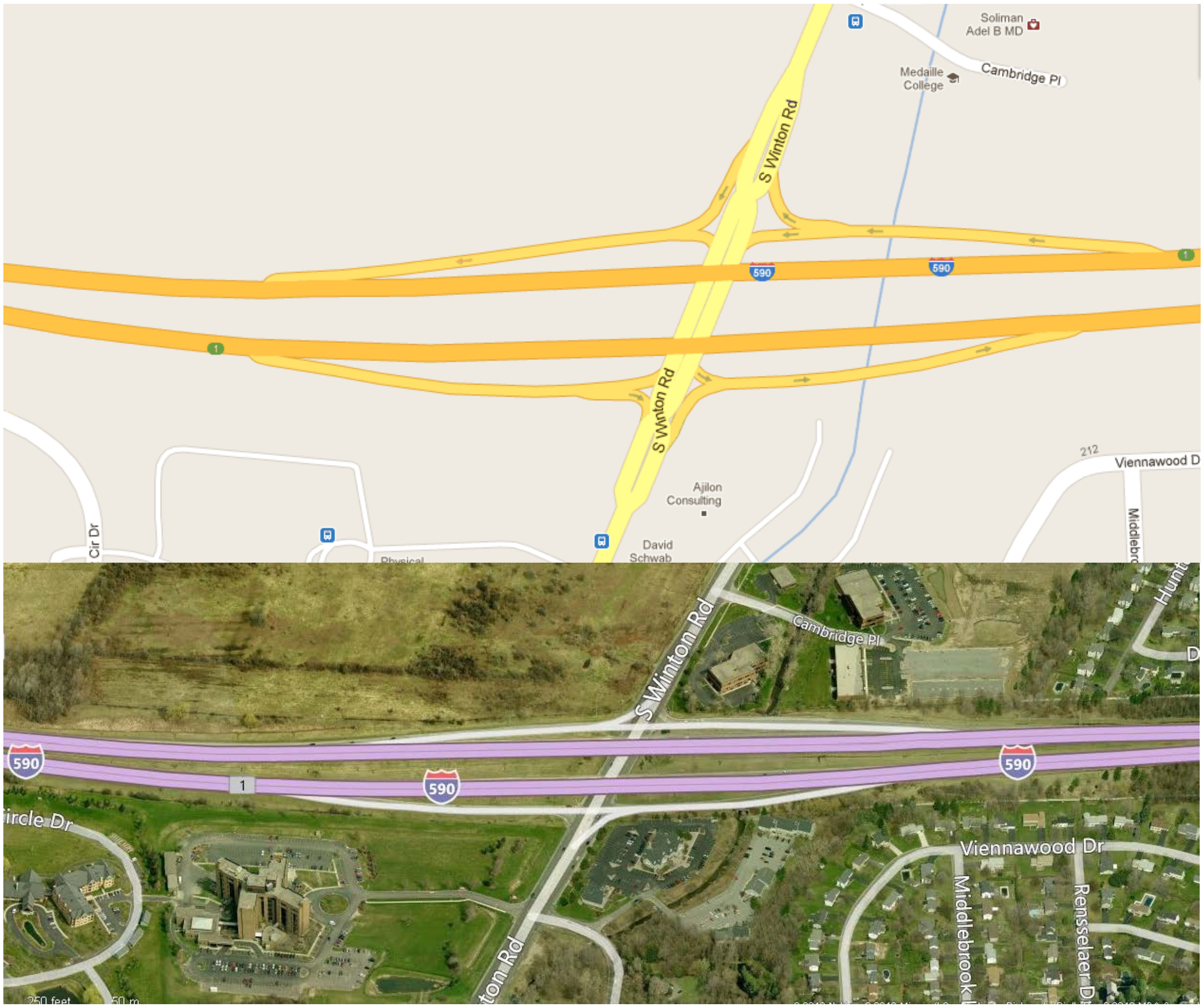

Figure 2. Closer view of project location.

Figure 3. View of Winton Road before construction from the north.

Figure 4. View of Winton Road before construction from the south.

PROJECT DESCRIPTION

The I-590/Winton Road facility had exhibited several deficiencies before construction. A 1999 corridor study identified this location as a problem area with safety and congestion issues during peak travel periods. The interchange experienced significant delays, especially during peak hours. NYSDOT had worked since 2003 to develop a plan that improves the situation while minimizing the impact on the surrounding area.

In 2008, NYSDOT evaluated prevailing mobility, safety, and environmental conditions, deficiencies, and needs in the project area and analyzed design alternatives. The study observed that the traffic congestion was worsening on the I-590 southbound off ramps in the morning peak hours and the I-590 northbound off ramps in the evening peak hours. The level of service (LOS) dropped to LOS D and LOS C during morning and evening peak hours, respectively. Maneuverability was noticeably restricted with significant reduction in travel speeds and driver comfort during the peak hours.

The northbound Winton Road traffic backed up from the interchange south over the Erie Canal to Brighton-Henrietta Town Line Road. This 0.75-mile backup resulted in many congestion-related lef-turn and rear-end crashes at the interchange. There were as many constraints as traffic problems at this interchange.

The 2008 NYSDOT study included a highway safety evaluation for the intersections and segments of I-590 and Winton Road. Crash data collected during a 3-year period (February 2006 through January 2009) indicated that 73 crashes on I-590 and 78 crashes on Winton Road occurred within the project area.[1] The congestion caused numerous left-turn and rear-end crashes at the I-590/Winton Road ramps as well as at the French Road intersection. Although the frequency of crashes was not uncommon for roadways with high traffic volumes, prevailing traffic congestion combined with several critical movements could have lead to a higher number of crashes on this facility. Therefore, the NYSDOT saw a need to address these safety problems as well.

Project Goals

Based on the deficiencies and needs discussed above, the NYSDOT developed the following goals for this project:

1. Improve the capacity at the I-590 southbound/Winton Road intersection to provide an LOS D or better for critical movements through the 20-year design period.
2. Improve the capacity at the I-590 northbound/Winton Road intersection to provide an LOS D or better for critical movements through the 20-year design period.
3. Improve the capacity of the Winton Road corridor to provide an LOS D or better for critical movements through the 20-year design period.

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[1] *I-590/Winton Road Interchange Improvement Project*, Final Design Report, New York State Department of Transportation, October 2009.

