FINAL REPORT

Signal Operations
90th Street and Blondo Street

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In Association With:

Consor Engineers, LLC

FHU Reference No. 121062-03

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Executive Summary

Felsburg Holt & Ullevig (FHU) and Consor Engineers, LLC (Consor) have completed traffic signal retiming efforts for the 90th Street and Blondo Street Traffic Signal Operations project of the Omaha Signal System Master Plan. Elements of this task included Project Administration, Data Collection, Optimization, Implementation, Performance Evaluation, and Safety Analysis.

The project included 40 signalized intersections: 39 signals along four corridors and one isolated intersection. Each corridor is described below. The intersection of 144th Street & Blondo Street was retimed concurrently with this project and was included in the travel time runs along Blondo Street.

- Blondo Street – 141st Avenue to Benson Gardens Boulevard
- 90th Street – Burt Street to Military Road
- 120th Street – Burke Street to Stonegate Street
- Maple Street – 97th Street to 72nd Street

Network Performance Evaluation

The existing conditions Synchro model was used as a benchmark by which the implemented conditions could be compared. Network performance measures including total delay, total stops, total travel time, and fuel consumed were analyzed and are summarized in **Table ES.1**. These performance measures are calculated, not field measured, and reflect data for all vehicles in the network.

Table ES.1 Network Performance Measures – Total

	AM Peak			PM Peak		
	Ex	Imp	Dif	Ex	Imp	Dif
Total Delay (hr)	322	323	0.3%	770	739	-4.0%
Total Stops (#)	30,933	27,919	-9.7%	49,771	48,265	-3.0%
Total Travel Time (hr)	897	898	0.1%	1,590	1,558	-2.0%
Fuel Consumed (gal)	1,348	1,317	-2.3%	2,195	2,154	-1.9%
	MD Peak			Off Peak		
	Ex	Imp	Dif	Ex	Imp	Dif
Total Delay (hr)	286	278	-2.8%	227	215	-5.3%
Total Stops (#)	30,540	28,029	-8.2%	25,923	24,004	-7.4%
Total Travel Time (hr)	847	838	-1.1%	717	705	-1.7%
Fuel Consumed (gal)	1,291	1,260	-2.4%	1,108	1,080	-2.5%

Corridor Performance Evaluation

Field measured performance metrics were recorded with Tru-Traffic (v10) software and a direct connect GPS receiver. Travel time runs were conducted in late August and early September 2023 before new timings were implemented and after fine tuning was complete in October 2023 to document improvements for vehicles travelling along the Blondo Street and 90th Street corridors. Maximum corridor benefits are summarized in **Table ES.2** for Blondo Street between 144th Street and Benson Gardens Boulevard and for 90th Street between Military Road and Burt Street

Table ES.2 Maximum Corridor Benefits

Blondo St	Eastbound	Westbound
Travel Time Reduction (min:sec)	2:15	1:37
Percent Delay Reduction	65%	61%
Percent Stops Reduction	65%	63%
90th St	**Northbound**	**Southbound**
Travel Time Reduction (min:sec)	1:17	1:06
Percent Delay Reduction	70%	69%
Percent Stops Reduction	50%	91%

Benefit Cost Analysis (Timing)

The City has developed a methodology, in-line with national industry standards, to calculate the monetary value of each benefit. Based on this methodology, the monetary benefit of this project over the next five years is anticipated to be $10,198,935. A breakdown of the project benefits over the next five years is shown in **Table ES.3**. The cost to complete this project will not exceed $214,682.74, yielding a benefit/cost ratio of at least 48:1.

Table ES.3 Project Benefits Over 5 Years

Performance Measure	Project Benefit	Present Value
Delay Reduction	154,034 hours	$4,328,293
Fuel Consumption Reduction	393,058 gallons	$1,297,479
Emissions Reduction	3,506 tons	$263,790
Crash Reduction	57 crashes	$4,309,373
Total Project Benefit		**$10,198,935**
Benefit:Cost Ratio		**48:1**

Long Term Safety and Operational Recommendations

The City of Omaha (the City) identified four locations to conduct a detailed safety evaluation based on crash history and operational performance. Long-term safety and operational improvements have been developed to mitigate crash patterns and improve traffic operations. The City provided crash data for review which was used to identify crash patterns by location, type, and severity, and to calculate the benefit/cost ratio for various improvements.

At the intersection of 120th Street & Q Street, the project would add overhead gantry signage to alert drivers of lane use adjustments in the eastbound and southbound directions. It would also widen Q Street west of the intersection to remove access to 122nd Street, provide more storage for the eastbound left-turn, extend the raised median, and create a westbound left-turn lane onto Magnolia Street to enter the neighborhood.

At the intersection of 60th Street & Center Street, two alternatives were identified.

- The Alternative A project would add dual westbound left-turn lanes, extend the northbound left-turn lane, add overhead gantry signage to notify drivers of the right-turn lane reassignment, and remove several access points adjacent to the intersection. Raised medians would be constructed along Center Street, as well as an eastbound right-turn lane.

- The Alternative B project would add dual northbound left-turn lanes, add overhead gantry signage to notify drivers of the right-turn lane reassignment, and remove several access points adjacent to the intersection. Raised medians would be constructed along Center Street, as well as an eastbound right-turn lane.

At the intersection of 90th Street & Blondo Street, the project would add crosswalks and auxiliary right-turn lanes on all approaches and restrict access to Parker Street by extending the raised median on the south approach. Additionally, the furthest west access point to the property on the northeast corner of the intersection will be removed.

At the intersection of 90th Street & Fort Street, the project would add crosswalks at all approaches, provide positive offset for all left-turn lanes, and add auxiliary right-turn lanes on the eastbound and southbound approaches.

A benefit-cost analysis (BCA) was completed for each of the proposed improvements. The BCA was completed based on the lifespan of the project, assuming an improvement life period and construction costs for each project. In general, projects with a B/C ratio of 1.0 or greater have larger benefits than costs over the analysis time period.

- 120th Street & Q Street – Anticipated B/C of 2.60
- 60th Street & Center Street (Alternative A) – Anticipated B/C of 4.52
- 60th Street & Center Street (Alternative B) – Anticipated B/C of 4.01
- 90th Street & Blondo Street – Anticipated B/C of 7.74
- 90th Street & Fort Street – Anticipated B/C of 4.71

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1. Introduction

1.1 Project Background

Felsburg Holt & Ullevig (FHU) and Consor Engineers, LLC (Consor) have completed traffic signal retiming efforts for the 90th Street and Blondo Street Traffic Signal Operations project of the Omaha Signal System Master Plan. Elements of this task included Project Administration, Data Collection, Optimization, Implementation, Performance Evaluation, and Safety Analysis. This report is formatted with a chapter for each of these tasks and Appendices with supporting technical information.

1.2 Signal Locations

Forty signalized intersections were included in this retiming effort. The list of project intersections can be found in **Table 1.1.** A map illustrating the location of the study intersections is provided in **Figure 1.1.**

Blondo Street – 141st Avenue to Benson Gardens Boulevard

The Blondo Street corridor from 141st Avenue to Benson Gardens Boulevard includes 15 signalized intersections. The posted speed limit along the roadway decreases in 5 miles per hour (MPH) increments from 45 MPH to 35 MPH from west to east. The roadway has several cross-sections that fit the changing environment along the roadway. The following cross-section were identified along the corridor:

- 141st Avenue – Papillion Parkway: four-lane divided
- Papillion Parkway – 102nd Street: five-lane with a two-way left-turn lane (TWLTL)
- 102nd Street – 90th Street: four-lane undivided
- 90th Street – Keystone Drive: five-lane with a TWLTL
- Keystone Drive – Roberston Drive: four-lane Undivided
- Robertson Drive – Benson Gardens Boulevard: five-lane with a TWLTL

The intersection of 144th Street & Blondo Street was retimed concurrently with this project by HDR. FHU worked with HDR to ensure optimal coordination was achieved for both the 144th Street and Blondo Street corridors. Travel time runs along Blondo Street for this project included the 144th Street intersection.

90th Street – Burt Street to Military Road

The 90th Street corridor from Burt Street to Military Road is a four-lane divided cross-section with exclusive left-turn lanes at major access points. The study area includes 11 signalized intersections along 90th Street with a posted speed limit along the corridor of 40 MPH.

120th Street – Burke Street to Stonegate Street

The 120th Street corridor from Burke Street to Stonegate Street is generally a five-lane cross-section with a TWLTL. At several locations near major intersections, the cross-section transitions to four-lane divided with exclusive left-turn lanes. The study area includes seven signalized intersections along 120th Street. The posted speed limit along the corridor is 40 MPH.

Maple Street – 97th Street to 72nd Street

The Maple Street corridor from 97th Street to 72nd Street is generally a four-lane divided cross-section with exclusive left-turn lanes at major access points. The study area includes 8 signalized intersections along Maple Street with a posted speed limit along the corridor of 40 MPH.

Table 1.1 Intersection List

Signal ID	Intersection	Signal ID	Intersection
671	141st Ave & Blondo St	798	120th St & Stonegate St
972	135th St & Blondo St	776	120th St & Miami St
696	132nd St & Blondo St	670	120th St & Miracle Hills Dr
843	123rd St & Blondo St	612	120th St & Webster St
557	120th St & Blondo St	567	120th St & West Dodge Rd
856	117th St & Blondo St	558	120th St & Burke St
824	Papillion Pkwy & Blondo St	938	115th St & Miracle Hills Dr
548	111th St & Blondo St	521	97th St & Maple St
536	108th St & Blondo St	513	93rd St & Maple St
527	102nd St & Blondo St	495	88th St & Maple St
520	97th St & Blondo St	48	Keystone St & Maple St
377	96th St & Blondo St	474	83rd St & Maple St
497	90th St & Blondo St	468	78th St & Maple St
492	85th St / 88th St & Blondo St	460	75th St & Maple St
3	Benson Gardens Blvd & Blondo St	450	72nd St & Maple St
710	90th St & Military Rd		
500	90th St & Ellison St		
501	90th St & Fort St		
498	90th St & Boyd St / Taylor		
504	90th St & Maplewood St		
645	90th St & Maple Village St		
503	90th St & Maple St		
505	90th St & Ohio St		
511	90th St & Western St		
499	90th St & Burt St		

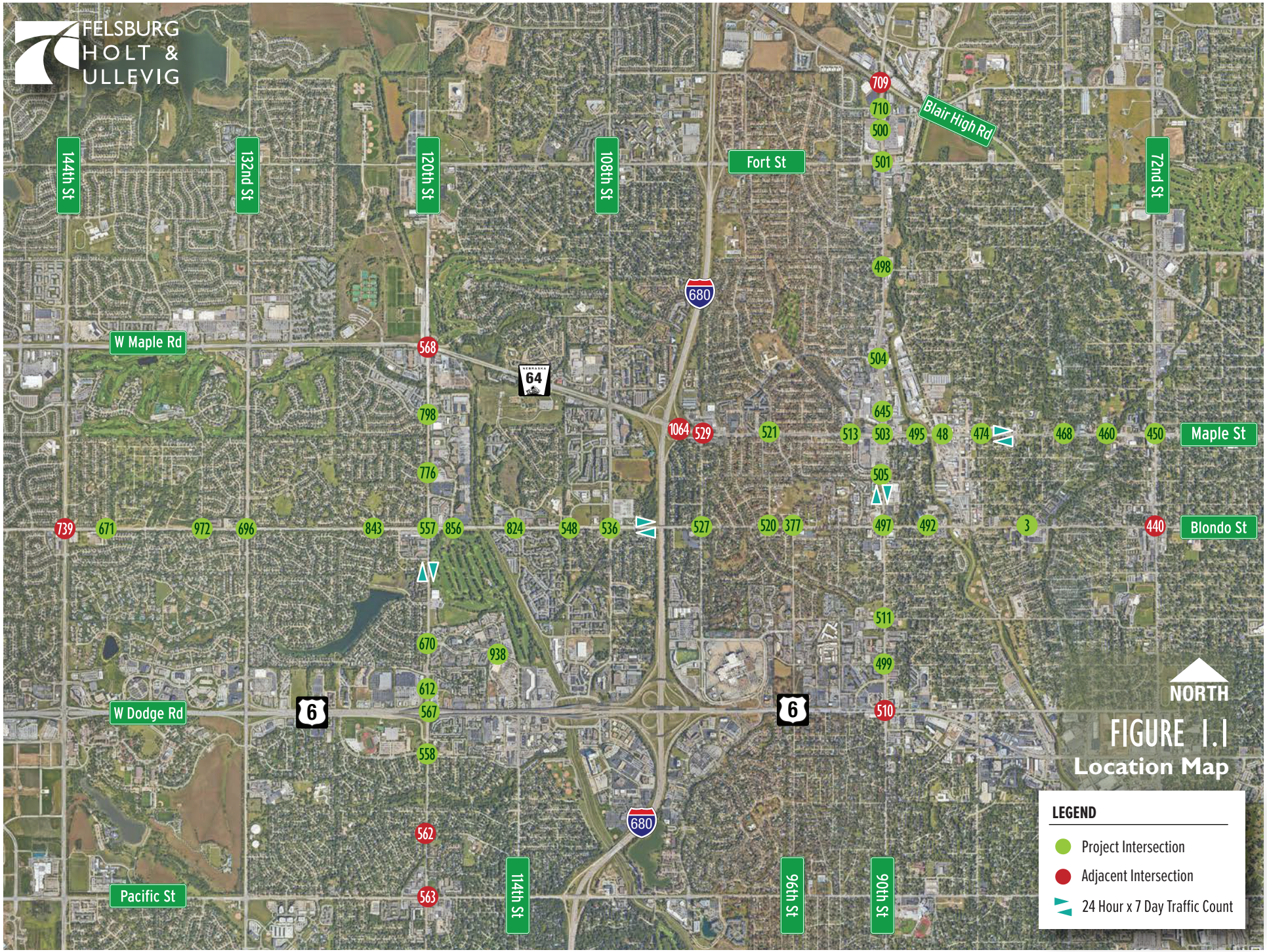

FIGURE 1.1
Location Map

2. Project Administration

2.1 Project Team

The project team guided the study through completion and included representatives from the City of Omaha, Nebraska Department of Transportation (NDOT), FHU, and Consor:

Representative	Organization
Nick Gordon	City of Omaha
Bryan Guy	City of Omaha (City Project Manager)
Mark Horak	City of Omaha
Juan Pizano	City of Omaha
Jeff Riesselman	City of Omaha (City Traffic Engineer)
Garret Schram	City of Omaha
Jenna Habegger	NDOT
Kevin Vrchoticky	NDOT
David Andersen	Felsburg Holt & Ullevig (Project Manager)
Colten Daake	Felsburg Holt & Ullevig
Philip Dunham	Felsburg Holt & Ullevig
Kornel Gwiazdowski	Felsburg Holt & Ullevig
Tom Loseke	Felsburg Holt & Ullevig
Molly Mayer	Felsburg Holt & Ullevig
Mark Meisinger	Felsburg Holt & Ullevig (Principal in Charge)
Peyton Weiss	Felsburg Holt & Ullevig
Diana McHale	Consor
Yaa Osafo	Consor
George Shakil	Consor

2.2 Project Meetings

A series of project meetings were conducted throughout the study as listed below. A project kick-off meeting with the City of Omaha (the City) and consultants was held on April 3, 2023, to provide an overview of goals and expectations for the 90th & Blondo Street project. Subsequently, progress meetings were held to further refine the project and the development of timing plans. The pre-implementation meeting was held on August 8 to discuss the proposed timings in detail. **Appendix A** includes meeting minutes from each of the following meetings:

- Kickoff Meeting – April 3, 2023
- Progress Meeting – May 31, 2023
- Progress Meeting – June 27, 2023
- Progress Meeting – July 18, 2023
- Pre-Implementation Meeting – August 8, 2023
- Progress Meeting – November 8, 2023

3. Data Collection

3.1 Lane Configurations

Lane configuration data was provided by the City and reviewed by FHU. The City-provided Synchro files were updated as needed to match existing conditions. Geometric characteristics were updated based on information from as-builts, field observations, and online data sources such as Google Earth and Bing Maps.

3.2 24-hour x 7-day Counts

Four seven-day bidirectional segment counts were conducted by All Traffic Data Services, LLC (ATD) from April 22 – 28, 2023. Segment counts collect data for 24-hours each day to provide insight into the traffic patterns of a corridor. The data is primarily used to assist in developing day plan schedules but can also illustrate unexpected peaks of traffic. **Table 3.1** summarizes daily count information and identifies the hour with the largest flow rate for each design period. **Figure 3.1** through **Figure 3.4** illustrate hourly bidirectional volumes by day of the week. Detailed segment count data can be found in **Appendix B**. The counts were completed at the following locations:

- Blondo Street east of 106th Street
- 90th Street south of Ohio Street
- 120th Street south of Franklin Street
- Maple Street east of 83rd Street

Table 3.1 Bidirectional Segment Count Summaries

Blondo St	Period	Weekday	Saturday	Sunday	MD Peak	AM Peak	PM Peak	Offpeak
	Time	Daily	Daily	Daily	12:00 PM	7:30 AM	4:30 PM	6:30 PM
	Total (Veh)	25,700	19,500	17,200	1,620	2,090	2,540	1,440
	EB (Veh)	12,300	9,400	8,400	770	1,190	1,080	650
	WB (Veh)	13,500	10,100	8,700	850	890	1,460	790
90th St	Period	Weekday	Saturday	Sunday	MD Peak	AM Peak	PM Peak	Offpeak
	Time	Daily	Daily	Daily	2:00 PM	7:30 AM	4:15 PM	6:30 PM
	Total (Veh)	23,000	19,900	16,800	1,550	1,470	2,040	1,370
	NB (Veh)	12,500	11,100	9,300	870	580	1,180	800
	SB (Veh)	10,500	8,900	7,600	690	890	860	570
120th St	Period	Weekday	Saturday	Sunday	MD Peak	AM Peak	PM Peak	Offpeak
	Time	Daily	Daily	Daily	12:00 PM	7:15 AM	4:30 PM	6:30 PM
	Total (Veh)	24,100	19,200	16,900	1,700	1,830	2,290	1,380
	NB (Veh)	12,000	9,900	9,100	830	710	1,300	720
	SB (Veh)	12,200	9,300	7,800	860	1,110	990	670
Maple St	Period	Weekday	Saturday	Sunday	MD Peak	AM Peak	PM Peak	Offpeak
	Time	Daily	Daily	Daily	2:00 PM	7:15 AM	4:30 PM	6:30 PM
	Total (Veh)	23,200	21,100	17,300	1,430	1,580	2,020	1,330
	EB (Veh)	12,400	11,700	9,300	770	810	1,120	760
	WB (Veh)	10,800	9,500	8,000	670	780	900	570

