Signal Operations 144th Street and Q Street

Omaha, Nebraska
December 21, 2023

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EXECUTIVE SUMMARY

In an effort to improve traffic operations, the City of Omaha Public Works Department is updating traffic signals and signal timing across various corridors throughout the city. Retiming traffic signals offers a number of advantages. It enhances traffic flow, reduces delays, and minimizing congestion, resulting in smoother and more efficient vehicle movement. This not only reduces travel times but also contributes to cost savings through decreased fuel consumption. Signal retiming promotes safety by reducing crashes and conflicts at intersections. Additionally, signal retiming benefits the environment with reduced emissions and improved air quality.

For the current phase of signal retiming HDR conducted signal operations studies for corridors in western Omaha. The objective of the signal operations studies was to create and implement modified signal timing plans to improve operations. The project also aimed to improve the safety of the corridors through signal retiming and implementation of leading pedestrian intervals. HDR also identified short term operations and safety improvements in the study area. Ultimately a benefit-cost analysis was conducted to determine the efficacy of the project.

The signal retiming project encompassed 14 signals along the 144th Street corridor, 2 signals in the Oakview Mall area, 15 signals along and adjacent to the Q Street corridor, and 8 signals along Regency Parkway and around Westroads for a total of 39 signals. The study area limits were:

- 144th Street: Harvey Oaks Avenue to Eagle Run Drive
- Oakview Drive: Hascall Street to 141st Plaza
- Q Street: 90th Street to 135th Street
- Regency Parkway: Pacific Street to California Street
- California Street: Nicholas Street to Westroads Entrance #8

Project performance measures were calculated using Synchro model outputs for the before and after implementation timing plans. These results are presented in **Table ES 1**.

Table ES 1. Network-Wide Performance Measures

Performance Measure	Existing	Implemented	Percent Change
Plan 1 - Midday (MD)			
Total Delay (hr)	191	198	4%
Stops (#)	23,826	22,090	-7%
Total Travel Time (hr)	632	639	1%
Fuel Consumed (gal)	995	982	-1%
Plan 2 - Morning (AM)			
Total Delay (hr)	281	264	-6%
Stops (#)	27,745	24,966	-10%
Total Travel Time (hr)	777	760	-2%
Fuel Consumed (gal)	1,204	1,161	-4%
Plan 3 - Afternoon (PM)			
Total Delay (hr)	460	457	-1%
Stops (#)	41,453	38,586	-7%
Total Travel Time (hr)	1,122	1,119	0%
Fuel Consumed (gal)	1,684	1,644	-2%
Plan 4 - Off-Peak (OP)			
Total Delay (hr)	139	123	-12%
Stops (#)	17,837	15,309	-14%
Total Travel Time (hr)	488	472	-3%
Fuel Consumed (gal)	777	738	-5%

A benefit-cost analysis was performed using measures such as: delay, fuel consumption, emissions, and crashes. The benefit-cost analysis was performed in accordance with the methodology that the City has developed with the US Department of Transportation (USDOT) guidelines for monetized performance measures. The total anticipated present value savings was calculated at about $9.8 million for five years of project benefits. **Table ES 2** provides a breakdown of the anticipated benefits.

Table ES 2. Anticipated Five Year Project Benefits

Performance Measure	Project Benefit	Present Value
Delay Reduction	132,288 Hours	$3,717,230
Fuel Consumption Reduction	457,376 Gallons	$1,552,992
Emission Reduction	4,079 Tons	$306,551
Crash Reduction	56 Crashes	$4,201,638
Total Benefit		**$9,778,411**

The total cost of the signal retiming project was $158,955. This results in a benefit-cost ratio of nearly 62:1 over a five-year period.

The project resulted in up to a 93% reduction in delay for Q Street and up to 83% delay reduction for 144th Street. Overall, this retiming project was a cost-effective solution that helped optimize the transportation system, enhance safety, reduce environmental impact, and provide a better commuting experience for road users.

1. INTRODUCTION

1.1. BACKGROUND

The City of Omaha Public Works Department is updating signal timing plans for different corridors in the city to accommodate current traffic patterns and incorporate safety enhancements. The program grouped various corridors together for different projects to retime the traffic signals. HDR conducted a signal operations study for multiple corridors including:

- 144th Street between Eagle Run Drive and Harvey Oaks Avenue
- Q Street between 90th Street and 135th Street
- Regency Parkway / California Street near Westroads Mall

The objective of this project was to prepare and implement optimized traffic signal timing plans and document measures of effectiveness. Short-term safety and operational improvements were also identified in the study area. In addition, a benefit-cost analysis was conducted for the signal timing optimization.

1.2. STUDY LOCATIONS

The project included 39 signalized intersections along/near 144th Street, Q Street, and Westroads Mall. Study intersections are listed and shown in **Table 1-1** and **Figure 1-1** through **Figure 1-3**.

Table 1-1. List of Signalized Project Intersections

Signal ID	Location	Signal ID	Location
851	144th St & Eagle Run Dr	676	I-80 & Q St / West Ramp
1168	144th St & Locust St	765	John Galt Blvd & Q St
924	144th St & Nelsons Creek	766	Roxbury Dr & Q St
739	144th St & Blondo St	543	108th St & Q St
672	144th St & Franklin St	686	99th St & Q St
850	144th St & Hamilton St	519	96th St & Q St
785	144th St & Eldorado Dr	514	93rd St & Q St
787	144th St & West Dodge Rd	507	90th St & Q St
1209	144th St & Canopy Ave / Overlook Rd	539	108th St & John Galt St
1208	144th St & Blossom Ave	642	108th St & Mockingbird St
762	144th St & Millard North High School	685	96th St & Park Dr
591	144th St & Pacific St	1015	102nd St & Nicholas St
761	144th St & Pine St	755	102nd St & California St / Ent #2
588	144th St & Harvey Oaks St	526	100th St & California St
795	Oakview Dr & Hascall St	523	98th St & California St
839	Oakview Dr & 141st Plz	751	98th St & Ent #8 / Westroads
1202	135th St & Q St	72	Regency Pkwy & West Dodge Rd
650	Harry Andersen Ave / 132nd St & Q St	71	Regency Pkwy & Regency Cir
57	Oaks Lane / Deauville Dr & Q St	31	Regency Pkwy & Harney Pkwy
564	120th St & Q St		

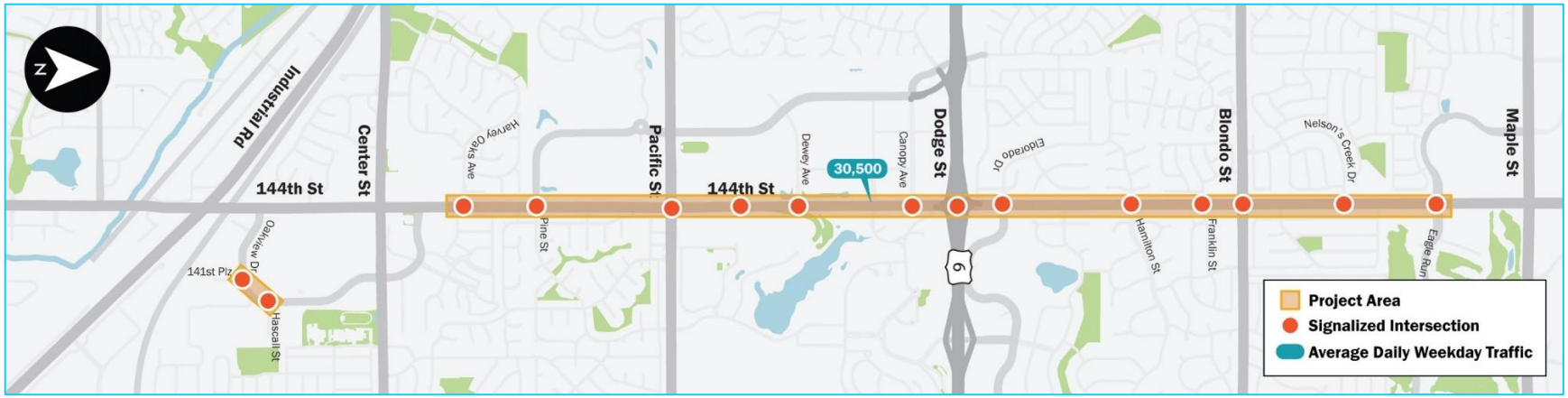


Figure 1-1. Map of Signalized Project Intersections – 144th Street Corridor

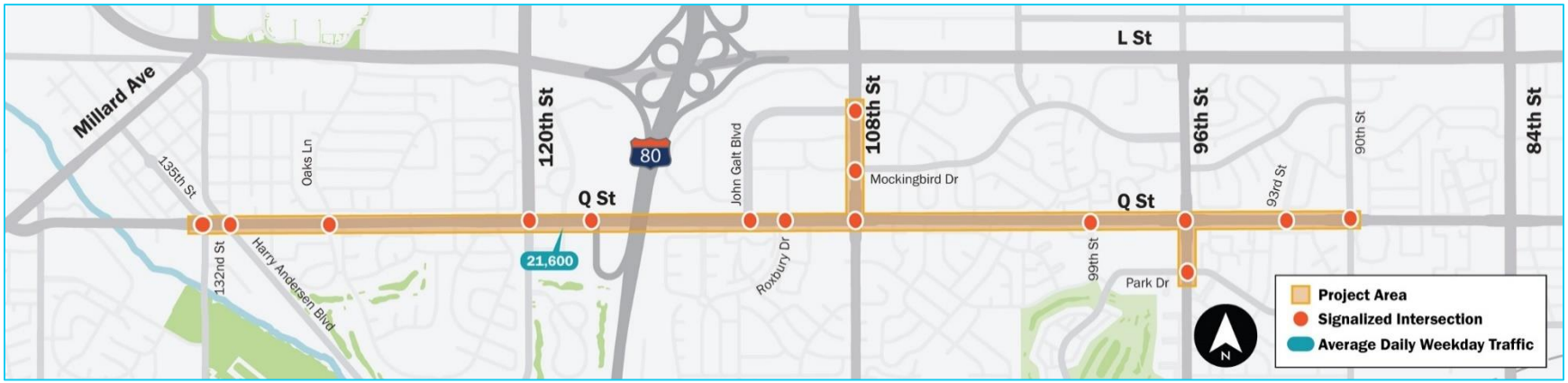


Figure 1-2. Map of Signalized Project Intersections – Q Street Corridor

Figure 1-3. Map of Signalized Project Intersections – Regency Parkway and Westroads Corridor

1.3. CORRIDOR CHARACTERISTICS

Table 1-2 details the speed and cross-sectional characteristics of the project corridors.

Table 1-2. Corridor Characteristics

Corridor	Segment	Speed Limit (mph)	Lanes
144th St	Harvey Oaks Ave – Pine St	45	2 NB / 2 SB
	Pine St – FNB Pkwy	45	3 NB / 3 SB
	FNB Pkwy – Eagle Run Dr	45	2 NB / 2 SB
Q St	132nd St – 108th St	40	2 EB / 2 WB
	108th St – 90th St	40	2 EB / 2 WB / 1 Center LT Lane
Westroads	Nicholas St – Regency Pkwy	30	2 SB / 3 NB
	Regency Pkwy – 98th St	30	2 EB / 3 WB
Regency	California St – EB W Dodge Rd Ramps	35	3 SB / 3 NB
	EB W Dodge Rd Ramps – Harney Pkwy	35	2 NB / 2 SB

2. PROJECT ADMINISTRATION

2.1. PROJECT TEAM

The project was guided and completed through efforts by team members comprised from the City of Omaha, Nebraska Department of Transportation (NDOT) and HDR listed below.

- Bryan Guy (City of Omaha, Project Manager)
- Jeff Riesselman (City of Omaha, City Traffic Engineer)
- Garret Schram (City of Omaha)
- Nick Gordon (City of Omaha)
- Jenna Habegger (NDOT)
- Karen Majerus (NDOT)
- Kevin Brown (HDR, Project Manager)
- Mike Forsberg (HDR)
- Bryce Hallmark (HDR)

2.2. PROJECT MEETINGS

Project meetings were held throughout the project to inform team members of activities, get input and make project decisions. Project meetings held are listed below. Meeting minutes can be found in the **Appendix**.

- April 12th, 2023 – Project Kickoff Meeting
- May 24th, 2023 – Progress Meeting #1
- June 26th, 2023 – Progress Meeting #2
- July 24th, 2023 – Progress Meeting #3
- August 10th, 2023 – Pre-Implementation Meeting
- September 13th, 2023 – Progress Meeting #4
- September 29th, 2023 – Implementation Week Debrief
- October 16th, 2023 – Progress Meeting #5
- November 9th, 2023 – Progress Meeting #6

3. DATA COLLECTION

3.1. EXISTING TRAFFIC OPERATIONS MODELS

Exiting traffic operations models via Synchro were provided by City of Omaha for AM, MD (midday), PM and OP (off-peak) plans.

3.2. LANE CONFIGURATIONS

Lane configurations were collected and verified through use of aerial photography and field observations.

3.3. SIGNAL TIMING DATA

Signal timing data was obtained via remote access to the City of Omaha's Maxview traffic management system.

3.4. DETECTION DATA

Signal as-builts showing detection and conversation with City of Omaha were used to identify signal detection.

3.5. 24-HOUR WEEK COUNTS

24-hour, week-long counts were collected at the locations listed in Error! Reference source not found..

Table 3-1. 24-Hour Count Locations and Daily Traffic

Location	Dates of Counts	Average Weekday Traffic	Average Weekend Day Traffic	MAPA ADT
144th St North of Blossom Ave	4/18/23 - 4/24/23	30,500	20,600	26,800 (2021)
Q St East of 118th St	4/26/23 - 5/2/23	21,600	15,900	21,200 (2018)
Regency Pkwy North of Harney Pkwy	4/18/23 - 4/24/23	10,700	8,000	15,000 (2021)
California St East of 102nd St	4/18/23 - 4/24/23	10,500	10,600	10,400 (2014)

Average hourly directional volumes are shown in **Figure 3-1**. This data was used to support updates to day plans that defines when specific timing patterns operate at each signal. Tables of the data are provided in the **Appendix**.

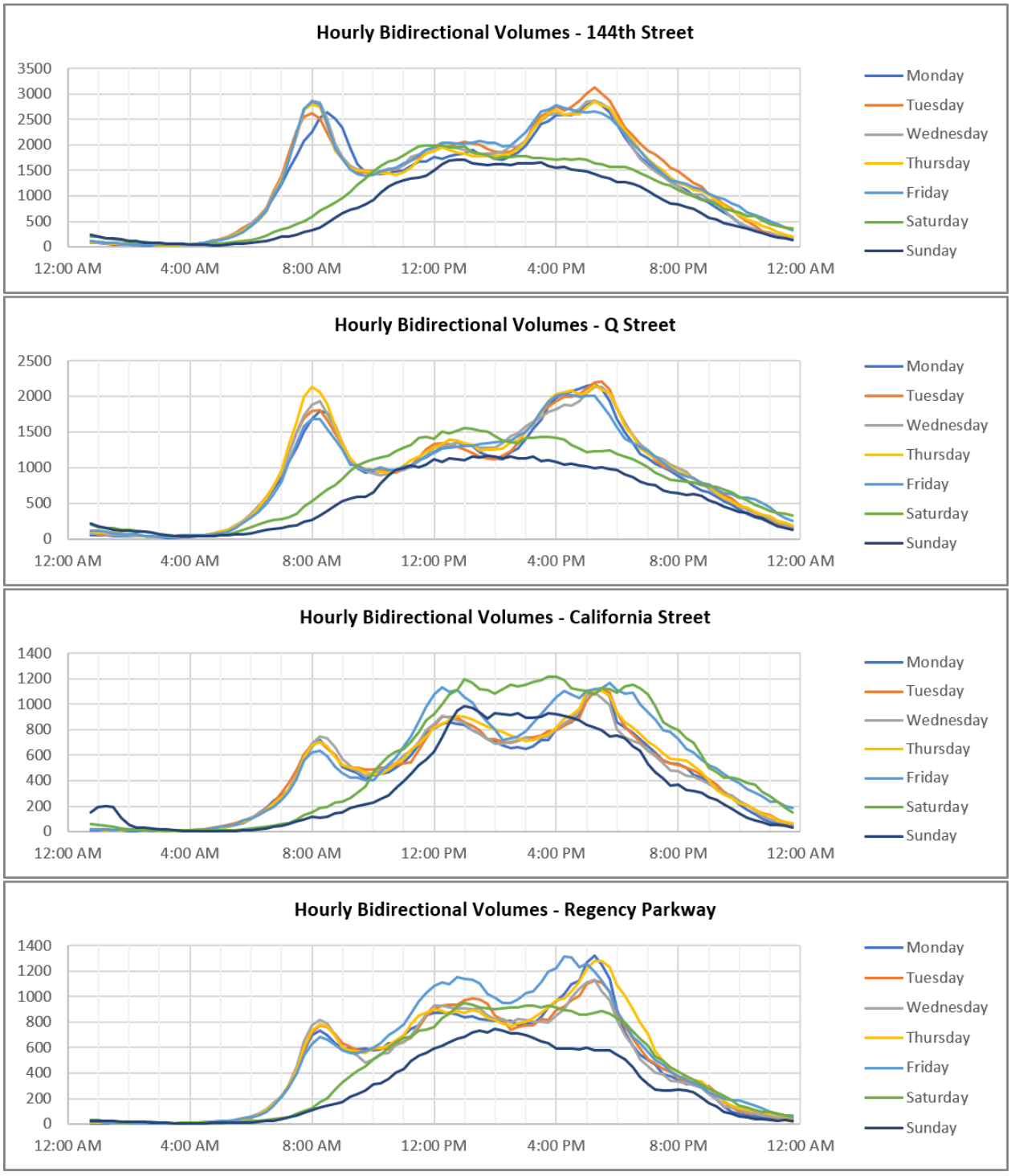


Figure 3-1. 24-Hour Daily Counts

3.6. TURNING MOVEMENT COUNTS

Turning movement counts at study intersections were provided by City of Omaha. The majority of the counts were collected across 2021–2022. Counts were collected for the 8-hour period of 7–11 AM and 2–6 PM. Peak hours during signal time plan periods were determined to be:

- Plan 1 MD peak hour – 2:00-3:00 PM; turning movement counts during this time were factored up based on collected segment 24-hour counts that identified peaking earlier in the period, generally over the lunch hour.
    - 144th Street counts from 2:00-3:00 PM were factored up 2.3%
    - Q Street counts from 2:00-3:00 PM were factored up 3.1%
    - Regency Parkway counts from 2:00-3:00 PM were factored up 21.4%
        - Regency Parkway experiences higher than normal traffic volumes on weekends due to proximity to malls.
    - Westroads (California Street) counts from 2:00-3:00 PM were factored up 24.8%
        - The streets around Westroads experiences higher than normal traffic volumes on weekends due to proximity to malls.
- Plan 2 AM peak hour
    - 144th Street – 7:30-8:30 AM
    - Q Street – 7:45-8:45 AM
    - Regency Parkway – 7:45-8:45 AM
    - Westroads (California Street) – 7:45-8:45 AM
- Plan 3 PM peak hour (all locations) – 4:45-5:45 PM
- Plan 4 OP peak hour – 144th Street, Q Street, and Westroads peak OP period volumes occurred 6:30-7:30 PM when there were no available turning movement counts. The 10:00-11:00 AM turning movement counts at these locations were factored up as follows:
    - 144th Street: 7.2%
    - Q Street: 13.9%
    - Regency Parkway peak hourly volumes occurred during the 10:00-11:00 AM hour and were not factored.
    - Westroads (California Street): 32.1%

Adjustments to some counts were made to account for fluctuations in traffic demand over the past few years and better balance traffic volumes throughout the study area. Additions and subtractions to through volumes, generally plus or minus 100-200, were made at spot locations to better balance traffic volumes between intersections. Calculations used to determine the factors are presented in **Table 3-2** and **Table 3-3**. The factors were calculated by taking the defined times specified in the scope and comparing them to the weekday maximum hourly count between 9:00 AM and 11:00 AM. Each value that resulted in a factor of greater than 1.0, or a count that was higher than the weekday maximum hourly count between 9:00 AM and 11:00 AM, was averaged to determine the final factor. The weekday counts of Monday through Thursday are represented in one column but count as 4 days in the averaging (if the factor is greater than 1.0).