4. Improve the operation of the I-590/Winton Road interchange to reduce the potential for traffic backups onto the I-590 mainline travel lanes.
5. Improve safety by providing operational improvements throughout the corridor.
6. Improve bicyclist and pedestrian accommodations by providing bicycle space on the highway and a complete sidewalk system in compliance with Americans With Disabilities Act guidelines.
7. Advance the Region 4 information technology services strategic plan where practical.

Alternative Analysis

Eight alternatives were considered as potential solutions to the Winton Road/I-590 interchange replacement:

1. Do nothing.
2. Construct a double-left on ramp to I-590 southbound.
3. Construct new I-590 southbound exit and entrance ramps to intersect with the proposed Senator Keating Boulevard (on ramp-off ramp couple tee intersection).
4. Construct a partial cloverleaf in the northwest quadrant.
5. Reconstruct an interchange with roundabouts.
6. Construct a single-point urban interchange.
7. Construct a triple-left I-590 southbound exit ramp.
8. Construct a diverging diamond interchange (DDI).

The first option, do nothing, was not a feasible alternative because the mobility and safety risks would continue to worsen. Furthermore, the mobility and safety performance was not sustainable over the 20-year design period. Figure 5 shows the original configuration of the Winton Road interchange as a traditional diamond design. Traffic studies indicated that the majority of the delays associated with the preconstruction configuration were from both ramps from I-590 to southbound Winton Road.

Analysis of the alternatives concluded that the double-left on ramp (alterantive 2), new southbound exits (alternative 3), and roundabouts (alternative 5) offered insufficient capacity and did not address the safety issues. A single-point urban interchange (alternative 6) and triple-left exit ramp (alternative 7) were expensive, but offered no significant improvement in the LOS. A partial cloverleaf (alternative 4) and DDI (alternative 8) were the feasible alternatives. Both alternatives appeared to meet the mobility and safety requirements, but the alternative that best met the project objectives was the DDI.

The partial cloverleaf option, as shown in figure 6, included a new loop ramp to be built for traffic exiting to Winton Road southbound and the on ramp to I-590 southbound would begin at the future Senator Keating Boulevard. This would add another left-turn movement for northbound Winton Road traffic to I-590 southbound, increasing the possibility of delay and collision risks. Moreover, this option required right-of-way acquisition of 23 acres at an estimated cost of $4.75 million on a $5 million project. This posed a challenge because the land use along Winton Road is a mix of commercial and residential properties. Therefore, the right-of-way acquisition was a significant decision factor in the alternative analysis for this project.

The preferred configuration, as shown in figure 7, will result in decreased travel times through the interchange and provide fewer conflict points, which is expected to result in fewer severe crashes. A new, innovative design that had never been implemented in the area, the DDI eliminated conflict points, minimized right-of-way requirements, and reduced the time required to complete the project, providing a solution that reduced construction costs and user costs associated with construction delay.

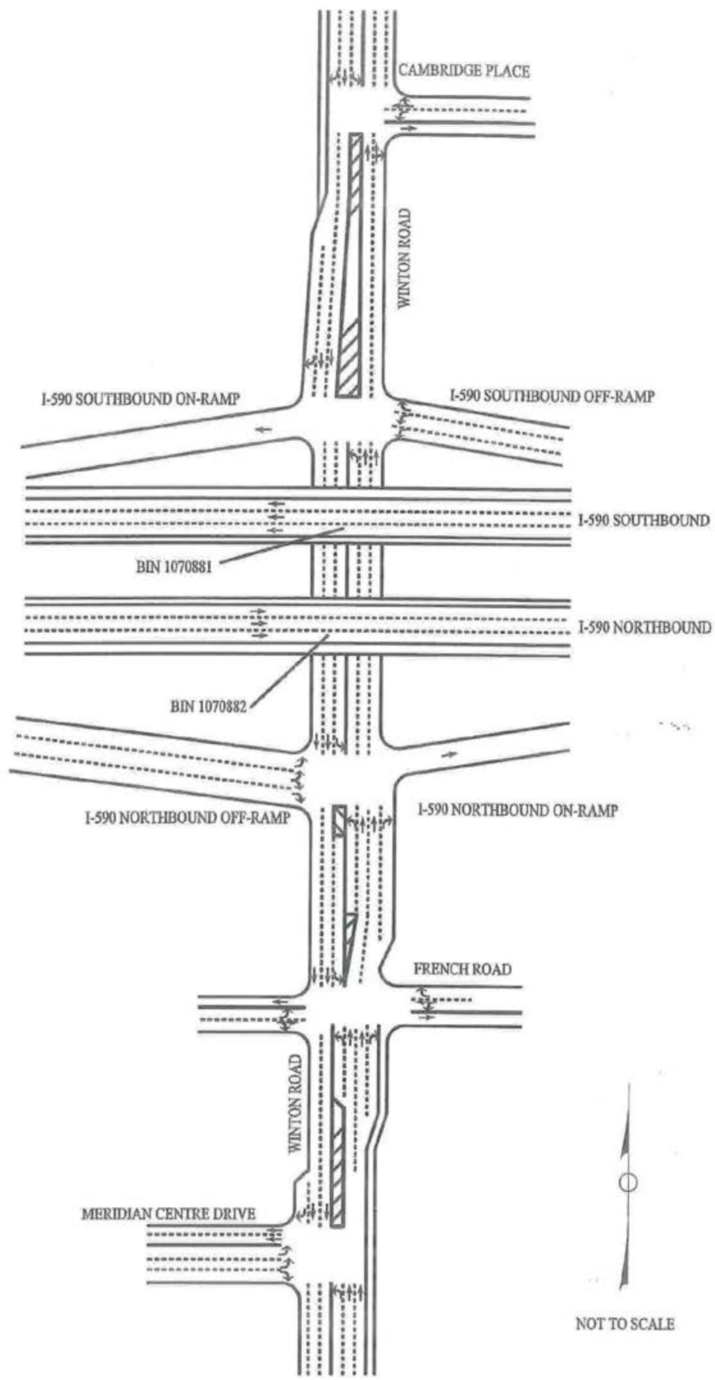


Figure 5. Existing Winton Road/I-590 interchange configuration.