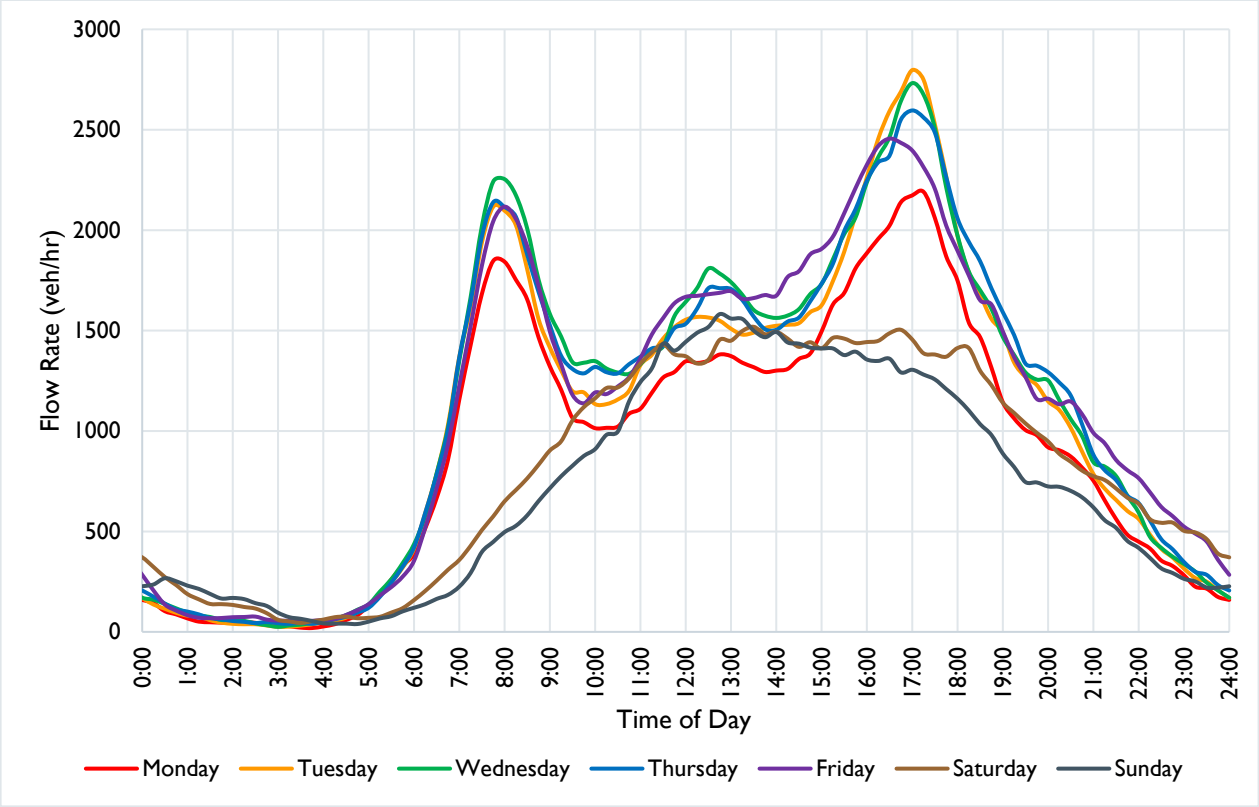

Figure 3.1 Blondo St Hourly Bidirectional Volumes

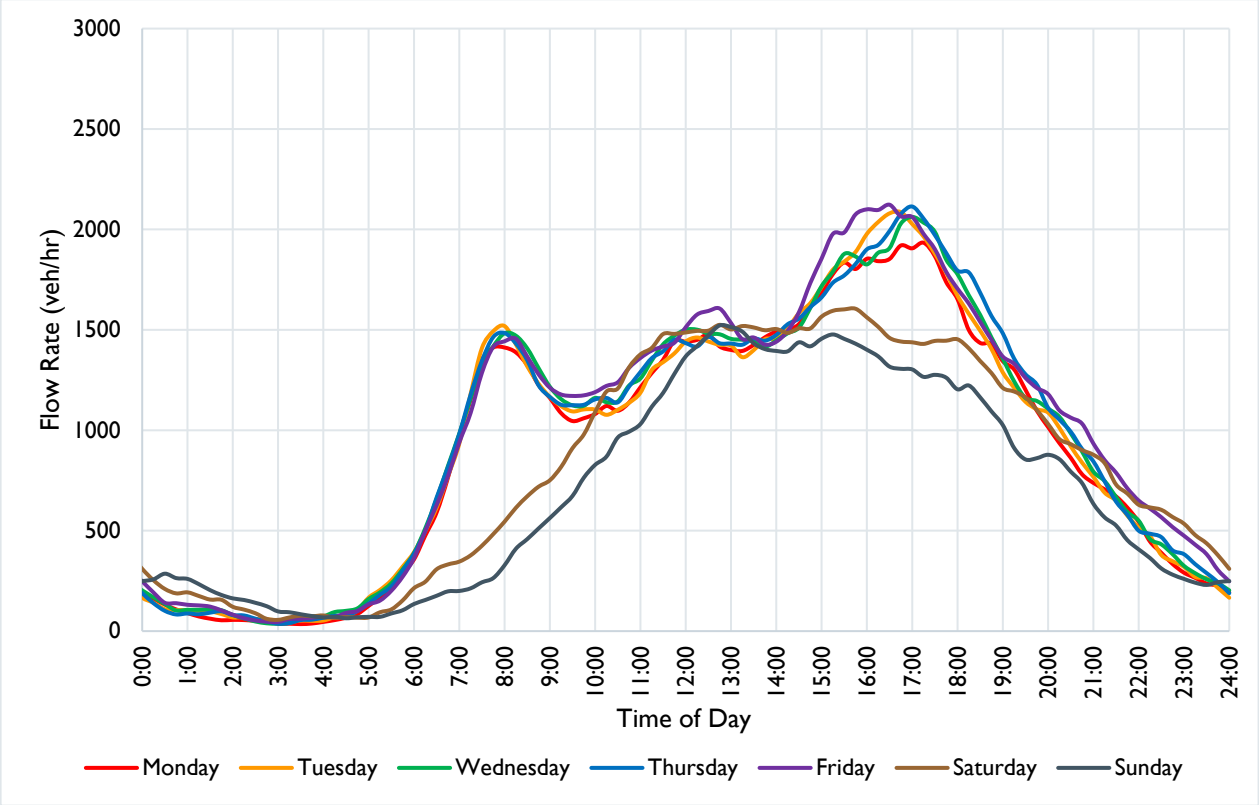

Figure 3.2 90th St Hourly Bidirectional Volumes

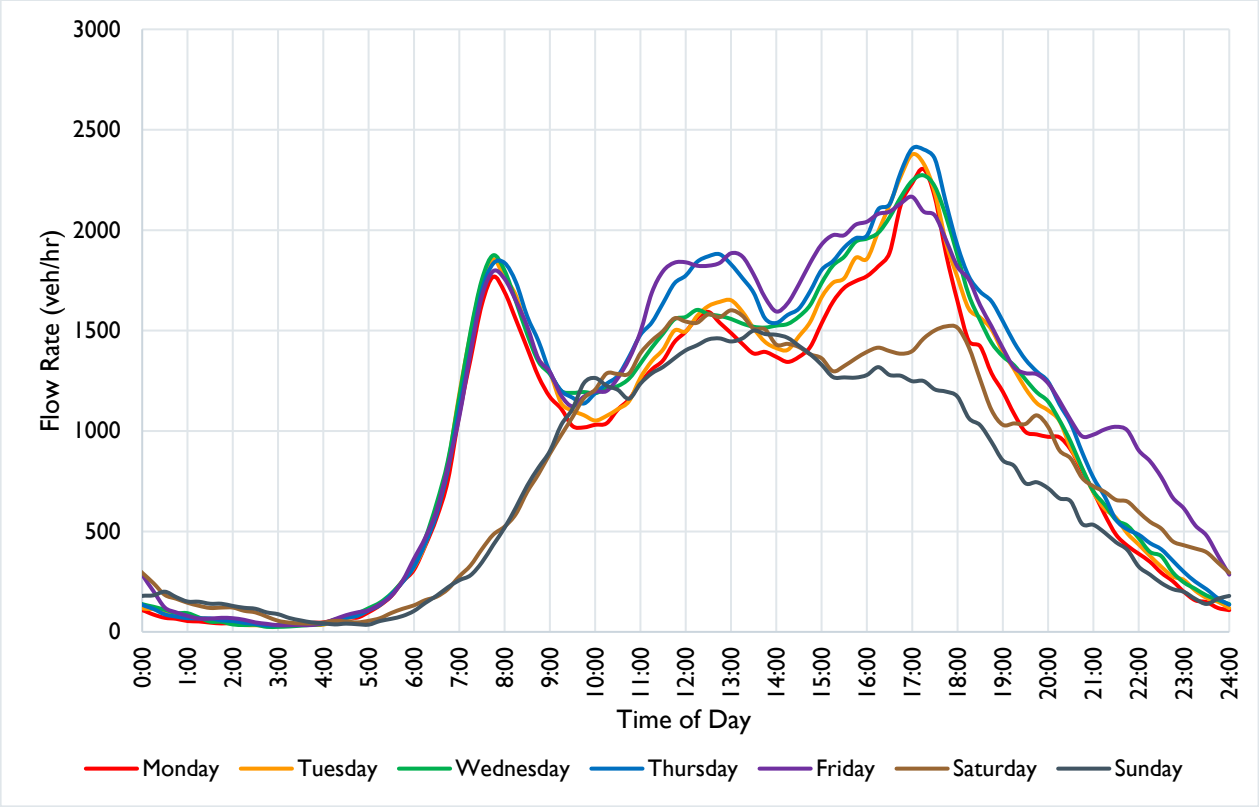

Figure 3.3 120th St Hourly Bidirectional Volumes

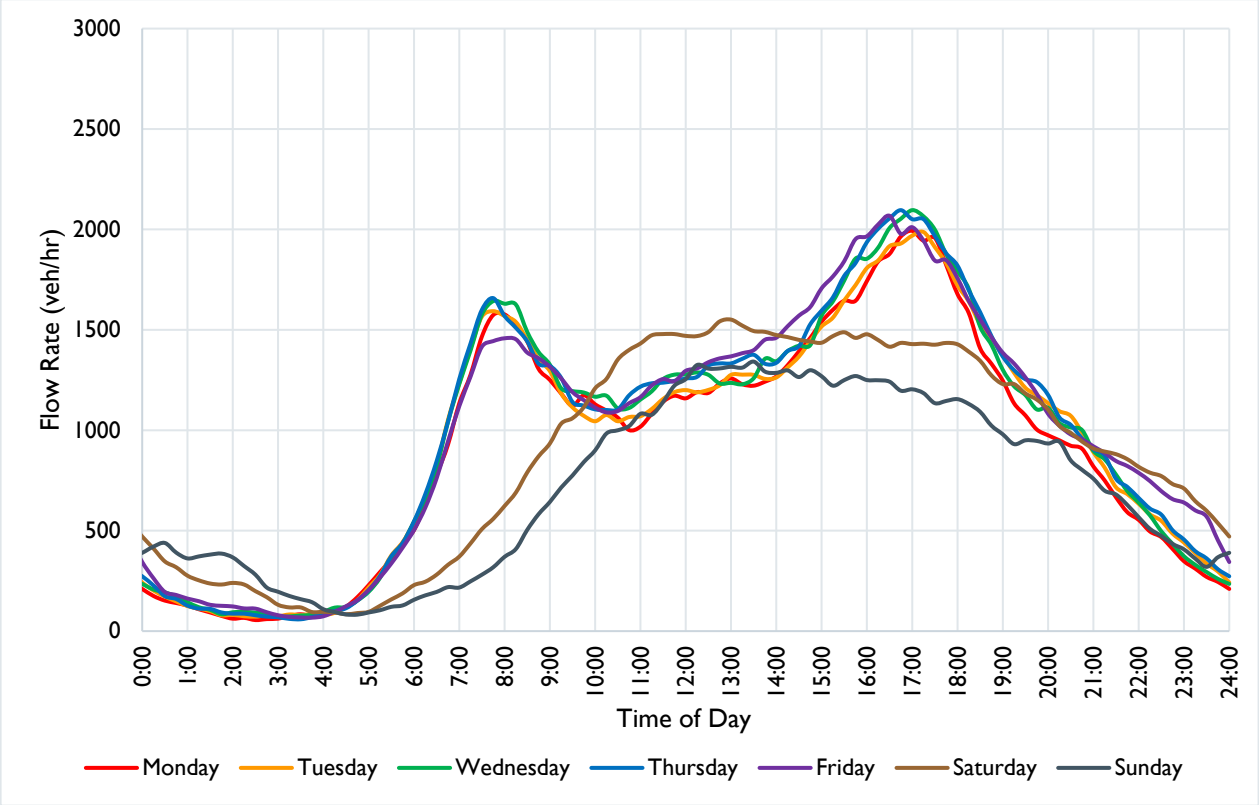

Figure 3.4 Maple St Hourly Bidirectional Volumes

3.3 Turning Movement Counts

Peak hour turning movement counts (TMCs) for each of the project intersections were provided by the City. The majority of the TMCs were collected in 2021 and 2022. The TMCs were conducted from 7:00 AM to 11:00 AM and 2:00 PM to 6:00 PM. This provided data for the AM peak, offpeak, and PM peak design periods but not the MD peak design period. The 24-hour x 7-day data was used to determine which count data to factor and by how much to create estimated MD peak hour volumes. It was determined to use 2:00 PM to 3:00 PM TMC data increased by 5%. PM offpeak operations, from 6:30 PM to 7:30 PM, were reviewed by increasing maximum hour volumes for each intersection between 9:00 AM and 11:00 AM by 13%.

3.4 Timing Sheets

Timing sheets were created using MAXVIEW Traffic Signal Management System software using the custom City of Omaha one page template. The existing timing sheets were used to review and update the City-provided existing condition Synchro files. Existing ("before" condition) timing sheets are included in **Appendix C** and implemented ("after condition) timing sheets are included in **Appendix D**.

3.5 Travel Time Runs

Travel time runs were conducted for "before" conditions on each corridor, listed below, in late August and early September 2023. Travel time runs for "after" conditions were conducted in October 2023. At least five runs were collected in the existing (before) and implemented (after) conditions during each design period and a weekend period (AM peak, MD peak, PM peak, offpeak, and weekend MD peak). Travel time data was collected using Tru-Traffic (v10), and videos were recorded during each run using a dash cam. The travel time run information was used as a baseline for development of timing plans.

- Blondo Street from 144th Street through Benson Gardens Boulevard
- 90th Street from Burt Street through Military Road

3.6 Intersection Observations

Intersection observations were conducted and logged during each design period. These observations were used in the development of the timing plans and to further calibrate the Synchro models. The following observations were noted:

108th Street & Blondo Street

- During the AM peak period, queues for the northbound left-turn movement spill into the adjacent through movement travel lane.

90th Street & Blondo Street

- During the AM peak period, queues for the westbound through movement extend beyond the storage length of the westbound left-turn movement, preventing left-turn traffic from entering the turn lane. Occasionally, by the end of the westbound through movement phase, queues for the westbound left-turn movement spill into the adjacent through movement travel lane.
- During the PM peak period, the eastbound left-turn, southbound through, westbound through, and northbound through movements experience cycle failures.

90th Street & Fort Street

- During the PM peak period, queues for the westbound through movement extend over 750 feet, resulting in cycle failures.
- During the PM peak period, queues for the eastbound through movement extend over 600 feet.

90th Street & Maple Street

- During the AM peak period, the eastbound through movement experiences cycle failures.
- During the PM peak period, queues for the northbound through movement extend over 600 feet, resulting in cycle failures.
- During the PM peak period, the eastbound left-turn movement experiences cycle failures.

120th Street & Webster Street

- During the AM and PM peak period, queues for the northbound left-turn movement spill into the adjacent through movement travel lane.
- During the PM peak period, the northbound left-turn movement experiences cycle failures. Queues for the northbound left-turn extend into the West Dodge Rd intersection, causing moments of brief gridlock. This brief gridlock appears to be a leading factor for eastbound left-turn cycle failures at West Dodge Road and reduces capacity for westbound through on West Dodge Road as traffic cannot immediately go at the start of green.

120th Street & West Dodge Road

- During the AM peak period, the southbound left-turn, eastbound left-turn, and northbound left-turn movements experience cycle failures.
- During the PM peak period, the eastbound left-turn, southbound left-turn, and westbound through movements experience cycle failures. Queues for the westbound through movement extend over 800 feet.

72nd Street & Maple Street

- During the AM peak period, the southbound through movement experiences cycle failures.
- During the PM peak period, queues for the eastbound through movement extend over 900 feet, resulting in cycle failures.
- During the PM peak period, queues for the northbound through movement extend over 400 feet, resulting in cycle failures.
- During the PM peak period, queues for the northbound left-turn movement spill into the adjacent through movement travel lane.

Special Generators

- The Nebraska State Track and Field Championship takes place at Burke High School each year in the spring near the end of the school year. FHU conducted on site observations in May 2023 during the event. Traffic for the event begins to arrive between 8:00 am and 9:00 am. The busiest time, however, is approximately 1:00 pm to 2:30 pm as there is both an ingress and egress of traffic as events switch out for the day. Traffic generated by this event impacts the intersections of 120th Street with Burke Boulevard and 120th Street with West Dodge Road. These impacts, however, are managed by the Omaha Police Department in coordination with the Nebraska School Activities Association.

3.7 Traffic Analysis Parameters

Traffic operations were analyzed for the study intersections using Synchro (v12). From the analyses, a key measure or "level of service" rating of the traffic operational condition was obtained. In general, level of service (LOS) is a qualitative assessment of traffic operational conditions within a traffic stream in terms of the average stopped delay per vehicle at a controlled intersection.

Levels of service are described by a letter designation of either A, B, C, D, E or F, with LOS A representing essentially uninterrupted flow, and LOS F representing a breakdown of traffic flow with noticeable congestion and delay. Signalized intersection capacity analysis produces a LOS result for the entire intersection. **Table 3.2** summarizes LOS criteria for both unsignalized and signalized intersections. In general, a LOS D or better is deemed acceptable by the City of Omaha.

Table 3.2 Level of Service (LOS) Criteria

Level of Service	Average Control Delay per Vehicle (sec/veh)	
	Signalized Intersections	Stop Sign Controlled Intersections
A	≤ 10	≤ 10
B	> 10 to 20	> 10 to 15
C	> 20 to 35	> 15 to 25
D	> 35 to 55	> 25 to 35
E	> 55 to 80	> 35 to 50
F	> 80	> 50
HCM 6th Edition, Exhibit 19-8 & Exhibit 20-2		

Each element of data collected was utilized to build a calibrated Synchro model. Once all the data was programmed into the models, the models were calibrated based on observations collected during the existing condition travel time runs. Various settings were adjusted to ensure Synchro and SimTraffic metrics reflected real world conditions as closely as possible.

4. Optimization

4.1 Clearance Interval Evaluation

As part of the Omaha Signal System Upgrade, clearance intervals are being evaluated at each intersection based on the City of Omaha's methodology. The City's methodology is a hybrid of the 1985 ITE Proposed Recommended Practice, the 2012 NCHRP 731 Method, and the 2015 ITE Proposed Recommended Practice. All intersections within the scope of this project have already had their clearance intervals evaluated and updated as part of prior phases of the Omaha Signal System Upgrade. No clearance intervals were evaluated as part of this project.

4.2 Left-turn Phasing Evaluation

The need for the protected portion of protected-permitted left-turn phases was evaluated based on the City's methodology, which considers left-turn volume, opposing volume, vehicle delay, and crash history for the left-turn movement. The analysis reviewed each movement at each intersection which currently has a four-section flashing yellow arrow (FYA) left-turn signal indication.

Tables in **Appendix E** summarize the results of the left-turn phasing evaluation for each time period. As the tables indicate, there were several movements in several time periods where the protected portion of the left-turn phase could be omitted. Based on the results of the analysis, field observations, and engineering judgement, **Table 4.1** indicates during each time period whether each left-turn phase was recommended to have the protected portion enabled or omitted for the implemented conditions.

Based on the available data to date, the City has determined a threshold where crashes appear to be more likely with protected-permitted lead-lag operation of four-section FYA indications. When the cross-product of through movement, right-turns, and opposing left-turns exceeds 100,000 vehicles for both approaches in an hour, lead-lead operation or protected only operation for the leading left-turn of lead-lag operation is recommended to reduce the risk of crashes. A summary of cross-products for intersections with at least one relevant four-section FYA is provided in **Table 4.2**. Cross products exceeding 100,000 have been highlighted in red. Based on this analysis, **Table 4.3** indicates the implemented operation of each four-section FYA.

Table 4.1 4-Section Left-Turn Warrants Summary

ID #	Intersection	Phase	Direction	Plan 1 MD	Plan 2 AM	Plan 3 PM	Plan 4 OP
856	117th St & Blondo St	5	EBL	Omit	Enable	Enable	Omit
824	Papillion Pkwy & Blondo St	1	WBL	Enable	Enable	Enable	Enable
536	108th St & Blondo St	5	EBL	Enable	Enable	Enable	Enable
536	108th St & Blondo St	1	WBL	Enable	Enable	Enable	Enable
536	108th St & Blondo St	3	NBL	Omit	Enable	Enable	Omit
536	108th St & Blondo St	7	SBL	Enable	Enable	Enable	Enable
527	102nd St & Blondo St	5	EBL	Omit	Omit	Enable	Omit
527	102nd St & Blondo St	1	WBL	Omit	Enable	Enable	Omit
527	102nd St & Blondo St	3	NBL	Enable	Omit	Enable	Enable
377	96th St & Blondo St	1	WBL	Enable	Enable	Enable	Omit
497	90th St & Blondo St	5	EBL	Protected	Enable	Protected	Protected
497	90th St & Blondo St	1	WBL	Enable	Enable	Enable	Enable
497	90th St & Blondo St	3	NBL	Protected	Protected	Protected	Protected
497	90th St & Blondo St	7	SBL	Enable	Enable	Enable	Enable
501	90th St & Fort St	5	EBL	Enable	Enable	Enable	Enable
501	90th St & Fort St	1	WBL	Enable	Enable	Enable	Enable
501	90th St & Fort St	3	NBL	Enable	Enable	Enable	Enable
501	90th St & Fort St	7	SBL	Enable	Enable	Enable	Enable
645	90th St & Maple Village St	3	NBL	Enable	Omit	Enable	Enable
645	90th St & Maple Village St	7	SBL	Omit	Omit	Omit	Omit
670	120th St & Miracle Hills Dr	7	SBL	Enable	Enable	Enable	Enable
612	120th St & Webster St	1	WBL	Enable	Enable	Enable	Enable
558	120th St & Burke St	3	NBL	Enable	Enable	Enable	Enable
474	83rd St & Maple St	5	EBL	Omit	Omit	Enable	Omit
450	72nd St & Maple St	1	WBL	Enable	Enable	Enable	Enable
450	72nd St & Maple St	3	NBL	Enable	Enable	Enable	Enable
450	72nd St & Maple St	7	SBL	Enable	Enable	Enable	Omit

Table 4.2 Cross-Product Review

ID #	Intersection	Direction	MD	AM	PM	OP
824	Papillion Pkwy & Blondo St	EBL	39,284	80,408	123,372	29,865
		WBL	67,166	154,100	163,254	41,500
		NBL	6,090	15,246	21,364	5,418
		SBL	4,403	11,970	8,496	4,294
536	108th St & Blondo St	EBL	117,315	138,976	743,390	53,072
		WBL	51,243	263,934	195,500	51,360
		NBL	11,550	34,510	67,396	10,951
		SBL	37,105	46,110	108,480	17,955
527	102nd St & Blondo St	EBL	22,080	20,748	66,096	10,556
		WBL	29,900	34,349	62,269	17,745
		NBL	20,904	9,476	53,148	11,039
		SBL	7,308	2,808	19,320	2,254
497	90th St & Blondo St	EBL	90,835	38,212	NA	30,849
		WBL	76,960	111,000	NA	47,886
		NBL	74,899	43,056	175,253	49,322
		SBL	124,780	57,024	235,371	60,258
501	90th St & Fort St	EBL	54,648	35,502	105,792	37,961
		WBL	61,596	60,588	74,186	43,401
		NBL	86,580	65,157	167,535	73,805
		SBL	58,608	10,374	81,500	25,300
645	90th St & Maple Village St	EBL	0	0	0	0
		WBL	0	0	0	0
		NBL	69,054	43,483	82,942	47,526
		SBL	20,608	6,461	20,559	7,140
612	120th St & Webster St	EBL	22,815	3,731	30,758	9,204
		WBL	67,056	15,656	90,200	36,079
		NBL	NA	NA	NA	NA
		SBL	NA	NA	NA	NA
558	120th St & Burke St	EBL	2,132	23,541	6,853	936
		WBL	1,040	4,230	8,618	560
		NBL	19,768	144,315	55,404	6,123
		SBL	20,305	35,088	53,248	12,328
474	83rd St & Maple St	EBL	38,584	15,250	97,722	18,833
		WBL	6,102	4,840	20,922	2,562
		NBL	689	1,358	1,500	539
		SBL	255	506	672	170
450	72nd St & Maple St	EBL	70,224	47,600	116,856	38,868
		WBL	66,882	43,260	88,704	33,354
		NBL	91,770	62,726	113,574	53,492
		SBL	39,151	15,050	40,057	15,316

Table 4.3 4-Section Left-Turn Implemented Operations Summary

ID #	Intersection	Phase	Direction	Plan 1 MD	Plan 2 AM	Plan 3 PM	Plan 4 OP
856	117th St & Blondo St	5	EBL	Omit	Enable	Enable	Omit
824	Papillion Pkwy & Blondo St	1	WBL	Enable	Enable	Enable	Enable
536	108th St & Blondo St	5	EBL	Enable	Enable	Enable	Enable
536	108th St & Blondo St	1	WBL	Enable	Enable	Enable	Enable
536	108th St & Blondo St	3	NBL	Omit	Enable	Enable	Omit
536	108th St & Blondo St	7	SBL	Enable	Enable	Enable	Enable
527	102nd St & Blondo St	5	EBL	Omit	Omit	Enable	Omit
527	102nd St & Blondo St	1	WBL	Omit	Enable	Enable	Omit
527	102nd St & Blondo St	3	NBL	Enable	Omit	Enable	Enable
377	96th St & Blondo St	1	WBL	Enable	Enable	Enable	Omit
497	90th St & Blondo St	5	EBL	Protected	Enable	Protected	Protected
497	90th St & Blondo St	1	WBL	Enable	Enable	Protected	Enable
497	90th St & Blondo St	3	NBL	Protected	Protected	Protected	Protected
497	90th St & Blondo St	7	SBL	Enable	Enable	Enable	Enable
501	90th St & Fort St	5	EBL	Enable	Enable	Enable	Enable
501	90th St & Fort St	1	WBL	Enable	Enable	Enable	Enable
501	90th St & Fort St	3	NBL	Enable	Enable	Enable	Enable
501	90th St & Fort St	7	SBL	Enable	Enable	Enable	Enable
645	90th St & Maple Village St	3	NBL	Enable	Omit	Enable	Enable
645	90th St & Maple Village St	7	SBL	Omit	Omit	Omit	Omit
670	120th St & Miracle Hills Dr	7	SBL	Enable	Enable	Enable	Enable
612	120th St & Webster St	1	WBL	Enable	Enable	Enable	Enable
558	120th St & Burke St	3	NBL	Enable	Enable	Enable	Enable
474	83rd St & Maple St	5	EBL	Omit	Omit	Enable	Omit
450	72nd St & Maple St	1	WBL	Enable	Enable	Enable	Enable
450	72nd St & Maple St	3	NBL	Enable	Enable	Enable	Enable
450	72nd St & Maple St	7	SBL	Enable	Enable	Enable	Omit

4.3 Day Plan

The day plan schedule was developed based on an analysis of the 24-hour x 7-day traffic count data, observations during the before travel time runs, and discussions with the City. **Figure 4.1** through **Figure 4.3** illustrate hourly directional volumes for weekdays, Saturdays, and Sundays on Blondo Street with the day plan pattern numbers and change times overlaid on the charts. Blondo Street is shown as a representative corridor, similar volume plots for each count location can be found in **Appendix B**. **Figure 3.1** through **Figure 3.4** graphically depict the day plan schedule and cycle lengths for each individual signal within this study area.

The intersection of 120th Street with West Dodge Road has diversion patterns programmed that are not called by the existing day plan schedule. These diversion patterns are for overpass lane closures are and only used on an as needed basis by the City. These patterns were maintained when programming the database with updated day plans and coordinated patterns, but they do interfere with the City's new standard pattern numbering for alternate AM, alternate PM, and alternate offpeak plans. An alternate PM plan was implemented during the fine-tuning process and, after discussion with the City, was programmed as pattern 13 instead of pattern 8.