Table 3-2. MD Volume Count Factors – Based Off Weekday 9:00 AM – 11:00 AM

Corridor	Variable	Weekday (M-Th) 2-3 PM	Weekday (M-Th) 11-3 PM	Friday 11-3 PM	Saturday 10-6:30 PM	Sunday 11-5 PM	Average / Factor
144th St	**Count**	**1924**	1924	2115	1998	1712	-
	Factor	**1.000**	1.000	1.099	1.038	< 1	1.023
Q St	**Count**	**1373**	1373	1444	1557	1167	-
	Factor	**1.000**	1.000	1.052	1.134	< 1	1.031
Westroads	**Count**	**706**	881	1132	1219	986	-
	Factor	**1.000**	1.124	1.335	1.502	1.243	1.389
Regency	**Count**	**787**	906	1155	950	750	-
	Factor	**1.000**	1.097	1.344	1.091	< 1	1.214

Table 3-3. OP Volume Factors – Based Off Weekday 9:00 AM – 11:00 AM

Corridor	Variable	Weekday (M-Th) 9-11 AM	Weekday (M-Th) 6:30-7:30 PM	Friday 6:30-7:30 PM	Saturday 9-10 AM	Saturday 6:30-7:30 PM	Sunday 10-11 AM	Sunday 5-6 PM	Average / Adjustment Factor Used
144th St	**Count**	**1487**	1601	1570	1342	1264	1248	1340	-
	Factor	**1.000**	1.076	1.056	< 1	< 1	< 1	< 1	1.072
Q St	**Count**	**964**	1116	1156	1079	914	977	984	-
	Factor	**1.000**	1.158	1.199	1.119	< 1	1.013	1.021	1.139
Westroads	**Count**	**525**	622	883	358	733	342	749	-
	Factor	**1.000**	1.185	1.682	< 1	1.396	< 1	1.427	1.321
Regency	**Count**	**631**	481	501	454	511	405	582	-
	Factor	**1.000**	< 1	< 1	< 1	< 1	< 1	< 1	1.000

3.7. TRAVEL TIME RUNS

Travel time runs were collected along 144th Street from Harvey Oaks Avenue to Eagle Run Drive and Q Street from 90th Street to 135th Street for conditions before and after new signal timings were implemented. Travel time runs were collected using a GPS device connected to a computer operating TruTraffic v10 software. A minimum of five runs per travel direction were collected during each design period plus one weekend peak period as descripted below:

- AM Peak: 7:00-9:00 AM
- MD Peak: 11:00-1:00 PM
- PM Peak: 3:30-5:30 PM
- Off-Peak: 9:00-11:00 AM
- Weekend MD Peak: 11:00-1:00 PM

A summary of travel time run data from before and after signal timings changes are provided in the **Performance Measures** chapter. Time-space diagram plots for the existing and implemented conditions for each time period can be found in the **Appendix**.

4. EXISTING INTERSECTION OPERATIONS

4.1. EXISTING DAY PLAN AND SPECIAL PLANS

A detailed breakdown of the existing and implemented day plans are shown side-by-side in the **Implemented Day Plans** section of the Implemented Timing Development chapter.

There were no patterns not called in the Existing Day Plan.

4.2. TRAFFIC OBSERVATIONS

Traffic observations were conducted during the months of April and May 2023. Observations were made during travel time runs, field visits to the intersections, and virtually through use of the City's camera network. Below is a summary of the observations that were made:

144TH STREET

- 144th Street & Pacific Street
  - All periods:
    - SB outside lane has low utilization due to the lane drop at Pine Street intersection (observed ~10% of traffic in third lane).
  - AM:
    - Heavy NB left-turn to WB right-turn for school drop-off.
  - MD:
    - Millard North open campus starts around 11:30.
  - PM:
    - Heavy pedestrian usage of all legs at the end of the school day. Students crossing to the parking lot in the southeast corner where parents were waiting for pickup.
    - Some SB split failures observed.
- 144th Street & Millard North High School
  - AM:
    - Heavy SB right-turning volume for school drop-off. Observed queue spillback into through lane.
    - Congestion within Millard North High School parking lot due to WB vehicles stopping at internal intersection.
    - EB left has heaver volume than EB right.
- 144th Street & Overlook Drive / Canopy Avenue
  - Lane sign and pavement markings don't match at west leg. Sign shows two left-turn lanes while pavement markings show single left-turn lane.
- 144th Street & W Dodge Road
  - Protected SB U-turn conflicts with protected WB right.
  - Protected NB U-turn conflicts with protected EB right.

- 144th Street & FNB Parkway / El Dorado
  - MD:
    - Heavy WB left-turn to SB left-turn at Dodge. Observed WB split failure at FNB.
  - PM:
    - Heavy WB left-turn to SB left-turn at Dodge.
- 144th Street & Blondo Street
  - AM:
    - Heavy WB left volume. WB left split failure observed.
    - EB had long queues.
  - PM:
    - WB split failure.
    - WB through queue blocked left-turning traffic.
- 144th Street & Eagle Run Drive
  - AM:
    - EB / WB traffic was mostly left turns.
    - Heavy SB left school traffic.

Q STREET

- Q Street & 120th Street
  - AM:
    - Long WB queues.
    - Minimal NB/SB traffic.
    - Some WB split failures
    - A lot of NB lefts from I-80 ramp intersection arrives on red at 120th.
  - MD:
    - SB left split failure
    - A lot of NB lefts from I-80 ramp intersection arrives on red at 120th.
  - PM:
    - Heavy SB left-turning traffic. Observed split failures.
    - SB through traffic blocked by left-turn queue spillback.
- Q Street & I-80 WB Ramp
  - AM:
    - Mostly NB left.
  - MD:
    - NB left and NB right evenly split.
  - PM:
    - Observed long EB/WB queues.
- Q Street & 108th Street
  - AM:
    - Long queues for SB left.

- Q Street & 99th Street
  - No SB lane signage. Wasn't clear which lane was meant for which direction. Two SB receiving lanes. The SB lane is a private street that is not maintained by the City.
- Q Street & 96th Street
  - PM:
    - WB left queue spillback.
    - Observed WB split failure.

REGENCY / WESTROADS

- California Street Between 100th Street (Regency Parkway) and 98th Street (WB Dodge Ramps)
  - Weaving traffic. NB right trying to merge left and EB through trying to merge right.
- California Street and 98th Street (WB Dodge Ramps)
  - EB right traffic typically treats it as one lane instead of two.

4.3. EXISTING MODEL VERIFICATION

Synchro files for the existing AM, MD, OP and PM timing plans were provided by the City of Omaha. The following checks were performed to review and update models to current conditions:

- The files were checked to make sure that the number of intersections matches in the networks.
- Signal IDs in the Synchro networks were checked against GIS ID numbers provided by the City.
- The number of lanes on each intersection approach in the Synchro files were checked using Google Earth and field observations.
- External links lengths were checked for minimum length of 500 feet. Some links were less than 500 feet and updated.
- The approaches at each intersection were checked for cardinal direction.
- Street names were checked to match City of Omaha naming conventions.
- Turn bay storage lengths at the intersections were measured using Google Earth and necessary adjustments were made to the existing storage lengths in the Synchro networks.
- Link speeds in the Synchro files were verified using street view images from Google Earth and field observations.
- Crosswalk widths were set to 16 feet and lane widths were set to 12 feet.
- A growth factor of 1 and a heavy vehicle percentage of 2% were used.
- Detectors in the networks were reviewed and updated at spot locations to match as-builts provided by the City. A detection zone length of 50 feet was used for lanes where the detection zone length was unknown.
- Traffic volumes from turning movement counts were imported into Synchro.
- Base signal timings, cycle lengths, splits and offsets at each study intersection were checked with MaxView and Wapiti and updated in Synchro to match.

5. IMPLEMENTED TIMING DEVELOPMENT

5.1. BASIC SIGNAL TIMING PARAMETERS

City staff had recently done a review and update of the Yellow, Red, Walk, and Flash Don't Walk clearance times so they were not reviewed as part of this project.

A review of the existing Minimum Green times and Minimum Splits was conducted for compliance with the City's current guidelines and nature of the intersection approaches. Table 5-1 shows the existing and implemented timings for the Min Green and Min Split.

Table 5-1. Updates to Min Green and Min Split Times

Intersection Name	Signal ID	Phase/ Direction	Min Green		Max Time	
			Existing	Implemented	Existing	Implemented
144th Street & Eagle Run Drive	**851**	2 / EB	-	-	50	30
		6 / WB	-	-	50	40
144th Street & West Dodge Road	**787**	3 / NBL	7	5	-	-
		4 / SB			20	15
		7 / SBL	7	5	-	-
		8 / NB			20	15
144th Street & Canopy Ave / Overlook Road	**1209**	3 / NBL	-	-	30	20
		7 / SBL	-	-	30	20
144th Street & Pacific Street	**591**	2 / EB	-	-	60	50
		3 / NBL	-	-	40	20
		6 / WB	-	-	60	50
144th Street & Pine Street	**761**	3 / NBL	-	-	30	20
Q Street & 135th Street	**1202**	2 / EB	-	-	80	50
		4 / SB	-	-	55	40
		6 / WB	-	-	80	50
		8 / NB	-	-	55	40
Q Street & 132nd Street / Harry Anderson Ave	**650**	2 / EB	-	-	80	50
		4 / SB	-	-	55	40
		6 / WB	-	-	80	50
		8 / NB	-	-	55	40
Q Street & Oaks Lane / Deauville Drive	**650**	2 / EB	-	-	90	50
		6 / WB	-	-	90	50

5.2. VARIABLE LEFT-TURN MODE ANALYSIS

A review and analysis of left-turn movements with existing permitted plus protected (Pm+Pt) phasing was conducted to determine movements to be modified to permitted phasing during specific timing plans. The City has developed a template for making these determinations that factors in left-turn volume, opposing volumes, left-turn delay, and crashes. If a location did not meet any of the criteria, it was considered for change to permitted phasing during that timing plan. Some locations do not currently meet any of the criteria, however, they were recommended to remain Pm+Pt due to expected development in the near future or to accommodate other peaking of turning traffic within the plan. Existing and implemented left-turn phases by time of day are shown in **Table 5-2**. A dash indicates no change from the existing. The left-turn warrant spreadsheets for each movement can be found in the **Appendix**.

Table 5-2. Left-Turn Phase Changes

Intersection	Signal ID	Mvmt	Existing				Implemented Changes			
			Plan 1 – MD	Plan 2 – AM	Plan 3 – PM	Plan 4 – OP	Plan 1 – MD	Plan 2 – AM	Plan 3 – PM	Plan 4 – OP
144th St & Eagle Run Dr	**739**	**NB**	Pm+Pt	Pm+Pt	Pm+Pt	Perm	-	-	-	-
		SB	Pm+Pt	Pm+Pt	Pm+Pt	Perm	-	-	-	-
144th St & Blondo St	**785**	**NB**	Pm+Pt	Pm+Pt	Pm+Pt[1]	Pm+Pt[1]	-	-	-	-
		SB	Pm+Pt	Pm+Pt	Pm+Pt	Pm+Pt	-	-	-	-
		EB	Pm+Pt	Pm+Pt	Pm+Pt	Pm+Pt	-	-	-	-
		WB	Pm+Pt	Pm+Pt[1]	Pm+Pt	Pm+Pt	-	-	-	-
144th St & El Dorado Dr / FNB Pkwy	**1208**	**NB**	Pm+Pt	Pm+Pt	Pm+Pt	Pm+Pt	-	-	-	**Perm**
		SB	Pm+Pt	Pm+Pt	Pm+Pt	Pm+Pt	**Perm**	-	-	**Perm**
		EB	Pm+Pt	Pm+Pt	Pm+Pt	Pm+Pt	-	-	-	-
144th St & Canopy Ave / Overlook Dr	**591**	**NB**	Pm+Pt	Pm+Pt	Pm+Pt	Pm+Pt	-	-	-	-
		SB	Pm+Pt	Pm+Pt	Pm+Pt	Pm+Pt	-	-	-	-
144th St & Blossom Ave / Dewey Ave	**761**	**NB**	Pm+Pt	Pm+Pt	Pm+Pt	Pm+Pt	-	-	-	-
144th St & Millard North HS	**588**	**NB**	Pm+Pt	Pm+Pt[1/2]	Pm+Pt	Pm+Pt	-	**Prot[1/2]**	-	-
144th St & Pine St	**795**	**NB**	Pm+Pt	Pm+Pt	Pm+Pt	Pm+Pt	-	-	-	-
144th St & Harvey Oaks Ave	**739**	**NB**	Pm+Pt	Pm+Pt	Pm+Pt	Pm+Pt	**Perm**	**Perm**	-	**Perm**
Oakview Dr and Hascall St	**523**	**SB**	Pm+Pt during weekend only				-	-	-	-
Oakview Dr & 141st Plz	**751**	**EB/WB**	Pm+Pt during weekend only				-	-	-	-
135th St & Q St	**1202**	**WB**	Pm+Pt	Pm+Pt	Pm+Pt	Pm+Pt	-	-	-	-
120th St & Q St	**564**	**SB**	Perm	Perm	Pm+Pt	Perm	-	-	-	-
Q St & John Galt Blvd	**765**	**EB**	Pm+Pt	Pm+Pt	Pm+Pt	Pm+Pt	-	-	-	-
Q St & Roxbury Dr	766	**WB**	Perm	Perm	Pm+Pt	Perm	-	-	-	-
108th St & Q St	**543**	**NB**	Pm+Pt	Pm+Pt	Pm+Pt	Pm+Pt	-	-	-	-
		SB	Pm+Pt	Pm+Pt	Pm+Pt	Pm+Pt	-	-	-	-
		EB	Pm+Pt	Pm+Pt	Pm+Pt[1]	Pm+Pt	-	-	**Prot[1]**	-
		WB	Pm+Pt	Pm+Pt	Pm+Pt	Pm+Pt	-	-	-	-
96th St & Q St	**519**	**NB**	Pm+Pt	Pm+Pt	Pm+Pt	Pm+Pt	-	-	-	-
		SB	Pm+Pt	Pm+Pt	Pm+Pt	Pm+Pt[1]	-	-	-	-
		EB	Pm+Pt	Pm+Pt	Pm+Pt	Pm+Pt	-	-	-	-
		WB	Pm+Pt	Pm+Pt	Pm+Pt	Pm+Pt	-	-	-	-
108th St & John Galt Blvd	**539**	**SB**	Prot	Prot	Prot	Pm+Pt	-	-	-	-
102nd St & Nicholas St	**1015**	**NB**	Perm	Pm+Pt	Perm	Perm	-	-	-	-
98th St & Westroads #8	**751**	**NB**	Pm+Pt	Pm+Pt	Pm+Pt	Pm+Pt	-	-	-	-

[1]Met Safety Threshold

[2]Met Capacity and Delay Threshold

A dash indicates no change from existing.

In addition to the operations review of left-turn modes, a safety evaluation and review was performed. At locations where a lead/lag was implemented or removed, a crash review from 9/25/23 - 11/3/23 was performed. Any crashes in the timeframe were documented and analyzed to determine the impact that the left-mode change had on the contributing circumstances of the crash. The results from the safety evaluations are shown in **Table 5-3**.