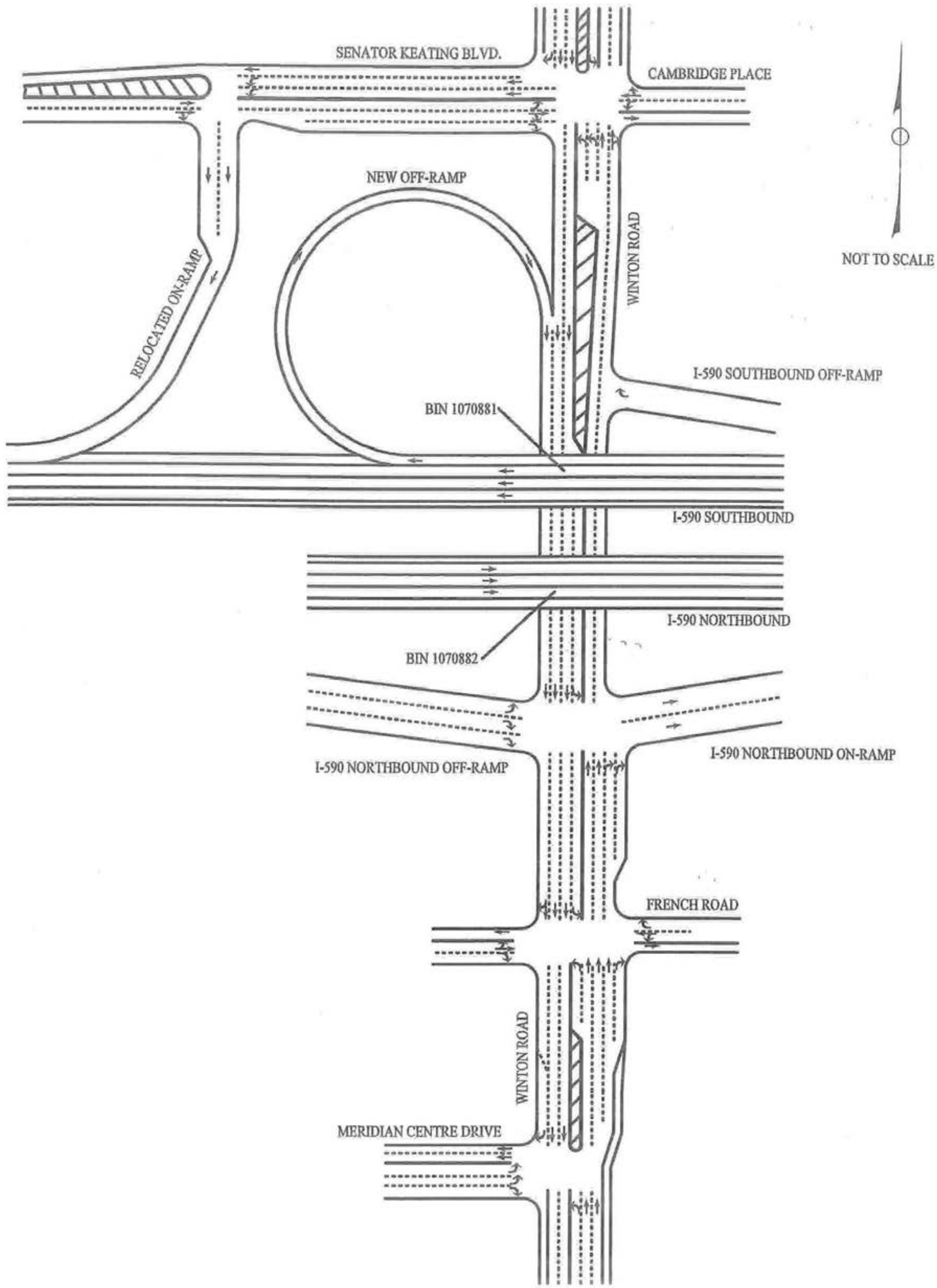


Figure 6. First alternate design (partial cloverleaf) for Winton Road/I-590 interchange.