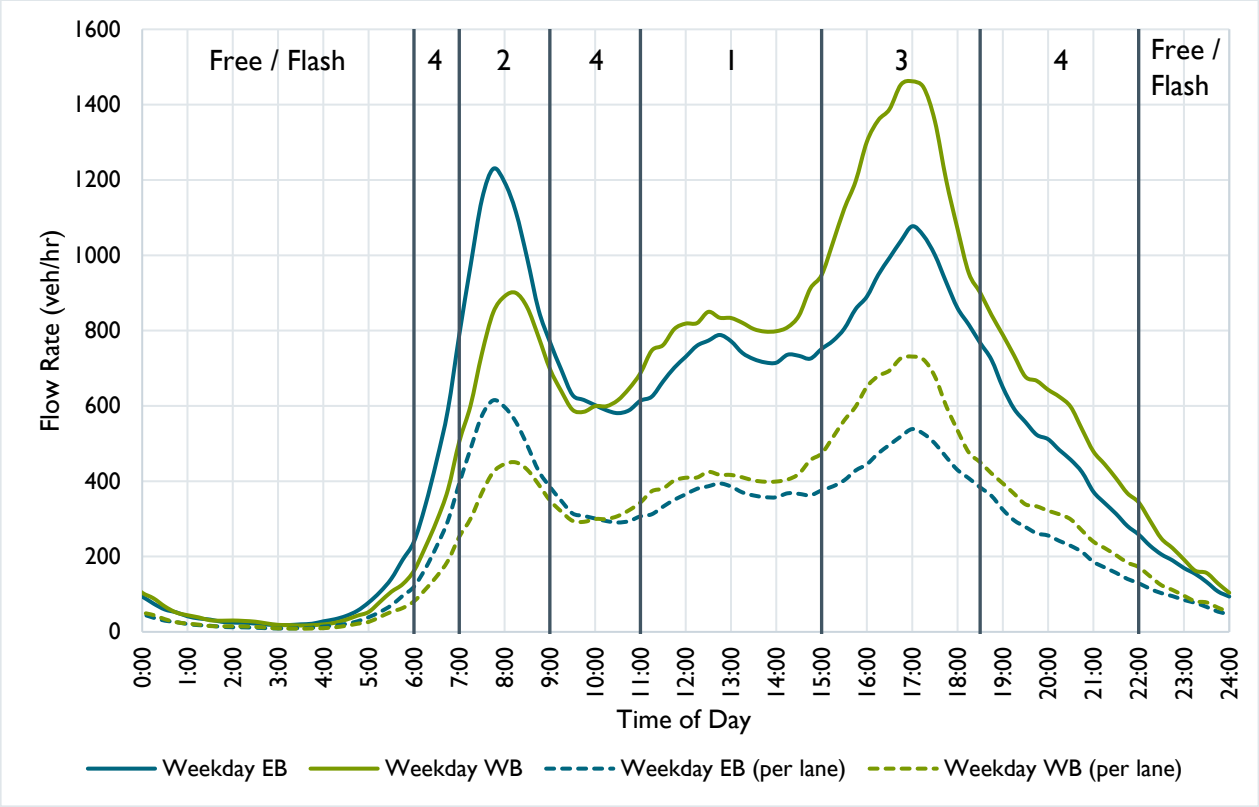

Figure 4.1 Blondo St Hourly Average Weekday Directional Volumes

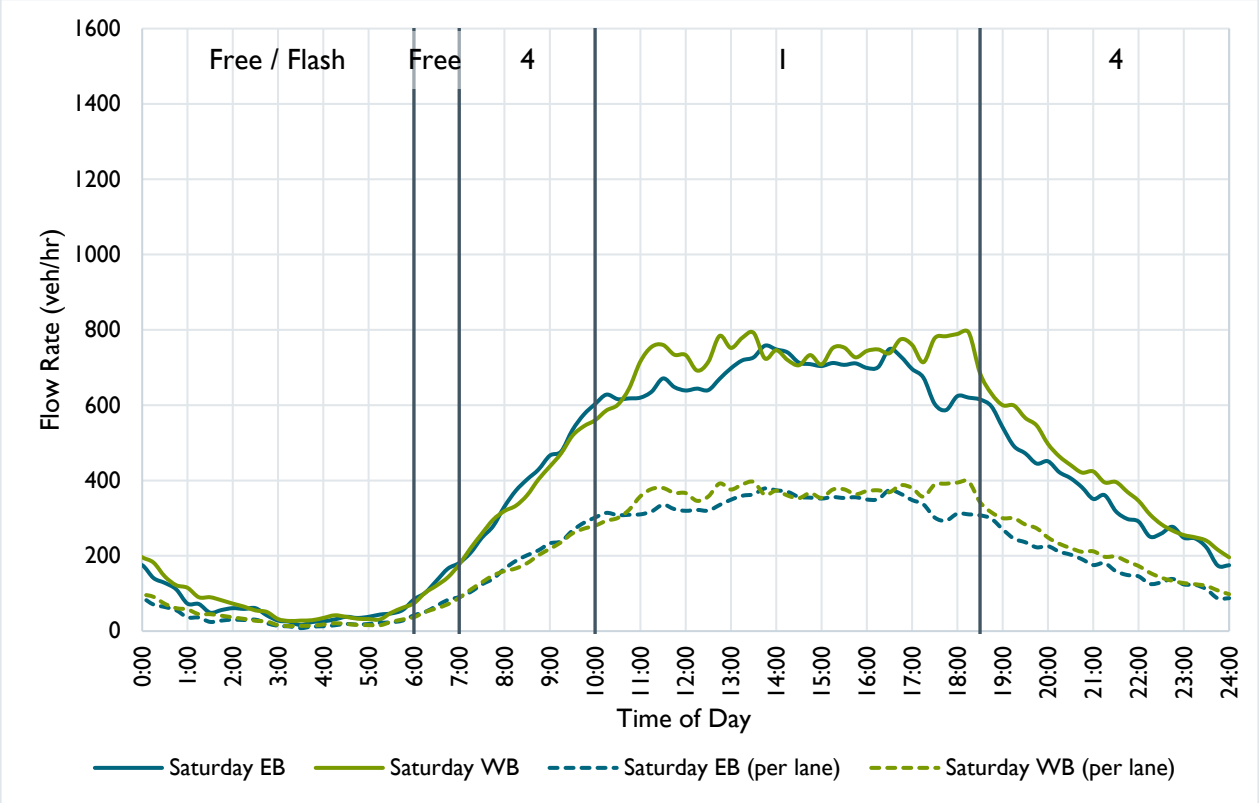

Figure 4.2 Blondo St Hourly Saturday Directional Volumes

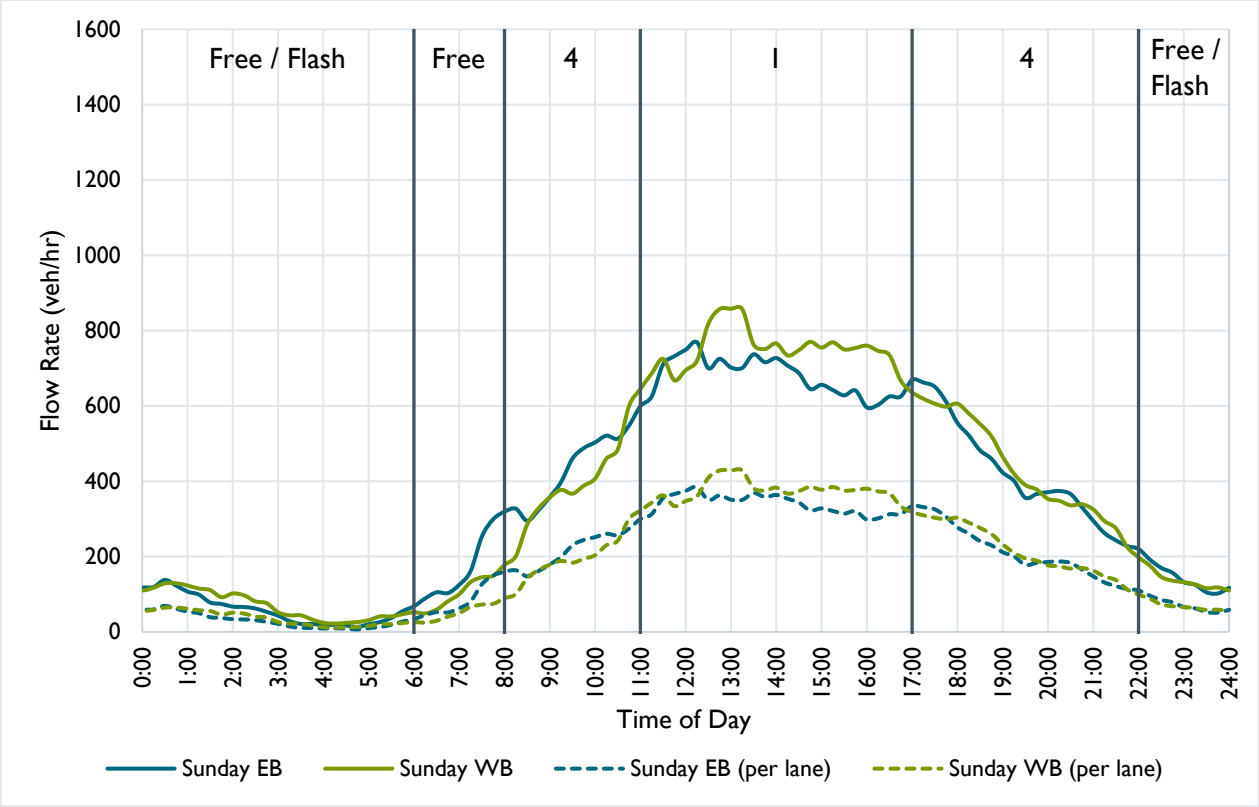

Figure 4.3 Blondo St Hourly Sunday Directional Volumes

EXISTING SCHEDULES
WEEKDAY

		12 am	1 am	2 am	3 am	4 am	5 am	6 am	7 am	8 am	9 am	10 am	11 am	12 pm	1 pm	2 pm	3 pm	4 pm	5 pm	6 pm	7 pm	8 pm	9 pm	10 pm	11 pm	12 am
BLONDO ST																										
739	144th St*	20 [free]							2 [90]			1 [90]						3 [90]			1 [90]				20 [free]	
671	141st Ave	19 [flash]						1 [90]	2 [90]			1 [90]						3 [90]			1 [90]				19 [flash]	
972	135th St	19 [flash]							2 [90]			1 [90]						3 [90]			1 [90]				19 [flash]	
696	132nd St	20 [free]							2 [90]			1 [90]						3 [120]			1 [90]				20 [free]	
843	123rd St	19 [flash]							2 [120]			1 [90]						3 [120]			1 [90]				19 [flash]	
557	120th St	20 [free]							2 [120]			1 [90]						3 [120]			1 [90]				20 [free]	
856	117th Ave	19 [flash]							2 [120]			1 [90]						3 [120]			1 [90]				19 [flash]	
824	Papillion Pkwy	19 [flash]							2 [120]			1 [90]						3 [120]			1 [90]				19 [flash]	
548	111th St	19 [flash]							2 [120]			1 [90]						3 [120]			1 [90]				19 [flash]	
536	108th St	20 [free]							2 [120]			1 [90]						3 [120]			1 [90]				20 [free]	
527	102nd St	20 [free]							2 [120]			1 [90]						3 [120]			1 [90]				20 [free]	
520	97th St	19 [flash]							2 [90]			1 [90]						3 [90]			1 [90]				19 [flash]	
377	96th St	20 [free]							2 [90]			1 [90]						3 [90]			1 [90]				20 [free]	
497	90th St	10 [free]							2 [90]			1 [90]						3 [90]			1 [90]				10 [free]	
492	85th St / 88th St	20 [free]								2 [90]		1 [90]						3 [90]			1 [90]				20 [free]	
3	Benson Gardens Blvd	19 [flash]						1 [90]		2 [90]		1 [90]						3 [90]			1 [90]				19 [flash]	
440	72nd St*	20 [free]						4 [90]		2 [120]		4 [90]		1 [120]				3 [150]			4 [90]				20 [free]	
90TH ST																										
709	Blair High Rd*	20 [free]							2 [90]			1 [90]						3 [90]			1 [90]				20 [free]	
710	Military Rd	20 [free]							2 [90]			1 [90]						3 [90]			1 [90]				20 [free]	
500	Ellison Plz	19 [flash]							2 [90]			1 [90]						3 [90]			1 [90]				19 [flash]	
501	Fort St	20 [free]							2 [90]			1 [90]						3 [90]			1 [90]				20 [free]	
498	Boyd St/Taylor St	19 [flash]							2 [90]			1 [90]						3 [90]			1 [90]				19 [flash]	
504	Maplewood Blvd	19 [flash]							2 [90]			1 [90]						3 [90]			1 [90]				19 [flash]	
645	Maple Village	19 [flash]							2 [90]			1 [90]						3 [90]			1 [90]				19 [flash]	
503	Maple St	20 [free]							2 [90]			1 [90]						3 [90]			1 [90]				20 [free]	
505	Ohio St	19 [flash]							2 [90]			1 [90]						3 [90]			1 [90]				19 [flash]	
511	Western Ave	20 [free]							2 [90]			1 [90]						3 [90]			1 [90]				20 [free]	
499	Burt St	20 [free]							2 [90]			1 [90]						3 [90]			1 [90]				20 [free]	
510	West Dodge Rd*	1 [90]							2 [120]			1 [90]						3 [150]			1 [90]					
120TH ST																										
568	West Maple Rd*	20 [free] A							2 [120]			4 [75]			1 [90]			3 [120]			1 [90]		4 [75]		20 [free]	
798	Stonegate Dr	19 [flash]							2 [120]			1 [90]						3 [120]			1 [90]				19 [flash]	
776	Miami St	19 [flash]							2 [120]			1 [90]						3 [120]			1 [90]				19 [flash]	
670	Miracle Hills Dr	20 [free]						1 [90]	2 [120]			1 [90]						3 [120]			1 [90]				20 [free]	
612	Webster St	20 [free]							2 [120]			1 [90]						3 [120]			1 [90]				20 [free]	
567	West Dodge Rd	20 [free]							2 [120]			1 [90]						3 [120]			1 [90]				20 [free]	
558	Burke St	20 [free]							2 [120]			1 [90]						3 [120]			1 [90]				20 [free]	
563	Pacific St*	20 [free]							2 [120]			1 [90]						3 [120]			1 [90]				20 [free]	
938	115th St & Miracle Hills Dr	19 [flash]													20 [free]										19 [flash]	
MAPLE ST																										
529	102nd St*	10 [free]							4 [75]	2 [120]		4 [75]			1 [90]			3 [120]			4 [75]				10 [free]	
521	97th St	19 [flash]							2 [90]			1 [90]						3 [90]			1 [90]				19 [flash]	
513	93rd St	19 [flash]							2 [90]			1 [90]						3 [90]			1 [90]				19 [flash]	
495	88th St	19 [flash]							2 [90]			1 [90]						3 [90]			1 [90]				19 [flash]	
48	Keystone Dr	19 [flash]							2 [90]			1 [90]						3 [90]			1 [90]				19 [flash]	
474	83rd St	20 [free]							2 [90]			1 [90]						3 [90]			1 [90]				20 [free]	
468	78th St	20 [free]							2 [90]			1 [90]						3 [90]			1 [90]				20 [free]	
460	75th St	19 [flash]							2 [90]			1 [90]						3 [90]			1 [90]				19 [flash]	
450	72nd St	20 [free]							4 [90]	2 [120]		4 [90]		1 [120]				3 [120]			4 [90]				20 [free]	

A - 4 [75]

*Non-project intersections shown for information only.

IMPLEMENTED SCHEDULES
WEEKDAY

		12 am	1 am	2 am	3 am	4 am	5 am	6 am	7 am	8 am	9 am	10 am	11 am	12 pm	1 pm	2 pm	3 pm	4 pm	5 pm	6 pm	7 pm	8 pm	9 pm	10 pm	11 pm	12 am
BLONDO ST																										
739	144th St*	20 [free]							4 [90]	2 [120]		4 [90]			1 [120]			3 [150]				4 [90]			20 [free]	
671	141st Ave	19 [flash]							4 [90]	2 [120]		4 [90]			1 [120]			8 [150] 3 [150]				4 [90]			19 [flash]	
972	135th St	19 [flash]							4 [90]	2 [120]		4 [90]			1 [120]			3 [150]				4 [90]			19 [flash]	
696	132nd St	20 [free]							4 [90]	2 [120]		4 [90]			1 [120]			3 [150]				4 [90]			20 [free]	
843	123rd St	19 [flash]							4 [90]	2 [120]		4 [90]			1 [120]			3 [150]				4 [90]			19 [flash]	
557	120th St	20 [free]							4 [90]	2 [120]		4 [90]			1 [120]			3 [150]				4 [90]			20 [free]	
856	117th Ave	19 [flash]							4 [90]	2 [120]		4 [90]			1 [120]			3 [150]				4 [90]			19 [flash]	
824	Papillion Pkwy	19 [flash]							4 [90]	2 [120]		4 [90]			1 [120]			3 [150]				4 [90]			19 [flash]	
548	111th St	19 [flash]							4 [90]	2 [120]		4 [90]			1 [120]			3 [150]				4 [90]			19 [flash]	
536	108th St	20 [free]							4 [90]	2 [120]		4 [90]			1 [120]			3 [150]				4 [90]			20 [free]	
527	102nd St	20 [free]							4 [90]	2 [120]		4 [90]			1 [90]			3 [120]				4 [90]			20 [free]	
520	97th St	19 [flash]							4 [90]	2 [120]		4 [90]			1 [90]			3 [120]				4 [90]			19 [flash]	
377	96th St	20 [free]							4 [90]	2 [120]		4 [90]			1 [90]			3 [120]				4 [90]			20 [free]	
497	90th St	10 [free]							4 [90]	2 [120]		4 [90]			1 [90]			3 [120]				4 [90]			20 [free]	
492	85th St / 88th St	20 [free]							4 [90]	2 [120]		4 [90]			1 [90]			3 [120]				4 [90]			20 [free]	
3	Benson Gardens Blvd	19 [flash]							4 [90]	2 [120]		4 [90]			1 [90]			3 [120]				4 [90]			19 [flash]	
440	72nd St*	20 [free]							4 [90]	2 [120]		4 [90]			1 [120]			3 [150]				4 [90]			20 [free]	
90TH ST																										
709	Blair High Rd*	20 [free]								2 [90]					1 [90]			3 [90]				1 [90]			20 [free]	
710	Military Rd	20 [free]							4 [90]	2 [120]		4 [90]			1 [90]			3 [120]				4 [90]			20 [free]	
500	Ellison Plz	19 [flash]							4 [90]	2 [120]		4 [90]			1 [90]			3 [120]				4 [90]			19 [flash]	
501	Fort St	20 [free]							4 [90]	2 [120]		4 [90]			1 [90]			3 [120]				4 [90]			20 [free]	
498	Boyd St/Taylor St	19 [flash]							4 [90]	2 [120]		4 [90]			1 [90]			3 [120]				4 [90]			19 [flash]	
504	Maplewood Blvd	19 [flash]							4 [90]	2 [120]		4 [90]			1 [90]			3 [120]				4 [90]			19 [flash]	
645	Maple Village	19 [flash]							4 [90]	2 [120]		4 [90]			1 [90]			3 [120]				4 [90]			19 [flash]	
503	Maple St	20 [free]							4 [90]	2 [120]		4 [90]			1 [90]			3 [120]				4 [90]			20 [free]	
505	Ohio St	19 [flash]							4 [90]	2 [60]		4 [90]			1 [90]			3 [60]				4 [90]			19 [flash]	
511	Western Ave	20 [free]							4 [90]	2 [120]		4 [90]			1 [90]			3 [120]				4 [90]			20 [free]	
499	Burt St	20 [free]							4 [90]	2 [120]		4 [90]			1 [90]			3 [120]				4 [90]			20 [free]	
510	West Dodge Rd*	4 [90]								2 [120]		4 [90]			1 [120]			3 [120]				4 [90]				
120TH ST																										
568	West Maple Rd*	20 [free] A								2 [120]		4 [75]			1 [90]			3 [120]			1 [90]		4 [75]		20 [free]	
798	Stonegate Dr	19 [flash]							4 [90]	2 [120]		4 [90]			1 [60]			3 [75]				4 [90]			19 [flash]	
776	Miami St	19 [flash]							4 [90]	2 [120]		4 [90]			1 [60]			3 [75]				4 [90]			19 [flash]	
670	Miracle Hills Dr	20 [free]							4 [90]	2 [120]		4 [90]			1 [120]			3 [150]				4 [90]			20 [free]	
612	Webster St	20 [free]							4 [90]	2 [120]		4 [90]			1 [120]			3 [150]				4 [90]			20 [free]	
567	West Dodge Rd	20 [free]							4 [90]	2 [120]		4 [90]			1 [120]		B	3 [150]				4 [90]			20 [free]	
558	Burke St	20 [free]							4 [90]	2 [120]		4 [90]			1 [120]		C	3 [150]				4 [90]			20 [free]	
563	Pacific St*	20 [free]								2 [120]					1 [90]			3 [120]				1 [90]			20 [free]	
938	115th St & Miracle Hills Dr	19 [flash]													20 [free]										19 [flash]	
MAPLE ST																										
529	102nd St*	10 [free]							4 [75]	2 [120]		4 [75]			1 [90]			3 [120]				4 [75]			10 [free]	
521	97th St	19 [flash]							4 [90]	2 [120]		4 [90]			1 [90]			3 [120]				4 [90]			19 [flash]	
513	93rd St	19 [flash]							4 [90]	2 [120]		4 [90]			1 [90]			3 [120]				4 [90]			19 [flash]	
495	88th St	19 [flash]							4 [90]	2 [120]		4 [90]			1 [90]			3 [120]				4 [90]			19 [flash]	
48	Keystone Dr	19 [flash]							4 [90]	2 [120]		4 [90]			1 [90]			3 [120]				4 [90]			19 [flash]	
474	83rd St	20 [free]							4 [90]	2 [120]		4 [90]			1 [90]			3 [120]				4 [90]			20 [free]	
468	78th St	20 [free]							4 [90]	2 [120]		4 [90]			1 [90]			3 [120]				4 [90]			20 [free]	
460	75th St	19 [flash]							4 [90]	2 [120]		4 [90]			1 [90]			3 [120]				4 [90]			19 [flash]	
450	72nd St	20 [free]							4 [90]	2 [120]		4 [90]			1 [90]			3 [120]				4 [90]			20 [free]	

A - 4 [75]

B - 13 [150]

C - 8 [150]

LEGEND

A white box indicates FREE operation, a shaded box indicates coordinated operation.

The first number specifies the pattern, the second number [in brackets] is the cycle length (s).

Darker shades represent a longer cycle length.

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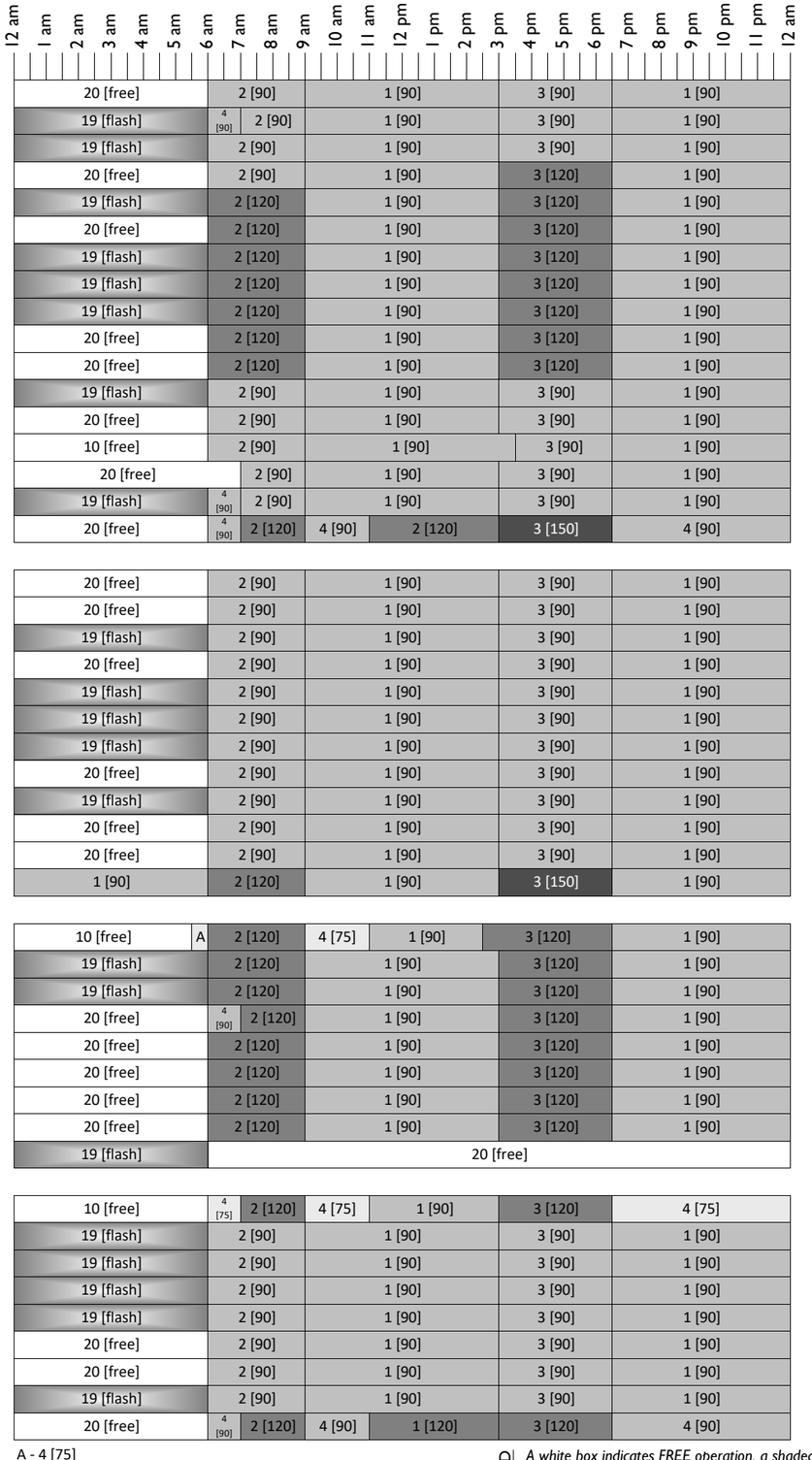
Figure 4.4
Weekday Day Plan Schedule

EXISTING SCHEDULES
FRIDAY



A - 4 [75]

*Non-project intersections shown for information only.

IMPLEMENTED SCHEDULES
FRIDAY

A - 4 [75]

B - 13 [150]

C - 8 [150]

LEGEND

A white box indicates FREE operation, a shaded box indicates coordinated operation.

The first number specifies the pattern, the second number [in brackets] is the cycle length (s).

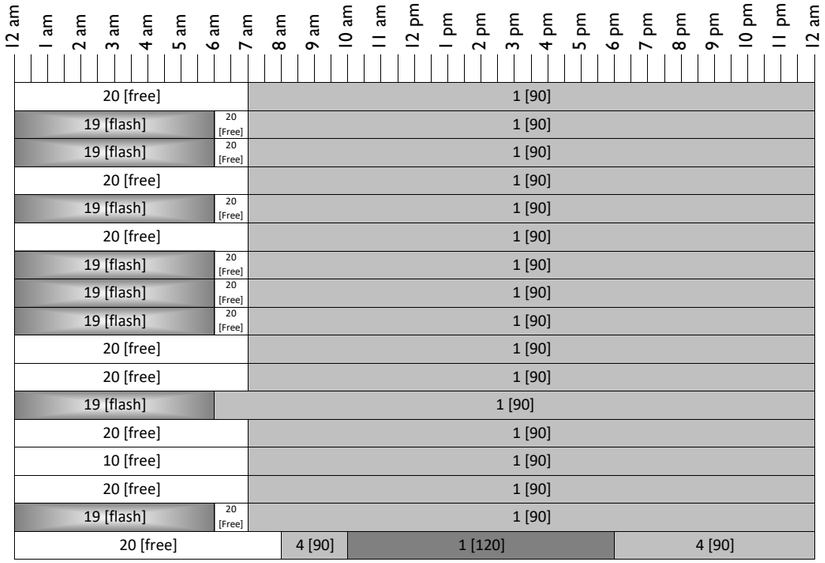
Darker shades represent a longer cycle length.