Table 5-3. Left-Turn Crash Evaluation

Intersection	Reason	Direction	Patterns	Reported Crashes (9/25/23 - 11/3/23)	Notes
144th St & Eldorado Dr/ FNB Pkwy	Omit	NBL	4	0	
	Omit	SBL	1, 4	0	
144th St & Harvey Oaks Ave	Omit	NBL	1, 2, 4	0	
144th St & Eagle Run Dr	Omit	NBL	4	0	Not a change with the project
	Omit	SBL	4	0	Not a change with the project
144th & Canopy Ave/ Overlook Dr	Lead/Lag	NBL/SBL	1	0	
	Lead/Lag	SBL/NBL	2	0	
120th St & Q St	Omit	SBL	1, 2, 4	0	Not a change with the project
96th St & Q St	Lead/Lag	EBL/WBL	1	0	
	Lead/Lag	NBL/SBL	2	0	
	Lead/Lag	SBL/NBL	3	0	
	Lead/Lag	WBL/EBL	3	1 (WBL - Lead)	
108th St & John Galt Blvd/ O St	Lead/Lag	NBL/SBL	3, 4	0	NBL does not have protected phase; SBL protected only during Pat 3; prot-perm during Pat 4
144th St & Arbor St	Lead/Lag	SBL/NBL	1, 3, 4	0	
144th St & Blondo St	Lead/Lag	EBL/WBL	1, 2, 3	0	
	Lead/Lag	SBL/NBL	1	0	
	Lead/Lag	WBL/EBL	4	0	
108th St & Q St	Lead/Lag	EBL/WBL	1	0	
140th Plz & Oakview Dr	Omit	EBL	ALL	0	Protected phase active during Sat 10:00 AM-6:30 PM; Sun 11:00 AM-5:00 PM
	Omit	WBL	ALL	0	Protected phase active during Sat 10:00 AM-6:30 PM; Sun 11:00 AM-5:00 PM
144th St & Blossom Ave	Lead/Lag	SBL/NBL	4	0	SBL is field access and is perm only
Hascall Plz & Oakview Dr	Omit	SBL	ALL	0	Protected phase active during Sat 10:00 AM-6:30 PM; Sun 11:00 AM-5:00 PM
Roxbury Dr & Q St	Omit	WBL	1, 2, 4	0	

5.3. LEADING PEDESTRIAN INTERVALS

A leading pedestrian interval (LPI) is a signal timing adjustment where the walk display is displayed a few seconds prior to the onset of green for the concurrent vehicular movement. The objective is to allow pedestrians to enter the intersection prior to the display of green, making them more visible to turning vehicles during green. LPI usually gives pedestrians 3-7 seconds of a head start entering the intersection, depending on the crossing distance. LPIs have been identified by the FHWA as a Proven Safety Countermeasure and have several safety and operational benefits. **Table 5-4** shows the LPI locations that the City implemented with the beginning of this project.

Table 5-4. Leading Pedestrian Interval Locations and Time

Intersection Name	Signal ID	Phase 2 Time (sec)	Phase 4 Time (sec)	Phase 6 Time (sec)	Phase 8 Time (sec)
144th St & Eagle Run Dr	851	5	6	5	5
144th St & Locust St	1168				
144th St & Nelsons Creek	924			5	
144th St & Blondo St	739	7	7	7	7
144th St & Franklin St	672	5		5	
144th St & Hamilton St	850	6	5	6	5
144th St & Eldorado Dr / FNB Pkwy	785	7	6	7	7
144th St & West Dodge Rd	787				
144th St & Canopy Ave / Overlook Rd	1209	7	4		
144th St & Blossom Ave / Dewey St	1208				
144th St & Millard North High School	762		3		
144th St & Pacific St	591	3	3	3	3
144th St & Pine St	761	6	3	7	3
144th St & Harvey Oaks St	588	6		6	
Oakview Dr & Hascall St	839	6		5	
Oakview Dr & 141st Plz	795		5		5
135th St & Q St	1202				5
Harry Andersen Ave / 132nd St & Q St	650		4		4
Oaks Lane / Deauville Dr & Q St	57		5		5
120th St & Q St	564	5	5	5	5
I-80 & Q St / West Ramp	676		5		
John Galt Blvd & Q St	765		5		5
Roxbury Dr & Q St	766		5		5
108th St & Q St	543	5	6	6	6
99th St & Q St	686	5	5	5	5
96th St & Q St	519	5	5	5	5
93rd St & Q St (Ped)	514				
90th St & Q St	507		5		5
108th St & John Galt St	539	5		5	
108th St & Mockingbird St	642	5		5	
96th St & Park Dr	685	5	3	5	3
102nd St & Nicholas St	1015	5	6	6	5
102nd St & California St / Ent #2	755				
100th St & California St (Regency)	526				
98th St & California St (Dodge Wb)	523	3	3		
98th St & Ent #8	751			7	
Regency Pkwy & West Dodge Rd Eb	72				
Regency Pkwy & Regency Cir	71	6	5		
Regency Pkwy & Harney Pkwy	31				

5.4. PASSAGE TIME ADJUSTMENTS

A review of phase passage time was conducted to determine locations where passage time is not consistent with typical values for detection type/equipment and intersection movement. The intersections shown in **Table 5-5** had passage time adjustments made.

Table 5-5. Passage Time Adjustments

Intersection Name	Signal ID	Signal Phase							
		1	2	3	4	5	6	7	8
144th St & West Dodge Rd	787	0.7	NA	0.7	2.1	0.7	NA	0.7	2.1
144th St & Canopy Ave / Overlook Rd	1209	NA	1.4	0.7	2.1	NA	1.4	0.7	2.1
144th St & Millard North High School	762	NA	1.4	0.7	2.1	NA	1.4	NA	2.1
144th St & Pacific St	591	0.7	2.1	0.7	2.1	0.7	2.1	0.7	2.1
144th St & Pine St	761	NA	1.4	0.7	2.1	NA	1.4	NA	2.1
108th St & L St	540	0.7	2.1	0.7	1.8	0.7	2.1	0.7	1.8
96th St & Mockingbird Ln	517	NA	1.4	NA	-	NA	1.4	NA	-
Regency Pkwy & Regency Cir	71	NA	1.4	NA	-	NA	NA	NA	-

A dash indicates no change from existing.

5.5. CYCLE LENGTH OPTIMIZATION

Multiple cycle lengths were considered at study intersections during each of the four timing plans. Cycle lengths of 60, 90, 120, 150, and 180 seconds were analyzed for each corridor. **Table 5-6** through **Table 5-8** provide network performance metrics for the cycle length scenarios. The 180 second cycle length performed the worst on all study areas and time periods and was excluded from these tables.

Table 5-6. Cycle Length Trial Network Performance – 144th Street

Time of Day Plan	Scenario	Cycle Length	Control Delay / Veh (sec/veh)	Total Delay (hr)	Stops / Veh	Stops (#)	Total Travel Time (hr)	Fuel Consumed (gal)	Unserved Vehicles (#)	Performance Index
MD	Existing	(90 sec)	14	76	0.37	9,282	232	409	0	101.6
	Scenario 1	(60 sec)	14	90	0.36	10,356	263	457	0	118.4
	Scenario 2	(90 sec)	14	76	0.32	9,068	249	431	0	100.7
	Scenario 3	(120 sec)	14	87	0.29	8,186	261	429	0	110.1
	Scenario 4	(150 sec)	14	104	0.28	7,939	278	438	0	126.2
AM	Existing	(120 / 90 sec)	14	152	0.40	15,595	371	624	0	192.3
	Scenario 1	(60 sec)	14	171	0.48	17,546	390	676	25	220.1
	Scenario 2	(90 sec)	14	138	0.43	15,658	357	627	10	181
	Scenario 3	(120 sec)	14	152	0.36	13,419	371	610	0	189.2
	Scenario 4	(150 sec)	14	169	0.37	13,480	388	623	0	206.3
PM	Existing	(120 / 90 sec)	14	228	0.45	19,290	509	817	183	281.2
	Scenario 1	(60 sec)	14	230	0.48	21,410	521	860	102	289.9
	Scenario 2	(90 sec)	14	220	0.40	17,812	510	807	325	269
	Scenario 3	(120 sec)	14	210	0.36	16,370	500	782	80	255.8
	Scenario 4	(150 sec)	14	220	0.36	16,051	510	785	1	264.8
OP	Existing	(90 sec)	14	69	0.47	9,645	200	370	0	95.7
	Scenario 1	(60 sec)	14	69	0.32	7,366	211	358	0	89.1
	Scenario 2	(90 sec)	14	55	0.27	6,365	198	336	0	73
	Scenario 3	(120 sec)	14	68	0.28	6,487	210	347	0	86
	Scenario 4	(150 sec)	14	81	0.25	5,795	223	348	0	91.1

Table 5-7. Cycle Length Trial Network Performance – Q Street

Time of Day Plan	Scenario	Cycle Length	Control Delay / Veh (sec/veh)	Total Delay (hr)	Stops / Veh	Stops (#)	Total Travel Time (hr)	Fuel Consumed (gal)	Unserved Vehicles (#)	Performance Index
MD	Existing	(90 sec)	15	85	0.41	9,943	281	421	19	113.1
	Scenario 1	(60 sec)	15	84	0.42	10,158	280	422	19	112.5
	Scenario 2	(90 sec)	15	79	0.38	9,092	274	408	19	103.8
	Scenario 3	(120 sec)	15	100	0.36	8,637	295	419	19	123.7
	Scenario 4	(150 sec)	15	121	0.33	8,014	316	429	19	143.1
AM	Existing	(120 / 90 sec)	15	113	0.39	10,845	342	496	13	142.9
	Scenario 1	(60 sec)	15	90	0.45	12,367	320	493	13	124.7
	Scenario 2	(90 sec)	15	90	0.39	10,708	319	478	13	119.4
	Scenario 3	(120 sec)	15	109	0.36	9,849	338	484	13	136
	Scenario 4	(150 sec)	15	134	0.34	9,325	363	498	13	159.6
PM	Existing	(120 / 90 sec)	15	208	0.45	16,641	500	704	72	253.8
	Scenario 1	(60 sec)	15	178	0.54	19,981	471	714	21	233.6
	Scenario 2	(90 sec)	15	191	0.48	17,629	483	701	229	239.5
	Scenario 3	(120 sec)	15	197	0.45	16,587	490	697	21	243.2
	Scenario 4	(150 sec)	15	230	0.41	15,355	523	709	88	272.8
OP	Existing	(90 sec)	15	59	0.41	7,878	217	333	14	80.9
	Scenario 1	(60 sec)	15	61	0.37	7,080	219	325	0	80.4
	Scenario 2	(90 sec)	15	55	0.32	6,296	213	314	0	72.6
	Scenario 3	(120 sec)	15	71	0.31	6,011	230	324	0	88.1
	Scenario 4	(150 sec)	15	89	0.30	5,754	247	334	0	104.6

Table 5-8. Cycle Length Trial Network Performance – Regency / Crossroads

Time of Day Plan	Scenario	Cycle Length	Control Delay / Veh (sec/veh)	Total Delay (hr)	Stops / Veh	Stops (#)	Total Travel Time (hr)	Fuel Consumed (gal)	Unserved Vehicles (#)	Performance Index
MD	Existing	(60 / 75 sec)	8	21	0.43	4,622	99	138	0	22.3
	Scenario 1	(60 sec)	8	17	0.38	4,057	94	130	0	18.2
	Scenario 2	(90 sec)	8	24	0.38	4,060	104	138	0	23.7
	Scenario 3	(120 sec)	8	31	0.36	3,874	116	145	0	29.2
	Scenario 4	(150 sec)	8	39	0.37	3,917	128	154	0	35.2
AM	Existing	(60 sec / Free)	8	16	0.37	2,572	63	90	0	11.7
	Scenario 1	(60 sec)	8	12	0.31	2,108	60	84	0	9.2
	Scenario 2	(90 sec)	8	16	0.29	2,033	63	86	0	10.5
	Scenario 3	(120 sec)	8	19	0.29	1,976	68	89	0	12.5
	Scenario 4	(150 sec)	8	23	0.28	1,925	70	91	0	14.2
PM	Existing	(60 / 75 sec)	8	37	0.46	5,327	114	159	0	26
	Scenario 1	(60 sec)	8	31	0.41	4,795	108	151	0	22
	Scenario 2	(90 sec)	8	41	0.40	4,625	118	156	0	26.5
	Scenario 3	(120 sec)	8	53	0.40	4,641	130	166	0	26.5
	Scenario 4	(150 sec)	8	64	0.40	4,512	141	174	0	32.7
OP	Existing	(60 / 75 sec)	8	16	0.38	2,740	61	87	0	11.5
	Scenario 1	(60 sec)	8	15	0.33	2,434	61	85	0	11
	Scenario 2	(90 sec)	8	22	0.32	2,376	67	88	0	14
	Scenario 3	(120 sec)	8	27	0.35	2,546	74	94	0	17.3
	Scenario 4	(150 sec)	8	33	0.29	2,106	78	95	0	19.4

IMPLEMENTED CYCLE LENGTHS

Performance measures and adjacent cycle lengths were reviewed to determine proposed cycle lengths for each corridor. Selected cycle lengths that were implemented are shown in **Table 5-9** and **Figure 5-1** through **Figure 5-3**.

Table 5-9. Implemented Cycle Lengths

Timing Plan	Scenario	Cycle Length by Corridor or Subarea		
		144th Street	Q Street	Regency / Westroads
Plan 1 MD	**Existing**	90	90	60[1] / 75
	Implemented	120	90	90
Plan 2 AM	**Existing**	90 / 120[2]	90 / 120[3]	60[1] / Free/Flash
	Implemented	120	120	60
Plan 3 PM	**Existing**	90 / 120[2]	90 / 120[2]	60[1] / 90
	Implemented	150	120 / 150[4]	90
Plan 4 OP	**Existing**[5]	90	90	60[1] / 75
	Implemented	90	90	60

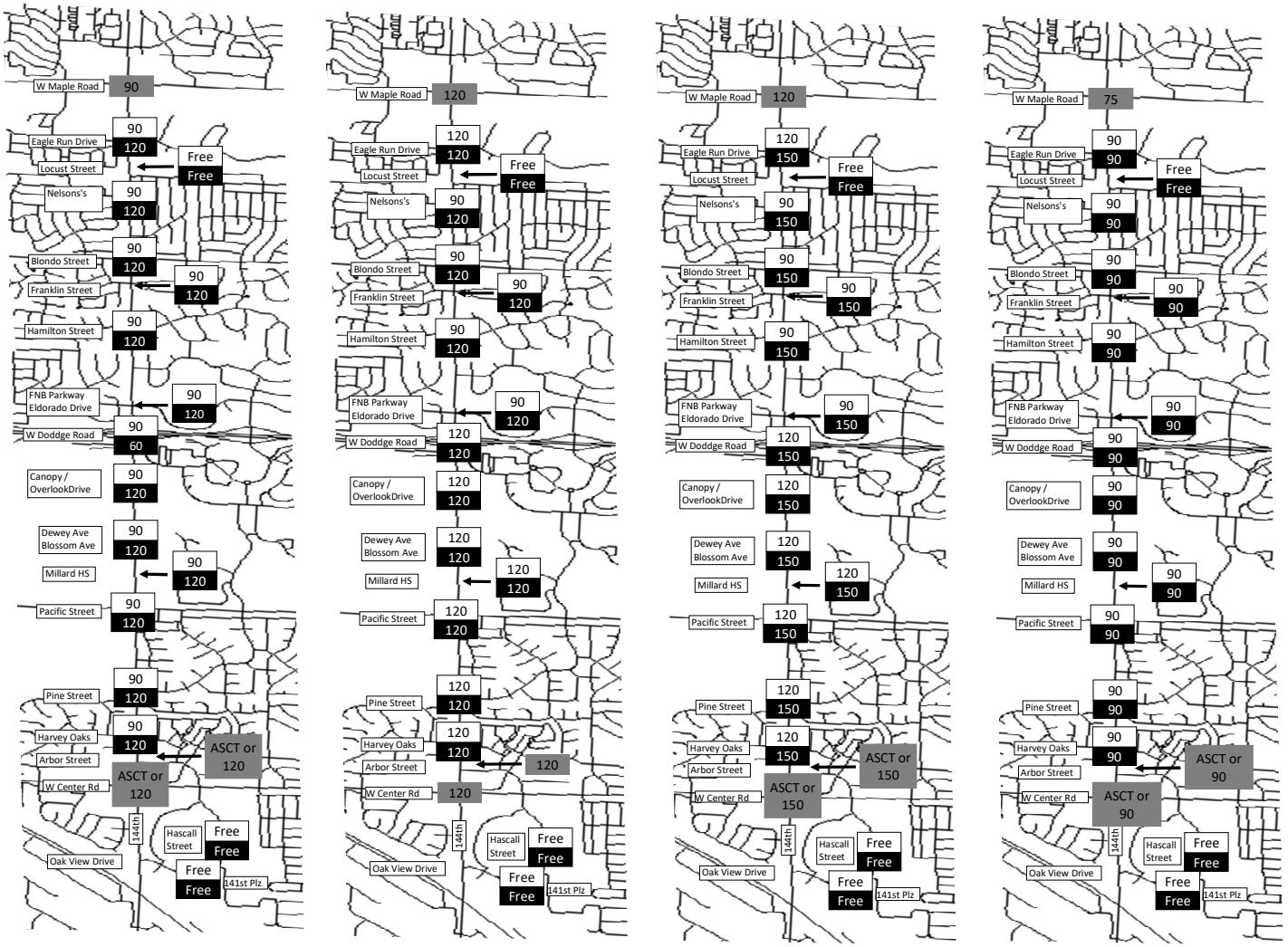
[1] Includes Regency Parkway & Harney Parkway and Regency Parkway & Regency Circle

[2] Includes signals north of and including FNB Parkway.

[3] Includes signals east of and including 99th Street.