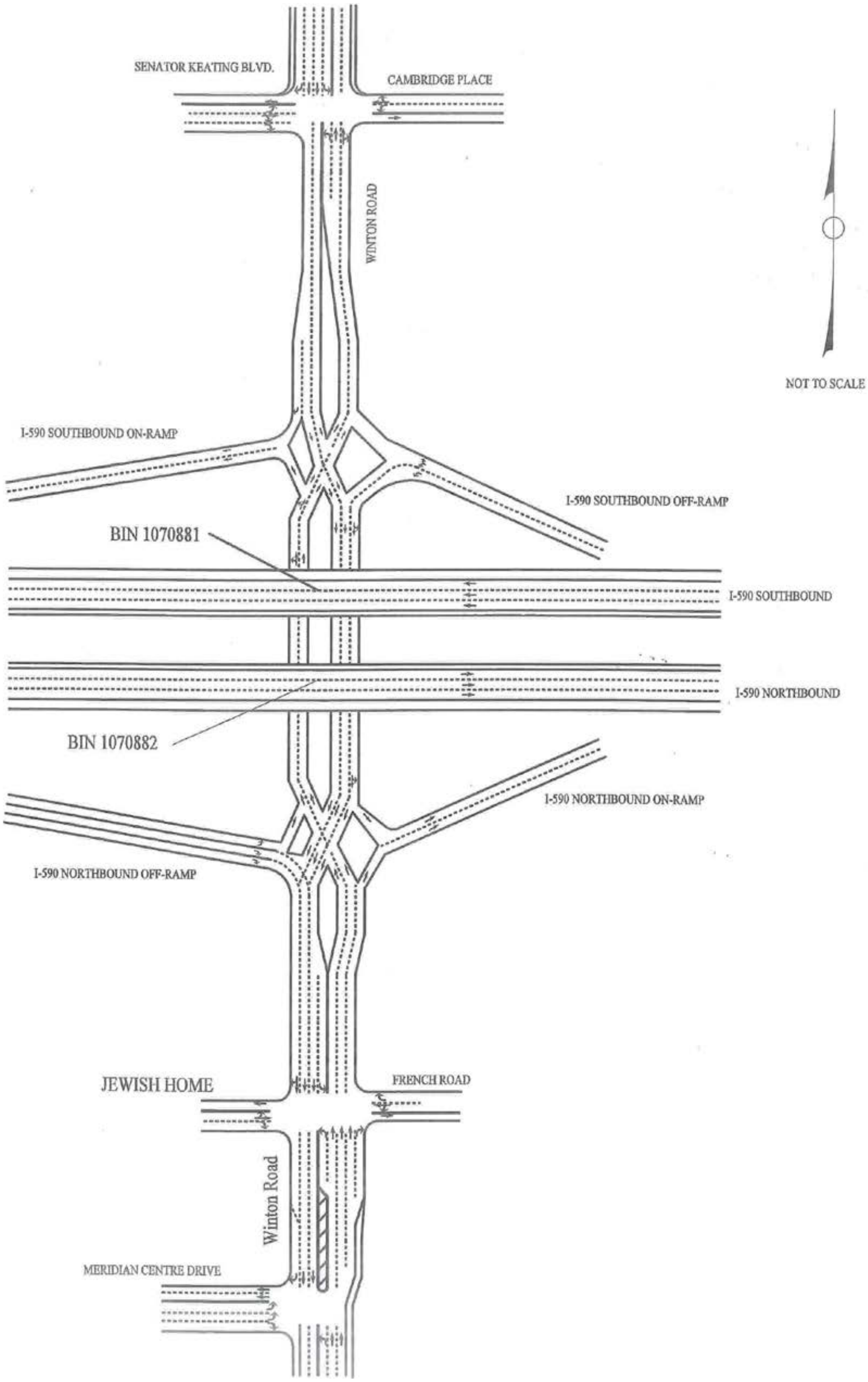


Figure 7. Diagram of diverging diamond interchange selected for construction.

PUBLIC OUTREACH

Because this was the first DDI constructed in New York State, NYSDOT put great emphasis on educating the public during preliminary planning and throughout the design and construction phases. The agency began the public outreach process as early as 2007, to educate the public on the issues and alternatives available at this location. Formal meetings began in 2008 to gather input on specific alternatives. Altogether, between 10 and 20 meetings were held with local groups, office parks and professional orginazations before the DDI alternatively was formally selected.

The agency held a another public meeting on April 19, 2012, with about 100 people attending (see Figure 8). The purpose was to educate the public in detail on the DDI concept, lay out a timeframe for construction, and build a survey pool for comments before construction and after project completion.

Figure 8. Public meeting held April 19, 2012.

At the public hearing, NYSDOT made maps and plan sheets available for review, gave a presentation on the project, and showed a virtual drive-through video. Three local television stations covered the hearing and provided NYSDOT contacts and Web site information on broadcasts.

As part of its public relations effort on the project, NYSDOT added a live camera feed to its Web site to show the construction phase (see Figure 9). The HfL grant from FHWA covered the cost of the live feed. The camera remained in place until construction was completed in November 2012.

Figure 9. Screen capture from camera on NYSDOT Web site.

DATA ACQUISITION AND ANALYSIS

Data collection and analysis on the Winton Road/I-590 interchange project consisted of acquiring and comparing data before, during, and after construction to measure progress on the HfL goals. The results provide a guide to the expected performance of the innovations in future applications in the following areas:

- Work zone and worker safety during construction
- Facility safety after project completion
- Faster construction and reduced construction congestion
- User satisfaction

SAFETY

Safety goals for HfL projects are based on worker safety during construction and traveler safety during and after project completion. The worker safety goal is set at an incident rate of 4.0 or less, based on the OSHA 300 form available from the contractor. The public safety goal is a crash rate equal to or less than the preconstruction crash rate.

No worker injuries were reported on this project, meeting the HfL goal.

Based on discussion with NYSDOT, the limits used for the safety analysis in this report were assumed to be from Brighton Henrietta Town Line Road (southern limit) to Westfall Road north of I-590, a distance of 1.48 miles. State data indicated that 214 crashes occurred within these termini during the 2-year period before construction. Of these reported incidents, two involved fatalities, 43 involved injuries, and the remaining 169 were property damage only crashes. This equates to a 3-year total crash rate of 687 crashes per 100 million vehicle-miles traveled.

During construction, 30 crashes were reported in the same analysis area. Five involved injuries, and the remaining 25 were property damage only crashes. Using the construction period of April 1 through October 30, 2012, results in a total crash rate of 495 crashes per 100 million vehicle miles traveled, meeting the HfL goal

In most cases, it can be assumed that the crash rate would increase during the time of construction. In this case, several factors may have contributed to the lower work zone crash rate. The construction period was short (7 months) and did not include the winter months, during which weather can contribute to crashes. In addition, the urban nature of this project allowed for multiple parallel routes that could divert traffic from the project area. No traffic counts were taken in the project limits or on any of the possible alternate routes during the construction period. However, a 25 percent diversion of traffic would have been required to equal the crash rate before construction. Given these factors, the impact of the project on traveler safety during construction cannot be accurately determined.

CONSTRUCTION CONGESTION AND TRAVEL TIME STUDY

The goal established by the HfL program is a reduction in construction time of at least 50 percent. A second goal is to reduce the impact of construction on traffic. As discussed previously, the most likely alternative for this location if the DDI had not been used was the partial cloverleaf configuration. It is estimated that the construction duration of the alternative would have been two construction seasons, or 360 working days. Construction of the DDI lasted only 7 months, or 180 working days, achieving the HfL goal of a 50 percent reduction in total construction time.

Traffic Study

Construction of the DDI interchange was accomplished through typical partial width construction techniques on Winton Road, with occasional full interchange closures on weekends as needed for phase changes and other construction activities. The impacts of these construction activities on mobility were evaluated through travel time studies performed the last week of July 2012. This data was compared to data previously collected to assess the DDI concept.

Data Collection

Researchers used the floating vehicle methodology to collect travel times, attempting to mimic the typical driving speed of other vehicles along the various roadway segments of the detour route. Data were collected only during daytime hours, since traffic demands were lower at night. Data were collected along South Winton Road in both directions, passing through the interchange with I-590 on some runs and making the left turn onto I-590 on others. Data were collected during weekdays (Tuesday, July 24, through Friday morning, July 27, 2012) in the a.m. peak period (6 to 9 a.m.), offpeak period (9 a.m. to 4 p.m.), and p.m. peak period (4 to 7 p.m.).

To estimate the impacts of the occasional full road closures on Winton Road at the interchange, data collection staff also collected travel times on the various detour route segments defined by NYSDOT when the full closure was in place (see Figure 10). It was hypothesized that the lower traffic demands on weekends when the closures occurred would not lead to significantly increased congestion and travel times on these routes. Instead, it would be the additional travel distance (at the typical travel speeds on those detour segments) that would create the travel time delays during the closure. Data were collected during offpeak travel hours on these routes.

Over the 4-day period, researchers collected a total of 40 travel times in each direction on Winton Road, one-half traveling through the interchange and one-half making the left turn onto I-590. Two travel time runs were also made on each of the detour segments during the offpeak periods for detour route delay computations.