FELSBURG HOLT & ULLEVIG

Figure 4.5

Friday Day Plan Schedule

EXISTING SCHEDULES
SATURDAY



BLONDO ST

739	144th St*	20 [free] | 1 [90]
671	141st Ave	19 [flash] | 20 [Free] | 1 [90]
972	135th St	19 [flash] | 20 [Free] | 1 [90]
696	132nd St	20 [free] | 1 [90]
843	123rd St	19 [flash] | 20 [Free] | 1 [90]
557	120th St	20 [free] | 1 [90]
856	117th Ave	19 [flash] | 20 [Free] | 1 [90]
824	Papillion Pkwy	19 [flash] | 20 [Free] | 1 [90]
548	111th St	19 [flash] | 20 [Free] | 1 [90]
536	108th St	20 [free] | 1 [90]
527	102nd St	20 [free] | 1 [90]
520	97th St	19 [flash] | 1 [90]
377	96th St	20 [free] | 1 [90]
497	90th St	10 [free] | 1 [90]
492	85th St / 88th St	20 [free] | 1 [90]
3	Benson Gardens Blvd	19 [flash] | 20 [Free] | 1 [90]
440	72nd St*	20 [free] | 4 [90] | 1 [120] | 4 [90]

90TH ST

709	Blair High Rd*	20 [free] | 1 [90]
710	Military Rd	20 [free] | 1 [90]
500	Ellison Plz	19 [flash] | 20 [Free] | 1 [90]
501	Fort St	20 [free] | 1 [90]
498	Boyd St/Taylor St	19 [flash] | 20 [Free] | 1 [90]
504	Maplewood Blvd	19 [flash] | 20 [Free] | 1 [90]
645	Maple Village	19 [flash] | 20 [Free] | 1 [90]
503	Maple St	20 [free] | 1 [90]
505	Ohio St	19 [flash] | 1 [90]
511	Western Ave	20 [free] | 1 [90]
499	Burt St	20 [free] | 1 [90]
510	West Dodge Rd*	1 [90]

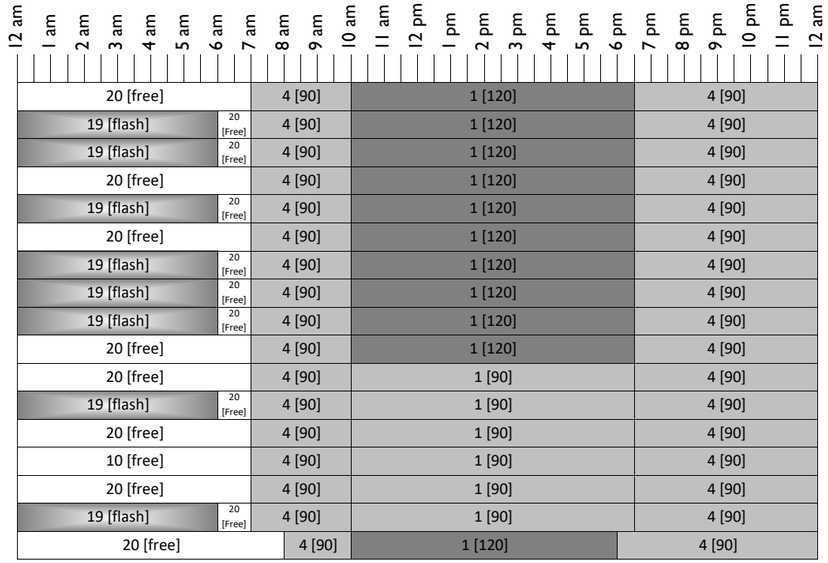
120TH ST

568	West Maple Rd*	20 [free] | 4 [75] | 1 [90] | 4 [75]
798	Stonegate Dr	19 [flash] | 20 [Free] | 1 [90]
776	Miami St	19 [flash] | 20 [Free] | 1 [90]
670	Miracle Hills Dr	20 [free] | 1 [90]
612	Webster St	20 [free] | 1 [90]
567	West Dodge Rd	20 [free] | 1 [90]
558	Burke St	20 [free] | 1 [90]
563	Pacific St*	20 [free] | 1 [90]
938	115th St & Miracle Hills Dr	19 [flash] | 20 [free]

MAPLE ST

529	102nd St*	10 [free] | 4 [75] | 1 [90] | 4 [75]
521	97th St	19 [flash] | 1 [90]
513	93rd St	19 [flash] | 20 [Free] | 1 [90]
495	88th St	19 [flash] | 20 [Free] | 1 [90]
48	Keystone Dr	19 [flash] | 20 [Free] | 1 [90]
474	83rd St	20 [free] | 1 [90]
468	78th St	20 [free] | 1 [90]
460	75th St	19 [flash] | 20 [Free] | 1 [90]
450	72nd St	20 [free] | 4 [90] | 1 [120] | 4 [90]

IMPLEMENTED SCHEDULES
SATURDAY



BLONDO ST

739	144th St*	20 [free] | 4 [90] | 1 [120] | 4 [90]
671	141st Ave	19 [flash] | 20 [Free] | 4 [90] | 1 [120] | 4 [90]
972	135th St	19 [flash] | 20 [Free] | 4 [90] | 1 [120] | 4 [90]
696	132nd St	20 [free] | 4 [90] | 1 [120] | 4 [90]
843	123rd St	19 [flash] | 20 [Free] | 4 [90] | 1 [120] | 4 [90]
557	120th St	20 [free] | 4 [90] | 1 [120] | 4 [90]
856	117th Ave	19 [flash] | 20 [Free] | 4 [90] | 1 [120] | 4 [90]
824	Papillion Pkwy	19 [flash] | 20 [Free] | 4 [90] | 1 [120] | 4 [90]
548	111th St	19 [flash] | 20 [Free] | 4 [90] | 1 [120] | 4 [90]
536	108th St	20 [free] | 4 [90] | 1 [120] | 4 [90]
527	102nd St	20 [free] | 4 [90] | 1 [90] | 4 [90]
520	97th St	19 [flash] | 20 [Free] | 4 [90] | 1 [90] | 4 [90]
377	96th St	20 [free] | 4 [90] | 1 [90] | 4 [90]
497	90th St	10 [free] | 4 [90] | 1 [90] | 4 [90]
492	85th St / 88th St	20 [free] | 4 [90] | 1 [90] | 4 [90]
3	Benson Gardens Blvd	19 [flash] | 20 [Free] | 4 [90] | 1 [90] | 4 [90]
440	72nd St*	20 [free] | 4 [90] | 1 [120] | 4 [90]

90TH ST

709	Blair High Rd*	20 [free] | 1 [90]
710	Military Rd	20 [free] | 4 [90] | 1 [90] | 4 [90]
500	Ellison Plz	19 [flash] | 20 [Free] | 4 [90] | 1 [90] | 4 [90]
501	Fort St	20 [free] | 4 [90] | 1 [90] | 4 [90]
498	Boyd St/Taylor St	19 [flash] | 20 [Free] | 4 [90] | 1 [90] | 4 [90]
504	Maplewood Blvd	19 [flash] | 20 [Free] | 4 [90] | 1 [90] | 4 [90]
645	Maple Village	19 [flash] | 20 [Free] | 4 [90] | 1 [90] | 4 [90]
503	Maple St	20 [free] | 4 [90] | 1 [90] | 4 [90]
505	Ohio St	19 [flash] | 20 [Free] | 4 [90] | 1 [90] | 4 [90]
511	Western Ave	20 [free] | 4 [90] | 1 [90] | 4 [90]
499	Burt St	20 [free] | 4 [90] | 1 [90] | 4 [90]
510	West Dodge Rd*	4 [90] | 1 [120] | 4 [90]

120TH ST

568	West Maple Rd*	20 [free] | 4 [75] | 1 [90] | 4 [75]
798	Stonegate Dr	19 [flash] | 20 [Free] | 4 [90] | 1 [60] | 4 [90]
776	Miami St	19 [flash] | 20 [Free] | 4 [90] | 1 [60] | 4 [90]
670	Miracle Hills Dr	20 [free] | 4 [90] | 1 [120] | 4 [90]
612	Webster St	20 [free] | 4 [90] | 1 [120] | 4 [90]
567	West Dodge Rd	20 [free] | 4 [90] | 1 [120] | 4 [90]
558	Burke St	20 [free] | 4 [90] | 1 [120] | 4 [90]
563	Pacific St*	20 [free] | 1 [90]
938	115th St & Miracle Hills Dr	19 [flash] | 20 [free]

MAPLE ST

529	102nd St*	10 [free] | 4 [75] | 1 [90] | 4 [75]
521	97th St	19 [flash] | 20 [Free] | 4 [90] | 1 [90] | 4 [90]
513	93rd St	19 [flash] | 20 [Free] | 4 [90] | 1 [90] | 4 [90]
495	88th St	19 [flash] | 20 [Free] | 4 [90] | 1 [90] | 4 [90]
48	Keystone Dr	19 [flash] | 20 [Free] | 4 [90] | 1 [90] | 4 [90]
474	83rd St	20 [free] | 4 [90] | 1 [90] | 4 [90]
468	78th St	20 [free] | 4 [90] | 1 [90] | 4 [90]
460	75th St	19 [flash] | 20 [Free] | 4 [90] | 1 [90] | 4 [90]
450	72nd St	20 [free] | 4 [90] | 1 [90] | 4 [90]

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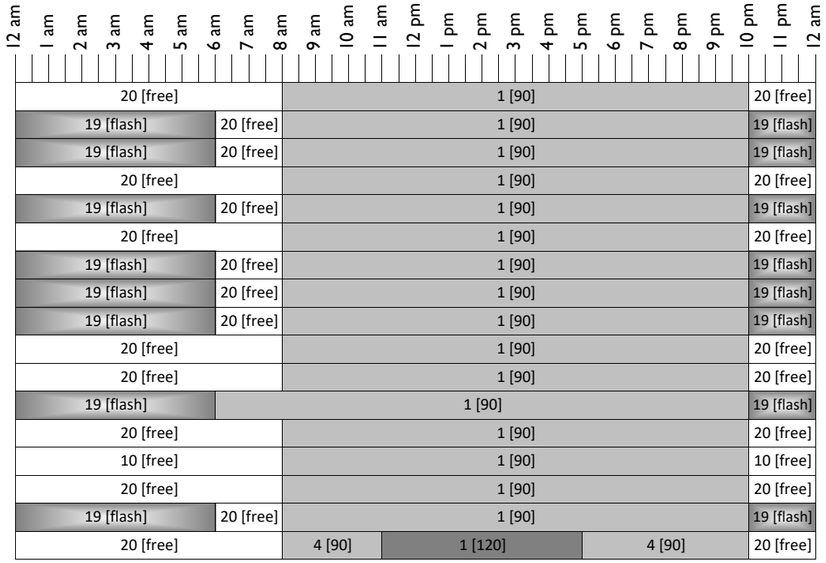
*Non-project intersections shown for information only.

LEGEND

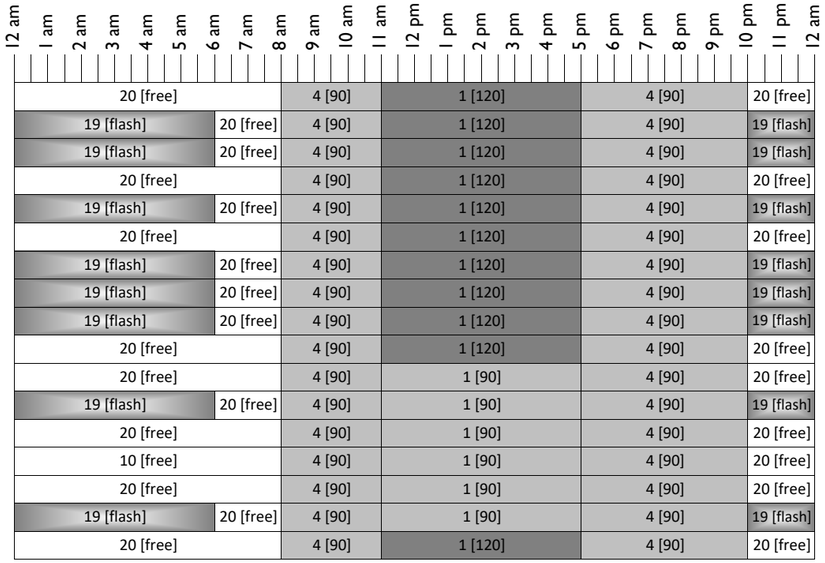
A white box indicates FREE operation, a shaded box indicates coordinated operation.
The first number specifies the pattern, the second number [in brackets] is the cycle length (s).
Darker shades represent a longer cycle length.

Figure 4.6
Saturday Day Plan Schedule

EXISTING SCHEDULES
SUNDAY



IMPLEMENTED SCHEDULES
SUNDAY



*Non-project intersections shown for information only.

LEGEND

A white box indicates FREE operation, a shaded box indicates coordinated operation.
The first number specifies the pattern, the second number [in brackets] is the cycle length (s).
Darker shades represent a longer cycle length.

Figure 4.7
Sunday Day Plan Schedule

4.4 Cycle Length Evaluation

Cycle lengths for each corridor were evaluated using Synchro's cycle length optimization tool. Cycle lengths were considered in 10-second intervals, but emphasis was given to maintaining the City's use of 90, 120, and 150-second cycle lengths. An emphasis was also placed on trying to choose a network-wide cycle length, but due to varying roadway characteristics and traffic volumes, it was determined the optimal solution for the MD and PM peak periods was to select independent cycle lengths east and west of Interstate 680 (I-680).

For the MD peak period, a 120-second cycle length was initially selected to provide a network-wide cycle length. However, upon deeper analysis during the optimization process, it was determined that the optimal solution was to split the network and run a 90-second cycle length for the portion of the network east of I-680. The implemented cycle lengths for each intersection are shown in **Figure 4.8** through **Figure 4.11**. Network measures of effectiveness used to inform initial cycle length selections can be found in **Appendix F**.

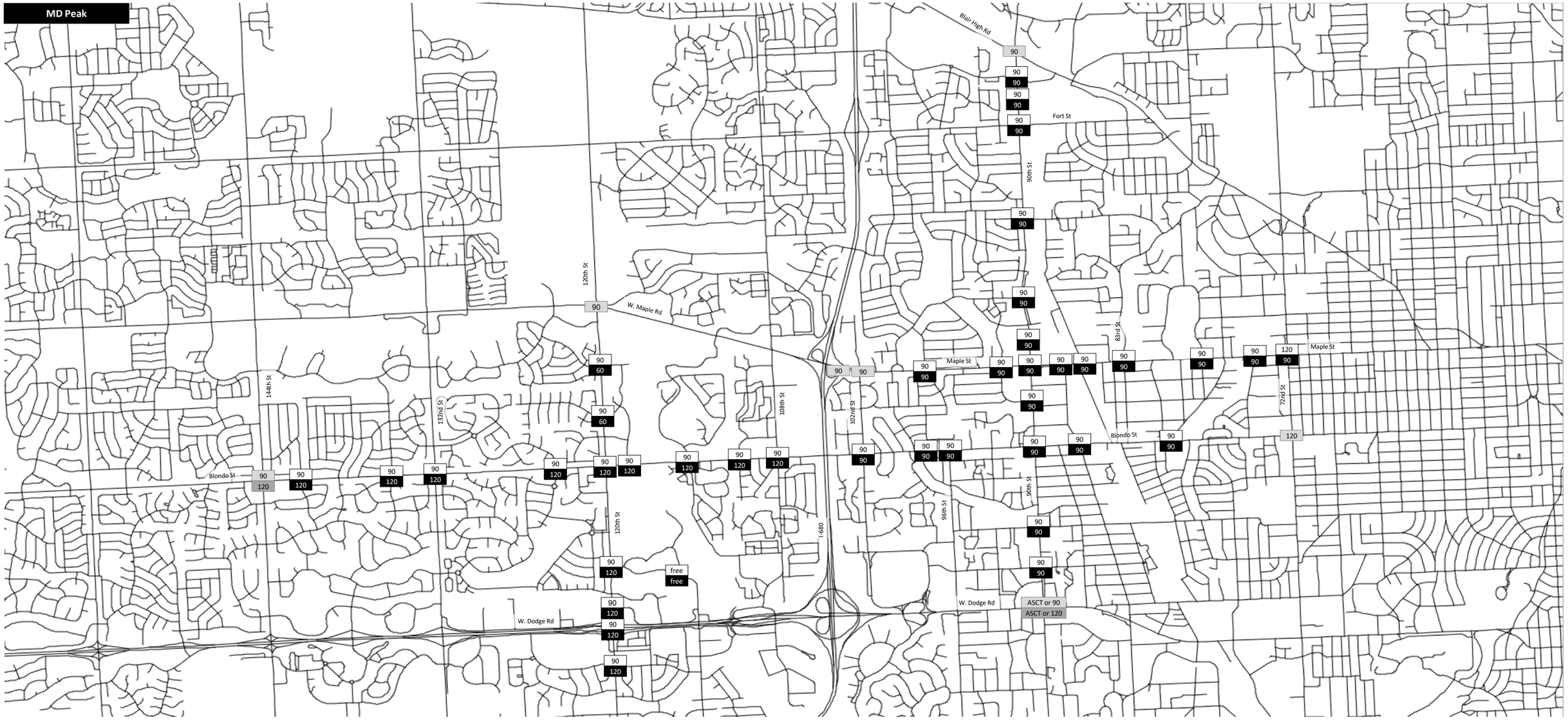
4.5 Progression Summary

Once cycle lengths were selected and agreed upon, progression was optimized for each corridor based on traffic demand for each analysis period. General descriptions of the strategy for each analysis period and corridor are provided below.

Plan 1 – MD Peak

- Traffic volumes are generally balanced along Blondo Street. A bidirectional progression plan was developed with the intention of minimizing stop delay at the major intersections.
- Traffic volumes are generally balanced along 90th Street. A bidirectional green band of approximately 25 seconds was achieved through the corridor.
- Traffic volumes are generally balanced along 120th Street. Special care was given to providing progression to high volume turning movements including the westbound left-turn from 120th Street & Blondo Street and the eastbound left-turn and westbound right-turn from 120th Street & West Dodge Road. The westbound right-turn movement from 120th Street & West Dodge Road has a larger volume of traffic than the eastbound left-turn movement but is less critical when it comes to potential gridlock conditions with 120th Street & Webster Street. A twice per cycle left-turn (TPCLT) was implemented for the northbound left-turn at 120th Street & Webster Street to help keep the 120th Street segment between Webster Street and West Dodge Road clear and reduce the risk of momentary gridlock conditions.
- Traffic volumes are generally balanced along Maple Street. A bidirectional green band of approximately 17 seconds was achieved through the corridor.

MD Peak



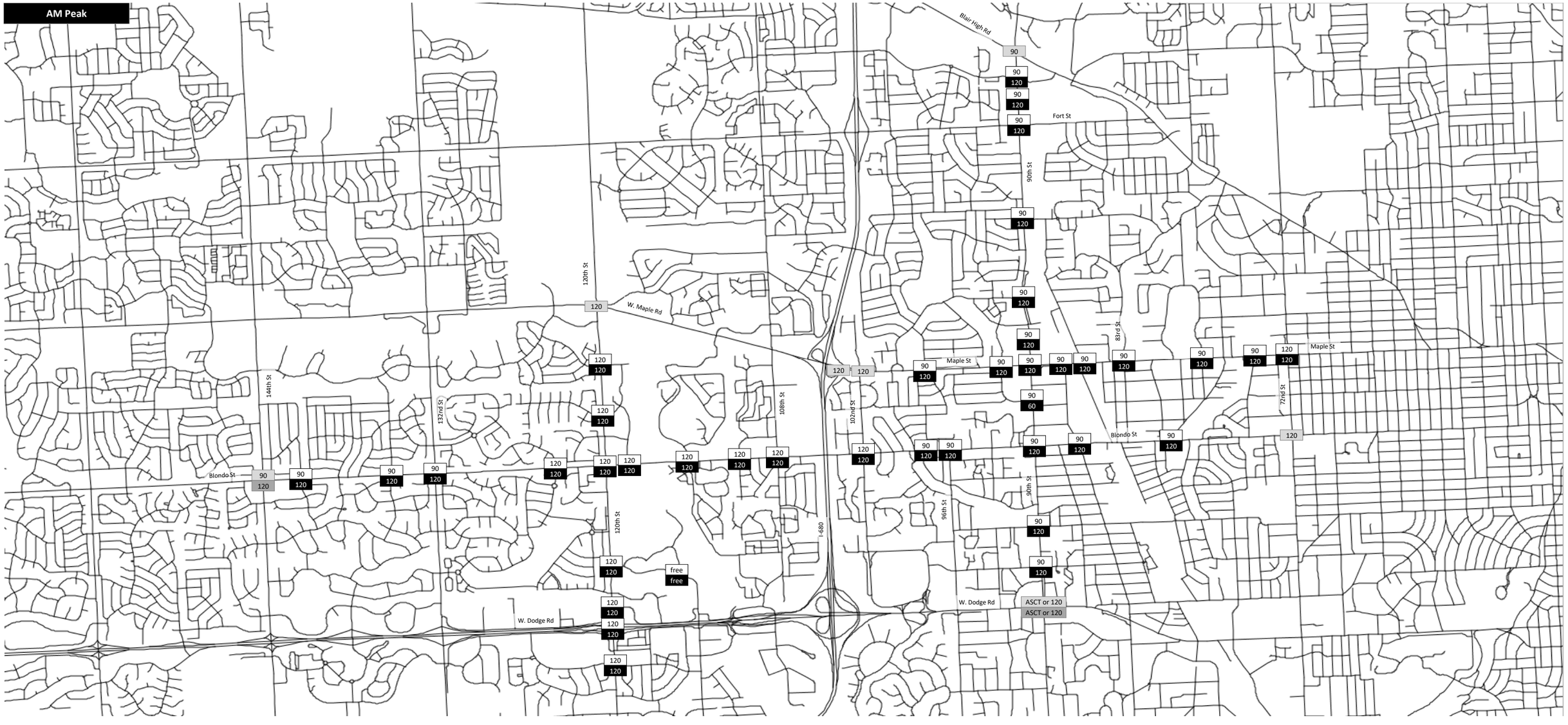
120 Existing Cycle Length
120 Implemented Cycle Length

120 Existing Cycle Length (Adjacent Intersection)
120 Implemented Cycle Length (Adjacent Intersection)

N

Figure 4.8
Plan 1 - MD Cycle Lengths

AM Peak



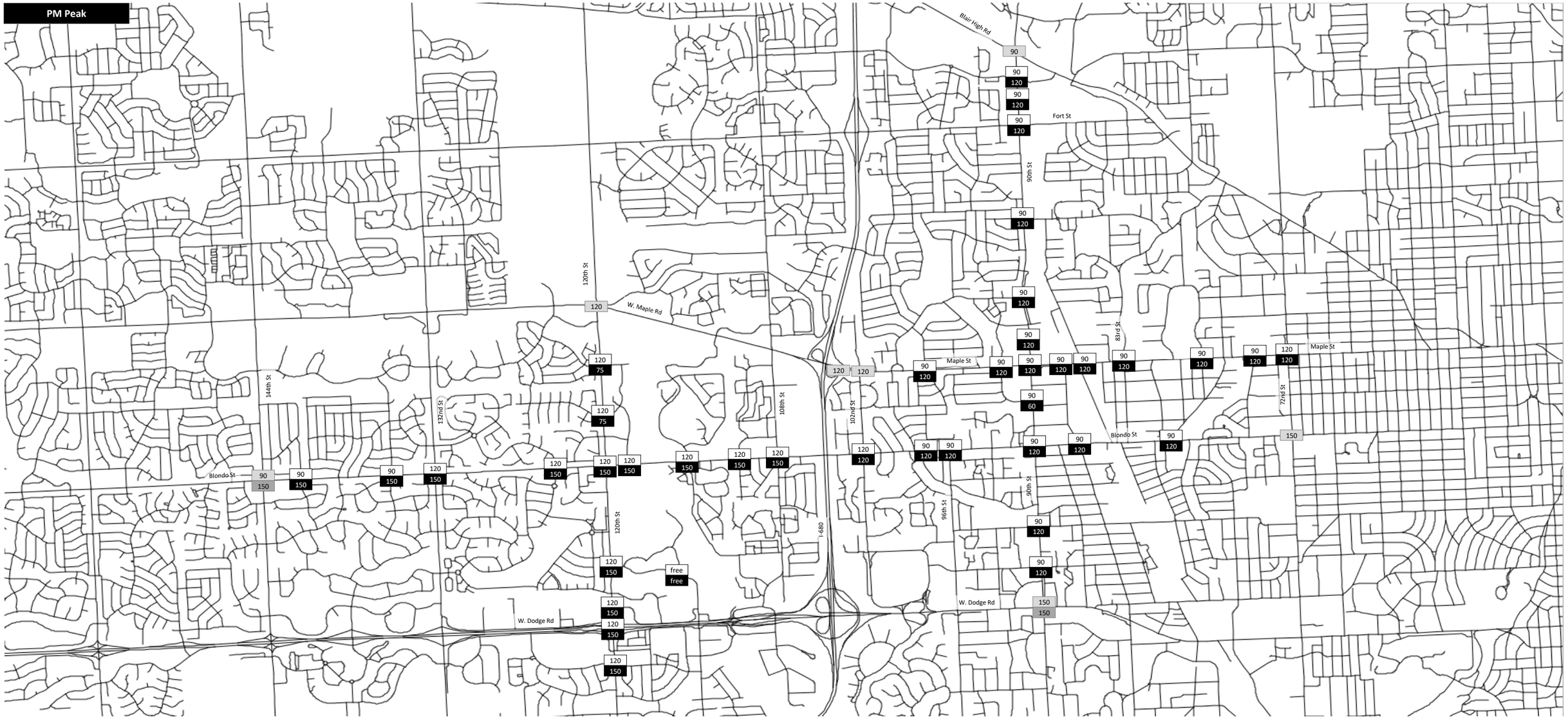
120 / 120 Existing Cycle Length / Implemented Cycle Length

120 / 120 Existing Cycle Length (Adjacent Intersection) / Implemented Cycle Length (Adjacent Intersection)

N

Figure 4.9
Plan 2 - AM Cycle Lengths

PM Peak



120 Existing Cycle Length
120 Implemented Cycle Length

120 Existing Cycle Length (Adjacent Intersection)
120 Implemented Cycle Length (Adjacent Intersection)

N

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Figure 4.10
Plan 3 - PM Cycle Lengths

Offpeak

Blair High Rd
Fort St
90th St
120th St
W. Maple Rd
Maple St
83rd St
72nd St
144th St
132nd St
108th St
102nd St
Blondo St
96th St
90th St
I-680
W. Dodge Rd

120 Existing Cycle Length
120 Implemented Cycle Length

120 Existing Cycle Length (Adjacent Intersection)
120 Implemented Cycle Length (Adjacent Intersection)

N

Figure 4.11
Plan 4 - Offpeak Cycle Lengths

Plan 2 – AM Peak

- Traffic volumes are heavier in the eastbound direction along Blondo Street but a more balanced from 102nd Street to the east. An eastbound green band of 20 seconds through the corridor up to 72nd Street was achieved. Westbound progression has a few planned short stops at 90th Street, around 120th Street, and potentially a long stop at 144th Street.
- Traffic volumes are heavier in the southbound direction along 90th Street. Special care was given to providing progression to high volume turning movements including the westbound left-turn from 90th Street & Blondo Street. A southbound green band of 36 seconds through the corridor up to West Dodge Road was achieved. Northbound progression has planned short stops at Blondo Street and Maplewood Boulevard.
- Traffic volumes are heavier traveling towards West Dodge Road along 120th Street but are somewhat balanced between Blondo Street and West Dodge Road. Special care was given to providing progression to high volume turning movements including the westbound left-turn from 120th Street & Blondo Street and the eastbound left-turn from 120th Street & West Dodge Road. A TPCLT was implemented for the northbound left-turn at 120th Street & Webster Street to help keep the 120th Street segment between Webster Street and West Dodge Road clear and reduce the risk of momentary gridlock conditions.
- Traffic volumes are slightly heavier in the westbound direction along Maple Street. A green band of 29 seconds westbound, which is all the green time for westbound through at 72nd Street & Maple Street, and 20 seconds eastbound was achieved through the corridor.