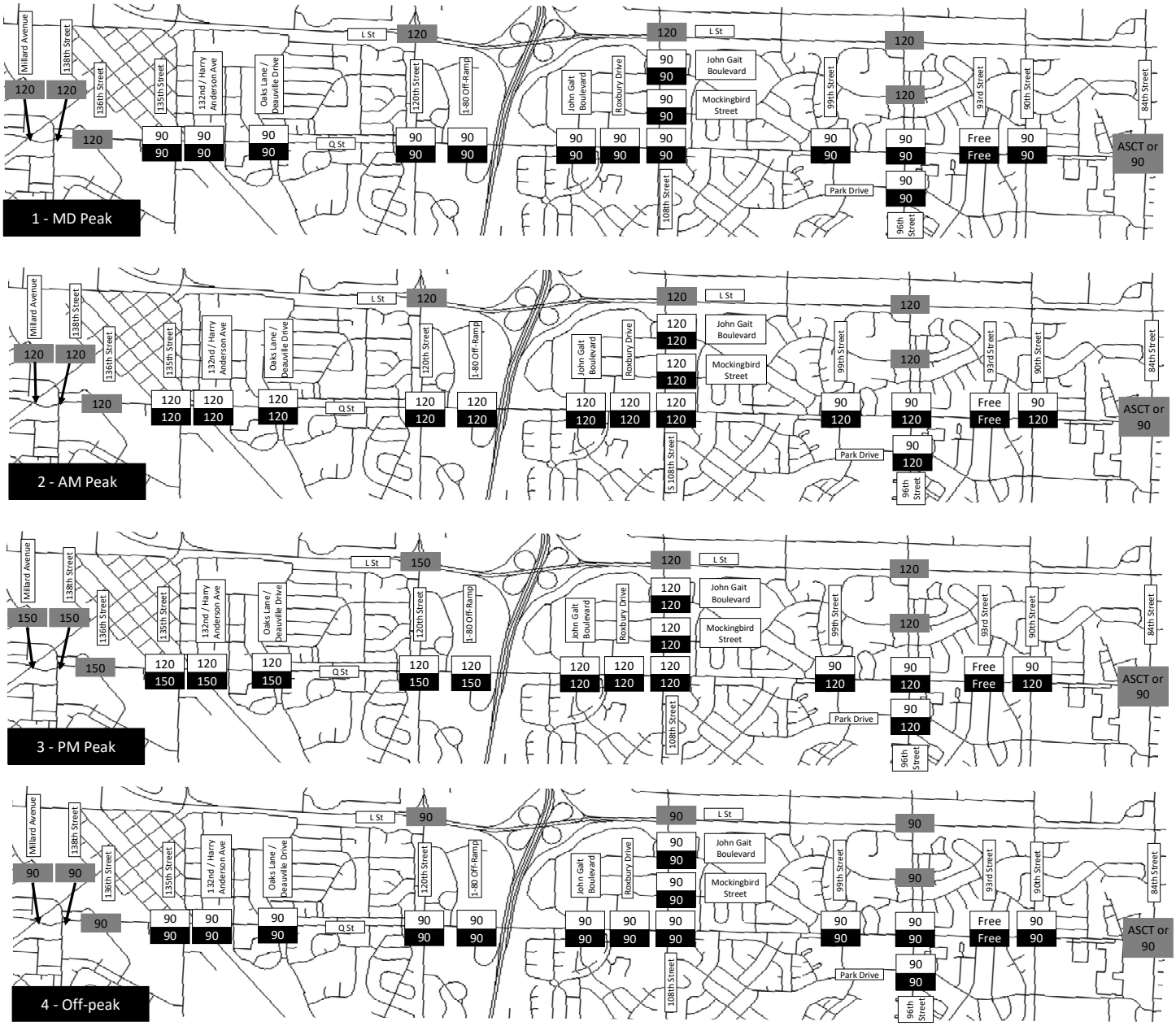
[4] Includes signals west of and including I-80 WB ramps.

[5] No existing Plan 4. Cycle lengths shown are based on Plan 1 which operates during Plan 4.



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

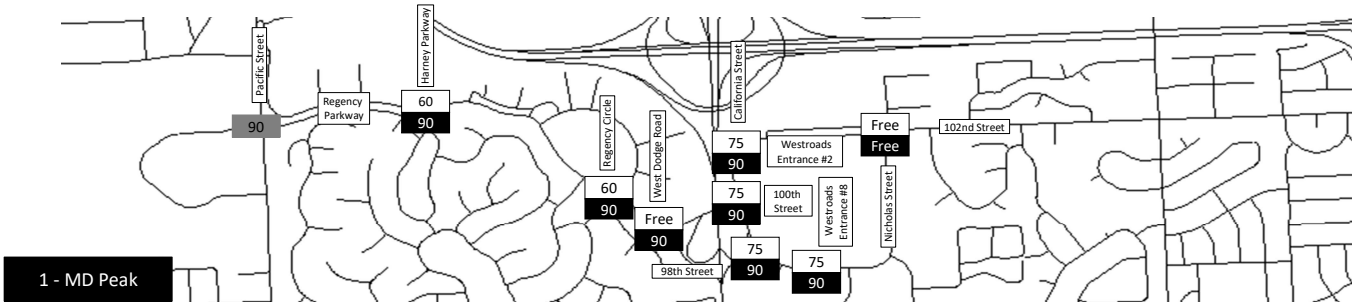
Figure 5-1
144th Street Cycle Lengths

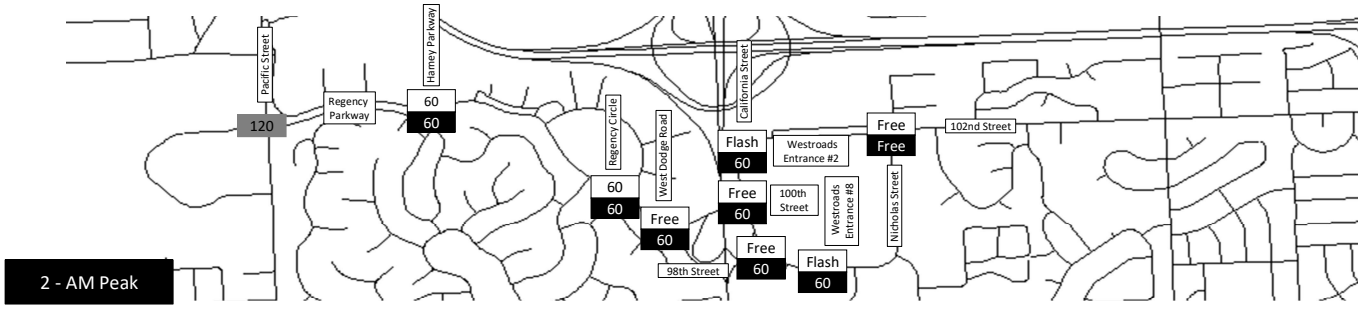


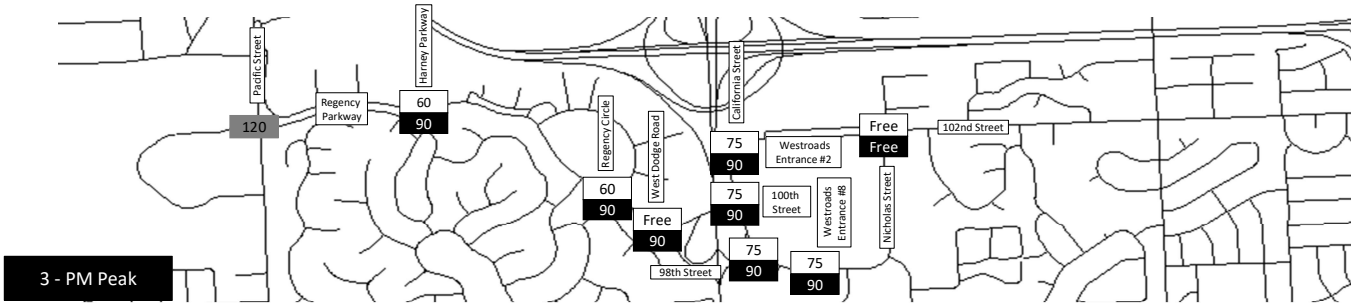
120	Existing Cycle Length
120	Implemented Cycle Length
120	Cycle Length (Adjacent Intersection)

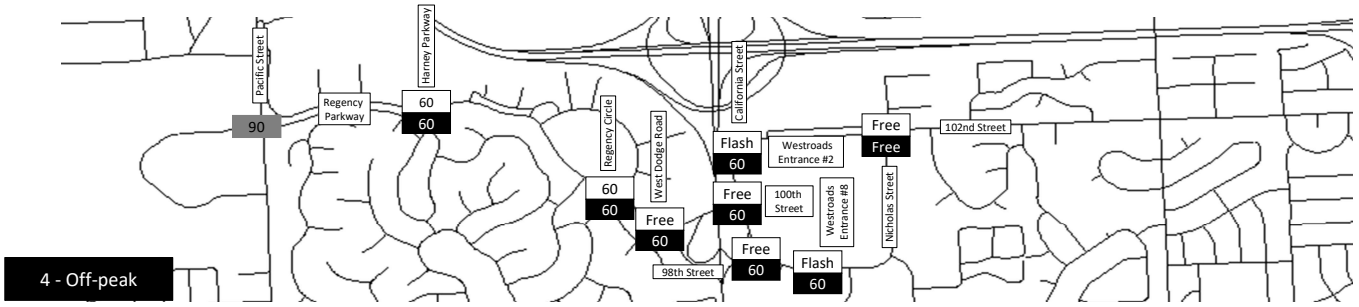
N

Figure 5-2
Q Street Cycle Lengths









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

Figure 5-3
Westroads and Regency Cycle Lengths

5.6. IMPLEMENTED DAY PLANS

Implemented day plans for optimized timings are shown alongside the existing in **Figure 5-4**, **Figure 5-6**, and **Figure 5-8**. 24-hour volume counts are in **Figure 5-5**, **Figure 5-7**, and **Figure 5-9**. The 24-hour counts were used to verify that the City's standard day plan schedule aligned with the flow of traffic on each of these corridors. There were no implemented special plans.

144th St

EXISTING SCHEDULES: MONDAY - FRIDAY

Signal ID	Signal Location	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
731	West Maple Rd & 144th St**	20 [free]						4 [75]	2 [120]			4 [75]		1 [90]				3 [120]			4 [75]					20 [free]*
851	Eagle Run Dr & 144th St	20 [free]						2 [120]	2 [120]			1 [90]		1 [90]				3 [120]			1 [90]					20 [free]*
924	Nelson Creek Dr & 144th St	19 [flash]						2 [90]	2 [90]			1 [90]		1 [90]				3 [90]			1 [90]					19 [flash]*
739	Blondo St & 144th St	20 [free]						4 [90]	2 [90]			1 [90]		1 [90]				3 [90]			1 [90]					20 [free]*
672	Franklin St & 144th St	19 [flash]						2 [90]	2 [90]			1 [90]		1 [90]				3 [90]			1 [90]					19 [flash]*
850	Hamilton St & 144th St	19 [flash]						2 [90]	2 [90]			1 [90]		1 [90]				3 [90]			1 [90]					19 [flash]*
785	Eldorado Dr / FNB Pkwy & 144th St	20 [free]						2 [90]	2 [90]			1 [90]		1 [90]				3 [90]			1 [90]					20 [free]*
787	West Dodge Rd & 144th St	20 [free]							2 [120]				1 [90]					3 [120]			1 [90]					20 [free]*
1209	Canopy Ave / Overlook Rd & 144th St	20 [free]							2 [120]				1 [90]					3 [120]			1 [90]					20 [free]*
1208	Blossom Ave (Dewey) & 144th St	20 [free]							2 [120]				1 [90]					3 [120]			1 [90]					20 [free]*
762	Millard North & 144th St	19 [flash]							2 [120]				1 [90]					3 [120]			1 [90]					19 [flash]*
591	Pacific St & 144th St	20 [free]							2 [120]				1 [90]					3 [120]			1 [90]					20 [free]*
761	Applied Pkwy / Pine St & 144th St	19 [flash]							2 [120]				1 [90]					3 [120]			1 [90]					19 [flash]*
588	Harvey Oaks Ave & 144th St	20 [free]						2 [120]	2 [120]			1 [90]		1 [90]				3 [120]			1 [90]					20 [free]*
703	Arbor St & 144th St**	19 [flash]						2 [120]	2 [120]			Adaptive [Varies]														19 [flash]*
592	West Center Rd & 144th St**	20 [free]						2 [120]	2 [120]			Adaptive [Varies]														20 [free]*
839	Oakview & Hascall	19 [flash]						10 [free]	10 [free]			10 [free]		10 [free]				10 [free]			10 [free]					19 [flash]*
795	Oakview & 141st Plz	19 [flash]						10 [free]	10 [free]			10 [free]		10 [free]				10 [free]			10 [free]					19 [flash]*

IMPLEMENTED SCHEDULES: MONDAY - FRIDAY

Signal ID	Signal Location	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
731	West Maple Rd & 144th St**	20 [free]						4 [75]	2 [120]			4 [75]		1 [90]				3 [120]			4 [75]					20 [free]*
851	Eagle Run Dr & 144th St	20 [free]						4 [90]	2 [120]			4 [90]		1 [120]				3 [150]			4 [90]					20 [free]*
924	Nelson Creek Dr & 144th St	19 [flash]						4 [90]	2 [120]			4 [90]		1 [120]				3 [150]			4 [90]					19 [flash]*
739	Blondo St & 144th St	20 [free]						4 [90]	2 [120]			4 [90]		1 [120]				3 [150]			4 [90]					20 [free]*
672	Franklin St & 144th St	19 [flash]						4 [90]	2 [120]			4 [90]		1 [120]				3 [150]			4 [90]					19 [flash]*
850	Hamilton St & 144th St	19 [flash]						4 [90]	2 [120]			4 [90]		1 [120]				3 [150]			4 [90]					19 [flash]*
785	Eldorado Dr / FNB Pkwy & 144th St	10 [free]						4 [90]	2 [120]			4 [90]		1 [120]				3 [150]			4 [90]					10 [free]*
787	West Dodge Rd & 144th St	20 [free]						4 [90]	2 [120]			4 [90]		1 [60]				3 [150]			4 [90]					20 [free]*
1209	Canopy Ave / Overlook Rd & 144th St	20 [free]						4 [90]	2 [120]			4 [90]		1 [120]				3 [150]			4 [90]					20 [free]*
1208	Blossom Ave (Dewey) & 144th St	20 [free]						4 [90]	2 [120]			4 [90]		1 [120]				3 [150]			4 [90]					20 [free]*
762	Millard North & 144th St	19 [flash]						4 [90]	2 [120]			4 [90]		1 [120]				3 [150]			4 [90]					19 [flash]*
591	Pacific St & 144th St	20 [free]						4 [90]	2 [120]			4 [90]		1 [120]				3 [150]			4 [90]					20 [free]*
761	Applied Pkwy / Pine St & 144th St	19 [flash]						4 [90]	2 [120]			4 [90]		1 [120]				3 [150]			4 [90]					19 [flash]*
588	Harvey Oaks Ave & 144th St	10 [free]						4 [90]	2 [120]			4 [90]		1 [120]				3 [150]			4 [90]					10 [free]*
703	Arbor St & 144th St**	19 [flash]						4 [90]	2 [120]			Adaptive [Varies]														19 [flash]*
592	West Center Rd & 144th St**	20 [free]						4 [90]	2 [120]			Adaptive [Varies]														20 [free]*
839	Oakview & Hascall	19 [flash]						10 [free]	10 [free]			10 [free]		10 [free]				10 [free]			10 [free]					19 [flash]*
795	Oakview & 141st Plz	19 [flash]						10 [free]	10 [free]			10 [free]		10 [free]				10 [free]			10 [free]					19 [flash]*

a: 2 [120] b: 2 [free]

*Not called on Fridays **Adjacent intersection for information only

Q St

EXISTING SCHEDULES: MONDAY - FRIDAY

Signal ID	Signal Location	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
651	136th & Q St**	19 [flash]						4 [90]	2 [120]			4 [90]		1 [120]				3 [150]			4 [90]					19 [flash]*
1202	135th St & Q St	20 [free]							2 [120]				1 [90]					3 [120]			1 [90]					20 [free]*
650	132nd St / Harry Andersen Ave & Q St	20 [free]							2 [120]				1 [90]					3 [120]			1 [90]					20 [free]*
57	Oaks Lane / Deauville Dr & Q St	19 [flash]							2 [120]				1 [90]					3 [120]			1 [90]					19 [flash]*
564	120th St & Q St	10 [free]						2 [120b]	12 [120a]	9		1 [90]		1 [90]				3 [120]			1 [90]					10 [free]*
676	I-80 off-ramp & Q St	20 [free]						2 [120b]	2 [120]			1 [90]		1 [90]				3 [120]			1 [90]					20 [free]*
765	John Galt Blvd & Q St	19 [flash]						2 [120b]	2 [120]			1 [90]		1 [90]				3 [120]			1 [90]					19 [flash]*
766	Roxbury Dr & Q St	19 [flash]						2 [120b]	2 [120]			1 [90]		1 [90]				3 [120]			1 [90]					19 [flash]*
543	108th & Q St	20 [free]						2 [120b]	2 [120]			1 [90]		1 [90]				3 [120]			1 [90]					20 [free]*
686	99th St & Q St	19 [flash]						2 [90]	2 [90]			1 [90]		1 [90]				3 [90]			1 [90]					19 [flash]*
519	96th St & Q St	20 [free]						2 [90]	2 [90]			1 [90]		1 [90]				3 [90]			1 [90]					20 [free]*
514	93rd St Ped & Q St	20 [free]						20 [free]	20 [free]			20 [free]		20 [free]				20 [free]			20 [free]					20 [free]*
507	90th St & Q St	20 [free]						2 [90]	2 [90]			1 [90]		1 [90]				3 [90]			1 [90]					20 [free]*
649	84th St & Q St**	20 [free]						Adaptive [Varies]																		20 [free]*
539	L St & 108th St**	20 [free]						4 [90]	2 [120]			4 [90]		1 [120]				3 [120]			4 [90]					20 [free]*
539	John Galt Blvd & 108th St	19 [flash]						2 [90]	2 [120]			4 [90]		1 [90]				3 [120]			4 [90]					19 [flash]*
642	Mockingbird & 108th St	19 [flash]						2 [120b]	2 [120]			1 [90]		1 [90]				3 [120]			4 [90]					19 [flash]*
543	108th & Q St	20 [free]						2 [120b]	2 [120]			1 [90]		1 [90]				3 [120]			4 [90]					20 [free]*
519	96th St & Q St	20 [free]						2 [90]	2 [90]			1 [90]		1 [90]				3 [90]			1 [90]					20 [free]*
685	Park Dr & 96th St	19 [flash]						2 [90]	2 [90]			1 [90]		1 [90]				3 [90]			1 [90]					19 [flash]*