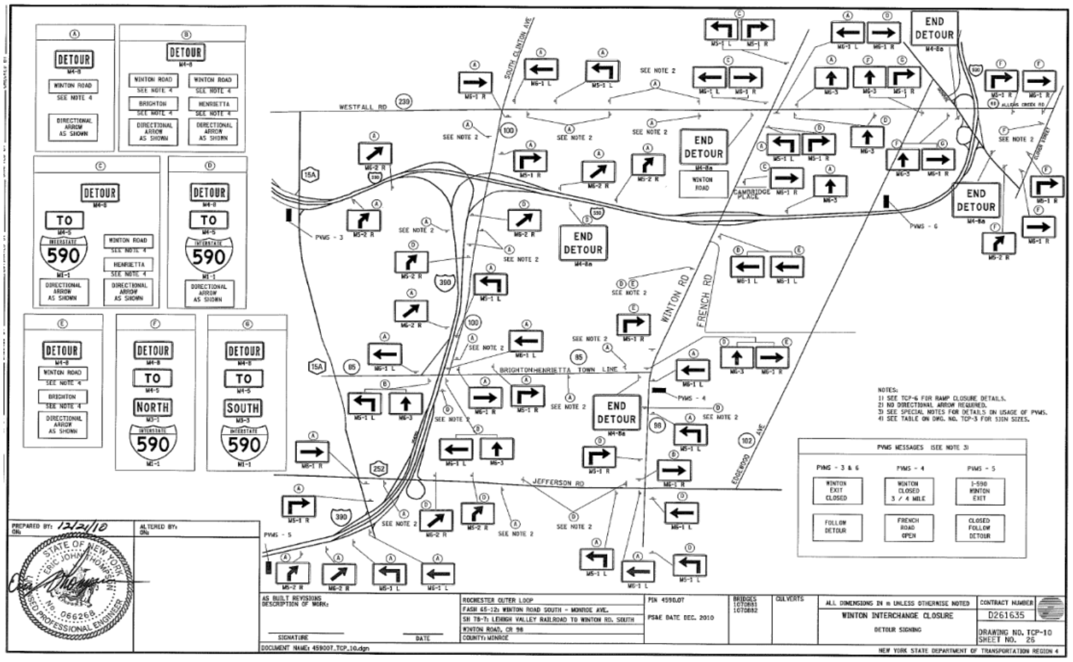


Figure 10. Detour map.

Travel Time Comparison Results

Daily Impacts on Winton Road

Table 1 compares travel conditions before and during construction of the DDI along Winton. Both overall average travel speeds for traffic passing through the interchange and remaining on Winton are presented, as well as additional intersection delays incurred by left-turning traffic attempting to enter I-590. As the table illustrates, the partial width construction technique had minimal effects on travel on Winton. The biggest changes were a 12 mi/h reduction in average speed southbound during the p.m. peak period and a 9 mi/h reduction in average speed northbound in the a.m. peak period. Over the distances evaluated, this represents an approximate 2-minute increase in travel time during these periods. Changes in average speed in the other time periods were less dramatic (and actually increased slightly in one case), resulting in less than a 1-minute increase in travel times, on average.

Table 1. Comparison of Winton Road average travel speeds.

	Before Construction (mi/h)	**During Construction (mi/h)**	**Change (mi/h)**
SB Winton			
a.m. peak	30.7	25.4	-5.3
offpeak	25.5	23.6	-1.9
p.m. peak	39.4	27.3	-12.1
NB Winton			
a.m. peak	36.2	26.8	-9.4
offpeak	N/A	21.7	N/A
p.m. peak	24.0	24.4	+0.4

Construction also had a minimal impact on left-turning traffic from Winton Road at I-590. As shown in Table 2, the average additional left-turn delay was less than 18 seconds per vehicle in both peak periods. A 40-second increase in left-turn delay was computed for the northbound to westbound left turn in the offpeak period. However, because of data collection difficulties, this value represented only one travel time measurement, so it may not fully represent typical conditions for that maneuver during that time period.

Table 2. Additional left-turn delays at I-590.

	Before Construction (sec)	**During Construction (sec)**	**Change (sec)**
NB Winton Left Turn to I-590 WB:			
a.m. peak	34	48	+14
offpeak	51	92	+41
p.m. peak	45	42	-3
SB Winton Left Turn to I-590 EB:			
a.m. peak	59	53	-6
offpeak	N/A	61	N/A
p.m. peak	58	76	+18

Previous turning movement data at the interchange suggest that about 50 to 65 percent of southbound Winton Road traffic travels through the interchange, while 30 percent turns right onto westbound I-590 and 5 to 20 percent makes the left turn onto I-590 eastbound. Northbound, only 20 to 35 percent of Winton Road traffic travels through the interchange. About 40 to 50 percent turns right onto I-590 eastbound, and 20 to 30 percent turns left onto I-590 westbound. Hourly traffic volumes for the various turning movements were not available. Therefore, assuming that the right-turning traffic from both directions onto I-590 is only minimally affected, the effects of construction on travel times per day is estimated as follows, based on an assumed Winton Road average daily traffic (ADT) of 25,000 vpd northbound and 11,000 vpd southbound:

<u>Northbound Winton Road Delay</u>

Through delays = 25,000*0.53*1.5 min/veh = 331 veh-hours/day
Added left-turn delay = 25,000*0.24*0.33 min/veh = 33 veh-hours/day

<u>Southbound Winton Road Delay</u>

Through delays = 11,000*0.69*1.5 min/veh = 190 veh-hours/day
Added left-turn delay = 11,000*0.12*0.33 min/veh = 7 veh-hours/day

Total added delays during part-width construction = 561 veh-hours/day

Notes:

1. It is assumed that the majority of the additional delays incurred by through movements at the interchange occur within the interchange, so that both through and left-turn traffic entering the interchange experience that delay.
2. Left turning traffic experiences the additional delay while turning.

3. A liberal estimate of 1.5 minutes of through delay per vehicle is assumed for both northbound and southbound Winton road traffic (given that maximum additional delays recorded were 2 minutes per vehicle, as reported above).
4. Additional left-turning delays are assumed to average a liberal 20 seconds per vehicle (based on a review of the delays per time period shown in Table 2 and the assumption that about 60 percent of traffic flow occurs in the two peak periods and 40 percent occurs during the offpeak period).
5. It is assumed that 47 percent of northbound Winton Road traffic enters I-590 eastbound per day and 31 percent of southbound Winton Road traffic enters I-590 westbound.
6. It is assumed that 24 percent of northbound Winton road traffic makes the left turn onto I-590 westbound and 12 percent of southbound Winton Road traffic turns left onto I-590 eastbound.