Plan 3 – PM Peak

- Traffic volumes are heavier in the westbound direction along Blondo Street but a more balanced from 102nd Street to the east. A westbound green band of 25 seconds through the corridor was achieved. Eastbound progression has a planned stop at either 132nd Street or Papillion Parkway. The corridor has different cycle lengths on either side of I-680, so there is potential for additional stops as drivers cross between 108th Street and 102nd Street.
- Traffic volumes are heavier in the northbound direction along 90th Street. Special care was given to providing progression to high volume turning movements including the eastbound left-turn from 90th Street & Maple Street and the eastbound left-turn and westbound left-turn from 90th Street & Blondo Street. A green band of 28 seconds northbound through the corridor with a planned short stop at Maplewood Boulevard and 18 seconds southbound through the corridor was achieved.
- Traffic volumes are generally heavier in the northbound direction along 120th Street. Special care was given to providing progression to high volume turning movements including the westbound left-turn from 120th Street & Blondo Street and the eastbound left-turn and westbound right-turn from 120th Street & West Dodge Road. The westbound right-turn movement from 120th Street & West Dodge Road has a larger volume of traffic than the eastbound left-turn movement but is less critical when it comes to potential gridlock conditions with 120th Street & Webster Street. A TPCLT was implemented for the northbound left-turn at 120th Street & Webster Street to help keep the 120th Street segment between Webster Street and West Dodge Road clear and reduce the risk of momentary gridlock conditions.
- Traffic volumes are generally balanced along Maple Street. An eastbound green band of 34 seconds was achieved through the corridor, which is all the green time for eastbound through at 72nd Street & Maple Street. A westbound green band of 32 seconds through the corridor was achieved, which is all the green time for westbound through at 90th Street & Maple Street.

Plan 4 – Offpeak

- Traffic volumes are generally balanced along Blondo Street. A bidirectional progression plan was developed with the intention of minimizing stop delay at the major intersections. A westbound green band of 18 seconds was achieved through the corridor, which is all the green time for westbound through at 90th Street & Blondo Street. Eastbound progression has only a few planned short stops.
- Traffic volumes are generally balanced along 90th Street. A green band of 21 seconds northbound and 22 seconds southbound was achieved through the corridor.
- Traffic volumes are generally balanced along 120th Street. A bidirectional green band of approximately 15 seconds was achieved through the corridor. Special care was given to providing progression to high volume turning movements including the westbound left-turn from 120th Street & Blondo Street and the eastbound left-turn and westbound right-turn from 120th Street & West Dodge Road. The westbound right-turn movement from 120th Street & West Dodge Road has a larger volume of traffic than the eastbound left-turn movement but is less critical when it comes to potential gridlock conditions with 120th Street & Webster Street. The cycle length is not long enough to effectively implement a TPCLT, but the shorter cycle length will help to reduce the risk of momentary gridlock conditions.
- Traffic volumes are generally balanced along Maple Street. An eastbound green band of 18 seconds through the corridor up to 72nd Street was achieved. A westbound green band of 16 seconds through the corridor with a planned short stop at 90th Street was achieved.

5. Implementation

5.1 Controller Programming

Once optimized timings were developed and reviewed with the City, the consultants programmed the controller databases with the new timings. Prior to programming the new timings, uploads were performed to ensure the latest database was utilized. The signalized intersections within this project were operated by MAXTIME based 2070 ATC standard controllers. The controllers were programmed using VPN access to the City's web based MAXVIEW advanced traffic management system. Database programming was reviewed by the City prior to implementation.

5.2 Database Modifications

Alternate phase plans may be required when changing maximum green limits or other basic timing parameters by time-of-day. Lagging a permitted-protected four-section left-turn on any approach or omitting the green portion a four-section FYA on a non-coordinated approach will require an alternate detector plan for the phase to continue to be called properly. Similarly, omitting the FYA portion of a four-section FYA to run protected only operation will require an alternate overlap plan to omit the FYA and an alternate detector plan for the phase to continue to be called properly. Alternate phase plans are not common and none were utilized as part of this project. A summary of alternate detector and overlap plans by pattern is provided in **Table 5.1**. A list of locations with implemented sequences that are different than the existing (before condition) sequences is presented in **Table 5.2**. A detailed list of all existing and implemented sequences is provided in **Appendix G**.

An alternate detector plan was implemented at the intersection of 120th Street & Miracle Hills Drive during the AM peak period to allow the southbound left-turn to re-service when there is no demand on Miracle Hills Drive. Miracle Hills Drive primarily serves office complexes where traffic arrives during the AM peak but minimal traffic departs the area. To prevent the heavy southbound left-turn phase from being skipped when the intersection does not cycle to Miracle Hills Drive, an alternate detector plan was implemented that removes the southbound left-turn detector switching.

Recall and other database settings may be modified to improve efficiency, provide cross-corridor coordination, and/or to remove settings that are no longer relevant. For this project, the coordinated phases for the intersections of 132nd Street & Blondo Street and 72nd Street & Maple Street was changed from the north/south approaches to the east/west approaches. This was done to clarify east-west coordination is the priority, despite having lower volumes, due to proximity of neighboring signalized intersections. Maximum recall was set for east/west and left on for north/south at these intersections. Maximum recall was also set for east/west at the intersection of 120th Street & Blondo Street to allow east/west coordination.

Occasionally, maximum recall is set in place for a through movement opposing a lagging left-turn on the side-street approach. This is done to prevent excessive left-turn splits when the leading through movement gaps out but the lagging through movement is still extending potentially to its maximum split. The eastbound left-turn at 120th Street & West Dodge Road is set to lag during all standard coordinated patterns. The opposing through movement, however, is not set to max recall. This was done to allow for additional time for the eastbound left-turn as it is a heavy movement.

Table 5.1 Alternate Detector Plans / Overlap Plans by Pattern

ID #	Intersection	Detail	Plan 1 MD	Plan 2 AM	Plan 3 PM	Plan 4 OP
856	117th St & Blondo St	Plans	1 / 1	2 / 1	1 / 1	1 / 1
		EBL	-	ϕ5-Lag	-	-
536	108th St & Blondo St	Plans	5 / 1	1 / 1	1 / 1	4 / 1
		EBL	ϕ5-Lag	-	-	ϕ5-Lag
		NBL	ϕ3-Omit	-	-	ϕ3-Omit
527	102nd St & Blondo St	Plans	1 / 1	2 / 1	3 / 1	1 / 1
		WBL	-	ϕ1-Lag	ϕ1-Lag	-
		NBL	-	ϕ3-Omit	-	-
497	90th St & Blondo St	Plans	5 / 5	2 / 2	3 / 3	4 / 4
		EBL	ϕ5-Protected	ϕ5-Lag	ϕ5-Protected	ϕ5-Protected
		WBL	-	-	ϕ1-Protected	-
		NBL	ϕ3-Protected	ϕ3-Protected	ϕ3-Protected	ϕ3-Protected
501	90th St & Fort St	Plans	5 / 1	2 / 1	3 / 1	4 / 1
		EBL	-	ϕ5-Lag	-	-
		NBL	ϕ3-Lag	ϕ3-Lag	ϕ3-Lag	ϕ3-Lag
		SBL	-	ϕ7-Lag	-	-
645	90th St & Maple Village St	Plans	5 / 1	1 / 1	3 / 1	4 / 1
		NBL	ϕ3-Lag	-	ϕ3-Lag	ϕ3-Lag
670	120th St & Miracle Hills Dr	Plans	1 / 1	2 / 1	1 / 1	4 / 1
		SBL	-	ϕ7-Re-Service	-	ϕ7-Lag
612	120th St & Webster St	Plans	5 / 5	2 / 2	3 / 3	1 / 1
		NBL	ϕ3-TPCLT	ϕ3-TPCLT	ϕ3-TPCLT	-
558	120th St & Burke St	Plans	1 / 1	1 / 1	1 / 1	4 / 1
		NBL	-	-	-	ϕ3-Lag
450	72nd St & Maple St	Plans	1 / 1	2 / 1	1 / 1	4 / 1
		WBL	-	ϕ1-Lag	-	ϕ1-Lag
		SBL	-	-	-	ϕ7-Omit

Table 5.2 Unique Existing and Implemented Sequences

ID #	Intersection		Plan 1 MD	Plan 2 AM	Plan 3 PM	Plan 4 OP
696	132nd St & Blondo St	Existing	Seq 1	Seq 1	Seq 1	Seq 1
		Implemented	Seq 5	Seq 16	Seq 2	Seq 7
557	120th St & Blondo St	Existing	Seq 1	Seq 1	Seq 1	Seq 1
		Implemented	Seq 4	Seq 13	Seq 4	Seq 10
856	117th St & Blondo St	Existing	Seq 5	Seq 1	Seq 5	Seq 5
		Implemented	Seq 1	Seq 5	Seq 1	Seq 1
536	108th St & Blondo St	Existing	Seq 1	Seq 1	Seq 1	Seq 1
		Implemented	Seq 5	Seq 1	Seq 1	Seq 5
527	102nd St & Blondo St	Existing	Seq 1	Seq 1	Seq 1	Seq 1
		Implemented	Seq 1	Seq 2	Seq 2	Seq 1
497	90th St & Blondo St	Existing	Seq 1	Seq 1	Seq 1	Seq 1
		Implemented	Seq 7	Seq 5	Seq 5	Seq 7
501	90th St & Fort St	Existing	Seq 1	Seq 1	Seq 1	Seq 1
		Implemented	Seq 3	Seq 15	Seq 3	Seq 3
645	90th St & Maple Village St	Existing	Seq 3	Seq 3	Seq 3	Seq 3
		Implemented	Seq 3	Seq 1	Seq 3	Seq 3
503	90th St & Maple St	Existing	Seq 1	Seq 1	Seq 1	Seq 1
		Implemented	Seq 7	Seq 10	Seq 10	Seq 7
670	120th St & Miracle Hills Dr	Existing	Seq 9	Seq 9	Seq 1	Seq 9
		Implemented	Seq 1	Seq 1	Seq 1	Seq 9
612	120th St & Webster St	Existing	Seq 3	Seq 3	Seq 3	Seq 3
		Implemented	Seq 9	Seq 1	Seq 9	Seq 1
567	120th St & West Dodge Rd	Existing	Seq 3	Seq 1	Seq 1	Seq 3
		Implemented	Seq 13	Seq 7	Seq 13	Seq 13
558	120th St & Burke St	Existing	Seq 1	Seq 1	Seq 1	Seq 1
		Implemented	Seq 1	Seq 1	Seq 1	Seq 3
450	72nd St & Maple St	Existing	Seq 1	Seq 1	Seq 1	Seq 1
		Implemented	Seq 5	Seq 6	Seq 5	Seq 2

5.3 Implementation Day

Optimized signal timings were downloaded on September 18, 2023. Prior to downloading the new timings, another upload was performed for each intersection. This was to ensure no critical changes were made to the controller's database between the date of the upload used for programming and implementation day. Once any relevant changes were applied to the databases with new timings, the consultants downloaded the new timings to the controllers one by one from the City's traffic maintenance shop. Consultant staff were present at each intersection to ensure all movements served properly prior to downloading new timings to the next intersection.

5.4 Fine-Tuning

Immediately following implementation, fine tuning of the optimized timings began. Each intersection was observed during each optimized time period and the corridors were repeatedly driven with GPS connected Tru-Traffic software to ensure proper operation of the timings. Changes to further improve the timings were implemented immediately via VPN connection to the City's servers from a consultant laptop in the field. This allowed the changes to be observed immediately and further refined as necessary. A summary of changes was provided to the City upon completion of the fine-tuning process.

5.5 Public Comments

One citizen comment regarding traffic operations was received after the new timings were implemented in September 2023. FHU staff subsequently made site visits to the project intersection to determine if any signal timing changes needed to be made to address the comment. The following is a summary of the comment received:

- 120th Street & West Dodge Road – A comment was received relating to the duration of the eastbound left-turn phase. A time of day was not provided, but the comment described 20 seconds of green for eastbound through and 10 seconds of green for the eastbound left-turn, allowing only 1-2 cars to turn left per cycle. These green times accurately describe the offpeak plan, pattern 4. The comment is likely describing just after 9:00 AM or just after 6:30 PM, when the signal is transitioning from a longer cycle length to the shorter offpeak cycle length. During these times, it is possible for the left-turn to receive as little as around 7 seconds of green for one or two cycles while the controller transitions to be synchronized for the offpeak period. This could result in only 2 left-turning vehicles per lane making it through the signal. The issue only occurs during transitions and helps to quickly synchronize with nearby signals. No change was made as this is part of normal signal function and is one of the trade-offs with shorter cycle lengths that reduce overall delay.

5.6 Crash Monitoring for Perceived Yellow Traps

One of the operational benefits of implementing FYA left-turns is the ability safely lag opposing left-turns without creating a yellow trap because the signal is actively providing drivers information on the control status for their left-turn. However, a concern remains for a perceived yellow trap. This happens when the opposing lagging left-turn is about to become active, the adjacent through movement is ending, and drivers perceive their left-turn phase to be ending even though they are still receiving a FYA indication.

The City has taken a proactive approach to providing safe and efficient operations to drivers in Omaha. They are actively monitoring for crashes occurring at locations where a perceived yellow trap could occur. **Table 5.3** summarizes crashes occurring at these locations over the first 46 days since the timings were implemented. Only two crashes have occurred, and they were associated with the lagging left-turn direction and therefore not related to a perceived yellow trap. The City will continue to monitor these locations for any increases in crash rates and consider changes if an increase is observed.

Table 5.3 Crash Monitoring for Perceived Yellow Traps

ID #	Intersection	Reason	Direction	Patterns	Reported Crashes (9/18/23 - 11/3/23)
856	117th St & Blondo St	Omit	EBL	1, 4	0
536	108th St & Blondo St	Omit	NBL	1, 4	0
		Lead/Lag	WBL/EBL	1, 4	0
527	102nd St & Blondo St	Omit	EBL	1, 2, 4	0
		Omit	WBL	1, 4	0
		Omit	NBL	2	0
		Lead/Lag	EBL/WBL	2, 3	0
377	96th St & Blondo St	Omit	WBL	4	0
645	90th St & Maple Village St	Omit	NBL	2	0
		Omit	SBL	ALL	0
		Lead/Lag	SBL/NBL	1, 3, 4	0
474	83rd St & Maple St	Omit	EBL	1, 2, 4	0
450	72nd St & Maple St	Omit	SBL	4	0
		Lead/Lag	WBL/EBL	1, 3	0
		Lag/Lag	EBL/WBL	2	0
497	90th St & Blondo St	Lead/Lag	SBL/NBL	1, 4	0
		Lead/Lag	WBL/EBL	1, 2, 4	1 (EBL - Lag)
501	90th St & Fort St	Lead/Lag	SBL/NBL	1, 3, 4	0
		Lag/Lag	NBL/SBL	2	0
		Lead/Lag	WBL/EBL	2	1 (EBL - Lag)
558	120th St & Burke St	Lead/Lag	SBL/NBL	4	0

6. Performance Evaluation

6.1 Network Performance Measures

The existing conditions Synchro model was used as a benchmark by which the implemented conditions could be compared. Network performance measures including total delay, total stops, total travel time, and fuel consumed were analyzed. These performance measures are calculated, not field measured, and reflect data for all vehicles in the network. **Table 6.1** depicts the MOE's for the total project area. **Table 6.2** and **Table 6.3** depict the MOEs for the implemented timing plans for the project area west and east of I-680, respectively. Synchro model output reports are provided in **Appendix H**.

Table 6.1 Network Performance Measures – Total

	AM Peak			PM Peak		
	Ex	Imp	Dif	Ex	Imp	Dif
Total Delay (hr)	322	323	0.3%	770	739	-4.0%
Total Stops (#)	30,933	27,919	-9.7%	49,771	48,265	-3.0%
Total Travel Time (hr)	897	898	0.1%	1,590	1,558	-2.0%
Fuel Consumed (gal)	1,348	1,317	-2.3%	2,195	2,154	-1.9%
	MD Peak			Off Peak		
	Ex	Imp	Dif	Ex	Imp	Dif
Total Delay (hr)	286	278	-2.8%	227	215	-5.3%
Total Stops (#)	30,540	28,029	-8.2%	25,923	24,004	-7.4%
Total Travel Time (hr)	847	838	-1.1%	717	705	-1.7%
Fuel Consumed (gal)	1,291	1,260	-2.4%	1,108	1,080	-2.5%

Table 6.2 Network Performance Measures – West of I-680

	AM Peak			PM Peak		
	Ex	Imp	Dif	Ex	Imp	Dif
Total Delay (hr)	190	183	-3.7%	409	382	-6.6%
Total Stops (#)	16,273	15,856	-2.6%	23,989	24,073	0.4%
Total Travel Time (hr)	441	434	-1.6%	753	725	-3.7%
Fuel Consumed (gal)	665	654	-1.7%	1,030	1,008	-2.1%
	MD Peak			Off Peak		
	Ex	Imp	Dif	Ex	Imp	Dif
Total Delay (hr)	122	133	9.0%	104	102	-1.9%
Total Stops (#)	12,754	12,029	-5.7%	11,239	10,918	-2.9%
Total Travel Time (hr)	328	339	3.4%	293	290	-1.0%
Fuel Consumed (gal)	511	512	0.2%	460	455	-1.1%

Table 6.3 Network Performance Measures – East of I-680

	AM Peak			PM Peak		
	Ex	Imp	Dif	Ex	Imp	Dif
Total Delay (hr)	133	140	5.3%	361	357	-1.1%
Total Stops (#)	14,660	12,063	-17.7%	25,782	24,193	-6.2%
Total Travel Time (hr)	456	463	1.5%	837	833	-0.5%
Fuel Consumed (gal)	684	663	-3.1%	1,166	1,146	-1.7%
	MD Peak			Off Peak		
	Ex	Imp	Dif	Ex	Imp	Dif
Total Delay (hr)	165	145	-12.1%	122	114	-6.6%
Total Stops (#)	17,786	16,000	-10.0%	14,684	13,087	-10.9%
Total Travel Time (hr)	518	498	-3.9%	424	415	-2.1%
Fuel Consumed (gal)	780	748	-4.1%	648	625	-3.5%

6.2 Intersection Performance Measures

Individual intersections were also analyzed by comparing the existing and implemented conditions Synchro models. **Table 6.4** through **Table 6.7** detail the intersection signal delay, in seconds per vehicle and LOS grade, for each intersection in the existing and implemented conditions. **Table 6.8** summarizes the number of intersections where overall delay per vehicle decreased, increased by five seconds or less, or increased by greater than five seconds.