IMPLEMENTED SCHEDULES: MONDAY - FRIDAY

Signal ID	Signal Location	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
651	136th & Q St**	19 [flash]						4 [90]	2 [120]			4 [90]		1 [120]				3 [150]			4 [90]					19 [flash]*
1202	135th St & Q St	20 [free]						4 [90]	2 [120]			4 [90]		1 [90]				3 [150]			4 [90]					20 [free]*
650	132nd St / Harry Andersen Ave & Q St	20 [free]						4 [90]	2 [120]			4 [90]		1 [90]				3 [150]			4 [90]					20 [free]*
57	Oaks Lane / Deauville Dr & Q St	19 [flash]						4 [90]	2 [120]			4 [90]		1 [90]				3 [150]			4 [90]					19 [flash]*
564	120th St & Q St	10 [free]						4 [90]	12 [120a]			4 [90]		1 [90]				3 [150]			4 [90]					10 [free]*
676	I-80 off-ramp & Q St	20 [free]						4 [90]	2 [120]			4 [90]		1 [90]				3 [150]			4 [90]					20 [free]*
765	John Galt Blvd & Q St	19 [flash]						4 [90]	2 [120]			4 [90]		1 [90]				3 [120]			4 [90]					19 [flash]*
766	Roxbury Dr & Q St	19 [flash]						4 [90]	2 [120]			4 [90]		1 [90]				3 [120]			4 [90]					19 [flash]*
543	108th & Q St	20 [free]						4 [90]	2 [120]			4 [90]		1 [90]				3 [120]			4 [90]					20 [free]*
686	99th St & Q St	19 [flash]						4 [90]	2 [120]			4 [90]		1 [90]				3 [120]			4 [90]					19 [flash]*
519	96th St & Q St	20 [free]						4 [90]	2 [120]			4 [90]		1 [90]				3 [120]			4 [90]					20 [free]*
514	93rd St Ped & Q St	20 [free]						20 [free]	20 [free]			20 [free]		20 [free]				20 [free]			20 [free]					20 [free]*
507	90th St & Q St	20 [free]						4 [90]	2 [120]			4 [90]		1 [90]				3 [120]			4 [90]					20 [free]*
649	84th St & Q St**	20 [free]						Adaptive [Varies]																		20 [free]*
539	L St & 108th St**	20 [free]						4 [90]	2 [120]			4 [90]		1 [120]				3 [120]			4 [90]					20 [free]*
539	John Galt Blvd & 108th St	19 [flash]						4 [90]	2 [120]			4 [90]		1 [90]				3 [120]			4 [90]					19 [flash]*
642	Mockingbird & 108th St	19 [flash]						4 [90]	2 [120]			4 [90]		1 [90]				3 [120]			4 [90]					19 [flash]*
543	108th & Q St	20 [free]						4 [90]	2 [120]			4 [90]		1 [90]				3 [120]			4 [90]					20 [free]*
519	96th St & Q St	20 [free]						4 [90]	2 [120]			4 [90]		1 [90]				3 [120]			4 [90]					20 [free]*
685	Park Dr & 96th St	19 [flash]						4 [90]	2 [120]			4 [90]		1 [90]				3 [120]			4 [90]					19 [flash]*

a: 2 [120]

*Not called on Fridays **Adjacent intersection for information only

Regency / Westroads

EXISTING SCHEDULES: MONDAY - FRIDAY

Signal ID	Signal Location	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
1015	Nicholas St & 102nd St	10 [free]						10 [free]	20 [free]			10 [free]		10 [free]				10 [free]			10 [free]					10 [free]*
755	102nd St & California St / Westroads E	19 [flash]						19 [flash]	19 [flash]			20 [free]		1 [75]				1 [75]			1 [75]					19 [flash]*
526	100th St & California St	20 [free]						20 [free]	20 [free]			20 [free]		1 [75]				1 [75]			1 [75]					20 [free]*
523	98th St & California St	20 [free]						20 [free]	20 [free]			20 [free]		1 [75]				1 [75]			1 [75]					20 [free]*
751	98th St & Westroads Ent #8	19 [flash]						19 [flash]	19 [flash]			20 [free]		1 [75]				1 [75]			1 [75]					19 [flash]*
526	100th St & California St	20 [free]						20 [free]	20 [free]			20 [free]		1 [75]				1 [75]			1 [75]					20 [free]*
72	West Dodge Rd & Regency Pkwy	20 [free]						20 [free]	20 [free]			20 [free]		20 [free]				20 [free]			20 [free]					20 [free]*
71	Regency Cir & Regency Pkwy	19 [flash]						2 [60]	2 [60]			1 [60]		1 [60]				3 [60]			1 [60]					19 [flash]*
31	Harney Pkwy & Regency Pkwy	19 [flash]						2 [60]	2 [60]			1 [60]		1 [60]				3 [60]			1 [60]					19 [flash]*
70	Pacific St & Regency Pkwy**	20 [free]						20 [free]	2 [120]			1 [90]		1 [90]		1 [90]		3 [120]		1 [90]		20 [free]				

IMPLEMENTED SCHEDULES: MONDAY - FRIDAY

Signal ID	Signal Location	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
1015	Nicholas St & 102nd St	10 [free]						10 [free]	10 [free]			10 [free]		10 [free]				10 [free]			10 [free]					10 [free]*
755	102nd St & California St / Westroads E	19 [flash]						20 [free]	20 [free]			2 [60]		4 [60]				1 [90]			3 [90]					19 [flash]*
526	100th St & California St	20 [free]						20 [free]	20 [free]			2 [60]		4 [60]				1 [90]			3 [90]					20 [free]*
523	98th St & California St	20 [free]						20 [free]	20 [free]			2 [60]		4 [60]				1 [90]			3 [90]					20 [free]*
751	98th St & Westroads Ent #8	19 [flash]						19 [flash]	19 [flash]			2 [60]		4 [60]				1 [90]			3 [90]					19 [flash]*
526	100th St & California St	20 [free]						20 [free]	20 [free]			2 [60]		4 [60]				1 [90]			3 [90]					20 [free]*
72	West Dodge Rd & Regency Pkwy	20 [free]						20 [free]	20 [free]			2 [60]		4 [60]				1 [90]			3 [90]					20 [free]*
71	Regency Cir & Regency Pkwy	19 [flash]						4 [60]	2 [60]			4 [60]		1 [90]				3 [90]			4 [60]					19 [flash]*
31	Harney Pkwy & Regency Pkwy	19 [flash]						4 [60]	2 [60]			4 [60]		1 [90]				3 [90]			4 [60]					19 [flash]*
70	Pacific St & Regency Pkwy**	20 [free]						20 [free]	2 [120]			1 [90]		1 [90]		1 [90]		3 [120]		1 [90]		20 [free]				

*Not called on Fridays **Adjacent intersection for information only

Figure 5-4: Existing and Implemented Weekday (Mon-Fri) Day Plans

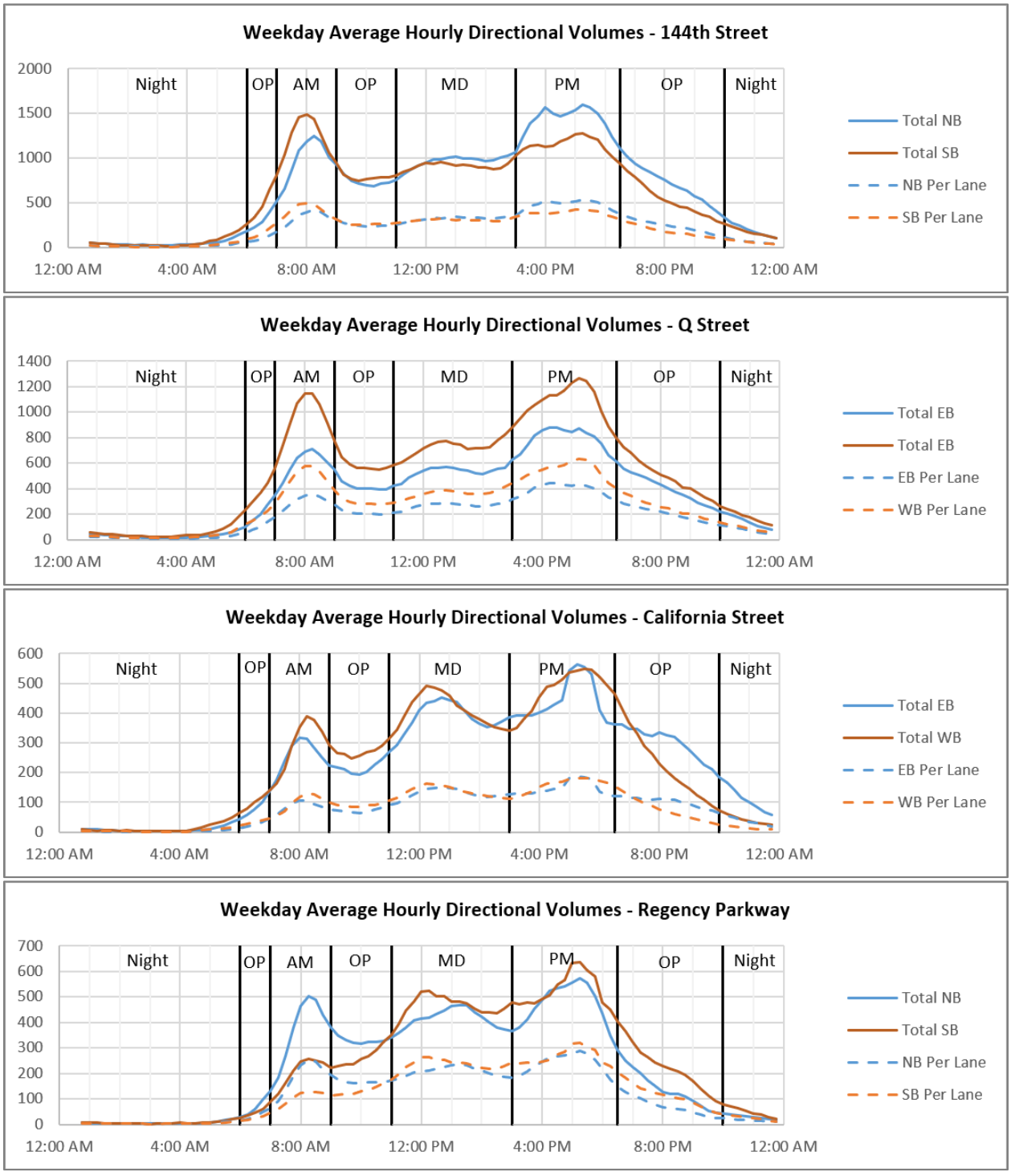


Figure 5-5. Weekday 24-Hour Directional Average Hourly Count Graphs

144th St

EXISTING SCHEDULES: SATURDAY

Signal ID	Signal Location
731	West Maple Rd & 144th St**
851	Eagle Run Dr & 144th St
924	Nelson Creek Dr & 144th St
739	Blondo St & 144th St
672	Franklin St & 144th St
850	Hamilton St & 144th St
785	Eldorado Dr / FNB Pkwy & 144th St
787	West Dodge Rd & 144th St
1209	Canopy Ave / Overlook Rd & 144th St
1208	Blossom Ave (Dewey) & 144th St
762	Millard North & 144th St
591	Pacific St & 144th St
761	Applied Pkwy / Pine St & 144th St
588	Harvey Oaks Ave & 144th St
703	Arbor St & 144th St**
592	West Center Rd & 144th St**
839	Oakview & Hascall
795	Oakview & 141st Plz

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
20 [free]						20 [free]	4 [75]				1 [90]							4 [75]						
20 [free]						20 [free]	1 [90]				1 [90]							1 [90]						
19 [flash]						20 [free]	1 [90]				1 [90]							1 [90]						
20 [free]						20 [free]	1 [90]				1 [90]							1 [90]						
19 [flash]						20 [free]	1 [90]				1 [90]							1 [90]						
19 [flash]						20 [free]	1 [90]				1 [90]							1 [90]						
20 [free]						20 [free]	1 [90]				1 [90]							1 [90]						
20 [free]											1 [90]													
20 [free]											1 [90]													
20 [free]											1 [90]													
19 [flash]											1 [90]													
20 [free]											1 [90]													
19 [flash]											1 [90]													
20 [free]						20 [free]	1 [90]				1 [90]							1 [90]						
19 [flash]						Adaptive [Varies]																	1 [90]	
20 [free]						Adaptive [Varies]																	4 [90]	
19 [flash]						10 [free]	10 [free]				20 [free]							10 [free]						
19 [flash]						10 [free]	10 [free]				20 [free]							10 [free]						

IMPLEMENTED SCHEDULES: SATURDAY

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
20 [free]						20 [free]	4 [75]				1 [90]							4 [75]						
20 [free]						20 [free]	4 [90]				1 [120]							4 [90]						
19 [flash]						20 [free]	4 [90]				1 [120]							4 [90]						
20 [free]						20 [free]	4 [90]				1 [120]							4 [90]						
19 [flash]						20 [free]	4 [90]				1 [120]							4 [90]						
19 [flash]						20 [free]	4 [90]				1 [120]							4 [90]						
10 [free]						10 [free]	4 [90]				1 [120]							4 [90]						
20 [free]						20 [free]	4 [90]				1 [120]							4 [90]						
20 [free]						20 [free]	4 [90]				1 [120]							4 [90]						
20 [free]						20 [free]	4 [90]				1 [120]							4 [90]						
19 [flash]						20 [free]	4 [90]				1 [120]							4 [90]						
20 [free]						20 [free]	4 [90]				1 [120]							4 [90]						
19 [flash]						20 [free]	4 [90]				1 [120]							4 [90]						
10 [free]						10 [free]	4 [90]				1 [120]							4 [90]						
19 [flash]						Adaptive [Varies]																	1 [90]	
20 [free]						Adaptive [Varies]																	4 [90]	
19 [flash]						10 [free]	10 [free]				20 [free]							10 [free]						
19 [flash]						10 [free]	10 [free]				20 [free]							10 [free]						

**Adjacent intersection for information only

Q St

EXISTING SCHEDULES: SATURDAY

Signal ID	Signal Location
651	136th & Q St**
1202	135th St & Q St
650	132nd St / Harry Andersen Ave & Q St
57	Oaks Lane / Deauville Dr & Q St
564	120th St & Q St
676	I-80 off-ramp & Q St
765	John Galt Blvd & Q St
766	Roxbury Dr & Q St
543	108th & Q St
686	99th St & Q St
519	96th St & Q St
514	93rd St Ped & Q St
507	90th St & Q St
649	84th St & Q St**
539	L St & 108th St**
539	John Galt Blvd & 108th St
642	Mockingbird & 108th St
543	108th & Q St
519	96th St & Q St
685	Park Dr & 96th St

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
19 [flash]						20 [free]	4 [90]				1 [120]							4 [90]						
20 [free]						20 [free]	1 [90]																	
20 [free]						20 [free]	1 [90]																	
19 [flash]						20 [free]	1 [90]																	
10 [free]						a	1 [90]				1 [90]							1 [90]						
20 [free]						20 [free]	1 [90]				1 [90]							1 [90]						
19 [flash]						20 [free]	1 [90]				1 [90]							1 [90]						
19 [flash]						20 [free]	1 [90]				1 [90]							1 [90]						
20 [free]						20 [free]	1 [90]				1 [90]							1 [90]						
19 [flash]						1 [90]	1 [90]				1 [90]							1 [90]						
20 [free]						20 [free]	1 [90]				1 [90]							1 [90]						
20 [free]						20 [free]	20 [free]				20 [free]							20 [free]						
20 [free]						20 [free]	1 [90]				1 [90]							1 [90]						
20 [free]						1 [90]	Adaptive [Varies]																1 [90]	
20 [free]							4 [90]				1 [120]							4 [90]						
19 [flash]						20 [free]	4 [90]				1 [90]							4 [90]						
19 [flash]						20 [free]	1 [90]				1 [90]							4 [90]						
20 [free]						20 [free]	1 [90]				1 [90]							4 [90]						
20 [free]						20 [free]	1 [90]				1 [90]							4 [90]						
19 [flash]						20 [free]	1 [90]				1 [90]							4 [90]						

IMPLEMENTED SCHEDULES: SATURDAY

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
19 [flash]						20 [free]	4 [90]				1 [120]							4 [90]						
20 [free]						20 [free]	4 [90]				1 [90]							4 [90]						
20 [free]						20 [free]	4 [90]				1 [90]							4 [90]						
19 [flash]						20 [free]	4 [90]				1 [90]							4 [90]						
10 [free]						10 [free]	4 [90]				1 [90]							4 [90]						
20 [free]						20 [free]	4 [90]				1 [90]							4 [90]						
19 [flash]						20 [free]	4 [90]				1 [90]							4 [90]						
19 [flash]						20 [free]	4 [90]				1 [90]							4 [90]						
20 [free]						20 [free]	4 [90]				1 [90]							4 [90]						
19 [flash]						20 [free]	4 [90]				1 [90]							4 [90]						
20 [free]						20 [free]	4 [90]				1 [90]							4 [90]						
20 [free]						20 [free]	20 [free]				20 [free]							20 [free]						
20 [free]						20 [free]	4 [90]				1 [90]							4 [90]						
20 [free]						1 [90]	Adaptive [Varies]																1 [90]	
20 [free]							4 [90]				1 [120]							4 [90]						
19 [flash]						20 [free]	4 [90]				1 [90]							4 [90]						
19 [flash]						20 [free]	4 [90]				1 [90]							4 [90]						
20 [free]						20 [free]	4 [90]				1 [90]							4 [90]						
20 [free]						20 [free]	4 [90]				1 [90]							4 [90]						
19 [flash]						20 [free]	4 [90]				1 [90]							4 [90]						

**Adjacent intersection for information only

Regency / Westroads

EXISTING SCHEDULES: SATURDAY

Signal ID	Signal Location
1015	Nicholas St & 102nd St
755	102nd St & California St / Westroads E
526	100th St & California St
523	98th St & California St
751	98th St & Westroads Ent #8
526	100th St & California St
72	West Dodge Rd & Regency Pkwy
71	Regency Cir & Regency Pkwy
31	Harney Pkwy & Regency Pkwy
70	Pacific St & Regency Pkwy**

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
10 [free]						10 [free]	10 [free]				10 [free]							10 [free]						
19 [flash]						19 [flash]	19 [flash]				1 [75]							1 [75]						
20 [free]						20 [free]	20 [free]				1 [75]							1 [75]						
20 [free]						20 [free]	20 [free]				1 [75]							1 [75]						
19 [flash]						19 [flash]	19 [flash]				1 [75]							1 [75]						
20 [free]						20 [free]	20 [free]				1 [75]							1 [75]						
20 [free]						20 [free]	20 [free]				20 [free]							20 [free]						
19 [flash]						20 [free]	1 [60]				1 [60]							1 [60]						
19 [flash]						20 [free]	1 [60]				1 [60]							1 [60]						
20 [free]						20 [free]	1 [90]																	

IMPLEMENTED SCHEDULES: SATURDAY

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
10 [free]						10 [free]	10 [free]				10 [free]							10 [free]						
20 [free]						20 [free]	4 [60]				1 [90]							4 [60]						
20 [free]						20 [free]	4 [60]				1 [90]							4 [60]						
20 [free]						20 [free]	4 [60]				1 [90]							4 [60]						
19 [flash]						20 [free]	4 [60]				1 [90]							4 [60]						
20 [free]						20 [free]	4 [60]				1 [90]							4 [60]						
20 [free]						20 [free]	4 [60]				1 [90]							4 [60]						
19 [flash]						20 [free]	4 [60]				1 [90]							4 [60]						
19 [flash]						20 [free]	4 [60]				1 [90]							4 [60]						
20 [free]						20 [free]	1 [90]																	