Impacts of Weekend Detours During Full Winton Road Interchange Closures

On weekends when the Winton Road interchanged was completely closed, additional travel times were imposed on drivers who wanted to use Winton Road but were forced to use a detour to reach their destination. An assessment of the impacts of those closures can be made by assessing additional travel times that were required to take each of the signed detour routes and comparing it to the travel time that would have been required if the interchange had been open. Seven primary routes were considered:

1. Winton Road just south of I-590 to head east on I-590 (detour to French Road, to Edgewood Avenue, to Westfall Road, to I-590 eastbound)
2. Winton Road just south of I-590 to head west on I-590 (detour to Brighton Henrietta Town Line Road, to E. Henrietta Road to I-590 westbound)
3. Winton Road just south of I-590 to head west on I-590 to I-390 southbound (detour to Jefferson Road to I-390 southbound)
4. Winton Road just north of I-590 to head east on I-590 (detour to Westfall to I-590 eastbound)
5. Winton Road just north of I-590 to head west on I-590 (detour to Westfall to E. Henrietta to I-590 westbound)
6. Winton Road just north of I-590 to head west on I-590 to I-390 southbound (detour to Westfall to E. Henrietta to I-390 southbound)
7. Winton Road just north of I-590 to Winton Road just south of I-590 (detour to Westfall to Edgewood to French to Winton).

Comparisons of primary and detour distances and travel times are in Table 3. Overall, the full closure of Winton Road would require up to an additional 3.3 miles of travel distance (three of the defined detour routes would require less than 1 additional mile of travel). Because they involve the use of arterial streets rather than the interstate, however, these six detours required between 2.6 and 10.7 minutes of additional travel time per vehicle. Detailed origin-destination data on the weekend would be required to assess the total amount of delay (in vehicle-hours) that was incurred each weekend day that the interchange was closed. Assuming that weekend ADT is about 80 percent of weekday ADT (weekend ADT data were not available), a conservative estimate of total delay per weekend day can be made by multiplying the average Winton Road

ADT south of I-590 by the average added travel times for routes 4 through 6 and the average Winton Road ADT north of I-590 by the average added travel time for routes 1 through 3 (the number of trips made on route 7 below was assumed to be negligible).

Table 3. Added travel distance and time during Winton Road interchange closures.

Route	Primary		Detour		Difference	
	Distance (mi)	Travel Time (min)	Distance (mi)	Travel Time (min)	Distance (mi)	Travel Time (min)
1	1.7	1.7	2.5	6.8	0.8	5.1
2	2.1	2.1	4.2	10.0	2.1	7.9
3	3.0	3.0	2.6	5.6	-0.4	2.6
4	1.7	1.7	1.7	4.6	0.0	2.9
5	2.1	2.1	4.0	9.6	1.9	7.5
6	3.0	3.0	5.7	13.7	2.7	10.7
7	0.2	1.0	3.5	7.2	3.3	6.2

Winton Road North of I-590:

11,000*0.8*5.2 min = 763 veh-hours/day

Winton Road South of I-590

25,000*0.8*7.0 min = 2,333 veh-hours/day

Total per day of Winton Road interchange closure = 3,096 veh-hours/day

QUALITY

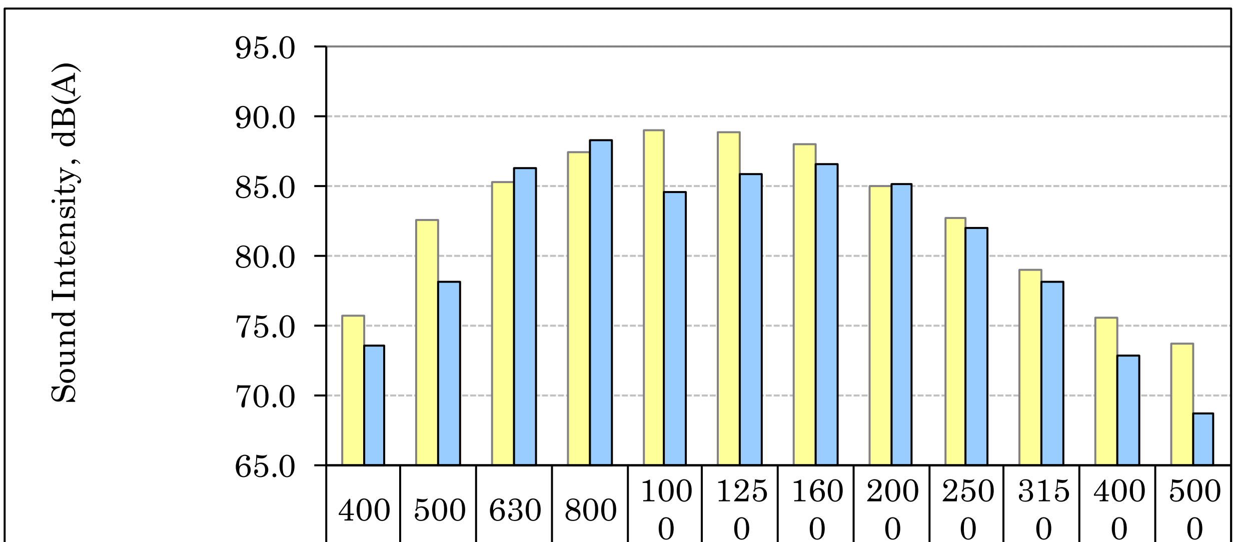
Sound Intensity Testing

Sound intensity (SI) measurements were made using the current OBSI technique AASHTO TP 76-08, which uses dual vertical sound intensity probes and an ASTM-recommended standard reference test tire (SRTT). The sound measurements were recorded and analyzed using an onboard computer and data collection system. A minimum of five runs were made at highway speed in the right wheel path of the mainline lanes and the ramp. The two microphone probes simultaneously captured noise data from the leading and trailing tire-pavement contact areas. Figure 11 shows the dual-probe instrumentation and the tread pattern of the SRTT.