Table 6.4 Intersection Performance Measures: Blondo St

ID #	Intersection	Delay (sec/veh) - LOS							
		Plan 1 MD		Plan 2 AM		Plan 3 PM		Plan 4 OP	
		Ex	Imp	Ex	Imp	Ex	Imp	Ex	Imp
671	141st Ave & Blondo St	11 - B	15 - B	14 - B	16 - B	6 - A	4 - A	4 - A	4 - A
972	135th St & Blondo St	2 - A	3 - A	4 - A	6 - A	4 - A	3 - A	2 - A	2 - A
696	132nd St & Blondo St	27 - C	31 - C	31 - C	31 - C	50 - D	49 - D	25 - C	25 - C
843	123rd St & Blondo St	7 - A	9 - A	12 - B	11 - B	6 - A	7 - A	6 - A	7 - A
557	120th St & Blondo St	27 - C	27 - C	31 - C	29 - C	40 - D	42 - D	26 - C	24 - C
856	117th Ave & Blondo St	6 - A	5 - A	6 - A	10 - A	55 - E	42 - D	5 - A	3 - A
824	Papillion Pkwy & Blondo St	9 - A	12 - B	22 - C	21 - C	23 - C	22 - C	9 - A	8 - A
548	111th St & Blondo St	5 - A	3 - A	2 - A	1 - A	5 - A	4 - A	4 - A	4 - A
536	108th St & Blondo St	16 - B	19 - B	32 - C	29 - C	73 - E	62 - E	16 - B	15 - B
527	102nd St & Blondo St	18 - B	15 - B	21 - C	17 - B	27 - C	26 - C	15 - B	13 - B
520	97th St & Blondo St	3 - A	2 - A	2 - A	2 - A	2 - A	1 - A	4 - A	2 - A
377	96th St & Blondo St	7 - A	7 - A	6 - A	6 - A	11 - B	12 - B	10 - A	5 - A
497	90th St & Blondo St	33 - C	37 - D	24 - C	29 - C	108 - F	105 - F	24 - C	26 - C
492	85th St/88th St & Blondo St	12 - B	12 - B	6 - A	9 - A	18 - B	24 - C	10 - A	9 - A
3	Benson Gardens Blvd & Blondo St	4 - A	4 - A	4 - A	3 - A	4 - A	5 - A	4 - A	4 - A

Table 6.5 Intersection Performance Measures: 90th St

ID #	Intersection	Delay (sec/veh) - LOS							
		Plan 1 MD		Plan 2 AM		Plan 3 PM		Plan 4 OP	
		Ex	Imp	Ex	Imp	Ex	Imp	Ex	Imp
710	90th St & Military Rd	11 - B	11 - B	9 - A	14 - B	9 - A	13 - B	7 - A	7 - A
500	90th St & Ellison Plz	8 - A	7 - A	4 - A	6 - A	9 - A	11 - B	8 - A	7 - A
501	90th St & Fort St	29 - C	25 - C	25 - C	30 - C	37 - D	39 - D	27 - C	26 - C
498	90th St & Taylor St/Boyd St	6 - A	5 - A	9 - A	10 - B	9 - A	9 - A	7 - A	6 - A
504	90th St & Maplewood Blvd	8 - A	9 - A	7 - A	7 - A	9 - A	13 - B	9 - A	8 - A
645	90th St & Maple Village	8 - A	7 - A	4 - A	2 - A	8 - A	7 - A	7 - A	7 - A
503	90th St & Maple St	33 - C	23 - C	31 - C	34 - C	46 - D	31 - C	29 - C	27 - C
505	90th St & Ohio St/Lake St	6 - A	6 - A	4 - A	3 - A	7 - A	4 - A	4 - A	4 - A
511	90th St & Western Ave	9 - A	10 - A	18 - B	19 - B	13 - B	18 - B	8 - A	9 - A
499	90th St & Burt St	7 - A	6 - A	7 - A	8 - A	14 - B	21 - C	10 - A	8 - A

Table 6.6 Intersection Performance Measures: 120th St

ID #	Intersection	Delay (sec/veh) - LOS							
		Plan 1 MD		Plan 2 AM		Plan 3 PM		Plan 4 OP	
		Ex	Imp	Ex	Imp	Ex	Imp	Ex	Imp
798	120th St & Stonegate St	5 - A	5 - A	10 - B	9 - A	9 - A	7 - A	6 - A	7 - A
776	120th St & Miami St	7 - A	5 - A	7 - A	6 - A	10 - B	9 - A	5 - A	4 - A
670	120th St & Miracle Hills Dr	10 - A	11 - B	9 - A	8 - A	13 - B	16 - B	7 - A	6 - A
612	120th St & Webster St	29 - C	29 - C	18 - B	19 - B	52 - D	48 - D	23 - C	26 - C
567	120th St & West Dodge Rd	29 - C	34 - C	41 - D	37 - D	43 - D	44 - D	28 - C	27 - C
558	120th St & Burke Blvd/Burke St	8 - A	10 - B	26 - C	25 - C	13 - B	17 - B	7 - A	7 - A
938	115th St & Miracle Hills Dr	5 - A	5 - A	2 - A	2 - A	8 - A	8 - A	3 - A	3 - A

Table 6.7 Intersection Performance Measures: Maple St

ID #	Intersection	Delay (sec/veh) - LOS							
		Plan 1 MD		Plan 2 AM		Plan 3 PM		Plan 4 OP	
		Ex	Imp	Ex	Imp	Ex	Imp	Ex	Imp
521	97th St & Maple St	4 - A	3 - A	4 - A	4 - A	5 - A	4 - A	3 - A	3 - A
513	93rd St & Maple St	5 - A	5 - A	3 - A	4 - A	8 - A	12 - B	5 - A	5 - A
495	88th St & Maple St	7 - A	6 - A	7 - A	7 - A	12 - B	13 - B	9 - A	9 - A
48	Keystone Dr & Maple St	6 - A	6 - A	6 - A	7 - A	7 - A	11 - B	6 - A	6 - A
474	83rd St & Maple St	8 - A	4 - A	9 - A	10 - B	9 - A	8 - A	8 - A	5 - A
468	78th St & Maple St	2 - A	2 - A	2 - A	2 - A	3 - A	3 - A	2 - A	2 - A
460	75th St & Maple St	6 - A	6 - A	4 - A	3 - A	4 - A	3 - A	3 - A	2 - A
450	72nd St & Maple St	34 - C	28 - C	31 - C	28 - C	39 - D	39 - D	25 - C	23 - C

Table 6.8 Intersection Performance Measures

Number of Intersections Where:	MD	AM	PM	OP
Delay Decreased	25	22	22	31
Delay Increased ≤ 5 sec/veh	15	18	16	9
Delay Increased > 5 sec/veh	0	0	2	0

Table 6.9 summarizes when and where overall intersection delay increased by more than 5 seconds per vehicle. In general, overall delay at an intersection will increase when the cycle length is increased to maintain coordination but is already above its natural cycle length, when an intersection becomes a programmed stop along the corridor when it was not previously, or when clearance intervals are increased, especially if the intersection is at or near capacity.

Table 6.9 Intersections with Delay Increased Greater Than 5 Seconds per Vehicle

ID #	Intersection	Period	Existing Delay (sec/veh) - LOS	Implemented Delay (sec/veh) - LOS
492	85th St/88th St & Blondo St	PM	18 - B	24 - C
499	90th St & Burt St	PM	14 - B	21 - C

The specific reasons for the increases in delay greater than 5 seconds per vehicle include:

- 85th St/88th St & Blondo St - Increased cycle length resulted in additional delay and the offset is now lined up to maximize westbound throughput at the intersection of 90th Street & Blondo Street. The offset location as well as the increased side-street split duration due to the longer cycle length result in stops for most of the southbound left-turn and northbound right-turn traffic from 90th Street.
- 90th St & Burt St - Increased cycle length resulted in additional delay for Burt Street. Approach delay for the northbound and southbound approaches changed from 5.0 to 5.1 and 3.4 to 2.0 seconds per vehicle, respectively, while approach delay for the eastbound and westbound approaches increased from 50.9 to 83.7 and 46.4 to 82.1 seconds per vehicle, respectively. The intersection has a natural cycle length of 40 seconds, but could not be half cycled due to traffic volumes on 90th Street as well as the spacing with Western Avenue is not conducive to progression with a 60-second cycle length.

6.3 Pedestrian Performance Measures

Pedestrian benefits are derived from safety, convenience, and delay. In addition to updating pedestrian clearance values, providing a leading pedestrian interval (LPI) is a way to improve pedestrian safety at signalized intersections. Pedestrian convenience comes from pedestrian recalls, reducing the effort required of a pedestrian to cross the intersection. Pedestrian delay comes directly from the coordinated cycle length. Longer cycle lengths lead to longer wait times for pedestrians to cross the intersection. There are 100 LPIs and 55 phases with pedestrian recalls in place out of a total of 153 pedestrian phases at the completion of this project.

6.4 Corridor Performance Measures

Field measured performance metrics were recorded with Tru-Traffic (v10) software and a direct connect GPS receiver. Travel time runs were conducted before new timings were implemented and after fine tuning was complete to document improvements for vehicles travelling along the corridors. Corridor performance measures including travel time, delay, and stops for through traffic along Blondo Street and 90th Street are summarized.

Maximum corridor benefits are summarized in **Table 6.10** for Blondo Street between 144th Street and Benson Gardens Boulevard and for 90th Street between Military Road and Burt Street. **Figure 6.1** depicts corridor performance MOEs for Blondo Street and **Figure 6.2** depicts corridor performance MOEs for 90th Street. Detailed corridor performance measures including travel time, delay, and stops for through traffic along Blondo Street and 90th Street are summarized in **Appendix I**.

Table 6.10 Maximum Corridor Benefits

Blondo St	Eastbound	Westbound
Travel Time Reduction (min:sec)	2:15	1:37
Percent Delay Reduction	65%	61%
Percent Stops Reduction	65%	63%
90th St	**Northbound**	**Southbound**
Travel Time Reduction (min:sec)	1:17	1:06
Percent Delay Reduction	70%	69%
Percent Stops Reduction	50%	91%

6.5 Benefit Cost Analysis (Timing)

A benefit cost analysis (BCA) was conducted to determine the City's anticipated return on investment from this project. The benefits of a retiming project are derived primarily from travel time savings, fuel savings, reductions in crash costs, reductions in greenhouse gas emissions, and air quality improvements.

The City has developed a methodology, in-line with national industry standards, to calculate the monetary value of each benefit. Based on this methodology, the monetary benefit of this project over the next five years is anticipated to be $10,199,000. A breakdown of the project benefits over the next five years is shown in **Table 6.11**. Detailed project benefit calculations are provided in **Appendix J**. The cost to complete this project will not exceed $214,682.74, yielding a benefit/cost ratio of at least **48:1**.

Table 6.11 Project Benefits Over 5 Years

Performance Measure	Project Benefit	Present Value
Delay Reduction	154,034 hours	$4,329,000
Fuel Consumption Reduction	393,058 gallons	$1,297,000
Emissions Reduction	3,506 tons	$264,000
Crash Reduction	57 crashes	$4,309,000
Total Project Benefit		**$10,199,000**
Benefit : Cost Ratio		**48:1**

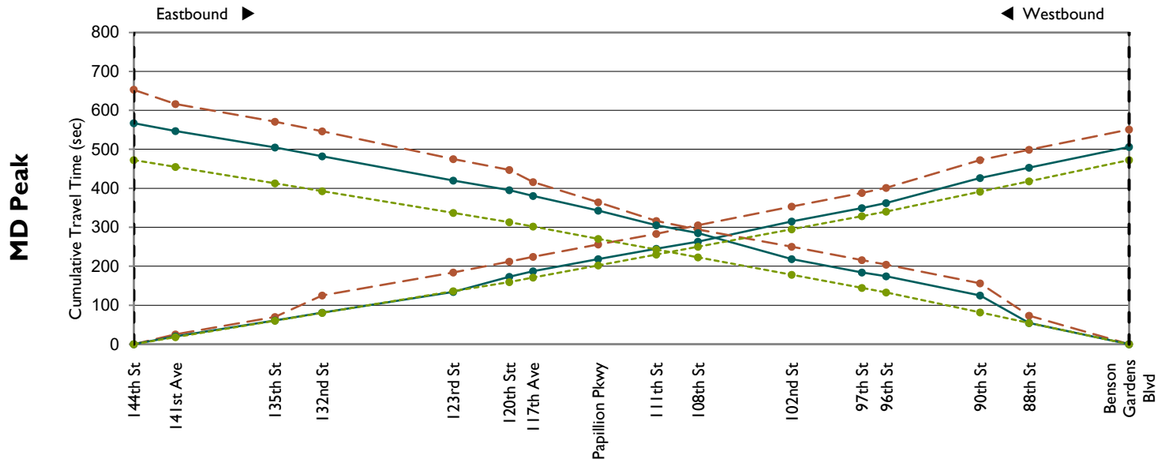
Average Total Travel Time & Delay

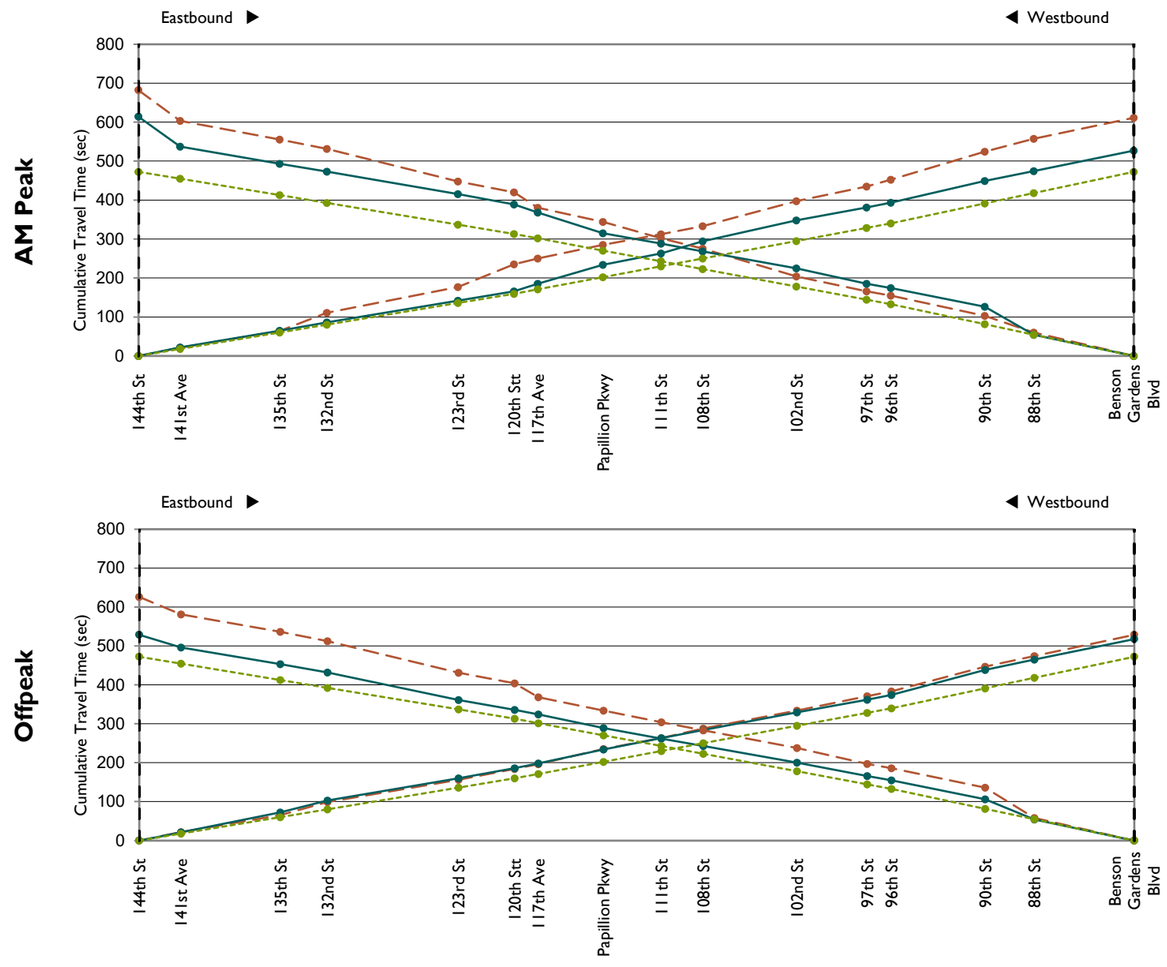
Blondo St: 5.3 miles

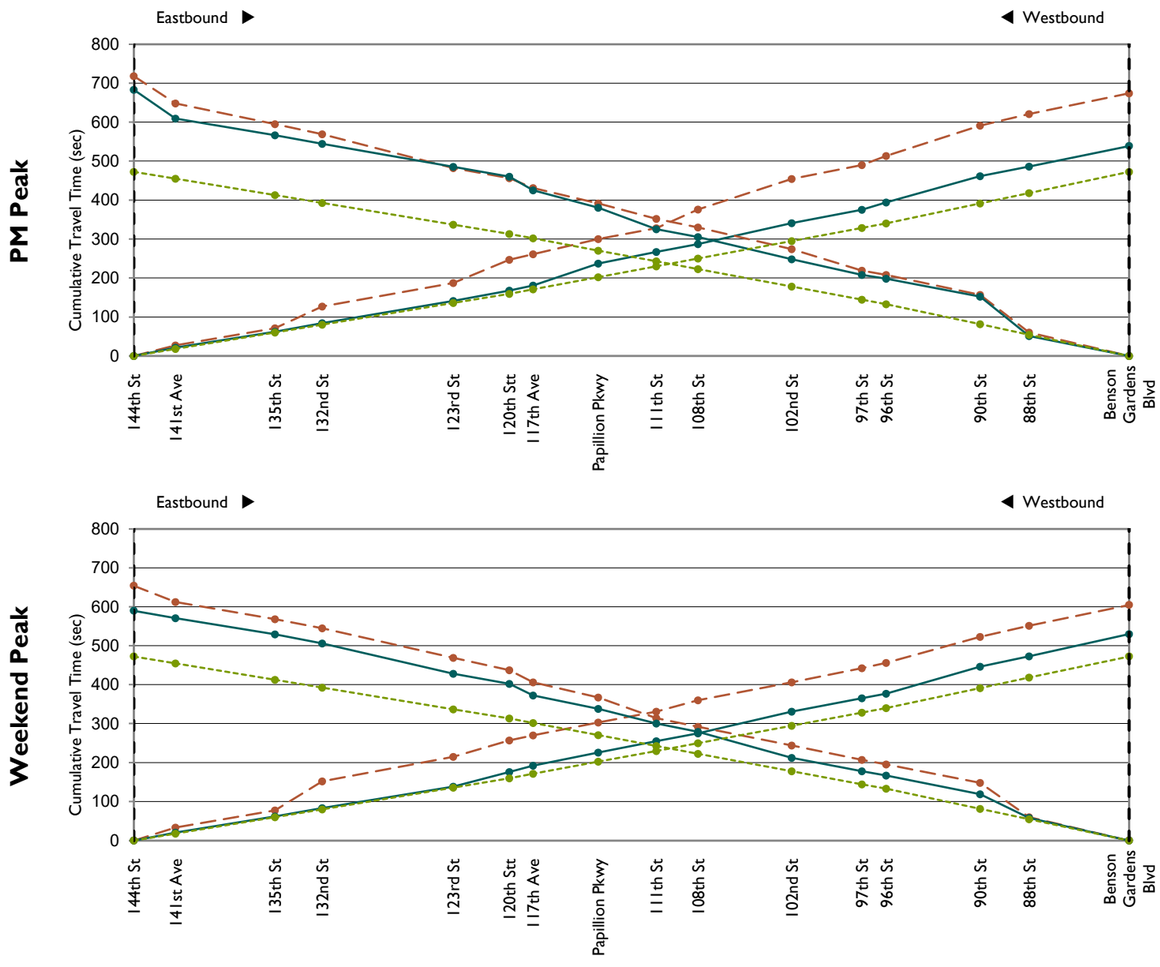
		AM Peak		Offpeak		MD Peak		PM Peak		Weekend Peak	
		Travel Time (sec)	Delay (sec)	Travel Time (sec)	Delay (sec)	Travel Time (sec)	Delay (sec)	Travel Time (sec)	Delay (sec)	Travel Time (sec)	Delay (sec)
Eastbound	Existing	611	145	529	63	551	85	674	208	605	139
	Implemented	527	61	518	52	506	40	539	73	530	63
	Difference	-84		-11		-45		-135		-75	
	% Difference	-13.7%	-57.9%	-2.1%	-17.5%	-8.2%	-52.9%	-20.0%	-64.9%	-12.4%	-54.0%
Westbound	Existing	682	216	626	160	653	187	718	251	654	188
	Implemented	614	147	529	63	567	101	683	217	590	124
	Difference	-68		-97		-86		-35		-64	
	% Difference	-10.0%	-31.5%	-15.5%	-60.6%	-13.2%	-46.0%	-4.9%	-13.9%	-9.8%	-34.0%

Eastbound : 144th St to Benson Gardens Blvd

Westbound : Benson Gardens Blvd to 144th St







FELSBURG HOLT & ULLEVIG

Existing
Implemented
Free Flow

Figure 6.1
Average Travel Time & Delay
Blondo St

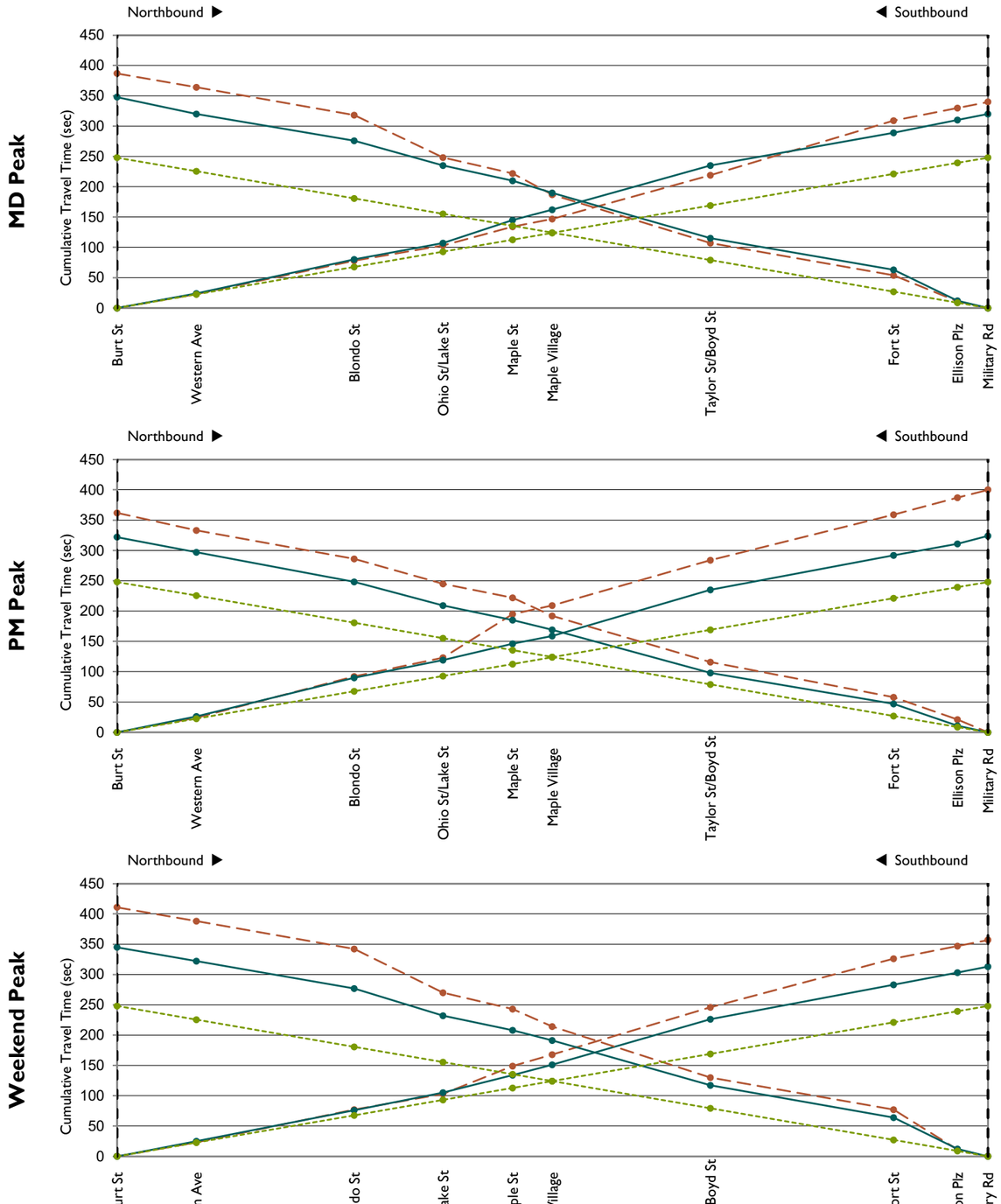
Average Total Travel Time & Delay

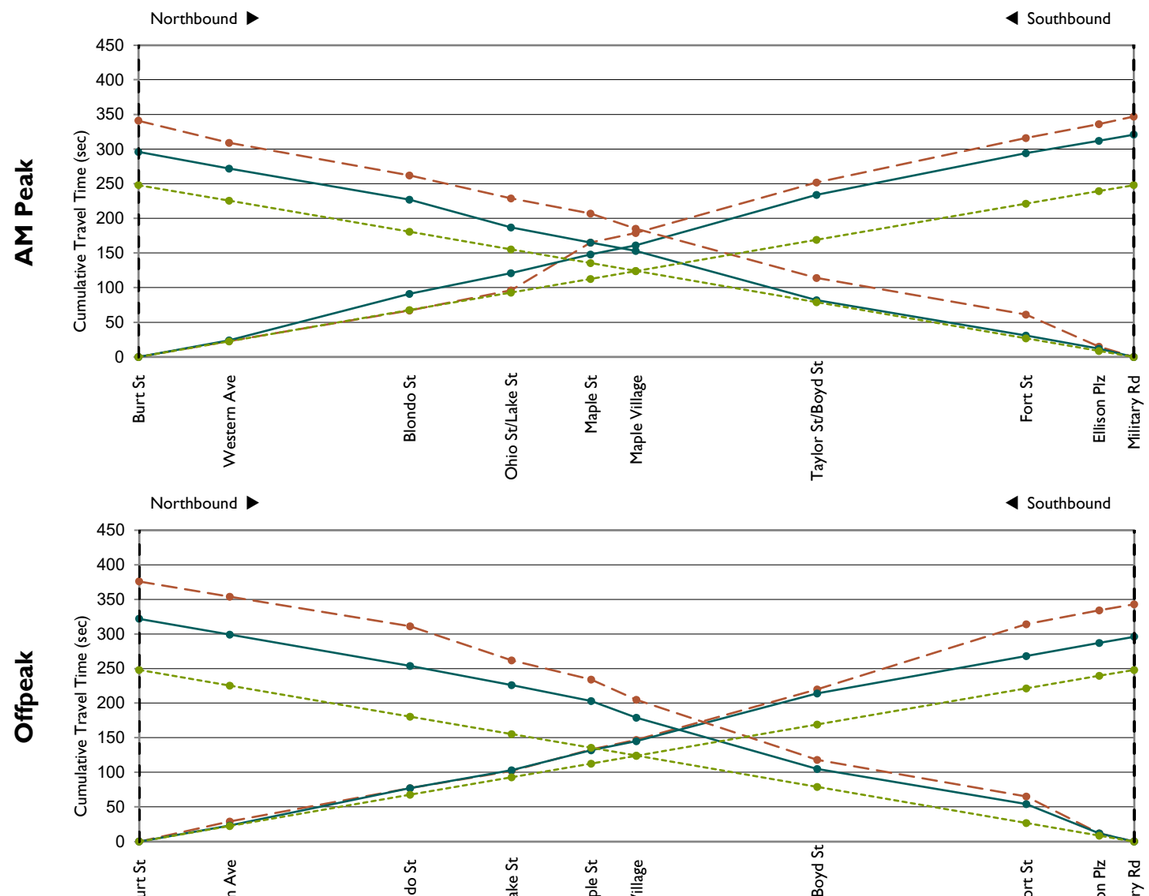
90th St: 2.8 miles

		AM Peak		Offpeak		MD Peak		PM Peak		Weekend Peak	
		Travel Time (sec)	Delay (sec)	Travel Time (sec)	Delay (sec)	Travel Time (sec)	Delay (sec)	Travel Time (sec)	Delay (sec)	Travel Time (sec)	Delay (sec)
Northbound	Existing	347	72	343	68	340	65	400	125	357	81
	Implemented	321	46	296	20	320	45	324	48	313	37
	Difference	-26		-47		-20		-76		-44	
	% Difference	-7.5%	-36.1%	-13.7%	-69.1%	-5.9%	-30.8%	-19.0%	-60.8%	-12.3%	-54.3%
Southbound	Existing	341	66	376	101	387	111	362	86	411	135
	Implemented	296	20	322	47	348	72	322	47	345	69
	Difference	-45		-54		-39		-40		-66	
	% Difference	-13.2%	-68.2%	-14.4%	-53.5%	-10.1%	-35.1%	-11.0%	-46.5%	-16.1%	-48.9%

Northbound: Burt St to Military Rd

Southbound: Military Rd to Burt St





FELSBURG HOLT & ULLEVIG

Existing
Implemented
Free Flow

Figure 6.2
Average Travel Time & Delay
90th St

7. Safety and Operational Recommendations

7.1 Short-Term Safety Recommendations

Based upon operational analysis and field observations, a short-term safety recommendation has been identified at intersections throughout the study area. Consider adding retroreflective borders to the backplates to increase the visibility of signal heads and address rear-end crashes.