**Adjacent intersection for information only

Figure 5-6: Existing and Implemented Saturday Day Plans

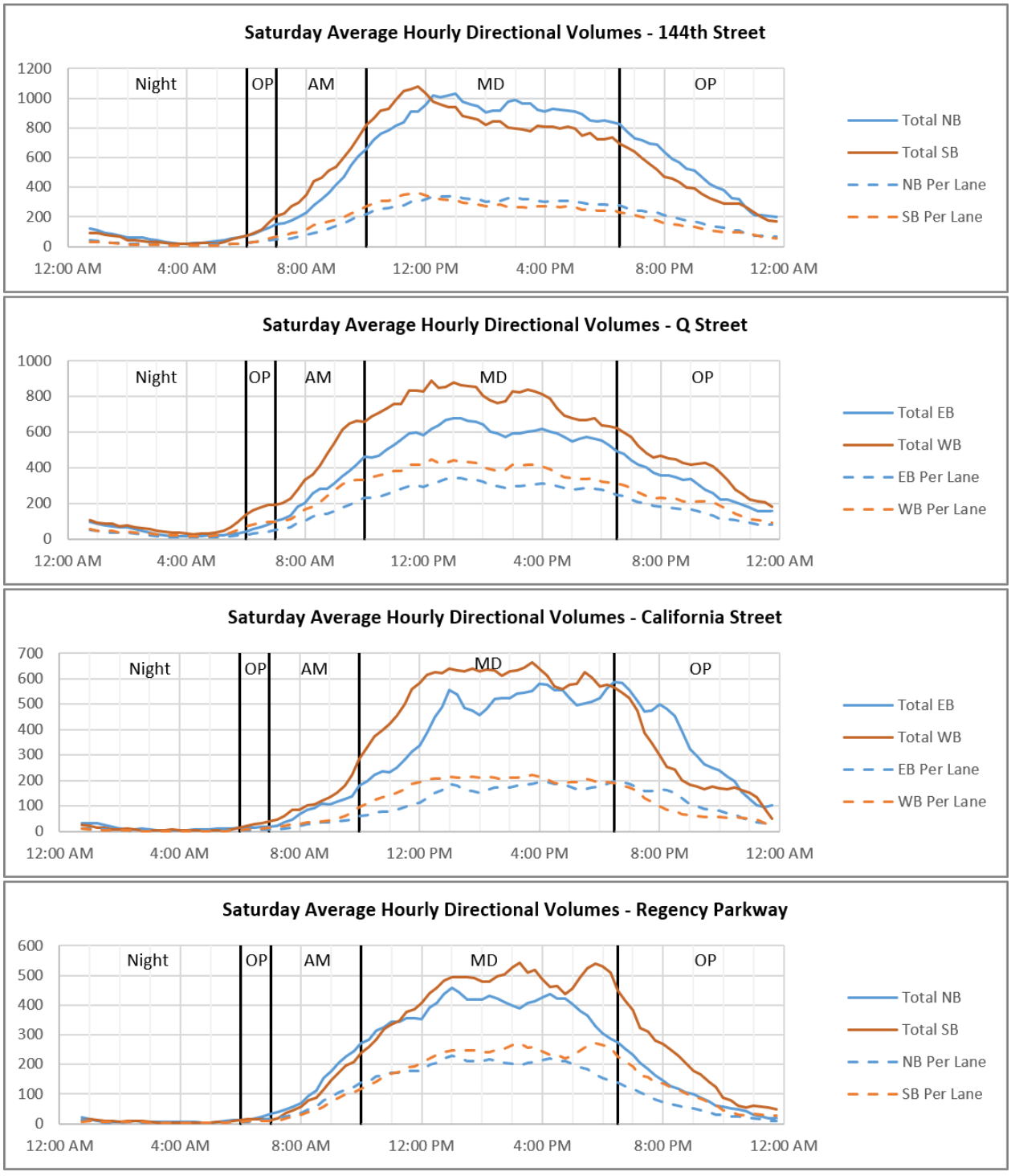


Figure 5-7. Saturday 24-Hour Directional Average Hourly Count Graphs

144th St

EXISTING SCHEDULES: SUNDAY

Signal ID	Signal Location
731	West Maple Rd & 144th St**
851	Eagle Run Dr & 144th St
924	Nelson Creek Dr & 144th St
739	Blondo St & 144th St
672	Franklin St & 144th St
850	Hamilton St & 144th St
785	Eldorado Dr / FNB Pkwy & 144th St
787	West Dodge Rd & 144th St
1209	Canopy Ave / Overlook Rd & 144th St
1208	Blossom Ave (Dewey) & 144th St
762	Millard North & 144th St
591	Pacific St & 144th St
761	Applied Pkwy / Pine St & 144th St
588	Harvey Oaks Ave & 144th St
703	Arbor St & 144th St**
592	West Center Rd & 144th St**
839	Oakview & Hascall
795	Oakview & 141st Plz

IMPLEMENTED SCHEDULES: SUNDAY

a: 20 [free] b: 4 [90] c: 1 [120]

**Adjacent intersection for information only

Q St

EXISTING SCHEDULES: SUNDAY

Signal ID	Signal Location
651	136th & Q St**
1202	135th St & Q St
650	132nd St / Harry Andersen Ave & Q St
57	Oaks Lane / Deauville Dr & Q St
564	120th St & Q St
676	I-80 off-ramp & Q St
765	John Galt Blvd & Q St
766	Roxbury Dr & Q St
543	108th & Q St
686	99th St & Q St
519	96th St & Q St
514	93rd St Ped & Q St
507	90th St & Q St
649	84th St & Q St**
539	L St & 108th St**
539	John Galt Blvd & 108th St
642	Mockingbird & 108th St
543	108th & Q St
519	96th St & Q St
685	Park Dr & 96th St

IMPLEMENTED SCHEDULES: SUNDAY

**Adjacent intersection for information only

Regency / Westroads

EXISTING SCHEDULES: SUNDAY

Signal ID	Signal Location
1015	Nicholas St & 102nd St
755	102nd St & California St / Westroads E
526	100th St & California St
523	98th St & California St
751	98th St & Westroads Ent #8
526	100th St & California St
72	West Dodge Rd & Regency Pkwy
71	Regency Cir & Regency Pkwy
31	Harney Pkwy & Regency Pkwy
70	Pacific St & Regency Pkwy**

IMPLEMENTED SCHEDULES: SUNDAY

**Adjacent intersection for information only

Figure 5-8: Existing and Implemented Sunday Day Plans

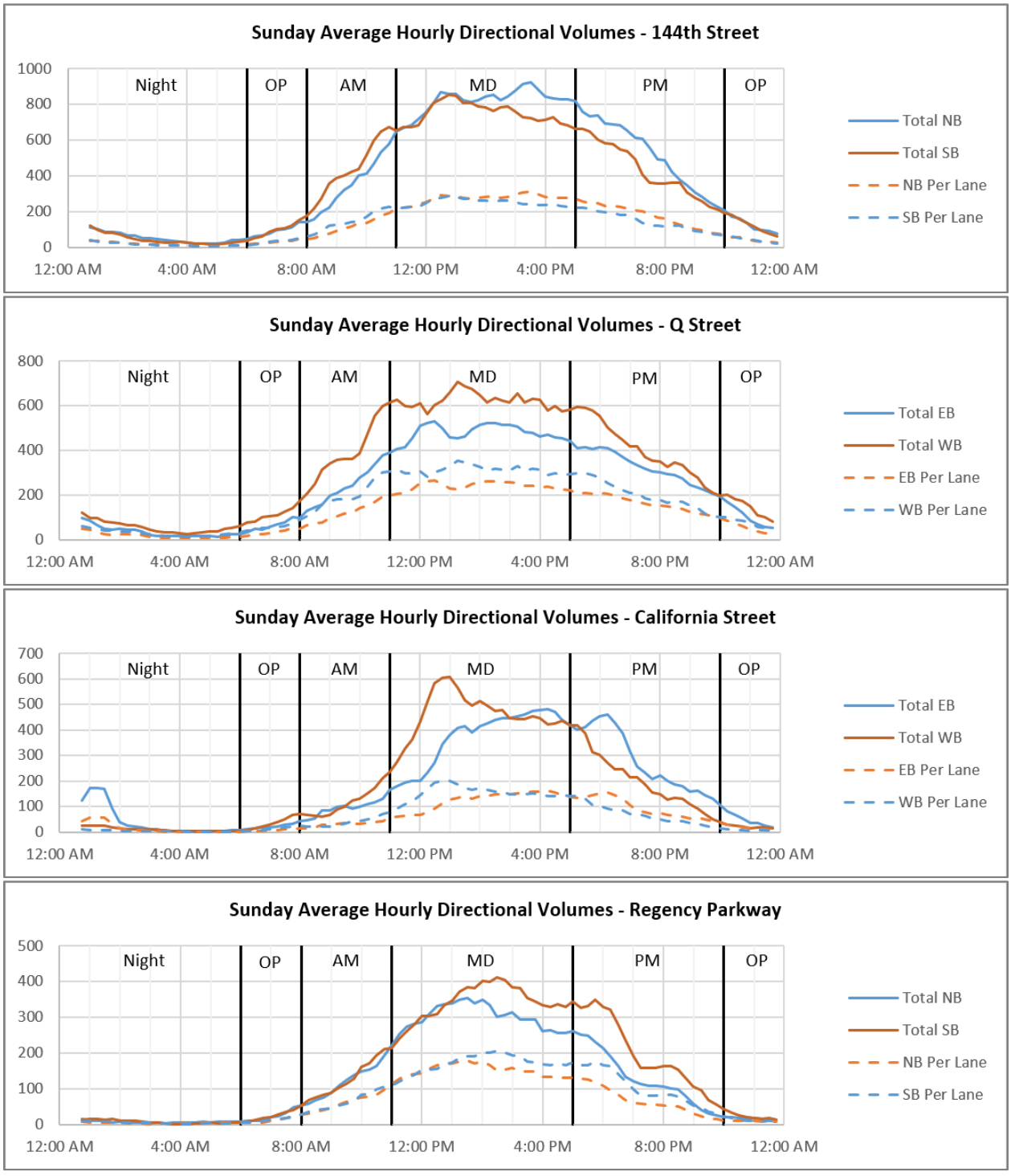


Figure 5-9. Sunday 24-Hour Directional Average Hourly Count Graphs

5.7. SPLIT OPTIMIZATION

Split times were updated to meet current vehicle demand and account for pedestrian signal timings. The following provides detailed information by plan.

PLAN 1 MD SPLIT OPTIMIZATION

Split times for minor road through phases were set to accommodate pedestrian crossing times when practical given the cycle length and vehicle demand of other movements.

PLAN 2 AM SPLIT OPTIMIZATION

Split times for minor road through phases were set to accommodate pedestrian crossing times when practical given the cycle length and vehicle demand of other movements.

In the Regency / Westroads zone, some side street split times were less than desired to accommodate long pedestrian crossing times for the coordinated movement.

PLAN 3 PM SPLIT OPTIMIZATION

Split times for minor road through phases were set to accommodate pedestrian crossing times when practical given the cycle length and vehicle demand of other movements. With longer cycle lengths, most locations were able to be accommodated.

PLAN 4 OP SPLIT OPTIMIZATION

Split times for minor road through phases were set to accommodate pedestrian crossing times when practical given the cycle length and vehicle demand of other movements. Despite shorter cycle lengths, pedestrian times were able to be accommodated at most non-major intersections. Some major intersections were also not able to accommodate pedestrian crossing times in the coordinated direction.

5.8. OFFSET AND SEQUENCE OPTIMIZATION

Offsets were adjusted and phase sequencing was reviewed and adjusted during the four timing plans. The offset strategies, particularly how corridors were coordinated with adjacent locations, and modified sequences are highlighted in the following sections.

Table 5-10 summarizes locations where there was a change in sequence from existing. Additionally, changes to the phase sequencing and left-turn phasing requires changes to the Overlap and Detector Plans. A summary of plan changes is in **Table 5-11**.

Locations with Pm+Pt left turns were analyzed using a volume cross product methodology developed by the City of Omaha staff to determine if the leading left turn should be converted to protected-only mode. If a set of opposing left-turn movements have a cross product in both directions that exceed 100,000, the leading left turn is either operated in protected-only mode or lead/lag sequencing for that pair of left turns was not implemented. A summary of this analysis is included in **Table 5-12**. Locations highlighted in orange had opposing cross product values above the 100,000 threshold.

The only location that was converted to protected only due to a cross product above the threshold and proposed lead/lag sequence was the Q Street & 108th Street intersection. Due to it crossing the threshold, the eastbound left-turn movement was converted to protected-only.

Table 5-10. Sequence Change Summary

Description	Int ID	Scenario	Sequences					Notes
			1 - MD	2 - AM	3 - PM	4 - OP	Free	
144th St & Eagle Run Dr	**851**	Existing	1	5	1	1		
		Implemented	5	5	5	5	5	
144th St & Blondo St	**739**	Existing	1	1	1			
		Implemented	4	2	2	5		
144th St & Eldorado Dr / FNB Pkwy	**785**	Existing	1	1	1			
		Implemented	1	1	3	1		
144th St & West Dodge Rd	**787**	Existing	3	1	9			
		Implemented	1	9	3	3		
144th St & Canopy Ave / Overlook Rd	**1209**	Existing	1	1	1			
		Implemented	9	3	1	1		
144th St & Blossom Ave / Dewey St	**1208**	Existing	1	3	1			
		Implemented	1	1	1	3		
144th St & Pacific St	**591**	Existing	10	13	7			
		Implemented	9	3	3	9		
144th St & Pine St	**761**	Existing	3	1	3			
		Implemented	1	1	1	1		
144th St & Harvey Oaks St	**588**	Existing	1	1	1			
		Implemented	1	1	3	1		
120th St & Q St	**564**	Existing	2	2	5			
		Implemented	2	2	2	2		
Roxbury Dr & Q St	**766**	Existing	1	1	1			
		Implemented	1	1	2	1		
108th St & Q St	**543**	Existing	1	1	1			Phase 5 Prot during Plan 3 – PM.
		Implemented	2	1	2	1		
96th St & Q St	**519**	Existing	1	1	1			
		Implemented	2	9	7	1		
108th St & John Galt St	**539**	Existing	1	1	1	1		
		Implemented	1	1	9	9		
144th St & W Maple Rd[1]	**731**	Existing	2	2	1	2		
		Implemented		4				
144th St & Arbor St[1]	**703**	Existing	1	1	1	1		
		Implemented	3		3	3		
144th St & W Center Rd[1]	**592**	Existing	4	4	3	9		
		Implemented		10				
108th St & L St[1]	**540**	Existing	5	2	2	2		
		Implemented				4		

[1]Changes made to intersections adjacent to the project intersection. Only denotes changes made from existing.

Table 5-11. Overlap and Detector Plan Change Summary

Description	Int ID	Scenario	Pattern 20 - Free		Pattern 1 - MD		Pattern 2 - AM		Pattern 3 - PM		Pattern 4 - OP		Pattern 10 - Alt Free	
			Det Plan	Ovlp Plan	Det Plan	Ovlp Plan	Det Plan	Ovlp Plan	Det Plan	Ovlp Plan	Det Plan	Ovlp Plan	Det Plan	Ovlp Plan
144th St & Eagle Run Dr	**851**	Existing	1	1	1	1	1	1	1	1	1	1		
		Implemented	1	1	1	1	2	1	1	1	1	1		
144th St & Blondo St	**739**	Existing	1	1	1	1	1	1	1	1				
		Implemented	1	1	5	1	2	1	3	1	4	1		
144th St & Eldorado Dr / FNB Pkwy	**785**	Existing	1	1	1	1	1	1	1	1				
		Implemented	1	1	1	1	1	1	3	1	1	1	10	1
144th St & Canopy Ave / Overlook Rd	**1209**	Existing	1	1	1	1	1	1	1	1				
		Implemented	1	1	5	1	2	1	1	1	1	1		
144th St & Blossom Ave / Dewey St	**1208**	Existing	1	1	1	1	2	1	1	1				
		Implemented	1	1	1	1	1	1	1	1	4	1		
144th St & Millard North High School	**762**	Existing	1	1	1	1	1	1	1	1				
		Implemented	1	1	1	1	2	2	1	1	1	1		
144th St & Pine St	**761**	Existing	1	1	2	1	1	1	2	1				
		Implemented	1	1	1	1	1	1	1	1	1	1		
144th St & Harvey Oaks St	**588**	Existing	1	1	1	1	1	1	1	1				
		Implemented	1	1	1	1	1	1	3	1	1	1		
120th St & Q St[1]	**564**	Existing	1	1	1	1	1	1	3	1				
		Implemented	1	1	5	1	2	1	1	1	4	1	10	1
Roxbury Dr & Q St	**766**	Existing	1	1	1	1	1	1	2	1				
		Implemented	1	1	1	1	2	1	3	1	4	1		
108th St & Q St	**543**	Existing	1	1	1	1	1	1	1	1				
		Implemented	1	1	5	1	1	1	3	3	1	1		
96th St & Q St	**519**	Existing	1	1	1	1	1	1	1	1				
		Implemented	1	1	5	1	2	1	3	1	1	1		
108th St & John Galt St	**539**	Existing	1	1	1	1	1	1	1	1	2	1		
		Implemented	1	1	1	1	1	1	1	1	4	4		
144th St & Arbor St[2]	**703**	Existing	1	1	1	1	1	1	1	1	1			
		Implemented			5				3		4			
144th St & W Center Rd[2]	**592**	Existing	1	1	10	1	2	1	1	1	1	1		
		Implemented					2							

[1]Change FREE detection plan on unit operations from 3 to 1

[2]Changes made to intersections adjacent to the project intersection. Only denotes changes made from existing.