The average of the front and rear SI values was computed to produce SI values. Raw noise data were normalized for the ambient air temperature and barometric pressure at the time of testing. The resulting mean sound intensity levels were A-weighted to produce the noise-frequency spectra in one-third octave bands, shown in Figure 12.

Sound levels were calculated by using logarithmic addition of the one-third octave band frequencies between 315 and 4,000 hertz (Hz). The initial measurements of noise before construction averaged 95.9 dB(A) in both directions of travel. The postconstruction measurement averaged 94.6 dB(A), a reduction of 1.3 dB(A) and below the HfL goal of 96 dB(A). In an urban setting with a relatively low operating speed of around 40 mi/h, the pavement noise component is considered acceptable.

Figure 11. OBSI dual-probe system and the SRTT.



	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
Preconstruction	75.7	82.6	85.3	87.4	89.0	88.8	87.9	85.0	82.6	79.0	75.5	73.7
Postconstruction	73.6	78.1	86.3	88.3	84.6	85.8	86.6	85.1	82.1	78.1	72.8	68.6

Figure 12. Mean A-weighted sound intensity frequency spectra.

Smoothness Measurement

Smoothness testing, required by HfL as a quality indicator, was performed following the ASTM E 950 method in conjunction with noise testing for the original and the newly reconstructed ramp pavement using a high-speed inertial profiler built into the noise test vehicle. A similar vehicle with an identical onboard data collection system was used to test the newly reconstructed ramp and mainline pavements. Figure 13 shows the test vehicle with the profiler positioned in line with the right rear wheel.

Figure 13. High-speed inertial profiler mounted behind the test vehicle.

Smoothness, measured by IRI, was initially measured at 91 inches per mile in the northbound direction and 113 southbound. Postconstruction IRI measured 77 inches per mile northbound and 86 inches per miles southbound, above the HfL goal of 48 inches per mile. While the HfL goal was not met, this is an urban setting with relatively low operating speeds and several traffic signals. The measured IRI should provide adequate smoothness for the traveling public. A summary of the smoothness results are shown in Figure 14 and Figure 15.

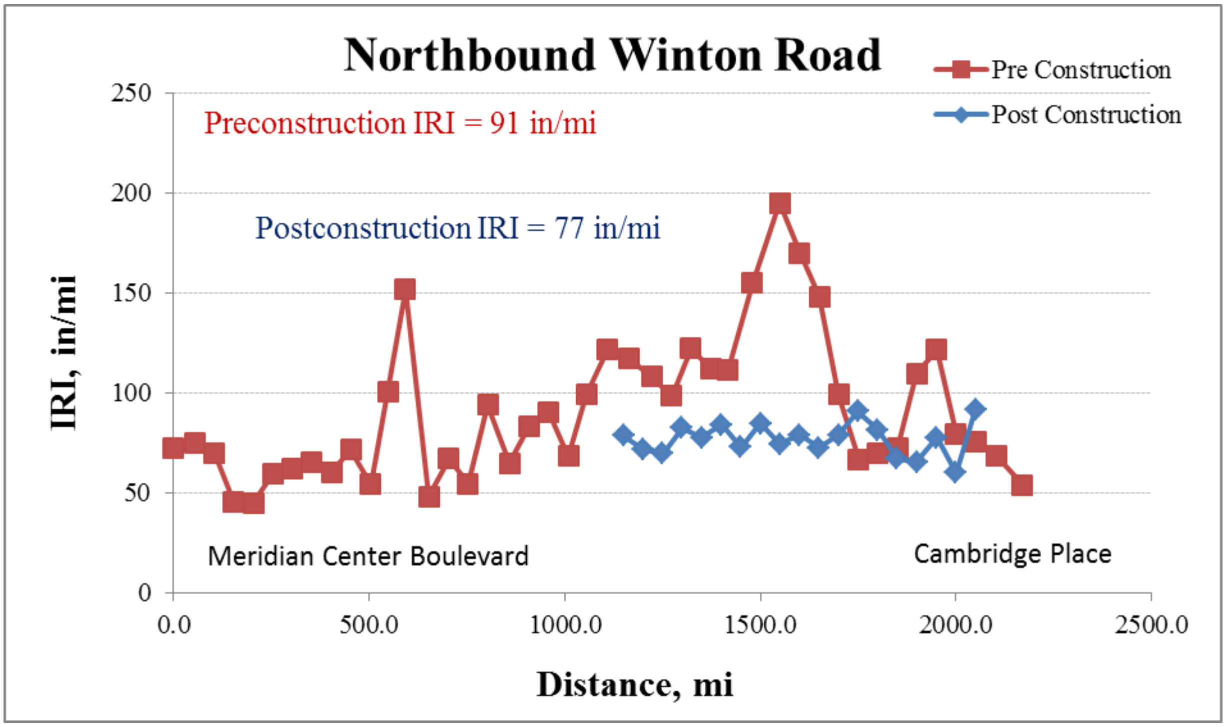


Figure 14. Summary of northbound IRI.