7.2 Short-Term Operational Recommendations

While many operational issues stem from capacity constraints that require long term solutions, occasionally short-term solutions can yield appreciable benefits at select locations. A list of short-term recommendations determined during the optimization and fine-tuning process is presented below.

90th Street & Blondo Street

Westbound left-turn queues occasionally extend beyond the storage capacity of the left-turn lane at the intersection of 90th Street with Blondo Street. Consider extending the westbound left-turn bay to provide approximately 300 feet of storage.

120th Street & Rose Lane

With the improved signal timings, less bidirectional gaps in traffic are available for traffic attempting to turn from Rose Lane onto 120th Street. Consider removing the northbound and southbound left-turn lanes by striping them as a TWLTL. This can provide refuge for drivers to make a two-stage left-turn when necessary.

7.3 Long-Term Safety and Operational Recommendations

As part of this project, the City identified four locations to conduct a detailed safety evaluation based on crash history and operational performance. Long-term safety and operational improvements have been developed to mitigate crash patterns and improve traffic operations. The City provided crash data for review which was used to identify crash patterns by location, type, and severity, and to calculate the benefit/cost ratio for various improvements. The identified locations include the following:

- 120th Street & Q Street
- 60th Street & Center Street
- 90th Street & Blondo Street
- 90th Street & Fort Street

Crash History

Crash data for the project area was provided by the City of Omaha from their GIS database. The time frame for intersection crash data was a three-year period ranging from January 1, 2017, through December 31, 2019. While data was provided through 2022, it was decided to keep the analysis range to pre-Covid dates. The data provided detailed the location, vehicle, and roadway characteristics of each crash.

The crash history of the study area intersections by crash type were analyzed and are provided in **Appendix K**. The majority of crashes at the signalized study intersections are rear-end or left-turn leaving, which are both indicative of congested conditions. Other crash types that were common were angle and sideswipe. Left-turn leaving and angle type collisions tend to be more severe in nature than rear-ends, which are more likely to result in property damage only. Summary tables and charts are provided in **Appendix K** that document intersection crash rates recorded over the analysis time frame. A benefit-cost analysis (BCA) was conducted to evaluate the feasibility of improvements at these intersections.

Benefit-Cost Analysis

A benefit-cost analysis (BCA) measures the effectiveness of a proposed project based on a benefit/cost ratio, i.e. – the benefits divided by the costs. A benefit-cost ratio above 1.0 means the benefits of the improvement outweigh the costs of it. Benefits come in the form of operational improvements and avoided crashes due to geometric and operational changes. Costs consist of factors like construction fees, maintenance, and operational costs.

Three years (2017 to 2019) of crash history data for intersections and segments within the project area was provided to the project team by the City of Omaha. This data was evaluated to identify problem areas and potential solutions. Crash modification factors (CMF) were used from CMF Clearinghouse, a web-based repository (http://www.cmfclearinghouse.org) of professionally researched and reviewed CMFs, to calculate the benefits of the roadway improvements.

When more than one CMF is applied to a specific project a composite CMF factor was developed using the FHWA methodology of the Dominant Residual Effect. Appropriate CMFs for some mitigations could not be identified and were therefore not applied to the BCA value. There were also a few CMFs that deviated in some aspects from the intersection characteristics (ex: Average Annual Daily Traffic). If the CMF matched most intersection characteristic for a mitigation, the CMF was still applied for planning purposes. All CMF calculations are included in **Appendix M**.

To quantify the benefit of avoided crashes, the Federal Highway Administration (FHWA) provides an estimated societal cost for crashes based on crash type, shown in **Table 7.1**. These costs are from 2019. No inflationary adjustments were applied to these values when calculating the benefits of each mitigation.

Table 7.1 FHWA Societal Cost of Traffic Accidents

Crash Type (Multi-Vehicle)	Societal Cost (2019)
Right Angle	$100,530
Rear End	$79.700
Sideswipe (Same Dir.)	$54.510
Sideswipe (Opposite Dir.)	$123,700
Head On	$374,700
Left-turn	$136,480
Other	$28,000
Pedestrian	$577,070
Bicycle	$256,500

A benefit-cost analysis (BCA) was completed for each of the proposed improvements. The BCA was completed based on the lifespan of the project, assuming an improvement life period, construction costs, and maintenance costs for each project. In general, projects with a B/C ratio of 1.0 or greater have larger benefits than costs over the analysis time period. BCA analysis included the application of CMF's relevant to the mitigations recommended at each location. Crash reduction and mitigated values were determined by applying the chosen CMF's to the relevant crash types provided by the selected CMF. Below is a description of the safety benefits of the improvements.

120th Street & Q Street

As shown in **Figure 7.1**, rear ends make up most crashes at this location, followed by sideswipes. Three out of the five possible injury crashes were rear-end crashes. The majority of the rear-end crashes were in the eastbound and southbound directions, making up 18 out of 23 crashes total. Almost half, 11 of 23 crashes, were making left turns in the eastbound and southbound directions.

One of the five possible injury crashes and the only visible injury crash was a ran-off road incident. There were no pedestrian or bicycle related crashes at this intersection.

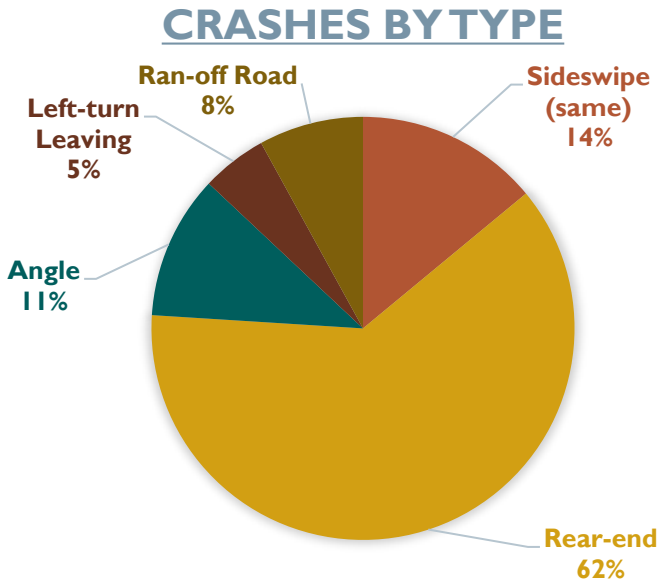


Figure 7.1 Crash History Summary – 120th St & Q St

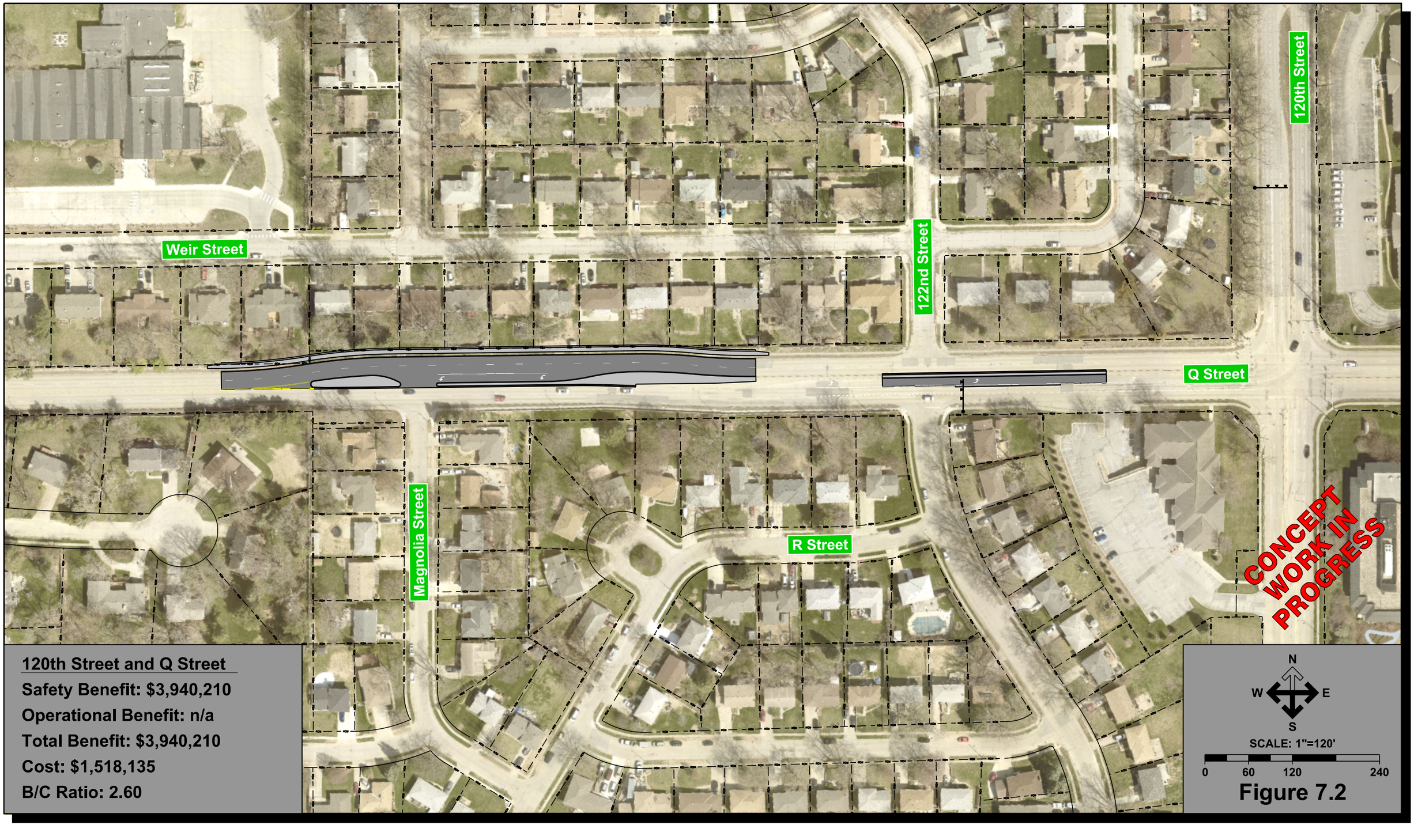
Figure 7.2 depicts the proposed improvement project at the intersection of 120th Street & Q Street. This project addresses both eastbound and southbound concerns related to lane reassignments, which may be causing confusion and/or lane changes close to the intersection, resulting in excessive rear ends and off-road crashes as part of avoiding maneuvers.

On the eastbound approach, the inside through lane becomes the outside left-turn lane of a dual left-turn lane at the intersection with protected only phasing. This project extends the raised median to provide more storage for the inside left-turn lane and limit access to the neighborhood to the south. To bring this location into compliance with City of Omaha design standards and guidelines, this project installs an overhead gantry sign on the eastbound approach to warn motorists of the upcoming lane reassignment. This project also adds a westbound left-turn lane at Magnolia Street to accommodate the neighborhood access that would be removed at 122nd Street.

Similarly, on the southbound approach, the outside through lane becomes a right-turn only lane at the intersection. The project adds and improves signing and striping to indicate the lane assignment change and installs an overhead gantry sign on the southbound approach to warn motorists of upcoming lane reassignment.

Mitigations applied in the BCA for this intersection included the overhead gantry signs for both the eastbound and southbound direction. The extension of the raised median to the west and addition of the westbound left-turn into the neighborhood at Magnolia Street was included in the BCA and will reduce crashes, however it cannot be determined if crashes elsewhere will increase as a result of shifting volumes. Results can be found in **Table 7.2** and **Table 7.3**.

Long-Term Recommendations - 120th St and Q St



120th Street and Q Street

Safety Benefit: $3,940,210

Operational Benefit: n/a

Total Benefit: $3,940,210

Cost: $1,518,135

B/C Ratio: 2.60

N

W E

S

SCALE: 1"=120'

0 60 120 240

Figure 7.2

Table 7.2 Crash Mitigations – 120th St & Q St

Crash Type*	Facility Type	Treatment	CMF**	CMF ID(s)	Value Mitigated
Other	Int. (EB)	Gantry Signs	0.85	62	$28,000.00
Right Angle	Int. (EB)	Gantry Signs	0.93	63	$46,914.00
Rear End	Int. (EB)				$371,933.33
Sideswipe (Same Dir.)	Int. (EB)				$101,752.00
Other	Int. (EB)				$26,133.33
Rear End	Int. (SB)	Gantry Signs	0.85	62	$159,400.00
Left Turn	Int. (SB)	Gantry Signs	0.93	63	$127,381.33
Rear End	Int. (SB)		0.93	63	$223,160.00
Sideswipe (Same Dir.)	Int. (SB)		0.93	63	$25,438.00
Right Angle	Int. (SB)		0.93	63	$93,828.00
Left Turn	Int. (122nd)	Change Full Access to RIRO	0.55	9821	$1,228,320.00
Right Angle	Int. (122nd)				$1,507,950.00

*Only one treatment should be applied to each Crash type.
**For crashes with multiple associated CMFs, the lowest of the Dominant Effect Methodology and the Dominant Residual Methodology is used.

Table 7.3 Long-Term Benefits – 120th St & Q St

Category	Anticipated Benefit
Facility Location	Urban
Service Life	20 years
Crash History Provided	3 years
Annual Daily Traffic	33,872 veh
Million Vehicles per Year	12.36
Crashes Mitigated Over Service Life	17.05
Crashes Mitigated/Year	0.85
Crashes Mitigated per million vehicles per year	0.07
Total Historical Societal Cost	$3,277,790
Total Cost Mitigated Over Service Life	$3,940,210
Average Cost per Mitigated Crash	$81,808
Operational Benefits	-
Benefits total	**$3,940,210**

The 120th Street & Q Street improvements are projected to cost approximately $1.52 million, yielding a benefit/cost ratio of approximately 2.60, as summarized in **Table 7.4**. The cost estimate is based on the concept drawing in **Figure 7.2**. A more detailed estimate is provided in **Appendix L**.

Table 7.4 Estimated Project Costs – 120th St and Q St

Category	Estimated Cost
Construction Subtotal	$1,016,560
Contingency (20%)	$203,300
Construction Total	$1,219,860
Right Of Way	$17,675
Utilities (3%)	$36,600
Engineering Services (12%)	$146,400
Construction Services (8%)	$97,600
Project Total Cost 2023 Dollars	**$1,518,135**
Benefit/Cost Ratio	**2.60**

60th Street & Center Street

At 60th Street and Center Street, **Figure 7.3** shows left-turn-leaving and rear-end crashes make up the majority of crashes. Two of three visible injury crashes and four of eight possible injury crashes were attributed to left-turn leaving type, while rear end crashes were the second-most common type and accounted for three of the eight possible injury crashes. Left-turn leaving crashes occur primarily in the eastbound and westbound directions. Rear-end crashes are most likely to occur in the northbound direction (9 of 19) and then in the westbound direction (5 of 19), which together account for three-quarters of all rear-end crashes.

There was one pedestrian crash over the three-year period which resulted in the final visible injury.

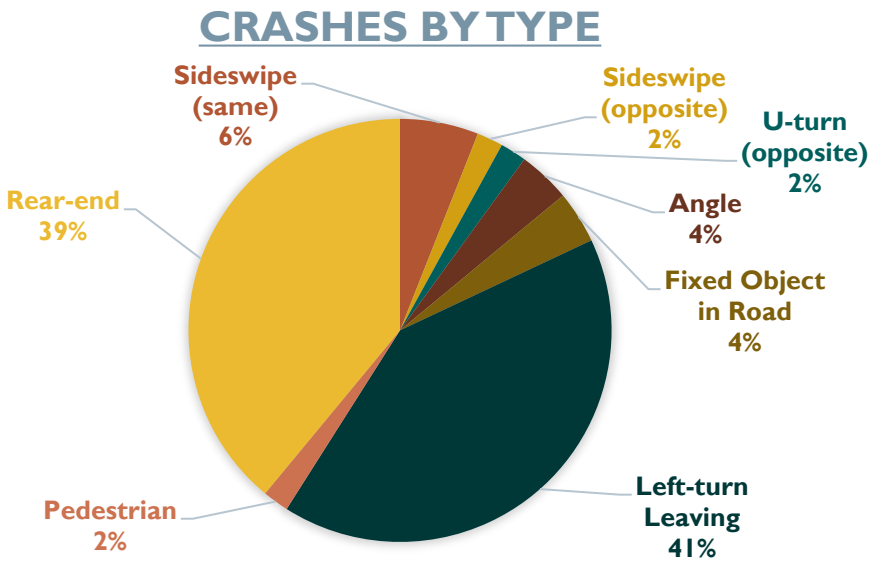


Figure 7.3 Crash History Summary – 60th St & Center St

Two alternatives were developed for proposed improvement for the intersection of 60th Street & Center Street. Alternative A includes dual westbound left-turn lanes while Alternative B includes dual northbound left-turn lanes. Alternative A will have greater safety benefits due to the protected only left-turn phasing for westbound left-turn, but will have an outsized impact on the surrounding businesses that are not able to be fully captured by the cost estimate.

Figure 7.4 depicts Alternative A at the intersection of 60th Street & Center Street. In the northbound direction, the project will extend the northbound turn lane to prevent spillback into the through lane and provide more queue storage. The project will add an overhead gantry sign to warn motorists of the upcoming lane reassignment of the northbound through to northbound right-turn direction. The overhead gantry and extended storage will help reduce the rear-end crashes.

The project also addresses the project team's review of access control needs for adjacent commercial properties with multiple access points. Due to westbound left-turn crashes and volumes exceeding 300 VPH in the PM peak, the project will add dual westbound left-turn lanes and close north access to Scooter's Coffee in the southeast corner. The dual left-turn lanes will require protected-only phasing. The project will add a raised median on the east approach to prevent westbound access from crossing the double lines to enter Scooters Coffee. The project will provide an auxiliary eastbound right-turn lane and add a raised median in the eastbound direction. The dual left-turn lanes and protected phasing will help reduce left-turn leaving crashes. The eastbound right-turn lane will help reduce the number of rear-end and side-swipe crashes.

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Long-Term Recommendations - 60th St and Center St (Alt A)

61st Avenue

61st Street

59th Street

58th Street

Marinda Street

Center Street

Dupont Street

60th Street

Arbor Street

CONCEPT WORK IN PROGRESS

60th Street and Center Street (Alt A)

Safety Benefit: $19,217,768

Operational Benefit: $1,007,691

Total Benefit: $20,225,459

Cost: $4,478,075

B/C Ratio: 4.52

N

W E

S

SCALE: 1"=120'

0 60 120 240

Figure 7.4

Mitigations applied in the BCA for this intersection included raised medians, addition of a right-turn lane, and restriction of accesses on the eastbound approach. For the westbound approach, the mitigations included a raised median, closure of accesses, and changing left-turn phasing to protected only. Northbound approach mitigations included gantry signs for the change in lane assignment. The extension of the northbound turn lane was not included as an appropriate CMF for this situation could not be found for the extension of turn lane storage length. Results can be found in **Table 7.5** and **Table 7.6**.

Table 7.5 Crash Mitigations – 60th St & Center St (Alternative A)

Crash Type*	Facility Type	Treatment	CMF**		CMF ID(s)	Value Mitigated
Left-Turn	Int. (EB)	Right-Turn Lane, Raised Median, Closed Access	0.29	0.68	286, 2219, 442	$4,522,037.33
Rear End	Int. (EB)		0.29	0.68		$1,508,986.67
Pedestrian	Int. (EB)		0.29	0.68		$2,731,464.67
Right Angle	Int. (EB)		0.29	0.68		$475,842.00
Sideswipe (Same Dir.)	Int. (EB)		0.29	0.69		$516,028.00
Fixed Object	Int. (WB)	Raised Median	0.29	0.68	286, 2219	$1,514,856.00
Sideswipe (Same Dir.)	Int. (WB)		0.29	0.88		$258,014.00
Rear End	Int. (WB)		0.29	0.68		$1,886.233.33
Rear End	Int. (NB)	Gantry Signs	0.85		62	$159,400.00
Left-Turn	Int. (NB)	Gantry Signs	0.93		63	$191,072.00
Rear End	Int. (NB)		0.93		63	$260,353.33
Sideswipe (Same Dir.)	Int. (NB)		0.93		63	$25,438.00
Left Turn	Int. (WB)	Raised Median and Protected Left Turn	0.29	0.62	10748, 2219	$5,168,042.67

*Only one treatment should be applied to each Crash type.
**For crashes with multiple associated CMFs, the lowest of the Dominant Effect Methodology and the Dominant Residual Methodology is used.

Table 7.6 Long-Term Benefits – 60th St & Center St (Alternative A)

Category	Anticipated Benefit
Facility Location	Urban
Service Life	20 years
Crash History Provided	3 years
Annual Daily Traffic	49,456 veh
Million Vehicles per Year	18.05
Crashes Mitigated Over Service Life	153.87
Crashes Mitigated/Year	7.69
Crashes Mitigated per million vehicles per year	0.43
Total Historical Societal Cost	$5,106,920
Total Cost Mitigated Over Service Life	$19,217,768
Average Cost per Mitigated Crash	$33,191
Operational Benefits	$1,007,691
Benefits total	**$20,225,459**

The 60th Street & Center Street Alternative A improvements are projected to cost approximately $4.48 million, yielding a benefit/cost ratio of approximately 4.52, as summarized in **Table 7.7**. The cost estimate is based on the concept drawing in **Figure 7.4**. A more detailed estimate is provided in **Appendix L**.

Table 7.7 Estimated Project Costs – 60th St & Center St (Alternative A)

Category	Estimated Cost
Construction Subtotal	$2,602,375
Contingency (20%)	$520,500
Construction Total	$3,122,875
Right Of Way	$637,000
Utilities (3%)	$93,700
Engineering Services (12%)	$374,700
Construction Services (8%)	$249,800
Project Total Cost 2023 Dollars	**$4,478,075**
Benefit/Cost Ratio	**4.52**

Figure 7.5 depicts Alternative B at the intersection of 60th Street & Center Street. In the northbound direction, the project will add dual northbound left-turn lanes to increase operational capacity and prevent spillback into the through lane. The dual left-turn lanes will require protected-only phasing. The project will add an overhead gantry sign to warn motorists of the upcoming lane reassignment of the northbound through to northbound right-turn direction. The overhead gantry and dual left-turn lanes will help reduce the rear-end crashes.

The project also addresses the project team's review of access control needs for adjacent commercial properties with multiple access points. The project will close the north access to Scooter's Coffee in the southeast corner. The project will add a raised median on the east approach to prevent westbound access from crossing the double lines to enter Scooters Coffee. The project will provide an auxiliary eastbound right-turn lane and add a raised median in the eastbound direction. The eastbound right-turn lane will help reduce the number of rear-end and side-swipe crashes.

Mitigations applied in the BCA for this intersection included raised medians, addition of a right-turn lane, and restriction of accesses on the eastbound approach. For the westbound approach, the mitigations included a raised median, closure of accesses. Northbound approach mitigations included gantry signs for the change in lane assignment, and changing left-turn phasing to protected only. Results can be found in **Table 7.8** and **Table 7.9**. It should also be noted that the CMF used for the Gantry Sign mitigation (62 and 63) were for local roads and not the urban road nature of the intersection.