Table 5-12. Cross Product Analysis for Lead/Lag Left-Turn Operations

Intersection	Int ID	Movement	Cross Product Values			
			1 - MD	2 - AM	3 - PM	4 - OP
144th St & Eagle Run Dr	851	NB	92,300	67,978	179,095	75,849
		SB	32,724	13,502	43,340	24,696
144th St & Blondo St	739	NB	79,255	69,052	213,435	38,488
		SB	70,840	106,560	161,460	46,956
		EB	20,358	28,275	112,119	16,775
		WB	23,772	124,775	68,716	25,198
144th St & El Dorado Dr / FNB Pkwy	785	NB	66,424	123,004	231,125	54,432
		SB	24,436	176,344	51,068	17,631
		EB	468	56	27,174	558
		WB	3,604	3,740	76,950	3,182
144th St & Canopy Ave / Overlook Dr	1209	NB	22,170	45,612	34,503	9,960
		SB	143,680	98,816	142,011	94,521
144th St & Pine St	761	NB	8,478	891	4,984	2,008
		SB	14,742	11,253	39,400	7,704
Oakview Dr & Hascall St	839	NB	852	0	1,127	612
		SB	4,095	469	5,428	2,023
Oakview Dr & 141st Plz	795	EB	4,095	170	3,162	1,785
		WB	10,234	2,096	5,356	4,784
135th St & Q St	1202	EB	16,775	12,054	60,384	16,066
		WB	101,101	87,048	192,252	50,758
120th St & Q St	564	NB	5,474	1,606	14,016	630
		SB	25,648	23,058	65,124	9,628
108th St & Q St	543	NB	56,016	63,609	118,236	46,596
		SB	60,755	53,760	138,693	50,140
		EB	51,336	102,336	103,395	47,360
		WB	45,524	32,770	123,088	43,674
96th St & Q St	519	NB	64,206	32,994	121,542	31,920
		SB	46,080	53,820	76,239	20,247
		EB	68,376	100,672	82,720	25,194
		WB	85,618	59,616	146,957	29,103
108th St & John Galt Blvd	539	NB	16,025	23,754	18,220	10,384
		SB	77,717	126,252	84,270	54,540
102nd Street & Nicholas St	1015	NB	9,898	57,196	1,645	16,796
		SB	27,136	9,792	31,590	16,768
98th St & Westroads #8	751	SB	3,432	1,388	4,046	5,502
		NB	54,000	1,633	53,265	25,066

Locations highlighted in orange had opposing cross product values above the 100,000 threshold.

PLAN 1 MD OFFSET AND SEQUENCE OPTIMIZATION

- 144th Street – South of West Dodge Road, the northbound direction has about 15-20% higher traffic volume than the southbound direction. North of West Dodge Road, the traffic volumes are fairly balanced in each direction. Progression is fairly balanced across the entire corridor with relatively short stops in each direction to accommodate the progression in the opposing direction.
- Q Street – The eastbound and westbound volumes are fairly balanced across Q Street. The implemented timing plan used a 90 second cycle for the whole corridor in an effort to reduce side street delay and reduce stops in the middle of the corridor. Progression was fairly balanced in each direction with the longest expected stop being at 120th St & Q St in the westbound direction.
- 108th Street – Volumes on 108th Street are somewhat higher in the northbound direction than southbound. Northbound traffic is progressed through John Galt Blvd. The L St intersection uses a 120 second cycle length so southbound is expected to have varying lengths of stops at the Q St intersection.
- Regency / Westroads – Volumes varied throughout the Regency and Westroads areas without any prevalent flow of traffic. The timing plans were set up to balance multiple directions of travel. The main flows of traffic prioritized were northbound Regency Pkwy to westbound California St and westbound California St to southbound Regency Pkwy.

PLAN 2 AM OFFSET AND SEQUENCE OPTIMIZATION

- 144th Street – During the AM period, traffic flow is predominantly in the southbound direction between Pacific St and W Maple Rd. Traffic is more balanced starting at Pacific St through the south end of the corridor. Timings were mostly set up for southbound progression until the Millard North and Pacific St intersections were there are stops to help progress northbound traffic.
- Q Street – The west side of the Q St corridor has nearly double the traffic volume in the eastbound direction than the westbound direction west of 120th St where about half of the eastbound traffic turns north. East of 120th St, traffic flows are more balanced in each direction.
- 108th Street – Traffic predominantly flows in the northbound direction. Two-way progression was able to be achieved with only a short stop in the northbound direction at L St.
- Regency / Westroads – Volumes varied considerably throughout the Regency and Westroads areas without any prevalent flow of traffic. The timing plans were set up to balance multiple directions of travel. The main flows of traffic prioritized were the eastbound Dodge offramp to westbound California St and eastbound California St to the westbound Dodge onramp. The California St and Westroads Ent #2 and the 98th St and Westroads Ent #8 were both changed from operating flash to operating coordinated.

PLAN 3 PM OFFSET AND SEQUENCE OPTIMIZATION

- 144th Street – PM peak traffic is predominantly flowing in the northbound direction through the entire 144th St corridor. Timings were set for the northbound direction. Southbound also progresses fairly well with a stop at Blondo St varying in length depending on when traffic arrives from W Maple Rd which has a different cycle length.
- Q Street – Traffic on Q St is heaviest in the direction away from the intersection of the I-80 ramp terminals. Progression west of the I-80 ramps prioritized the westbound direction. A shorter cycle length was used east of the I-80 ramps and progression is more balanced by using lead/lag left-turn operations at 108th St and 96th St.
- 108th Street – Traffic volumes are slightly higher in the southbound direction. Two-way progression was achieved for the through movements. However, southbound traffic turning from L St would get stopped at Jon Galt Blvd and Mockingbird Dr.
- Regency / Westroads – Volumes varied considerably throughout the Regency and Westroads areas without any prevalent flow of traffic. The main flows of traffic prioritized were northbound Regency Pkwy to westbound California St and westbound California St to southbound Regency Pkwy.

PLAN 4 OP OFFSET AND SEQUENCE OPTIMIZATION

- 144th Street – The volumes are fairly balanced across the entire corridor. The timings were set for two-way progression.
- Q Street – The volumes are fairly balanced across the entire corridor. The timings were set for two-way progression.
- 108th Street – Traffic volumes on 108th St are heavier in the northbound direction. The timings were set for two-way progression.
- Regency / Westroads – Volumes varied throughout the Regency and Westroads areas without any prevalent flow of traffic. The timing plans were set up to balance multiple directions of travel. The main flows of traffic prioritized were the eastbound Dodge offramp to westbound California St and eastbound California St to the westbound Dodge onramp.

6. IMPLEMENTATION

6.1. DATABASE PROGRAMMING

Database programming of the new signal timings occurred starting on September 5th. To account for recent changes made by City staff, the latest database was used. New timings were uploaded via the Maxview database.

6.2. IMPLEMENTATION DAY

Implementation of the new signal timings occurred on September 25th. Each intersection was uploaded and inspected one at a time to check for any recent programming changes. These intersections were also observed in the field to verify that timings were properly downloaded and implemented at the controller. HDR and City staff continued to monitor traffic cameras and Maxview to ensure proper signal operations.

6.3. FINE TUNING

Fine tuning of the signal timings started immediately following the implementation of the new signal timings. Fine tuning began in the PM on September 25th and was completed on September 29th. During fine tuning observations were made during each timing plan to verify proper progression of traffic and all movements were adequately served. Each intersection was also observed to ensure proper operations of permitted/protected calls, pedestrians signals, LPI, and other hardware. Updates to signal timings throughout the week were conducted via VPN to the City's controller software and then verified in the field. Changes were documented and sent to City staff daily. For the Wapiti controllers change log forms were needed for any updates.

6.4. PUBLIC COMMENT

At the time of publication, no public requests for changes or re-evaluations have been received related to the implemented signal timings. Public commenting period ran from September 25th through October 25th.

7. PERFORMANCE MEASURES

7.1. NETWORK MEASURES OF EFFECTIVENESS

Measures of effectiveness (MOEs) were estimated using Synchro based on the implemented signal timings. The network performance measures in **Table 7-1** show improvements from existing to implemented in all reported metrics for the AM, PM, and OP timing plans. For MD, it shows an increase in delay and total travel time of less than five percent but with improvements in number of stops and fuel consumption. The Synchro reports for the network MOEs can be found in the **Appendix**.

Table 7-1. Study Area and Network Performance Measures

		144th Street			Q Street[1]			Westroads/Regency			Network[2]		
		Existing	Implement	Percent Change	Existing	Implement	Percent Change	Existing	Implement	Percent Change	Existing	Implement	Percent Change
Plan 1 - MD	**Total Delay (hr)**	73	79	8%	72	72	0%	32	33	3%	191	198	4%
	Stops (#)	9,221	8,362	-9%	7,941	7,512	-5%	4,643	4,047	-13%	23,826	22,090	-7%
	Total Travel Time (hr)	247	252	2%	241	241	0%	101	102	1%	632	639	1%
	Fuel Consumed (gal)	431	425	-1%	362	358	-1%	139	136	-2%	995	982	-1%
Plan 2 - AM	**Total Delay (hr)**	151	139	-8%	99	97	-2%	20	14	-30%	281	264	-6%
	Stops (#)	14,185	12,431	-12%	9,278	8,910	-4%	3,043	2,280	-25%	27,745	24,966	-10%
	Total Travel Time (hr)	371	358	-4%	295	293	-1%	68	62	-9%	777	760	-2%
	Fuel Consumed (gal)	619	588	-5%	431	427	-1%	95	86	-9%	1,204	1,161	-4%
Plan 3 - PM	**Total Delay (hr)**	212	199	-6%	188	187	-1%	38	41	8%	460	457	-1%
	Stops (#)	19,035	15,307	-20%	14,232	15,245	7%	5,754	4,968	-14%	41,453	38,586	-7%
	Total Travel Time (hr)	502	489	-3%	442	442	0%	114	117	3%	1,122	1,119	0%
	Fuel Consumed (gal)	816	759	-7%	623	632	1%	160	158	-1%	1,684	1,644	-2%
Plan 4 - OP	**Total Delay (hr)**	61	52	-15%	50	49	-2%	17	13	-24%	139	123	-12%
	Stops (#)	7,527	6,207	-18%	6,243	5,477	-12%	2,525	2,365	-6%	17,837	15,309	-14%
	Total Travel Time (hr)	203	194	-4%	186	185	-1%	63	59	-6%	488	472	-3%
	Fuel Consumed (gal)	355	332	-6%	285	277	-3%	87	83	-5%	777	738	-5%

[1] Does not include the three adjacent intersections on 108th St and 96th St.

[2] Includes adjacent signals not included in corridor performance measures.

7.2. INTERSECTION PERFORMANCE MEASURES

Delay was analyzed on an intersection-by-intersection basis in a comparison between the existing and implemented signal operations. Table 7-2 summarizes the results of the comparison by displaying the number of intersections for each criterion: decrease in delay, no change in delay, an increase of less than 5 seconds of delay, and an increase of more than 5 seconds of delay. Delay is reported in seconds per vehicle. The existing and implemented Synchro reports can be found in the Appendix.

Table 7-2. Intersection Delay Change Summary

Number of Intersections Where:	Plan 1 MD	Plan 2 AM	Plan 3 PM	Plan 4 OP
Delay Decreased	15	17	13	26
Delay Unchanged	6	2	2	6
Delay Increased <= 5 sec/veh	14	15	21	5
Delay Increased > 5 sec/veh	2	1	1	0

Four intersections were found to operate with more than five seconds of delay when compared to the existing operations. Those intersections are summarized in Table 7-3.

Table 7-3. Intersections with Delay Increase Over Five Seconds

Int ID	Intersection	Plan	Existing Delay and LOS	Implemented Delay and LOS	Difference
739	**144th St & Blondo St**	Plan 1 - MD	16.1 - B	21.9 - C	5.8
591	**144th St & Pacific St**	Plan 1 - MD	25.9 - C	31.0 - C	5.1
539	**108th St & John Galt Blvd**	Plan 2 - AM	8.6 - A	13.7 - B	5.1
642	**108th St & Mockingbird St**	Plan 3 - PM	8.2 - A	13.8 - B	5.6

The 144th Street & Blondo Street intersection had an increase in delay of 5.8 seconds during the MD plan. The West Dodge Road intersection was set up with a half cycle. The increase in delay at the Blondo Street intersection was the result of the off-cycle traffic from West Dodge Road. Additionally, the Blondo Street intersection now has a longer cycle length than existing.

The 144th Street & Pacific Street intersection saw an increase of 5.1 seconds of delay per vehicle during the MD plan. This was primarily due to a longer cycle length and a change in the 144th Street progression that included a stop at Pacific Street.

The 108th Street & John Galt Boulevard intersection had an increase of 5.1 seconds of delay during the AM plan. This was primarily due to some of the turning traffic from both the 108th Street & L Street and the 108th Street & Q Street intersections arriving on red.

The 108th Street & Mockingbird Drive intersection delay increased by 5.6 seconds during the PM plan. The progression on 108th Street was changed from existing to remove a long wait at Q Street. This resulted in some vehicles getting stopped at the 108th Street & Mockingbird Drive intersection which increased delay.

The overall LOS and delay were compared between the existing and the implemented Synchro reports. The comparison is shown in **Table 7-4**. Each cell denotes the intersection delay, and the background color denotes the LOS.

Table 7-4. Intersection LOS and Delay for Existing and Implemented Signals

Int ID	Intersection	Existing				Implemented			
		MD	AM	PM	OP	MD	AM	PM	OP
526	100th St & California St	16.2	14.6	15.6	12.4	12.8	5.5	13.1	9.1
755	102nd St & California St / Ent #2	5.3	-	8.0	2.5	6.4	0.7	5.0	2.1
1015	102nd St & Nicholas St	6.4	7.9	7.8	6.3	6.4	8.0	6.8	5.8
539	108th St & John Galt Blvd	12.6	8.6	17.8	12.5	14.4	13.7	19.4	8.2
642	108th St & Mockingbird St	6.1	5.4	8.3	5.5	6.1	5.5	13.8	5.3
543	108th St & Q St	22.7	28.5	35.3	23.2	23.4	27.2	29.2	21.8
564	120th St & Q St	26.4	29.9	42.7	21.6	25.3	29.4	43.8	18.6
1202	135th St & Q St	13.9	13.6	22.8	12.5	13.3	11.5	27.0	11.2
739	144th St & Blondo St	18.1	29.1	33.6	18.0	21.9	24.4	35.4	17.9
1208	144th St & Blossom Ave	4.2	7.9	3.6	0.7	5.0	3.4	3.8	0.8
851	144th St & Eagle Run Dr	13.2	9.6	14.0	12.1	10.7	7.8	12.9	7.8
785	144th St & Eldorado Dr	9.2	9.8	38.6	8.6	6.1	9.0	33.5	6.2
672	144th St & Franklin St	3.2	4.1	3.3	2.9	1.1	4.0	1.9	0.8
850	144th St & Hamilton St	1.8	3.3	4.8	1.7	2.7	4.6	3.2	2.4
588	144th St & Harvey Oaks St	2.9	11.4	13.1	2.3	3.0	7.2	5.0	2.7
1168	144th St & Locust St	-	-	-	-	-	-	-	-
762	144th St & Millard North High School	4.6	13.8	5.7	2.7	3.7	14.4	6.7	1.7
1209	144th St & Canopy Ave / Overlook Rd	5.4	4.0	5.0	5.0	7.0	5.7	5.4	3.9
924	144th St & Nelsons Creek	1.7	6.5	2.2	2.3	1.7	5.3	2.1	2.0
591	144th St & Pacific St	24.9	34.9	37.1	24.8	31.0	39.0	40.3	21.9
761	144th St & Pine St	4.8	3.7	6.9	4.3	2.2	2.9	4.2	3.9
787	144th St & West Dodge Rd	17.1	25.4	24.0	18.6	16.3	21.6	26.3	18.1
507	90th St & Q St	9.4	11.0	13.0	7.4	9.4	15.0	17.6	7.4
514	93rd St & Q St	-	-	-	-	-	-	-	-
685	96th St & Park Dr	6.3	6.3	6.1	6.1	7.2	7.8	7.3	5.6
519	96th St & Q St	23.1	24.6	32.3	19.7	24.6	26.7	29.6	21.9
523	98th St & California St	10.4	8.2	11.3	11.0	13.7	8.4	14.5	9.2
751	98th St & Ent #8 / Westroads	11.6	-	8.6	8.2	10.3	0.8	10.8	4.3
686	99th St & Q St	5.8	6.8	5.1	4.6	4.9	8.8	5.5	4.6
650	Harry Andersen Ave / 132nd St & Q St	9.4	16.1	14.2	7.9	9.1	13.1	21.0	8.2
676	I-80 & Q St / West Ramp	11.0	17.3	35.7	7.7	11.0	14.8	34.6	10.3
765	John Galt Blvd & Q St	3.8	3.9	5.4	2.6	4.2	4.8	6.8	2.6
57	Oaks Lane / Deauville Dr & Q St	5.0	7.7	4.9	2.6	4.9	7.2	6.4	2.2
839	Oakview Dr & Hascall St	5.1	7.9	16.4	3.8	2.8	1.5	15.2	14.4
795	Oakview Dr & 141st Plz	8.3	4.0	8.6	6.6	6.3	3.4	10.0	10.3
31	Regency Pkwy & Harney Pkwy	7.9	4.8	4.0	4.1	4.6	2.7	5.9	3.4
71	Regency Pkwy & Regency Cir	9.6	10.5	12.5	8.3	11.0	2.1	14.7	6.5
72	Regency Pkwy & West Dodge Rd	11.0	9.7	11.8	7.2	14.3	15.0	20.0	7.9
766	Roxbury Dr & Q St	3.1	8.3	9.0	3.8	2.5	8.4	11.4	3.8

A dash denotes a signal that was analyzed as two-way, stop-controlled
The following color scale denotes level-of-service: **LOS A – LOS B – LOS C – LOS D – LOS E – LOS F**

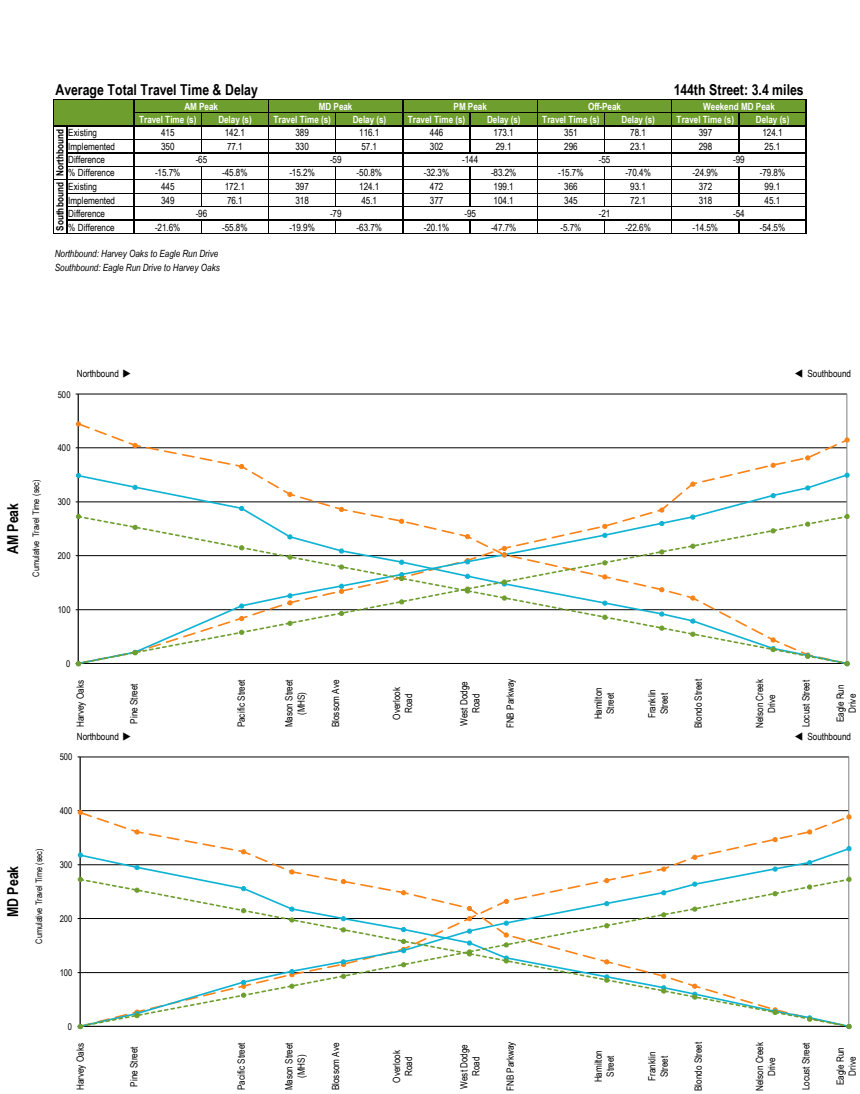
7.3. TRAVEL TIME RUN PERFORMANCE

Travel time runs were performed before and after the signal timing implementation. The five time periods analyzed are outlined in **Chapter 3 - Data Collection**. The before and after runs were then plotted, as well as a free flow speed line. **Figure 7-1** and **Figure 7-2** provide the graphs for the 144th Street and Q Street travel time run results, respectively. The orange line depicts the before travel time, the blue depicts the after travel time, and the green depicts the free flow speed. A breakdown of the travel time runs by time of day plan can be seen in **Table 7-5** and **Table 7-6**. Completed travel time runs from the before and after condition are shown via Tru-Traffic plots in the **Appendix**.