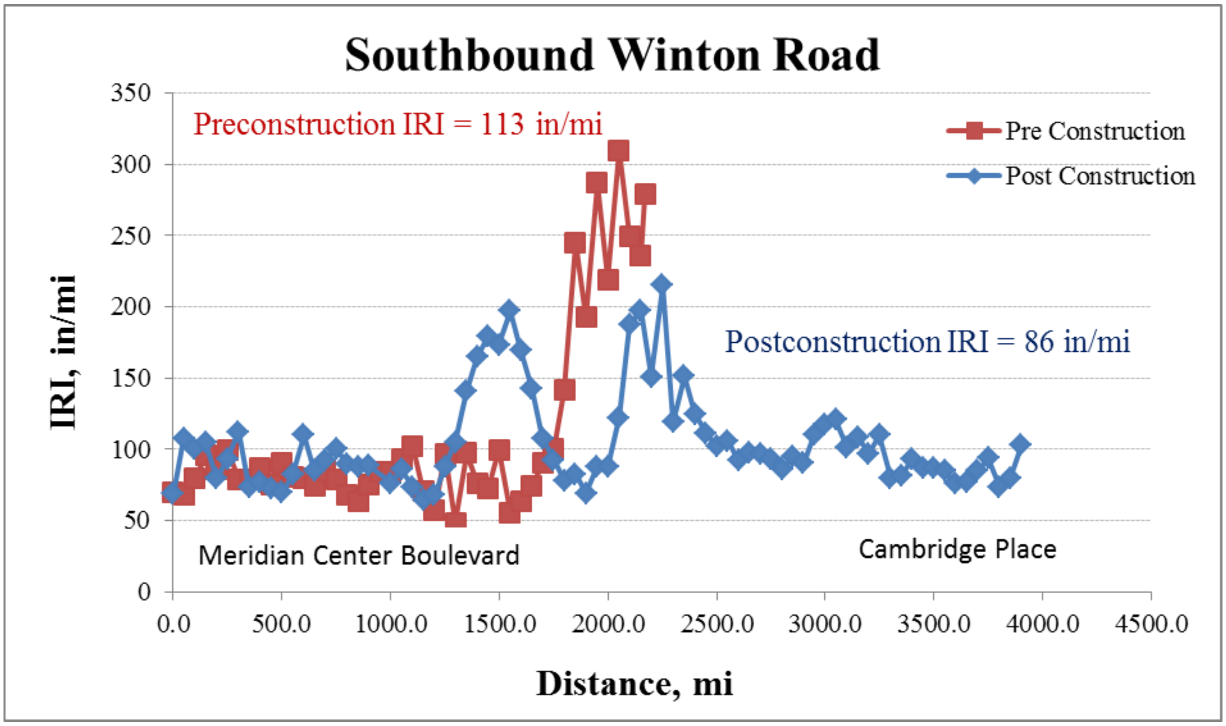


Figure 15. Summary of southbound IRI.

ECONOMIC ANALYSIS

A major component of the HfL program is quantifying the monetary value of the selected innovation compared to the most likely traditional method the highway agency uses. This analysis includes several items, such as the base construction and design costs, the user cost associated with delays and detours, and the safety value of reduced crashes associated with reduced construction time or other innovative safety features. In this case, NYSDOT supplied most of the data.

CONSTRUCTION TIME

The most likely alternative to the DDI would have been the partial cloverleaf interchange shown in figure 6. It is estimated that the construction of this alternative would have involved two full construction seasons and would have affected traffic on both Winton Road and I-590 because of the need to replace or expand the bridge structures on I-590. The ability to construct the DDI within the existing footprint without impacting I-590 traffic directly resulted in a total construction time of only 7 months.

CONSTRUCTION COSTS

Table 4 compares the results of the costs associated with construction of the HfL innovation and the traditional NYSDOT alternative. Costs shown for the as-built project are taken from bid documents, while costs for the alternative are based on scoping estimates used during project development.

The construction of the DDI resulted in a cost savings of $4.9 million when compared to the baseline (partial cloverleaf) scenario.

Table 4. Capital cost comparison.

Category	Baseline Cost (Partial Cloverleaf	As-Built Cost (DDI)
Design and Engineering	0.75 *	0.5
Right-of-Way Acquisition	4.7	0.2
Utilities	2.0	1.2
Roadway Construction	5.0	5.6
Construction Inspection	0.45	0.5
Total	12.9	8.0

*Estimated at 15 percent of construction cost

The roadway construction estimate for the traditional solution is shown as slightly greater than the DDI estimate. This is because of two factors. The original estimate was developed almost 7 years before the design of the DDI and was not updated after the as-built scenario was selected. Work along the roadway was added to the DDI design that was not included in the original scope of design.

USER COSTS

Three categories of user costs are normally used in an economic and life-cycle cost analysis: vehicle operating costs (VOC), delay costs, and safety-related costs. The delay and safety costs are included in a comparative analysis of cost differences between the baseline and as-built alternatives.

Delay Costs

The impact on traffic of the baseline alternative is based on the construction of a partial cloverleaf design, using traditional contracting and construction methods. It is estimated that nearly $1.9 million was saved as a result of accelerating the construction to only a single season and limiting road closures to a few weekends. These savings were calculated using the following assumptions:

The volume of trucks on Winton Road south of I-590 is about 13.8 percent. North of the interstate, it is about 17 percent. Based on traffic volume, the weighted average of commercial traffic is about 15 percent.

As concluded in the "Traffic Study" section of this report, 561 vehicle-hours of delay per day occurred during periods of partial-width construction. About 3,096 vehicle-hours of delay per day were calculated for periods of weekend road closure.

For work zone cost comparison, NYSDOT uses a cost of $15.41 an hour for private vehicles and $35.28 an hour for commercial traffic. VOC costs are estimated using $0.205 per mile for private vehicles and $0.840 per mile for commercial vehicles.

NYSDOT estimates that an average construction year has 180 working days. This is based on working 6 days per week from April 1 through October 31, or 30 weeks. The baseline scenario was estimated at 2 construction years, or 360 working days. Construction time for the DDI was one season, or 180 days, resulting in a time savings of 180 days.

NYSDOT indicated that the days of total closure for the baseline scenario would have been about the same as required for construction of the DDI, with closure required only for the setting of beams for the bridge widening.

No effort has been made to include the cost of delay on I-590 under the baseline scenario. While not included in the scope of this report, these costs would have been substantial, given the much higher volume (75,000 vpd) on the interstate, adding even more value to the alternative selected.

If the closure days are assumed to be the same for both the baseline and as-built alternatives, the user cost is the cost per day for partial closure multiplied by the difference in the total construction duration, or 180 days.
For private vehicles: Vehicle hours of delay/day*percent personal vehicles*hourly cost*construction time savings = 561vehicle hours of delay/day*85 percent personal vehicles*$15.41/hour*180 days = $1,322,686.

For commercial vehicles: Vehicle hours of delay/day*percent commercial vehicles*hourly cost*construction time savings = 561vehicle hours of delay/day*15 percent personal vehicles*$35.28/hour*180 days = $534,386.

The total delay cost savings is the sum of the private and commercial costs, or $1,857,072.

Safety Costs

The crash rates calculated for the construction period were significantly less than the 3-year period before construction. Given that the shorter construction time eliminated impacts on traffic during the winter, when inclement weather could be expected to increase driving hazards, and the lack of data on possible traffic diversions, it is safe to assume that construction of the project had no net safety impact on the public.

Given the data available, it is assumed that no safety costs or savings resulted from construction of the DDI can be accurately determined.

COST SUMMARY

Construction costs for the Winton Road improvement totaled about $8 million, about $4.9 million less than the traditional alternative. The greatest component of this savings was in right-of-way acquisition, at $4.5 million. While not a direct capital cost, the implementation of the DDI resulted in a savings to the public of nearly $1.9 million in delay costs because it enabled NYSDOT to deliver the completed project in half the time estimated for the partial cloverleaf alternative.