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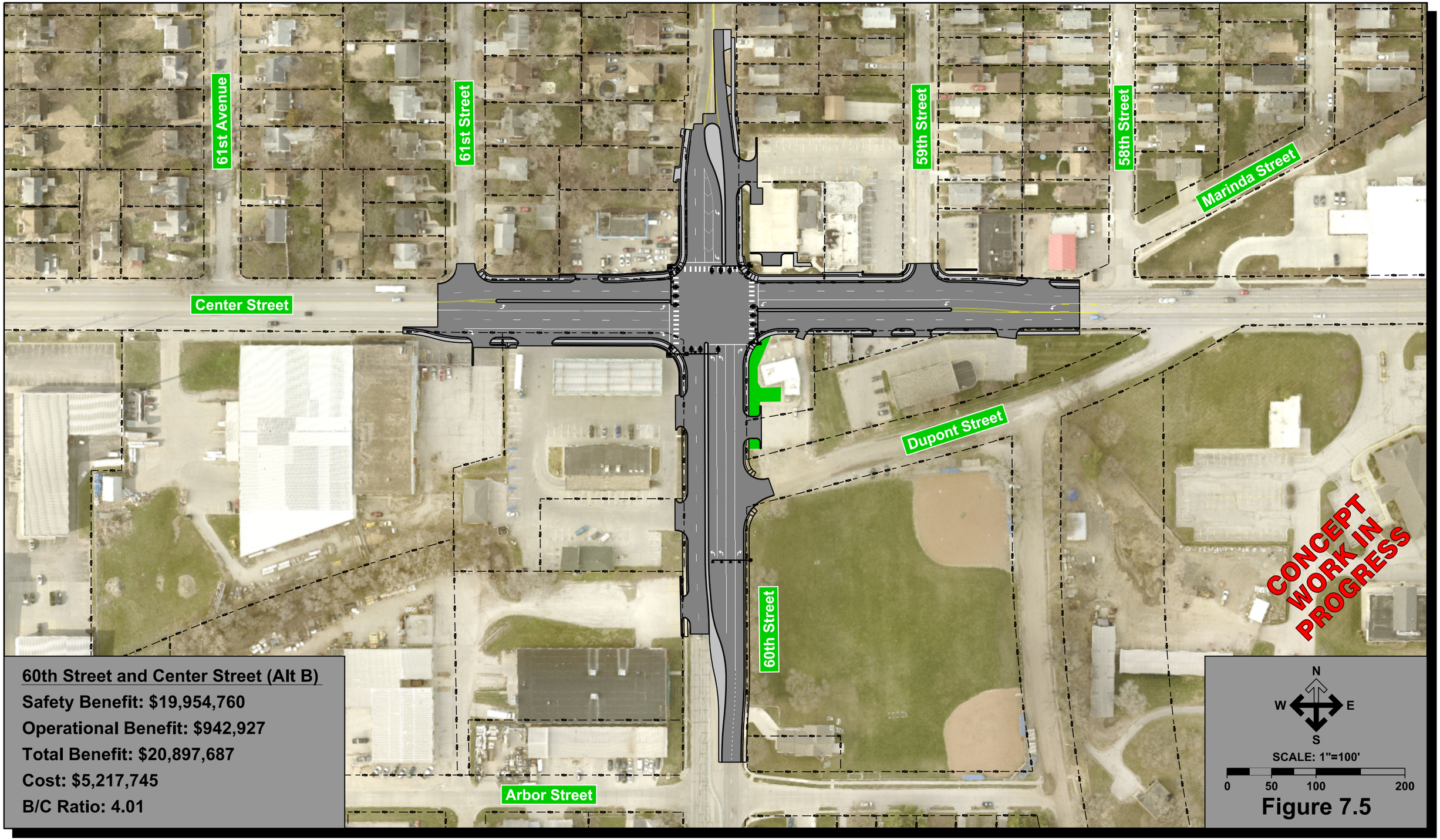
Long-Term Recommendations - 60th St and Center St (Alt B)



60th Street and Center Street (Alt B)

Safety Benefit: $19,954,760

Operational Benefit: $942,927

Total Benefit: $20,897,687

Cost: $5,217,745

B/C Ratio: 4.01

Figure 7.5

Table 7.8 Crash Mitigations – 60th St & Center St (Alternative B)

Crash Type*	Facility Type	Treatment	CMF**		CMF ID(s)	Value Mitigated
Left-Turn	Int. (EB)	Right-Turn Lane, Raised Median, Closed Access	0.29	0.68	286, 2219, 442	$4,522,037.33
Rear End	Int. (EB)		0.29	0.68		$1,508,986.67
Pedestrian	Int. (EB)		0.29	0.68		$2,731,464.67
Right Angle	Int. (EB)		0.29	0.68		$475,842.00
Sideswipe (Same Dir.)	Int. (EB)		0.29	0.69		$516,028.00
Rear End	Int. NB	Gantry Signs	0.85		62	$159,400.00
Rear End	Int. NB	Gantry Signs	0.93		63	$260,353.33
Sideswipe (Same Dir.)	Int. NB	Gantry Signs	0.93		63	$25,438.00
Left Turn	Int. (NB)	Protected Left Turn, Gantry Sign	0.66		10748, 63	$928,064.00
Fixed Object	Int. (WB)	Raised Median	0.29	0.68	286, 2219	$1,514,856.00
Left Turn	Int. (WB)		0.29	0.68		$5,168,042.67
Sideswipe (Same Dir.)	Int. (WB)		0.29	0.88		$258,014.00
Rear End	Int. (WB)		0.29	0.68		$1,886.233.33

*Only one treatment should be applied to each Crash type.
**For crashes with multiple associated CMFs, the lowest of the Dominant Effect Methodology and the Dominant Residual Methodology is used.

Table 7.9 Long-Term Benefits – 60th St & Center St (Alternative B)

Category	Anticipated Benefit
Facility Location	Urban
Service Life	20 years
Crash History Provided	3 years
Annual Daily Traffic	49,456 veh
Million Vehicles per Year	18.05
Crashes Mitigated Over Service Life	159.27
Crashes Mitigated/Year	7.96
Crashes Mitigated per million vehicles per year	0.44
Total Historical Societal Cost	$5,106,920
Total Cost Mitigated Over Service Life	$19,954,760
Average Cost per Mitigated Crash	$32,065
Operational Benefits	$942,927
Benefits total	**$20,897,687**

The 60th Street & Center Street Alternative A improvements are projected to cost approximately $5.22 million, yielding a benefit/cost ratio of approximately 4.01, as summarized in **Table 7.10**. The cost estimate is based on the concept drawing in **Figure 7.5**. A more detailed estimate is provided in **Appendix L**.

Table 7.10 Estimated Project Costs – 60th St & Center St (Alternative B)

Category	Estimated Cost
Construction Subtotal	$3,288,245
Contingency (20%)	$657,600
Construction Total	$3,945,845
Right Of Way	$364,300
Utilities (3%)	$118,400
Engineering Services (12%)	$473,500
Construction Services (8%)	$315,700
Project Total Cost 2023 Dollars	**$5,217,745**
Benefit/Cost Ratio	**4.01**

90th Street & Blondo Street

As shown in **Figure 7.6**, rear-end crashes make up the majority of crashes at the 90th Street and Blondo intersection, followed by left-turn-leaving crashes. Rear ends resulted in nine of the 17 possible injury crashes and two of the four visible injury crashes. Left-turn-leaving crashes resulted in 12 of the 17 possible injury crashes, one of four visible injury crashes, and the only disabling injury for a total of 14 of the 33 reported injuries. There was one bicycle crash during the study period. Rear-end crashes were distributed equally across all approaches, while half of the left-turn leaving crashes occur in the northbound direction.

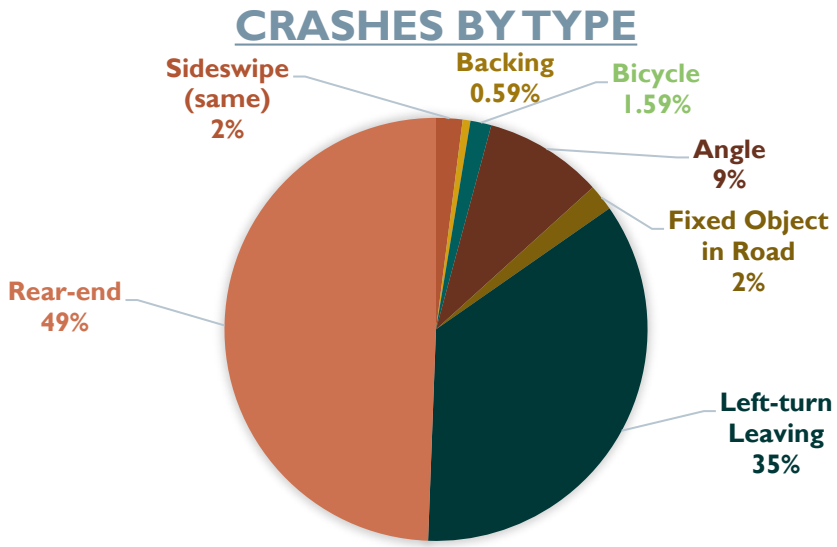


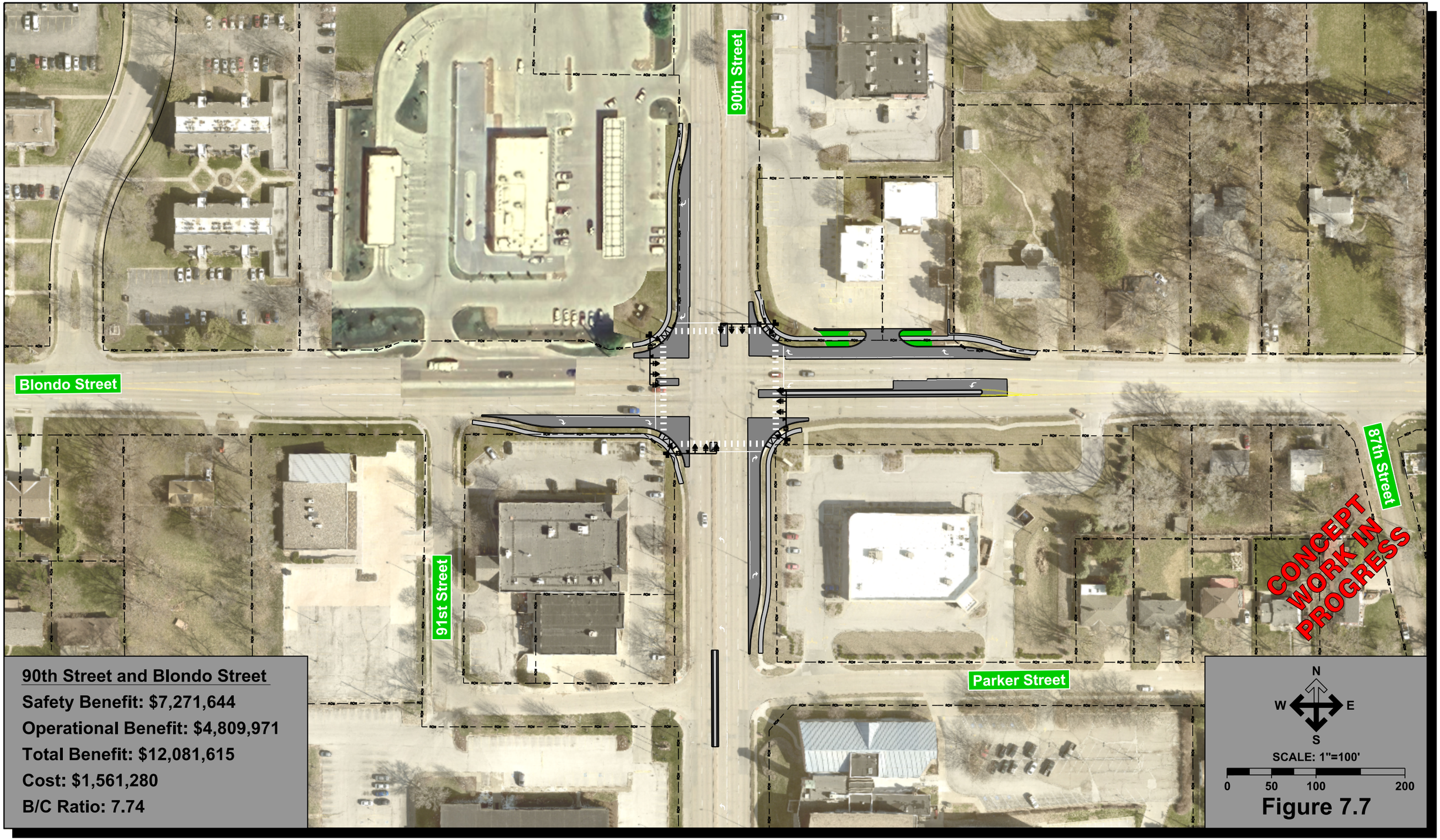
Figure 7.6 Crash History Summary – 90th St & Blondo St

Figure 7.7 depicts the proposed improvement projects at the intersection of 90th Street & Blondo Street. The project will provide striped crosswalks and auxili on all approaches to improve pedestrian safety and visibility. Since left-turn leaving crashes are prevalent at this intersection, the signal timing project implemented protected-only phasing for the northbound left-turn phase. Extending the westbound left-turn lane and adding auxiliary right-turn lanes in all directions will reduce rear-end crashes.

The furthest west access point to the property on the northeast corner of the intersection will be removed due to its proximity to the intersection. The raised median on the south leg of the intersection will be extended to restrict access to Parker Street, which often has congestion related to the northbound left-turn queues and will reduce rear-end crashes along 90th Street. It should be noted that while changing the access at Parker Street will result in a reduction of crashes at this particular location, crashes due to diverted traffic may occur at another location.

Mitigations applied in the BCA for this intersection include adding auxiliary right-turn lanes in all directions, extension of the westbound left-turn lane, extension of the raised median through Parker Road, and access control for the northbound and westbound directions. It should be noted that crosswalks are a recommended mitigation but are not applied in the BCA as there were no pedestrian crashes. Results can be found in **Table 7.11** and **Table 7.12**.

Long-Term Recommendations - 90th St and Blondo St



90th Street and Blondo Street

Safety Benefit: $7,271,644

Operational Benefit: $4,809,971

Total Benefit: $12,081,615

Cost: $1,561,280

B/C Ratio: 7.74

Figure 7.7

Table 7.11 Crash Mitigations – 90th St & Blondo St

Crash Type*	Facility Type	Treatment	CMF**	CMF ID(s)	Value Mitigated
Sideswipe (Same Dir.)	Intersection (NB, SB, EB)	Right Turn Lane	0.96	286	$14,536.00
Fixed Object	Intersection (NB, SB, EB)				$42,672.00
Rear End	Intersection (NB, SB, EB)				$488,826.67
Bicycle	Intersection (NB, SB, EB)				$68,400.00
Left-Turn	Intersection (SB, EB)				$218,368.00
Right Angle	Intersection (NB, SB, EB)				$160,848.00
Sideswipe (Same Dir.)	Intersection (NB, SB, EB)				$7,466.67
Rear End	Intersection (WB)	Access Control and Right Turn Lane	0.90	286, 442	$425,428.87
Left-Turn	Intersection (WB)				$455,320.99
Left-Turn	Intersection (NB)	Right Turn Lane and Protected Only Phasing	0.66	286, 10748	$3,093,546.67

*Only one treatment should be applied to each Crash type.
**For crashes with multiple associated CMFs, the lowest of the Dominant Effect Methodology and the Dominant Residual Methodology is used.

Table 7.12 Long-Term Benefits – 90th St & Blondo St

Category	Anticipated Benefit
Facility Location	Urban
Service Life	20 years
Crash History Provided	3 years
Annual Daily Traffic	45,182 veh
Million Vehicles per Year	16.49
Crashes Mitigated Over Service Life	62.74
Crashes Mitigated/Year	3.14
Crashes Mitigated per million vehicles per year	0.19
Total Historical Societal Cost	$7,204,400
Total Cost Mitigated Over Service Life	$7,271,644
Average Cost per Mitigated Crash	$114,828
Operational Benefits	$4,809,971
Benefits total	**$12,081,615**

The 90th Street & Blondo Street improvements are projected to cost approximately $1.56 million, yielding a benefit/cost ratio of approximately 7.74, as summarized in **Table 7.13**. The cost estimate is based on the concept drawing in **Figure 7.7**. A more detailed estimate is provided in **Appendix L**.

Table 7.13 Estimated Project Costs – 90th St & Blondo St

Category	Estimated Cost
Construction Subtotal	$960,180
Contingency (20%)	$192,000
Construction Total	$1,152,180
Right Of Way	$144,000
Utilities (3%)	$34,600
Engineering Services (12%)	$138,300
Construction Services (8%)	$92,200
Project Total Cost 2023 Dollars	**$1,561,280**
Benefit/Cost Ratio	**7.74**

90th Street & Fort Street

As shown in **Figure 7.8**, rear-end crashes make up the majority of crashes, followed by angle and left-turn-leaving crashes. Rear-ends accounted for 10 of 18 possible injury crashes and one of three visible injury crashes. The remaining two injury crashes and three of 18 possibly injury crashes were angle crashes. Left-turn-leaving crashes accounted for four of 18 possible injury crashes. There was one bicycle crash during the study period.

There was one pedestrian crash that occurred in 2022, which is outside of this study period, however it resulted in a pedestrian injury which is notable. The pedestrian was struck by a southbound right-turning vehicle.

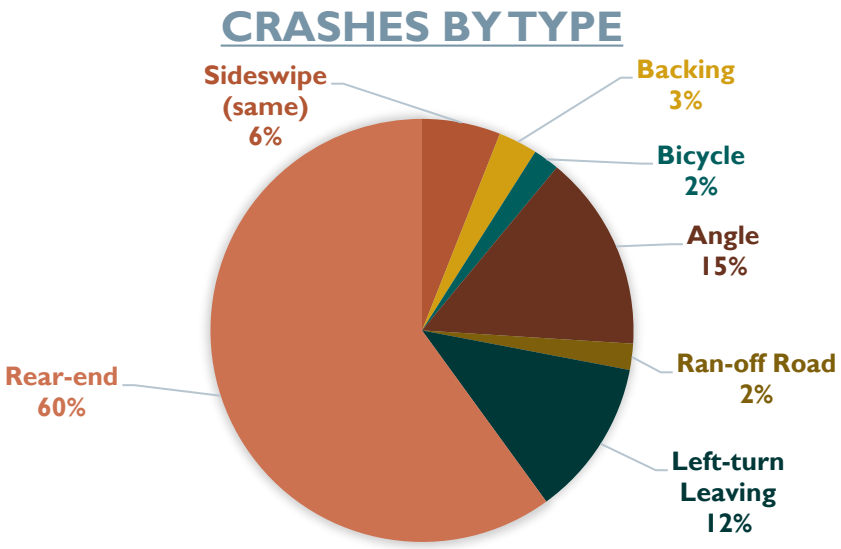
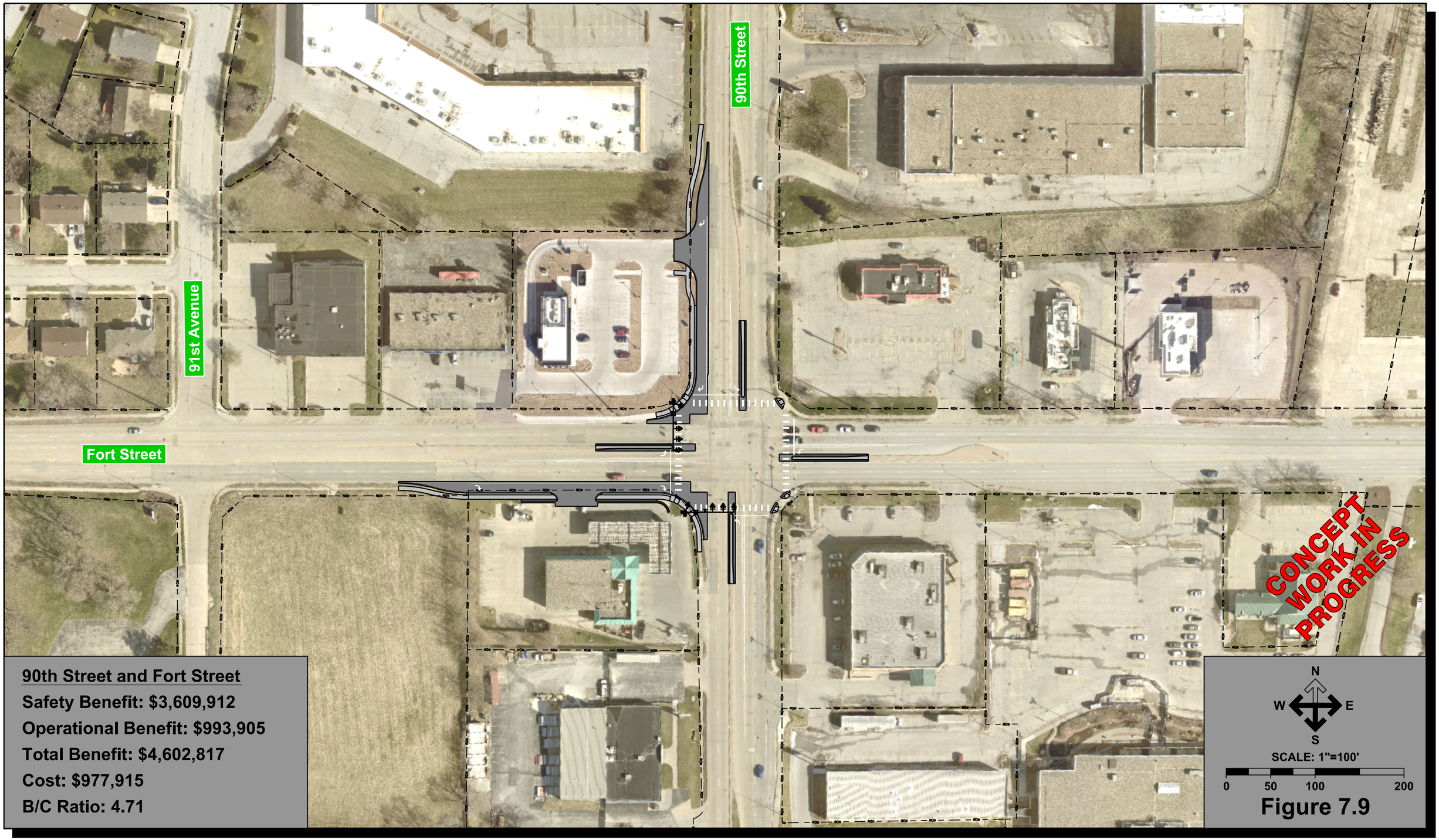


Figure 7.8 Crash History Summary – 90th St & Fort St

Figure 7.9 depicts an improvement project at the intersection of 90th Street & Fort Street. The project will provide striped crosswalks on all approaches to improve pedestrian safety. Positive left-turn offsets in all travel directions will address left-turn-leaving crashes. In the eastbound and southbound directions, the project will provide auxiliary right-turn lanes to address rear-end crashes and angle crashes.

Mitigations applied in the BCA for this intersection included positive offsets for left-turn lanes in all directions. The mitigations also include exclusive right-turn lanes for the eastbound and southbound directions. It should be noted that there were no pedestrian crashes recorded at this intersection during the study period, and therefore no CMF was applied to the BCA for the intersection. Results can be found in **Table 7.14** and **Table 7.15**. It should be noted that the ADT range provided in the CMF for the positive offset (6097) was lower than the estimated ADT for this intersection.

Long-Term Recommendations - 90th St and Fort St



90th Street and Fort Street

Safety Benefit: $3,609,912

Operational Benefit: $993,905

Total Benefit: $4,602,817

Cost: $977,915

B/C Ratio: 4.71

N

W E

S

SCALE: 1"=100'

0 50 100 200

Figure 7.9

Table 7.14 Crash Mitigations – 90th St & Fort St

Crash Type*	Facility Type	Treatment	CMF**		CMF ID(s)	Value Mitigated
Left-Turn	Int. (NB, WB)	Positive Offset	0.62		6097	$1,728,746.67
Right Angle	Int. (all directions)	Right-Turn Lanes	0.96		286	$214,464.00
Rear End	Int. (all directions)					$552,586.67
Bicycle	Int. (all directions)					$68,400.00
Other	Int. (all directions)					$7,466.67
Left-Turn	Int. (EB, SB)	Right-Turn Lanes, Positive Offsets	0.62	0.72	6097, 296	$1,037,248.00

*Only one treatment should be applied to each Crash type.
**For crashes with multiple associated CMFs, the lowest of the Dominant Effect Methodology and the Dominant Residual Methodology is used.

Table 7.15 Long-Term Benefits – 90th St & Fort St

Category	Anticipated Benefit
Facility Location	Urban
Service Life	20 years
Crash History Provided	3 years
Annual Daily Traffic	39,340 veh
Million Vehicles per Year	14.36
Crashes Mitigated Over Service Life	29.87
Crashes Mitigated/Year	1.49
Crashes Mitigated per million vehicles per year	0.1
Total Historical Societal Cost	$4,252,780
Total Cost Mitigated Over Service Life	$3,609,912
Average Cost per Mitigated Crash	$142,392
Operational Benefits	$993,905
Benefits total	**$4,602,817**

The 90th Street & Fort Street improvements are projected to cost approximately $0.98 million, yielding a benefit/cost ratio of approximately 4.71, as summarized in **Table 7.16**. The cost estimate is based on the concept drawing in **Figure 7.9**. A more detailed estimate is provided in **Appendix L**.

Table 7.16 Estimated Project Costs – 90th St & Fort St

Category	Estimated Cost
Construction Subtotal	$610,215
Contingency (20%)	$122,000
Construction Total	$732,215
Right Of Way	$77,200
Utilities (3%)	$22,000
Engineering Services (12%)	$87,900
Construction Services (8%)	$58,600
Project Total Cost 2023 Dollars	**$977,915**
Benefit/Cost Ratio	**4.71**