Average Total Travel Time & Delay **144th Street: 3.4 miles**

		AM Peak		MD Peak		PM Peak		Off-Peak		Weekend MD Peak	
		Travel Time (s)	Delay (s)	Travel Time (s)	Delay (s)	Travel Time (s)	Delay (s)	Travel Time (s)	Delay (s)	Travel Time (s)	Delay (s)
Northbound	Existing	415	142.1	389	116.1	446	173.1	351	78.1	397	124.1
	Implemented	350	77.1	330	57.1	302	29.1	296	23.1	298	25.1
	Difference	-65		-59		-144		-55		-99	
	% Difference	-15.7%	-45.8%	-15.2%	-50.8%	-32.3%	-83.2%	-15.7%	-70.4%	-24.9%	-79.8%
Southbound	Existing	445	172.1	397	124.1	472	199.1	366	93.1	372	99.1
	Implemented	349	76.1	318	45.1	377	104.1	345	72.1	318	45.1
	Difference	-96		-79		-95		-21		-54	
	% Difference	-21.6%	-55.8%	-19.9%	-63.7%	-20.1%	-47.7%	-5.7%	-22.6%	-14.5%	-54.5%

Northbound: Harvey Oaks to Eagle Run Drive
Southbound: Eagle Run Drive to Harvey Oaks



Existing
Implemented
Free Flow

Figure 7-1

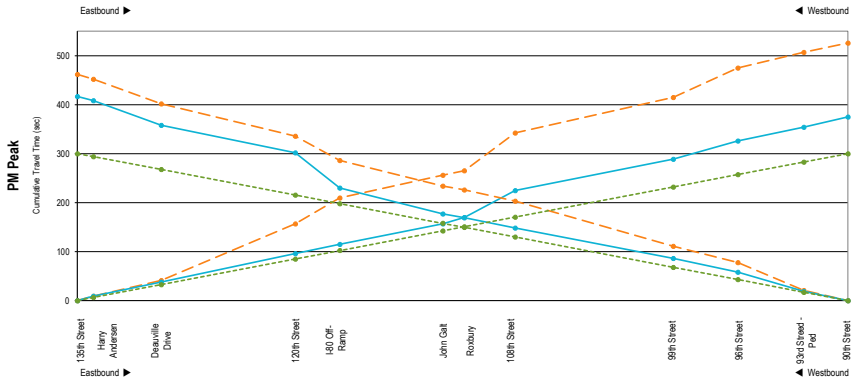
Average Corridor Travel Time & Delay

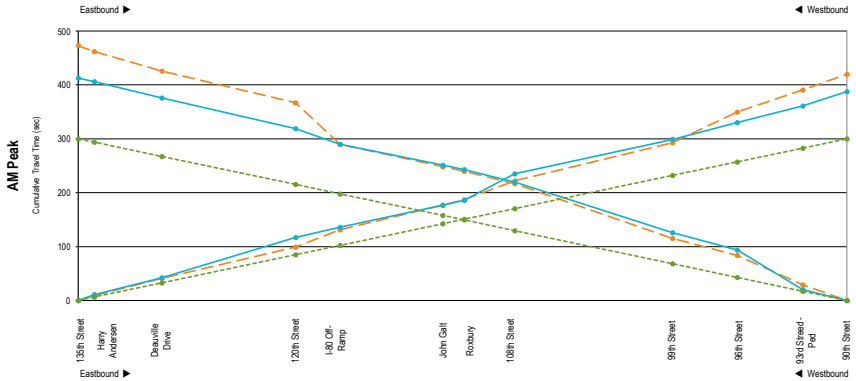
144th Street: Harvey Oaks to Eagle Run Drive

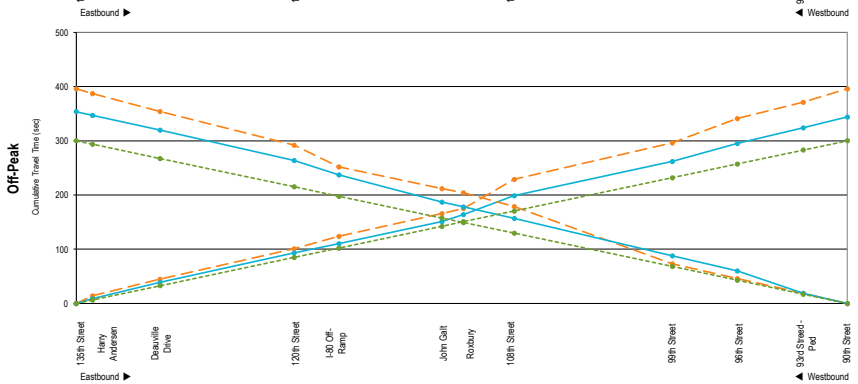
Average Total Travel Time & Delay — **Q Street: 3.5 miles**

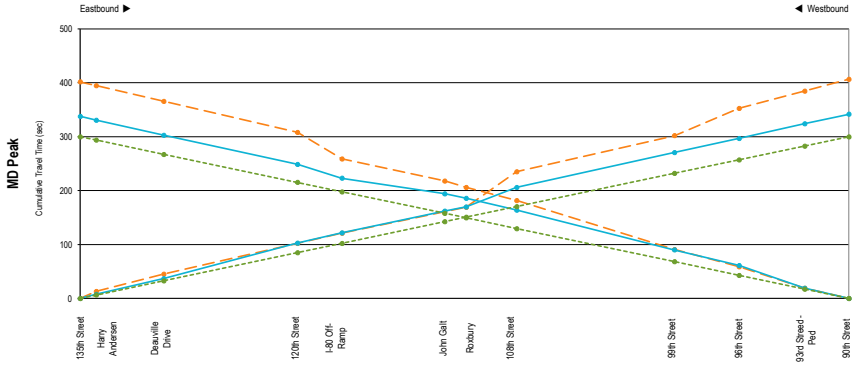
		AM Peak		MD Peak		PM Peak		Off-Peak		Weekend MD Peak	
		Travel Time (s)	Delay (s)	Travel Time (s)	Delay (s)	Travel Time (s)	Delay (s)	Travel Time (s)	Delay (s)	Travel Time (s)	Delay (s)
Eastbound	Existing	420	119.9	407	106.9	526	225.9	396	95.9	386	85.9
	Implemented	388	87.9	342	41.9	375	74.9	344	43.9	337	36.9
	Difference	-32		-65		-151		-52		-49	
	% Difference	-7.6%	-26.7%	-16.0%	-60.8%	-28.7%	-66.9%	-13.1%	-54.2%	-12.7%	-57.1%
Westbound	Existing	473	172.9	402	101.9	462	161.9	396	95.9	388	87.9
	Implemented	413	112.9	338	37.9	417	116.9	354	53.9	306	5.9
	Difference	-60		-64		-45		-42		-82	
	% Difference	-12.7%	-34.7%	-15.9%	-62.8%	-9.7%	-27.8%	-10.6%	-43.8%	-21.1%	-93.3%

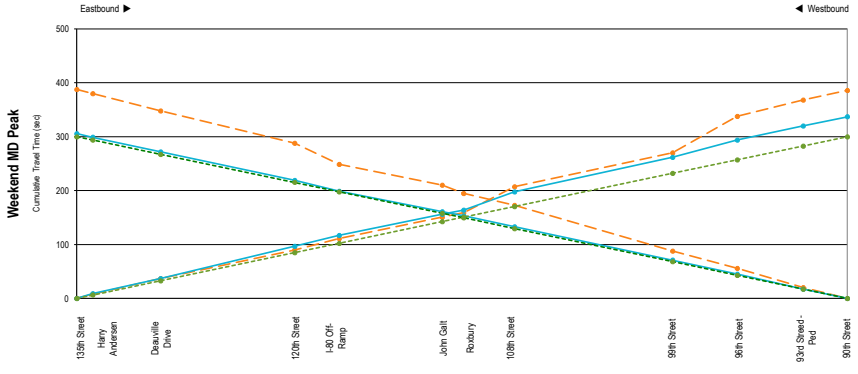
Eastbound: 135th Street to 90th Street
Westbound: 90th Street to 135th Street











Existing
Implemented
Free Flow

Figure 7-2

Average Corridor Travel Time & Delay

Q Street: 135th Street to 90th Street

Table 7-5. 144th Street Travel Times

Plan	Travel Time					
	Northbound			Southbound		
	Before	After	Difference	Before	After	Difference
MD	6m 29s	5m 30s	-59s	6m 37s	5m 18s	-1m 19s
AM	6m 55s	5m 50s	-1m 5s	7m 25s	5m 49s	-1m 36s
PM	7m 26s	5m 2s	-2m 24s	7m 52s	6m 17s	-1m 35s
OP	5m 51s	4m 56s	-55s	6m 6s	5m 45s	-21s
Weekend MD	6m 37s	4m 58s	-1m 39s	6m 12s	5m 18s	-54s

Table 7-6. Q Street Travel Times

Plan	Travel Time					
	Eastbound			Westbound		
	Before	After	Difference	Before	After	Difference
MD	6m 47s	5m 42s	-1m 5s	6m 42s	5m 38s	-1m 4s
AM	7m 0s	6m 28s	-32s	7m 53s	6m 53s	-1m 0s
PM	8m 46s	6m 15s	-2m 31s	7m 42s	6m 57s	-45s
OP	6m 36s	5m 44s	-52s	6m 36s	5m 54s	-42s
Weekend MD	6m 26s	5m 37s	-46s	6m 28s	5m 6s	-1m 22s

144TH STREET TRAVEL TIME RUN SUMMARY

The 144th Street travel time runs resulted in delay savings of up to 83% for the northbound and up to 63% for the southbound. This amounted to a travel time reduction of up to 144 seconds.

The 144th Street MD travel time runs saw savings of 59 seconds in the northbound and 79 seconds in the southbound. The northbound direction saw delay improvements primarily at West Dodge Road and FNB Parkway with minor delay increases at Pacific Street. The southbound saw improvements at Blondo Street and West Dodge Road.

The AM travel time runs saw savings of 65 seconds in the northbound and 96 seconds in the southbound. The northbound direction saw delay improvements primarily at FNB Parkway and Blondo Street with minor delay increases at Pacific Street. The southbound saw improvements at Blondo Street and West Dodge Road.

The PM travel time runs saw savings of 144 seconds in the northbound and 95 seconds in the southbound. The northbound direction saw delay improvements primarily at West Dodge Road and FNB Parkway. There were significant savings at Pacific Street. The southbound saw improvements at Blondo Street and West Dodge Road.

The OP travel time runs saw savings of 55 seconds in the northbound and 21 seconds in the southbound. The northbound direction saw delay improvements primarily at Pacific Street and Blondo Street. The southbound saw improvements at West Dodge Road while delay increased at Blondo Street and Pacific Street.

The weekend MD travel time runs saw savings of 99 seconds in the northbound and 54 seconds in the southbound. The northbound direction saw delay improvements primarily at Pacific Street and West Dodge Road. The southbound saw improvements at West Dodge Road while delay increased at Blondo Street.

Q STREET TRAVEL TIME RUN SUMMARY

The Q Street travel time runs resulted in delay savings of up to 93% for the westbound and up to 67% for the eastbound. This amounted to a travel time reduction of up to 82 seconds.

The Q Street MD travel time runs saw savings of 65 seconds in the eastbound and 64 seconds in the westbound. The eastbound direction saw delay improvements primarily at 108th Street and 96th Street while the westbound direction saw improvements at 108th Street and 120th Street.

The AM travel time run in the eastbound direction showed a travel time reduction of 32 seconds. Much of the delay savings occurred at the east end at 96th Street and 90th Street. The westbound travel time saw a reduction of 60 seconds with savings occurring primarily at 120th Street.

The PM travel time runs saw savings of 151 seconds in the eastbound and 45 seconds in the westbound. The eastbound direction saw delay improvements at 120th Street while the westbound direction saw improvements at 96th Street. The westbound direction also saw increases in delay at 120th Street.

The OP travel time runs saw savings of 52 seconds in the eastbound and 42 seconds in the westbound. The eastbound direction saw delay improvements at 135th Street, 132nd Street, and 108th Street while the westbound direction saw improvements at 108th Street and 120th Street. The westbound direction also saw increases in delay at the 96th Street and the I-80 off-ramp intersection.

The MD weekend travel time runs saw savings of 46 seconds in the eastbound and 82 seconds in the westbound. The eastbound direction saw delay improvements at 108th Street and 96th Street while the westbound direction saw improvements at 96th Street and 120th Street. The eastbound direction also saw increases in delay at 120th Street.

7.4. BENEFIT COST ANALYSIS

A benefit-cost analysis was computed using the network performance measures. The network performance measures reported were estimated delay, fuel consumption, CO emissions, NOx emissions, VOC emissions, and crash reductions. These factors are analyzed over a 5-year period with the present value of savings stated in **Table 7-7**. US Department of Transportation (USDOT) guidelines were used in estimating the benefits from crash reductions as well as the number of crashes per year. The total anticipated present value savings for a 5-year period was calculated at about $9.8 million.

Table 7-7. Anticipated Five Year Project Benefits

Performance Measure	Project Benefit	Present Value
Delay Reduction	132,288 Hours	$3,717,230
Fuel Consumption Reduction	457,376 Gallons	$1,552,992
Emission Reduction	4,079 Tons	$306,551
Crash Reduction	56 Crashes	$4,201,638
Total Benefit		**$9,778,411**

The total anticipated delay reduction equates to about 848 hours per week, or 132,288 hours over 5-years. This encompasses all time-of-day plans. These saving were broken down into automobile and truck vehicle types and their respective time savings and occupancy estimates. The total anticipated fuel consumption reduction is 2,932 gallons per week. This equates to a 5-year savings of 457,376 gallons. Emissions reduction estimates are based on the reduction of NO_x, VOC, and CO_2 emissions. The anticipated emissions reductions are 0.04 (NO_x), 0.05 (VOC), and 26.05 (CO_2) metric tons per week. This equates to a 5-year reduction of 4,079 metric tons. The total anticipated crash reduction is calculated by taking the total number of crashes across the city and multiplying it by the ratio of intersections in the study area to the total number of intersections in the city. This yields an estimate of 56 crashes reduced over the 5-year period. A full breakdown of the benefit-cost analysis can be found in the **Appendix**. The total cost of the signal retiming project was $158,955. This results in a benefit-cost ratio of nearly 62:1 over a five-year period.

8. RECOMMENDATIONS

8.1. SAFETY OBSERVATIONS AND RECOMMENDATIONS

The project sought to maintain a focus on safety throughout the process. Observations and recommendations regarding safety were made during the data collection and signal timing implementation stages. The City will continue to monitor crash patterns at study intersections to identify changes that may have resulted from the project. This is especially true for locations where lead / lag left-turn operations were implemented. Individual intersection observations and recommendations are listed below:

98th St & California St (WB Dodge Ramps)

- View of signal for NBL obstructed by tree. Approximately 100 feet from visual of signal to stop bar. Recommend removal of the tree or installation of additional signal head.
    - Recommendation implemented as part of this project.

102nd St & California St (Westroads Ent #2)

- SBR limited sight distance of WB traffic for right-turn on red. Approximately 150 feet of sight distance. Recommend removal of AM flash and night flash.
    - Recommendation implemented as part of this project.

144th St & W Dodge Rd

- Conflicting turning movements. Recommend placing “No U Turn” signs on NB and SB approaches.
    - U-turns during protected green arrow for NBL conflicts with protected green arrow for EBR.
        - Recommendation implemented as part of this project.
    - U-turns during protected green arrow for SBL conflicts with protected green arrow for WBR.
        - Recommendation implemented as part of this project.

Oakview Dr & 141st Plz

- SBR limited sight distance of WB traffic for right-turn on red. Approximately 150 feet of sight distance. Recommend removal of night flash.
    - Recommendation implemented as part of this project.

APPENDIX

Copies of items listed in the **Appendix** have been provided digitally.